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Dislocations of the Brain: Subjectivity and Cerebral Topology from Descartes to Nineteenth-Century Neuroscience

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Dislocations of the Brain: Subjectivity and Cerebral Topology from Descartes to Nineteenth-Century Neuroscience

By

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Abstract

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In my dissertation, I examine the historical development from the seventeenth to the nineteenth century of the notion of the neural subject, or the scientific and philosophical identification of subjectivity with the states and processes of the brain alone. I do so by focusing specifically on the brain itself, by looking at the ways the concept of the brain has been thought to situate different and historically changing conceptions of subjectivity. Instead of regarding the brain as an anatomical organ whose biology naturally gives way to mental and affective properties, I approach the brain more broadly as a conceptual and formal site that, in one way or another, historically encapsulated scientific and philosophical formulations of the human subject. In this sense, I examine the concept of the brain in terms of the ways in which it has been topologized, or abstractly spatialized as the location of the subject, often according to complex, even paradoxical relations of proximity, envelopment, and interiority/exteriority that belied, to a degree, strictly physical or physiological descriptions of brain matter.

Modern formulations of the brain and the nervous system have relied upon complex and abstract spatial schematizations in order to define the intricate operations and objectives of neurophysiology. These often implicit topologies indexed not only the brain's biological complexity, but its conceptual overextension as a space that had to circumscribe and embody numerous anatomical and conceptual possibilities and even divergent ontologies. Even the most concrete formulations of the space of the brain as a localizable topography, or map, of biological structures with corresponding psychological functions often hid more complex topological configurations which could not in themselves be expressed in coherent or tangible material terms. The brain not only encapsulated the conditions of subjectivity, but it defined the contours of the most intricate physical, cognitive, social, and even ethical convergences. In this way, more than resolving the question of how the brain could localize the cognitive and affective dimensions of the subject, this dissertation shows how the brain actually demarcated the very problem of spatializing the subject in any way other than according to the most complex topological formulations — that the brain was itself only ever a formal problem of space.

In the dissertation, I closely examine three different historical conceptions of the brain as an abstract space of subjectivity. In each, the brain assumed a complex topological formation that encapsulated a number of different anatomical, organizational and even ontological conditions. I first look at René Descartes' formative neuroanatomy and specifically his controversial doctrine

of the pineal gland. The pineal gland constituted the space that could properly stage the ontological conjoining of body and soul into a distinctly human subject. The gland was no ordinary anatomical region, but had to take on an ontologically transitive and ecstatic dimensionality, a topological configuration that could not entirely cohere with a Cartesian conception of matter. The second conception I examine was prevalent from the end of the seventeenth century to the early-to-mid eighteenth century. During this period, the brain underwent a kind of conceptual retreat and was defined either directly according to a relatively diffuse definition of living matter, or indirectly through an increased emphasis on the pervasive functionality of the nervous system. The brain was conceptually and materially dispersed, and this dispersion was embodied in the concept of the *sensorium commune*, or the abstract space of organizational unity. Many notable neurophysiologists, including Albrecht von Haller and Robert Whytt imagined that the brain materially unified and substantiated the theoretical unity of the subject by constituting the space not only in which sensory perceptions were unified, but where the vital, mental and even social properties of the subject were all brought together and "rendered common," so to speak. In the final chapter, I examine how, throughout the early-to-late nineteenth century, the nervous system was abstractly spatialized as a hierarchy of vertical levels of neurological organization and complexity. The vertical spatialization of the nervous system was described by a variety of biologists, neurologists and philosophers during the period, including Franz Gall, Herbert Spencer, and John Hughlings Jackson. But this vertical paradigm actually concealed a more challenging micro-topological problem within the spaces that separated one level from another. These abstract, though relatively buried spaces at the lowest levels of the nervous system demarcated a fundamental material complexity, where physical abstractions implicitly led to the most incipient psychical emergences.

The episodes I outline mark a trajectory representing a gradual change in the notion of neurobiological matter, a change defined as a move towards a state of greater abstraction. The materiality of the brain and nervous system, particularly by the end of the nineteenth century, began to acquire extra-material or non-corporeal properties and slowly embodied a physicality that could be defined only in more and more abstract, topological terms. I end the dissertation by showing how these new conceptions of neurobiological matter did not necessarily constitute an impasse for neuroscience but were incorporated into new theorizations of the brain itself.

Prologue

THE SPACES OF NEUROPROSTHESIS

> The cortex cannot be adequately represented in a Euclidean way… We should say: the conversion of Euclidean space into topological space.
>
> —Gilbert Simondon, *L'individu et sa genèse physico-biologique*[1]

In 2005, the science of the interface between brains and machines made a dramatic leap into the public spotlight. The idea of interfacing, indeed blurring the line between our brains, biologies, and computing machines has loomed in the cultural background for much of the twentieth and now twenty-first century. By early 2005, reports and articles had emerged describing how Massachusetts based Cyberkinetcs developed a computer-brain interface (CBI), trademarked BrainGate, which, by direct implantation into the motor cortex of a young quadriplegic named Matthew Nagle who died only two years later, would enable him to animate and control a number of objects, including a computer cursor and a mechanized prosthetic hand.[2]

The story of this neuroprosthetic technology made headlines. There was something wondrous not only in the story itself, but particularly in the accompanying video and photographic images of a man, bound to an electric wheelchair with hardware protruding from the top of his head, controlling a number of artifacts in the world around him. The artifacts were themselves noteworthy in the culturally embedded associations and science fiction overtones they evinced: the mechanized prosthetic hand evoked the image of re-inhabited new mechanical bodies and even new selves given the popularity of brain enhancement technologies. While the scene of the unmediated manipulation of the cursor stirred up the prospect, however improbable, of direct encounters with computational-digital phenomena — the disquieting reverie of inhabiting the techno-computer itself.

And yet there was, in essence, nothing particularly novel about this development, from a technical standpoint. The science involved in interfacing with the motor cortex was not substantially different from the sensory neuroprostheses that had already been put into experimental use, including cochlear and retinal implants.[3] And Matthew Nagle was certainly not the first person to have undergone direct brain interface experimentation. In fact CBI research itself has been around for some time and is already undergoing its expected militarization.[4] To be sure, prosthetic dependency, even when generally defined as tool use, has been one of the ways people have narrated the origins of their anthropological differentiation from nature for some time, from Jean-Jacques Rousseau's 1754 *Discourse on the Origins of Inequality Among Men* to

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[1] Gilbert Simondon, *L'individu et sa genèse physico-biologique : l'individuation à la lumière des notions de forme et d'information* (Paris : Presses Universitaires de France, 1964), 262. Emphasis added.

[2] Leigh R. Hochberg et al., "Neuronal ensemble control of prosthetic devices by a human with tetraplegia," *Nature* 442 (July 13, 2006): 164-171. For the earlier report of the successful implementation of motor neuroprosthetic devices with monkeys, see Mijail D. Serruya et al., "Instant neural control of a movement signal," *Nature* 416 (March 14, 2002): 141-42. Vicki Brower, "When Mind Meets Machine," *EMBO reports* 6, no. 2 (2005): 108-110. Matthew Nagle died in 2007.

[3] On cochlear prosthetic implants, see David R. Moore and Robert V. Shannon, "Beyond cochlear implants: awakening the deafened brain," *Nature Neuroscience* 12, no. 6 (June 2009): 686-691.

[4] Brower, "When Mind Meets Machine."

contemporary accounts of tool use among humans as the significant factor in their ability to reason about the spatio-physical properties and causal relationships of objects.[5]

So why did the story, indeed the image of this neuroprosthetic event induce the sort of astonishment it did — enough at least to garner the mystical aura of a mind-reading technology?[6] In all its technical explicability, the event bore the formal characteristics of a relatively supernatural act: the movement and manipulation of objects using only "the power of thought."[7] Moreover, the event not only enacted, but in many ways reoriented our understanding of the literal meaning of "prosthesis": a substitution, extension or protraction of an organic body by artificial means yet in such a way that does not detract from the body's organic totality, but in fact reinforces and sustains it.[8] We saw a paralyzed man literally protracted beyond the limits of a body which he could no longer move and reestablish that lost motility in the guise of other objects — quite literally in/as other bodies — using nothing more than his mind. Well, to be fair, he was using his brain.

Indeed, what about the brain? What can be said of the "neuro-" in neuroprosthesis as the basis for such a seemingly marvelous and uncanny possibility? It's important to consider the fact that the brain was functioning no differently than it always had. This is, in fact, why BrainGate developer and Cyberkinetics director John Donoghue insists on the importance of direct (i.e., invasive) brain interfacing: attaching a sensor to the brain bypasses the need to train patients how to use the prostheses. The technology simply relies on the way the brain normally produces motor signals, and the patient need only explicitly think the motion. In fact, contemporary CBI research is even trying to bypass the substratum of intentional thought itself, in an attempt to harness and transpose non-conscious, embodied behavior such that a paralyzed patient could maneuver a mechanical limb, say, or a computer cursor as immediately, recognizably, and distinctively as the patient would her own body.

It's possible to say that while the novelty of neuroprosthetic technology lies in the technicalities involved in transposing brain activity into computational and mechanical commands, its wondrous and somewhat uncanny spectacle seems to arise from the fact that the ordinary functioning of the brain yields a relatively extraordinary result: on the basis of his brain's processes, Mr. Nagle's intentions were able to inhabit and animate a mechanical hand; his brain allowed him to appropriate it and, in a sense, to be re-embodied within it, albeit to a limited degree.

The news stories and reports do not venture this far, but such a strong assessment of the phenomenological effect of being neuroprosthetically re-instantiated outside one's body is not necessarily unwarranted, at least from a scientific standpoint:

> Previous findings indicated that when monkeys learn to use a tool, it becomes incorporated into their own internal body image. Patients who use neuroprosthetic devices for any period of time may come to regard them as natural extensions of their own body, because they can control them efficiently and relatively effortlessly through their own thought processes.[9]

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[5] Scott H. Johnson-Frey, "What's so Special about Human Tool Use?" *Neuron* 39 (July 2003): 201-204.
[6] The BBC headline from March 31, 2005 read "Brain Chip Reads Man's Thoughts," and the story began: "A paralysed man in the US has become the first person to benefit from a brain chip that reads his mind." http://news.bbc.co.uk/2/hi/health/4396387.stm
[7] Ian Sample, "Meet the Mind Readers," *The Guardian* (March 31, 2005).
[8] The term "prosthesis," from its original Greek *pros-tithenai* means to place or put in addition to or at the start of something.
[9] John F. Kalaska, "Brain control of a helping hand," *Nature* 453 (June 2008): 994.

The idea of a neuroprosthesis generally, when pushed slightly beyond the BrainGate example, introduces a number of important questions, not the least of which is the phenomenological question — that is, the status of our subjectivities or our ideas of our bodies and selves when we take into account the important fact that prostheses and tools, "by enabling us to extend our reaching space, can become incorporated into a plastic neural representation of our body." [10] In other words, our ideas of our bodies and our selves can be *substantially* augmented; and, perhaps more importantly, this augmentation, however mechanical or techno-computational it might be, nevertheless finds a *natural place* in the brain.[11]

This leads me to the question of the status of the brain itself. It is a question that motivates this entire analysis, and which would not at first appear to deserve much inquiry or attention at all, since, as I mentioned, nothing new or different is happening from the point of view of the brain's processes when it is "prosthesized" so to speak. But this is exactly the point. Because if we take the idea of neuroprosthesis a little further, perhaps closer to its very limits as an idea, the curious possibility emerges that by means of my brain and, no doubt, the neuroprosthesis that has been attached to it, I am able to occupy a space well beyond what had heretofore been the site where I thought "I" was located. But as I indicated, the motor neuroprosthesis does nothing essentially different than what our bodies had done before; it does so, in fact, with far less sensitivity, efficiency, and precision. What seems to be most peculiar is that it is precisely the brain, on the basis of a set of processes it had always performed and by virtue of being technologically harnessed, that allows me to be both in my own head as well as in another('s) body.

The BrainGate story, I would like to suggest, is not wondrous in what it achieves (although this is, no doubt noteworthy), but in what it only just reveals. And that it reveals something — something perhaps counterintuitive — about the brain, an object that we may have believed has been long secured and historically entrenched in a number of ways: as a scientific object, a modern philosophical assumption, a socio-cultural figure, and even an ethical-political metric, given the emerging discourses of "neuroethics" and the hypothesized utilization of brain imaging technologies in juridical and criminological contexts. The story, indeed the tenability of neuroprosthesis as a general idea, reveals that the brain has somehow always been the condition by which I could have been extended beyond myself, that I could be located in spaces — robotic hands, computer cursors, and so on — that well exceed me.

And yet, it has become a commonly held and nearly unshakable belief that the brain is where the subject is located in the first instance. The history of the science and knowledge of the brain has long reinforced the givenness of this belief through the continued demonstration of the localizability of mental and psychological capabilities — including language, perception, motor processes, reasoning, and certain socio-emotional dispositions — within centers of specialized cells or even distributed pathways throughout the brain. This scientific examination historically referred to as the doctrine of cerebral localization gained prominence in the latter half of the

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[10] Angelo Maravita and Atsushi Iriki, "Tools for the body (schema)," *Trends in Cognitive Sciences* 8, no. 2 (February 2004): 85. Jens Clausen writes, "Melding brain and machine makes the latter an integral part of the individual. This could be seen to challenge our notions of personhood and moral agency." See Jens Clausen, "Man, machine, and in between," *Nature* 457, no. 26 (February 2009): 1080.

[11] Andrew Clarke and David Chalmers have proposed that in solving a problem or carrying out any kind of epistemic act, there is no essential difference between carrying out that act through the internal processing of the brain versus an actively externalist processing that would rely on physical techniques, practices, and the general machinery of the environment. In a sense, they propose that the mind is itself prosthesized into and as the environment and that the brain can ground, or merely facilitate such a protraction. See "The Extended Mind," *Analysis* 58, no. 1 (1998): 7-19.

nineteenth century, and by the mid-twentieth century it had acquired the status of a modest physiological assumption.[12] Little more was often necessary to confirm even the minimal veracity of this doctrine than the demonstration that injury to the brain would affect the quality and processes of mind and subjectivity quite differently than would injury to any other organ or nervous center in the body.

Of course, the theory of strict localization was scientifically challenged from the start, even though the neurosciences today remain for the most part committed to the assumption that the brain is where experiences, consciousness, and subjectivity happen. In fact, recent literature in diverse fields including history, anthropology, and both continental and analytical philosophy has sought either to understand the pre-conditions for and the implications of, or to question altogether, the rigorous identification of the self with the brain, an identification that considers the brain as the absolute basis, power, and demarcation of subjectivity and typically disregards other varieties of subjective experience, the integral role played by bodies, alternative modes of embodiment, or the "external" (contextual, social, political, historical, etc.) factors in constituting a sense of self.[13]

Nevertheless, even if we abandon the strict identification of the subject with the subject's brain — the idea that the brain is the sole source and cause of the subject — we still find ourselves bound to the dominant scientific, philosophical, and anthropological idea that the brain at least to some extent ensures the localization of the self; that the brain, in other words, *situates* or *positions* the self within (or as) a body, for example, or within a milieu (even the popular neurobiologist Antonio Damasio confirms this point when he writes, "Due to the mediation of the brain, the mind is grounded in the body-proper"[14]). Or otherwise put, the qualitative nature of experience tends to have a relationship with the brain that, if not foundational, original or causal, is at least *spatial* in some measure — that I am situated or positioned in, by, or through the brain.

When these competing conceptions are brought together, we are forced to accept a premise that the brain both situates the self while also locating it, or being able to locate it, elsewhere, in locations that may well exceed the brain altogether.[15] Neuroprosthesis, in other words, acts as a kind of paradigm, one that when observed closely introduces a peculiar formulation which may be subtending, perhaps subverting some basic assumptions and rationalizations of contemporary neuroscience: that I am situated in and by my brain by which I inhabit other spaces. This formulation is no doubt anomalous, but it is one that I suggest is not only relevant today, but underlies in important ways the historical development of the knowledge of the brain.

In order to understand the full effect of this formulation, I posit that it is necessary to take on a new analytical approach to the brain, one which neither presumes its natural givenness nor

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[12] The literature on the history of cerebral localization is vast. See Walther Riese and Ebbe C. Hoff, "A History of the Doctrine of Cerebral Localization: Sources, Anticipations, and Basic Reasoning," *Journal of the History of Medicine* (Winter 1950): 50-71; Michael Hagner, "Aspects of Brain Localization in Late XIXth Century Germany," in *Essays in the History of the Physiological Sciences,* ed. Claude Debru, Clio Medica 33 (Amsterdam: Rodopi B.V., 1995); Anne Harrington, *Medicine, Mind, and the Double Brain* (Princeton, 1987); Robert Young, *Mind, Brain, and Adaptation in the Nineteenth Century* (Oxford: Clarendon Press, 1970); and Edwin Clarke and L.S. Jacyna, *Nineteenth-Century Origins of Neuroscientific Concepts* (Berkeley: University of California Press, 1987), chapter 5.

[13] Historian Fernando Vidal has coined the expression "cerebral subject," to describe the historical inevitability of the cerebralization of the notion of modern self. See his article, "Brainhood, Anthropological Figure of Modernity," *History of the Human Sciences* 22, no. 1 (2009): 5-36. See also Alva Noë, *Out of Our Heads: Why You Are Not Your Brain, and Other Lessons from the Biology of Consciousness* (New York: Hill and Wang, 2009).

[14] Antonio Damasio, *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain* (New York: Harcourt, 2003), 191.

[15] This is, indeed, the premise underlying Noë's *Out of Our Heads,* which argues that consciousness and the entire field of subjectivity is only localizable in the complex dynamic relationship that makes up a subject's relation to her/his body and environment, a dynamic for which the brain is only a single, albeit integral, component.

which dismisses its actuality or the science of the brain in any measure. I ask, what is at the heart of the formulation, that I am situated in and by my brain by which I inhabit other spaces? How is the brain being framed by this postulation? The operative premise is not, as it might seem, the continuing question of subjectivity, nor indeed the mysterious functionality of the brain. It is, simply put, the issue of *space* which is in question: the space of the brain — the brain not as a mere physical mass, but as a *locale*, a place *in* and *through* which I am situated, and *from* which I am located elsewhere.

What this amounts to is abandoning for a moment a common standpoint which treats the brain as an organ, an object of scientific study, a framework of interrelated biological, chemical, or psychological concepts, a social figure or metric; and adopting an alternative analytical standpoint which understands the brain simply as a complex and even troubled anatomical, organizational, and ontological *topology*. A topological analysis means understanding the brain as an abstract and formal arrangement or configuration of situated orders (e.g., intellectual, affective, perceptual, vital, social, etc.) and ontologies — an understanding of the various ways in which the brain is, and has been, theoretically *spatialized,* even if some of those spatializations are knotty, convoluted, or inconsistent. But what does it mean to spatialize the brain — after all, isn't the space of the brain comprised of nothing more than approximately three pounds of neurobiology? Well, to provide an example, one of the most prevalent topological or spatializing paradigms in neuroscience has been the familiar topo*graphical* model — the localization paradigm, in other words — which refers to the brain as a mappable biological terrain of mental and affective states. Any concrete topo*graphy* of the brain embeds deeper topological complexities. In the localization paradigm, which I discuss more in the following chapter, the brain not only localizes cognitive processes and affective states, but it is the space which situates a subject, or the abstract locale that stages the equivalence between demarcated biological processes and regions and the dimensions of subjectivity. Unfortunately, the topographic paradigm has also been the spatial conception that historically lent itself to craniometric pursuits such as the formulation of the cephalic index or the general evaluation of brain size, and other related discourses that sought to produce intellectual as well as social and even racial stratifications on the basis of measurable biological — in this case neurological — markers.[16]

The topographic topology, however, may be quite insufficient in accounting for certain overflows in the brain's complex ontology — a point I have attempted to make through the paradigm of neuroprosthesis. Is it possible to map or localize the brain's radically "prosthesizing" capacities? If the brain is not only neurobiological matter, but also a place in and through which I am situated, and from which I am located elsewhere, then what sort of topology or spatialization is at work here? In some respects, the conceit which underlies the science and technology of neuroprosthesis is that the problem of mind-body has been resolved technologically; that the sheer success of the BrainGate technology in enabling Mr. Nagle to reestablish a certain kind of motility indexes what might be taken as the surprising simplicity of mind-brain/mind-body problem. The conceit imagines that all that was needed was a more precise and invasive techno-materialism in order to resolve the *philosophical* quandary of mind-

[16] The cephalic index is the ration of the brain's dimensional height to width as a measure of human intelligence particular in the context of the comparative assessments of race. See John Carson, *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750-1940* (Princeton: Princeton University Press, 2007), chapter 3. For a general survey of historical literature tying racial categorization to biological markers in America during the nineteenth and twentieth centuries, see *The Nature of Difference: Sciences of Race in the United States from Jefferson to Genomics,* ed. Evelynn M. Hammonds and Rebecca M. Herzig (Cambridge, MA: MIT Press, 2009). For the role of brain science and formulations of brain size in cementing racial divisions and stratifications, see Stephen J. Gould, *The Mismeasure of Man* (New York: W.W. Norton & Company, 1996).

body by way of the technological demonstration that mind-body interaction and intermediation could be artificially reproduced. As I tried to explain, however, the supposed simplicity underlying the contemporary science of neuroprosthesis embeds a fundamental problem as to the ontological status of the brain itself — a problem that I believe we can begin to understand and express topologically by viewing the brain as a conceptual place or analytic structure which is not necessarily, or at least not initially, a determinably dimensional area, volume, or mass.

To be clear, however, I am not presenting a *theory* of topology. I use the term only as a substitute for conceptually describing the abstract "space" of the brain, with the understanding that a consideration of a theoretical object's complex spatial attributes (the brain is certainly a theoretical object) can yield a more fruitful analysis of it. The brain has possessed many different topological configurations at many different historical periods, depending on the discourses according to which it has been defined — localization is simply one such topological formation, though perhaps not the most theoretically rigorous or radical. In the larger context of the history and philosophy of science, there have been several notable examples where approaching a scientific object from a more radical topological standpoint has significantly expanded the theoretical dimensions of the object in question.

The term topology was itself made popular in mathematics, where topological spaces referred to theoretical, but not dimensionally confined fields within which a given numerical set could be defined as a spatial property (independent of size and shape) that could undergo fundamental distortions and transformations while nevertheless remaining continuously preserved. It was the French psychoanalyst Jacques Lacan who in the mid-twentieth century took advantage of basic notions of mathematical topology in order to counter Freud's "topographical point of view" of the unconscious.[17] For Lacan, a more abstracted topological view of the psyche prevented or at least troubled facile imaginings of the unconscious, and allowed for the better schematization of the kinds of paradoxical formulations integral to describing the relation of the subject, the analyst, and the psychoanalytic other.[18] Still, Lacan was deploying the theoretical concept of topology to describe an already abstracted set of objects and relations, whereas I am more counterintuitively using topology to describe the brain, a physically instantiated organ and relatively concrete object of science.

A more useful example, then, of the utilization of the notion of topology in the history and philosophy of science might come from the French philosopher of science Gilbert Simondon who, in his 1964 *L'individu et sa genèse physico-biologique,* argued that the living organism did not abide by a spatiality that could measurably or coherently be called geometric or Euclidean. For Simondon, the living organism was instead essentially comprised of "a certain topological arrangement," which while never fully isolatable from its physical and chemical constitution, needed nevertheless to take stock of the spatiality of its "milieux," or abstract localities. The organism's milieux were divided between its homeostatic interiority and the exteriority of its surrounding environment.[19] For Simondon, however, it was necessary to recognize that the organism's interior and exterior milieux were not only interrelated, but also directly linked and, in fact, deeply intermingled. As Simondon explains, "The entire continuity of [the organism's] interior space is topologically in contact with the continuity of exterior space…. There is, in

[17] Sigmund Freud, "The Unconscious," *The Standard Edition of the Complete Psychology Works of Sigmund Freud,* vol. 14, ed. James Strachey, (London: Hogarth, 1957), 172-176.
[18] Jacques Lacan, *The Four Fundamental Concepts of Psychoanalysis,* The Seminar of Jacques Lacan Book XI*,* ed. Jacques-Alain Miller (New York: Norton, 1978).
[19] On the historical and philosophical plurality of this term, see Georges Canguilhem, "The Living and its Milieu," in *Knowledge of Life,* trans. Stefanos Geroulanos and Daniela Ginsburg (New York: Fordham University Press, 2008), 98-120.

effect, no distance in topology; the entire mass of living matter in the interior space is actively present in the exterior world."[20] There were, Simondon insisted, organs and systems "inside" the organism that were actually topologically exterior to the organism, and vice versa.

By insisting that the concrete, physical organism could be understood topologically, even if such an understanding led to counterintuitive formulations, Simondon was asserting that geometric or physically mechanistic accounts of the organism's spatial configuration were inadequate and that they occluded significant ontological details about the nature and sustainability of living organization. A more topologically oriented analysis, on the other hand, could describe spatial entanglements that more successfully represented the empirical workings and ontological makeup of a living being.[21] The topological analysis applied equally to the study of the brain. The brain was constituted by spatial configurations that had to be understood in more abstracted spatial terms. By adopting aspects of Simondon's topological standpoint — without, however, assuming his theoretical commitments to the philosophy of the living organism — we can begin to consider what sorts of the things the brain is asked in a very general sense to encompass, to contain, or to situate. A "cerebral topology," therefore, assumes that the brain is always the articulation of some kind of complex and formal spatialization which can, as Simondon suggests, be discordantly or even paradoxically configured.

The topological analysis of the brain means reorienting the philosophical and theoretical perspective on the brain by shifting the question of the brain from what or how, to where. We say of the brain, for example, that it is where neurons are generated, aggregated, and interrelated; it is where abstracted networks of neurons, neuronal-clusters, and even sub-cellular molecular components are organized and reorganized into complex, systematic self-organizing relations and proto-representational patterns; it is where the developmental dependency on sensory stimuli — or the very reliance on the environment and world — is demanded, managed, and incorporated. It is also where "I" usually find my place.

By reconsidering the brain simply from the analytical point of view of its topology, that is to say, to conceive of it only as a formal and theoretical spatiality, we can see that it gives space to — that it locates or situates — a number of competing levels, orders, and ontologies, which are certainly formal topologies in and of themselves, and which can be mutually incommensurable, or "explanatorily gapped" as it has been described in the philosophy of mind.[22] In other words, the brain is the site that must often co-locate ontologically varied structures and arrangements — entire frameworks including subjectivity — in such a way as to call for the critical question: what sort of capaciousness does the brain possess in order to give space to such discrepant material, organizational, and ontological orders? Indeed, it is this critical standpoint of the space of the brain that finally enables us to probe or at least express the paradoxical as well as the potentially productive nature of these incommensurable, even antinomic, relations that constitute and are circumscribed by the brain.

This question is all the more complicated by the fact that the brain is not only where "I" find my place, but as the neuroprosthesis paradigm has demonstrated, it is also where I am able to be located elsewhere; it is both the where and the whence of my displacement from myself. And this idea of being displaced or dislocated from oneself into and as other objects and bodies

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[20] Simondon, *L'individu,* 263.

[21] Historian and philosopher of science, Georges Canguilhem held a similar position when he wrote, "in order to understand living things one needs a non-metric theory of space, a science of order, a topology." *A Vital Rationalist,* Francois Delaporte, ed. (New York: Zone Books, 2000), 317.

[22] The term was introduced by Joseph Levine in "Materialism and Qualia: The Explanatory Gap," *Pacific Philosophical Quarterly* 64 (1983): 354-361. See also David J. Chalmers, *The Conscious Mind: In Search of a Fundamental Theory* (Oxford: Oxford University Press, 1996), chapters 2-3.

is not restricted to the example of neuroprosthesis alone. We can imagine the various ways in which the brain situates a kind of self-removal from the self — that is, the self's own self-"othering" — whether in the form of the self-transformations resulting from neurochemical augmentations or brain injury, or as the phantasmogenesis of severed limbs and other intra-corporeal sensory entanglements. The question of the relationship between self and brain, as well as the relationship between the brain and the alterity of the self, however it may be presented, augmented, conditioned, or critiqued, has always been in some measure an abstractly spatial or topological predicament.

This dissertation charts three significant historical, scientific, and philosophical spatializations of the brain from the seventeenth to nineteenth centuries, emphasizing in particular the relatively radical nature of some of those topological formulations — that the brain and the nervous system more generally, in other words, have spatialized and capaciously co-located ontologies, organizational relations, and levels in ways that no physical location or conceptual arrangement on its own could ever have. What emerges throughout the dissertation is the general idea that the very *matter* of the brain, in both senses, is more of a formal problem than, say, a scientific mystery or philosophical conundrum. And it reveals this while bypassing the sticky and perennial impasses that continue to pervade, even implicitly, the study of the brain, including the standoffs of the mind/body debates, the question of the logical origins of consciousness, or the need to differentiate the techno-computational machine from the animal or human — all of which could easily have been the directions taken in an analysis of neuroprosthesis, but none of which would have been able rigorously to assess the brain's ontological indeterminacies, excesses, and overflows.

The dissertation presents a meta-study of the brain not only as a historical and scientific object, but as a conceptual entity that has philosophically and discursively encompassed or acted as nothing but the site of a problem of spatialization itself, in terms of negotiating the relationship between cerebral terrain and the complex dimensions of cognitive, affective, social (etc.) subjects. The history of the knowledge of the brain, I will argue, has been in many ways the history of a problem of space and locality, and the excesses, protractions, and dislocations therein. The topological problem, as I will show, is what most informs the constitution of the very matter of the brain. And to say that the brain encompasses a formal, historical-conceptual problem of this magnitude is to say that the brain is topologically over-extended, as it were — stretched to its limits as a concept, overloaded as an object. To say all this is essentially to say that the brain is an entity whose ontology has not yet been fully settled. But to accept such a claim requires temporarily suspending our willingness to view the brain as natural or self-evident, without, however, renouncing it as a real object.

As a meta-study that takes the brain to be a scientifically and historically variable and philosophically expansive concept, this project is itself somewhat disciplinarily interstitial, weaving intellectual-historical investigations with philosophical reconsiderations and discursive analyses. In the next chapter, for example, I outline what is at stake in adopting the standpoint of analyzing the brain as a problem of its abstract spatiality — what such a standpoint reveals, what it resolves, and to what new questions or problems it leads, with an eye not only to contemporary neuroscience, but to the many philosophical, social, and ethical challenges the neurosciences pose for us today. In order to do this, I examine more closely the question of whether and how successfully the brain can be said to localize or situate the human subject, and I do so through a set of contemporary writings on the brain and brain science from a variety of fields, including philosophy, history, anthropology and sociology. I also present a critical historical and theoretical reconsideration of what has heretofore been the most salient spatial paradigm in neuroscience used to understand the cerebral demarcation of the subject — that is, the doctrine of localization. If the brain has always been a *problem* of space, it is vital to keep in mind the possibility that this is not something that must, nor perhaps can be resolved in a strict sense; for now, I set the more modest goal of simply articulating the problem, theoretically and historically.

In Chapter Two, I reconsider René Descartes' controversial neuroanatomy and his theory of the pineal gland. Descartes believed that the pineal gland, located at the center of the brain, was the site of both the commensurability of the soul and body, as well as the assurance of the radical ontological difference between them. Thus an extraordinary capaciousness was necessary in order for this "little gland" to constitute the site of an encounter too expansive to be satisfied by a mental or material entity alone. I show how Descartes accounts for such a capaciousness, and in what ways he employs implicit topological formulations of the brain and pineal gland that fundamentally complicate his theory of philosophical-physiological matter.

Chapter Three examines how the brain was imagined as the *sensorium commune,* or "common sensory," specifically in the context of mid-eighteenth-century neuroscience. The *sensorium commune* was a topology that allowed the brain to acquire the status of the space of organizational unity. It was, in other words, the space not only where sensory perceptions were unified, but indeed where the vital, mental and, in some cases, the social capacities of the subject were all brought together and "rendered common," so to speak, thereby materially substantiated the theoretical unity of subjectivity during the period. I examine the work of several notable physiologists, anatomist, and philosophers, including Albrecht von Haller, Robert Whytt, Emanuel Swedenborg, James Johnston, and Jerome Gaub in order to suggest the ways in which the brain's topology of organizational unity yielded some fundamental aporias concerning the nature of neuro-cerebral materiality.

Together these first two chapters demonstrate how certain dominant neuro-cerebral topologies have resulted in the material aporias of the brain and nervous system. The final chapter examines a dominant topological schema throughout the nineteenth century in which the nervous system was understood as a vertical and hierarchical structure of continuous and interrelated levels of nervous organization and complexity. Here, too, I examine several notable scientists and philosophers during several periods of the century, including Franz Gall, Herbert Spencer, John Hughlings Jackson, Hermann Lotze, and even Charles Darwin. I argue in this chapter that the biological matter of the brain acquired something of an indeterminate physical status, and actually came to rely implicitly on topological formulations of its material space. This last chapter shows how physiological accounts of the brain explicitly assume and literally incorporate or embody topological premises in order to add enormous conceptual complexity to physical states of cerebral matter.

Chapter One

CEREBRAL TOPOLOGIES AND DISLOCATIONS: LOCATING THE SUBJECT IN THE SPACES OF THE BRAIN

Introduction

One of the most important topological challenges to the study of the brain has been the question of how to situate the subject and the mental and affective dimensions of subjectivity. In this chapter I will present some contemporary elaborations and reconsiderations of what it means to circumscribe the subject and self according to the material and physiological constraints of the brain alone. I then transition to an historical analysis of the development of the nineteenth-century doctrine of cerebral localization, the conceptual paradigm according to which the brain was categorically spatialized as the site and locale for the subject and self. In that section, I reconsider through an extended example important topological formulations in the writings of three notable anatomist and physiologists from the nineteenth and early-twentieth century. I do so in order to demonstrate, from the outset of the dissertation, how a more rigorous and meticulous topological analysis can introduce new ways of thinking about the space of the brain, and the subject's localizability therein. Since this chapter is meant to be introductory in nature, as a means of setting up some overarching conceptual questions on which the following chapters will more precisely elaborate, it will end with a brief consideration of the relationship between cerebral topology and cerebral materiality. An extended analysis of the historical and theoretical spatializations or topologies of the brain, I will suggest, can potentially redefine the very materiality of the brain and nervous system.

The Problem of the Space of the Brain: Situating the Subject

When discussing the broad relationship between modern formulations of the subject or self and the brain, it is important to keep in mind that the general theoretical concept of the subject did not frequently receive independent elaboration within the narrow context of historical neurophysiology. Most seventeenth- and eighteenth-century natural philosophers of the brain and nervous system, and later nineteenth century neurophysiologists often bypassed any serious and independent examination of how a subject should be epistemologically or ontologically defined. The notion of the subject, and the later related notion of the self, was negotiated, particularly in the eighteenth and nineteenth centuries, more often, at the intersections of philosophical, psychological, and political discourses.[1] Indeed, more general accounts of a particularly Western conception of a subject and self have been narrated in terms of the moral, social, and epistemological formulations of self-identity, interiority, agency, and self-possession.[2] In some ways, a fair amount of modern neuroscience has assigned the brain the task of *accommodating*

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[1] For a recent example of the historical development of a psychological self, articulated through local conceptions of political power, see Jan Goldstein, *The Post-Revolutionary Self: Politics and Psyche in France, 1750-1850* (Cambridge, MA: Harvard University Press, 2005). While Goldstein comparatively invokes and relies on Michel Foucault it should be recognized that Goldstein's utilization of Foucault's sense of "power" is not necessarily identical to his own formulations. See Michel Foucault, "*Omnes et Singulatim:* Toward a Critique of Political Reason," and "The Subject and Power," in *Essential Works of Foucault, 1954-1984,* ed. James D. Faubion, vol. 3(New York: New Press, 2000), 298-348.

[2] Charles Taylor, *Source of the Self: The Making of Modern Identity* (Cambridge, MA: Harvard University Press, 1989). C.B. Macpherson, *The Political Theory of Possessive Individualism: Hobbes to Locke* (Oxford: Clarendon Press, 1962).

externally defined conceptions of self, subject, and subjectivity, rather than assigning it the task of determining those conceptions anew.

This is perhaps most true today insofar as a large proportion of contemporary neuroscience has identified for itself as a "a major goal … to understand cognitive functions in terms of their underlying neural circuitry — to link the mental level of description used in cognitive science with the physiological and anatomical levels that are the province of neurobiology."[3] In other words, for the contemporary neurosciences, the subject, defined most regularly — or most easily and quantifiably — as a function of cognition, is located somewhere within or as the brain, according to some manner of materialization or material organization. The psychological and cognitive sciences have long internalized this basic assumption, and a psychological education is today neurobiological to a fair degree. But as I discuss these notions of self, subject, and subjectivity my concern is not with the concepts themselves, but it is instead with the brain, in terms of how these notions are, in one way or another, expressed in relation to it, and what the localization or situation of the subject in and as the brain does to the brain itself.

One discourse that has spent several decades attempting to adjudicate how a human subject could be situated vis-à-vis the brain has been the North Atlantic philosophy of mind and science. But even the philosophical considerations that have emerged in that context have been for the most part unable to avoid adopting, with varying degrees of engagement and critical reflection, this cross-disciplinary point of convergence which rests upon the absolute identification of subjectivity with the brain. A very brief cross-section of some philosophical approaches, particularly in the Anglo-American philosophy of mind and brain, reveals that it is only the formality, the particular nature, of that identification which differs from one position to another, but rarely does the basic assumption in the strict philosophy of mind ever receive interrogation. But what is most significant about some of these positions, in terms of my own analysis, is precisely what some of these thinkers have implicitly done to, or what they have made of the brain, in terms of the ways in which the brain has been implicitly spatialized as the site of the subject.

For instance, by arguing that mental processes are caused by brain processes or, in other words, that essentially "brains cause minds," John Searle has posited the brain as the space where anatomy *causes* something that is, to a degree, extra-anatomical — that either a peculiar kind of anatomy or else causality is at play within the confines, the space, of the brain.[4] Ned Block on the other hand has proposed the more subtle description of the brain's *constitutive*, not causal, role in mental processes — that the brain necessarily determines experience as "a metaphysically necessary part of a metaphysically sufficient condition."[5] In this way, since for Block, "*nothing outside the brain* is part of … the minimal metaphysical sufficient condition"[6] for experience, then one could argue that whatever is encompassed by and within the brain must consequently adopt the status of metaphysical pre-condition, or what could also be called a categorical ground, but one which paradoxically would *at some point* need to be co-extensive with the brain as a material entity.

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[3] John H. Reynolds, "Mapping the microcircuitry of attention" *Nature Neuroscience* 11 (2008): 861 - 862. See also Paul Smaglik, "Brain Storm," *Nature* 450 (November 1, 2007): 130-131; and Chris I. Baker, "Face to Face with Cortex," *Nature Neuroscience* 11, no. 8 (August 2008): 862-864.

[4] John Searle, *Minds, Brains and Science* (Cambridge, MA: Harvard University Press, 1984), 39. More recently, see John Searle, "Putting Consciousness Back in the Brain: Reply to Bennett and Hacker, *Philosophical Foundations of Neuroscience,*" in *Neuroscience and Philosophy: Brain, Mind, and Language* (New York: Columbia University Press, 2007), 99, 121.

[5] Ned Block, *Consciousness, Function, and Representation: Collected Papers,* vol. 1 (Cambridge, MA: MIT Press, 2007), 348, 366.

[6] Ibid., 367, emphasis added.

Throughout the past three decades some philosophers and cognitive scientists have adopted what has been called a network or "connectionist" approach to the brain. This approach initially arose from the mathematical and computational psychophysiology of the mid-twentieth century and was reinvigorated in the mid-1980s after a two decade lull.[7] In connectionism or network approaches, cognitive phenomena are understood as emerging on the basis of the organizational interconnection of what are called "subsymbolic" processing elements[8] — typically the neuron taken in abstraction. But numerous physical and aggregative levels of the brain can also be seen as organizationally connected and functioning in parallel with one another, from the molecular level to the level of neuronal networks and multi-network systems.[9] Paul Churchland (who along with Patricia Smith Churchland have been connectionism's primary advocates) has argued that the basic features of neural-network models have been able "to reconstruct, in an explanatory way, the salient features" of cognitive activity.[10]

A brief account of the network approach is worth noting, specifically in terms of how it situates the subject. A neural network is a coordinated ensemble of interacting neurons that, through their organization, generate emergent patterns of activity, but not according to hard logical constraints and usually stochastically.[11] For Paul Churchland, such patterns over large-scale neural populations can "represent specific aspects of the external world" such that eventually "the abstract *space* of *possible* representational patterns, across a given neuronal population, slowly acquires … a specific structure … that assigns a family of dramatically preferred family of distinct stimuli at the networks sensory layer."[12] The late cognitive scientist Francisco Varela, along with Evan Thompson and Eleanor Rosch have noted that "because of the system's network constitution, there is a global cooperation that spontaneously emerges when the states of all participating 'neurons' reach a mutually satisfactory state."[13] The fundamental organizability of a network is what allows it to embody patterns and functions: "One can take the entire brain and divide it into subsections…. These subsections are made up of complex networks of cells, but they also relate to each other in a network fashion. As a result the entire system acquires an internal coherence in intricate patterns, even if we cannot say exactly how this occurs."[14]

While this approach has been popularized by neurobiologists like Antonio Damasio,[15] it has a number of antecedents including early twentieth century holistic neurology, mid-century cybernetics and information science (which I will discuss below), and post-War Soviet neuropsychology.[16] Soviet neuropsychologist Aleksandr Luria, for example, decades ago described mental functions as "complex functional systems" that "cannot be localized in narrow

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[7] Margaret A. Boden, *Mind as Machine: A History of Cognitive Science,* vol. 2 (Oxford: Clarendon Pres, 2006), 883-1001.
[8] David E. Rumelhart, "The Architecture of Mind: A Connectionist Approach," and Paul Smolensky, "Connectionist Modeling: Neural Computation/Mental Connections," in *Mind Design II: Philosophy, Psychology, Artificial Intelligence,* ed. John Haugeland (Cambridge, MA: MIT Press, 1997).
[9] Patricia Smith Churchland, *Brain-Wise: Studies in Neurophilosophy* (Cambridge: MA, MIT Press, 2002).
[10] Paul Churchland, *Neurophilosophy at Work* (Cambridge: Cambridge University Press, 2007), 38.
[11] Irwin B. Levitan and Leonard K. Kaczmarek, *The Neuron: Cell and Molecular Biology* (New York: Oxford University Press, 1997), 451.
[12] Paul Churchland, *Neurophilosophy at Work*, 41. Emphasis in original.
[13] Francisco J. Varela, Evan Thompson, and Eleanor Rosch, *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge, MA: MIT Press, 1991), 88.
[14] Ibid., 94.
[15] Antonio Damasio, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (New York: Harcourt Brace, 1999).
[16] For early twentieth century holistic neurology, see Anne Harrington, *Reenchanted Science: Holism in German Culture from Wilhelm II to Hitler* (Princeton: Princeton University Press, 1996).

zones of the cortex or in the isolated cell groups, but must be *organized in systems of concertedly working zones, each of which performs its role in complex functional system,* and which may be located in completely and often far distant areas of the brain."[17]

The particular patterns of activity that arise from the aggregative interaction of networked neurons have been described by Paul Churchland as the brain's multi-dimensional *maps,* what he refers to as "the representational powers of the biological brain."[18] He has described this representational map-making power as "Platonic" because of what the brain ends up mapping: "the abstract categories, invariant profiles, and enduring symmetries that provide the unchanging *background structure* of the world of ephemeral processes," in other words, the "domain[s] of contrasting but interrelated universals."[19] (Churchland's expressly "Platonic" neurobiology is curious, of course, since in *Phaedo,* Socrates warned of the body's contaminating effect on the soul, that only in death could the soul attain pure knowledge, but that in most cases the soul would be too "full of body" to do so once the body has died.[20])

But the real question to ask in the context of emerging patterns and cognitive properties as a consequence of the organized and self-organizing nature of neurons is whether the leap from matter to intelligence has been explained or simply re-positioned. When the brain is understood as organizationally systematic, the benefit is that it can consequently be described as both physical and semi-ideational. The problem of subjectivity would seem to be resolved on the basis of the organized pattern-generating features of neuronal systems. But it is important to ask whether the question of the origins of subjectivity has indeed been resolved, or whether a subtle *petitio principii* of the self hasn't been introduced into the equation. After all, is a cartographic representation, or any legible form, self-interpretative? If not, and if instead the intelligence of a map is predicated not strictly on its legibility but, more importantly, on the possibility of a legible moment, a moment when it could possible be read, then who ultimately reads the brain's Platonic mappings if not a subject that one has assumed all along? The premise of map-*reading* has been silently snuck into the elucidation of map-*making* since a legible structure only determines its general legibility, but on its own it neither explains nor justifies, but only assumes, the presence of a universal *lector,* a reader, that is, a subject. Of course, the connectionist assumption that map-making equals map-reading is necessary since without it, we would be left with an intelligent brain, but with no intelligence of which to speak.

To spatialize the brain as an organizationally cartographic terrain is to ignore a more fundamental and troubling space — in the sense of the gap — which persists between the brain as map-maker and the subject as map-reader. It is this nether region that continues to comprise the problematic space of the brain. When Patricia Churchland about a decade ago plotted the course of neuroscience and connectionism's cartographic future, she stated, "We are going to get the story of how the brain works. It's like Columbus discovering America."[21] One wonders whether today's adventures and discoveries will also be predicated on the kinds of fundamental and brutal misrecognitions that came to pass all those centuries ago. It might instead be more fruitful to consider alternatives to navigating through dark waters in the hopes of casting anchor on that sought after spot of land, that cerebral terrain which we believe will finally constitute the space of absolute commensurability for disparate ontological orders. Why not simply suggest

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[17] A.R. Luria, *The Working Brain: An Introduction to Neuropsychology,* trans. Basil Haigh (New York: Basic Books, 1973), 31. Emphasis in original.
[18] Paul Churchland, *Neurophilosophy at Work,* 234.
[19] Ibid., 233. Emphasis in original.
[20] Plato, *Phaedo* in *Five Dialogues,* trans. G.M.A. Grube (Indianapolis: Hackett, 1981), 122 (83d).
[21] Werner Callebaut, ed., *Taking the Naturalistic Turn or How Real Philosophy of Science Is Done,* (Chicago: University of Chicago Press, 1993), 339.

that the brain encapsulates, or stages, a set of radically *incommensurable differences*; to affirm the potentially antinomic nature of the brain; to suppose that it embodies and is embodied by the gap which we continuously try to fill — not the dry land but the very ocean depths, the "Descartian vortices" that for Herman Melville conjured the image of a "bottomless soul";[22] that the brain may in fact be the very space of incommensurability itself?

Certain recent discourses have gestured faintly in this direction, by posing the question and even unsettling the fixed equivalence between brain and self. These interventions have at least opened up a critical space in which the possibility of the brain's perplexing topology can be considered. Nikolas Rose, for example, has provided sociological accounts of the self as the malleable object of contemporary biomedical technology by discussing the effects of the "somatization" of the self into the brain. For Rose, the brain has become the concrete object that substantiates (in every sense) but also renders legible behaviors in relation not only to a subject's psychology but also to her socio-political possibilities. He describes how this somatization or cerebralization is anchored in part on the popular and palpable (even if not scientifically robust) technological visualization of the brain as the schematic materialization of behaviors, cognitive functions, and emotional traits.[23] The flattening of the subject with the brain into a kind of neurochemical self must be understood as a modern articulation of personhood not only by virtue of contemporary psychiatric and neuropathological discourses, but also by virtue of the industrial and rationalizing force of neuropharmaceutical bio-capital which has turned the self into an object of chemical transformation, intervention, and neo-liberal optimization, thereby imposing new dimensions and challenges to the ethics and normative constraints of the self.

Rose's account of contemporary neurochemical subjectivity is complemented by similar social-anthropological examinations of cerebral subjectivities within larger and more diverse social, discursive and practical contexts in the West. Francisco Ortega and Fernando Vidal examine the numerous ways — psychiatric, commercial, representational, and even aesthetic — in which subjectivity is identified as the very legibility, accessibility, and malleability of cerebral states.[24] Vidal has independently discussed some of the historical and philosophical conditions of the brain-subject equivalence, arguing that the philosophical history of the modern subject, starting with John Locke, has independently tended towards the consubstantiality of subject and brain, or the belief that subjectivity in its abstraction can be readily transposed into multiple states of materiality, and therefore cerebrality.[25] Vidal classifies this tendency as an historical-anthropological ideology, which, rather than emerging *from* neuroscientific research, acted instead as a pre-requisite *for* it. It is this very same ideological and neuroscientifically independent framework that animates the contemporary appeal and even legitimacy of contemporary neuroethical discourse — in other words, whatever can legitimately speak to the socio-ethical and legal consequences and implications of neuroscientific research — even if many of the discourse's conclusions are scientifically thin.

Of course, Vidal implicitly offers alternatives to the presumption that the subject is entirely delimited by the brain. These alternatives are not difficult to imagine: a subject could, for example, be embedded organically within the world, articulated by the phenomenality of her lived and probably normatively configured body, or, no doubt, constituted within the context of

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[22] Herman Melville, *Moby-Dick* (New York: Penguin, 1988), 172-73.
[23] Nikolas Rose, *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century* (Princeton: Princeton University Press, 2007). See chapter 7, "Neurochemical Selves," 187-223.
[24] Francisco Ortega and Fernando Vidal, "Mapping the Cerebral Subject in Contemporary Culture," *Elect. J. Commun. Inf. Innov. Health. Rio de Janeiro* 1, no.2 (July-December, 2007): 255-259.
[25] Fernando Vidal, "Brainhood, anthropological figure of modernity," *History of the Human Science* 22, no. 1 (2009): 5-36.

various historical-political matrices. This is a general point echoed most recently by philosopher Alva Noë who has been arguing that subjectivity, while certainly dependent on the brain, is not biologically circumscribed by it, but is instead constituted by a phenomenological-integrationist relationship with the body and world.[26]

Another reconsideration of the subject's bio-cerebral circumscription is made by French philosopher Catherine Malabou and her writings on neuro-plasticity. Malabou is critical of the conception of plasticity in its relatively facile scientific and popular proliferations where it is made synonymous with a notion of flexibility and extensively co-opted by neo-liberal economic and managerial discourses. She insists instead that we consider the neuro-plastic foundations of subjectivity according to a type of plasticity "never as yet envisaged by neuroscientists."[27] By drawing from continental, deconstructive and Hegelian traditions, she considers a notion of a potentially operative plasticity that is intermediate and transformative — even dialectical — in its ability to traverse the neuronal-mental difference without, however, eliminating it. By identifying the subject with the brain's plasticity, Malabou is not confining the subject to the limits of the brain, but is instead locating the subject in the very gap between one's neurons and the most elementary representational and proto-cognitive processes of the mind, in a gap that is traversed, but also dialectically preserved and transformed.

These theorizations and examinations begin to trouble the conceit that the brain and the subject are entirely and essentially commensurate, let alone identical, in some complete or coherent sense. They attempt to demonstrate that the brain's absolute circumscription of subjectivity is either a limited theoretical presumption, a neuroscientifically independent historical tendency, or that it comes at a number of socio-political costs. With this critical gap opened up between the brain and the subject it becomes possible to suggest that the mechanisms of equating the two terms are little more than strategies of *spatializing* subjectivity vis-à-vis the brain: for example, as strict co-location, parallelism, reductive supervenience, dualistic incommensurability, etc. By making such a claim, I do not mean to dismiss the link between subject and brain, but only to broaden the nature of that relation, and to show that at stake in that relation is the question and the complexity of the brain's topology. The brain is not only the space that situates the subject, but, returning to the earlier neuroprosthetic paradigm, the space that situates the potential discrepancies of subjectivity.

To approach the brain from the standpoint of a rigorous topological analysis means considering that from a certain standpoint, the brain becomes the space of incommensurability, or the site that situates the very discrepancy of the subject's localizability. To suggest that we imagine the space of the brain, the entire *matter* of the brain, topologically — and then in its topology as the site of possible incommensurability, discrepancies, or inconsistencies — is, as I have mentioned, to present the brain as a formal problem. To better understand the nature of the brain as a formal problem of space, I turn now to the history of the most prominent topological paradigm in brain science, one that I will attempt to reconsider briefly in the very next section.

The History of the Space of the Brain: Localization and its Discontents

It was in 1810, writes French historian and philosopher of science Georges Canguilhem, in his essay "Le cerveau et la pensée," that a veritable science of the brain effectively began,

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[26] Alva Noë, *Out of Our Heads*. Noë's integrationist tendencies turn almost organicistic when he describes a living being as a vital, "nonmechanistic," and "environmentally embedded unity," whose very activity of self-maintenance presents intelligent traits (39-41). Noë express his intellectual debt not only to Merleau-Ponty but to Evan Thompson, and so presumably also to Francisco Varela; traces of Varela's early work on "autopoiesis" with Humberto Maturana appear in Noë's writing.

[27] Catherine Malabou, *What Should We Do with Our Brain?* trans. Sebastian Rand (New York: Fordham, 2008), 69.

with the publication of the first volume of Austrian anatomist Franz Gall's *Anatomie et physiologie du système nerveux en général et du cerveau en particulier* [*Anatomy and Physiology of the Nervous System in General, and of the Brain in Particular*].[28] Franz Gall is known as the founder of phrenology or, more specifically "organology," the doctrine that the brain is composed of as many different material sub-organs as the mind is functions, and that the over- or under-development of each of these functions, which correspond to each of the sub-organs, can be detectable cranially. Canguilhem was being neither glib nor naïve, but actually quite grave in his assessment.[29] Although Gall's organology received suspicion from the moment of its emergence, his anatomy, like no other account of the brain before it, inaugurated the absolute alignment of brain and thought by making the brain the "sole physical support for the tableau of [mental] faculties," which were entirely founded on the "anatomical substrate of an organ," and on nothing else.[30]

Canguilhem is, to be sure, critical about the facile alignment of the brain with human thought,[31] what from that point was called the doctrine of localization, and spends much of his essay positioning it against numerous alternatives to that presumption as well as to the historical pitfalls that emerge from it. But by critically narrating a history of the science of the brain from the standpoint of the alleged brain-thought equivalence, Canguilhem is not only highlighting the theoretical difficulties involved in adopting cerebral localization, but underscoring how localization and its counter-discourses could almost single-handedly frame some of the most significant developments in both the brain and mind sciences from the nineteenth and twentieth centuries.[32] Indeed, as historians Michael Hagner and Cornelius Borck have more recently pointed out, the novelty of even the newest neuroscientific developments remain anchored in "often surprisingly conservative opinions about the mindful brain, partly dating back to the nineteenth century," including the renewed interest, by way of brain mapping and visualization technologies, in the localization of seemingly outdated behavioral dispositions like musical talent or criminality.[33]

Of course, this is not surprising, since of all the conceptual trajectories in the history of the science of the brain — including, for example, reflex action, the theory and histology of the

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[28] Georges Canguilhem, "Le cerveau et la pensée," in *Georges Canguilhem : philosophe, historien des sciences* (Paris : Albin Michel, 1993).

[29] Canguilhem's expertise on the history and theory of psychophysiology and the science of the brain and nervous system from the 17th and 18th centuries had been well demonstrated in his monograph on the history of the concept of reflex. *La formation due concept de réflexe aux XVIIe et XVIIIe siècles* (Paris : Presses Universitaires de France, 1955).

[30] Canguilhem, "La cerveau et la pensée," 12-13.

[31] So much so that in the volume in which Canguilhem's original 1980 lecture is published, Francisco Varela provides something of a short response, over ten years later, where he suggests that new concepts in cognitive neuroscience — including self-organization and the theory of emergence — would overcome some of the difficulties that Canguilhem noticed in neurosciences's attempts at accounting for human thought and experience. See Francisco Varela, "'Le cerveau et la pensée'," in *Georges Canguilhem: philosophe, historien des sciences* (Paris : Albin Michel, 1993), 279-285.

[32] Historian Anne Harrington writes, "The story of the rise and changing fortunes of modern brain localization theory … does not provide us with a window onto *all* important debates and issues confronting the nineteenth- and early twentieth century neurosciences. It does, however, offer itself as a sort of intellectual crucible that allows us to distill out what was — and in many respects still remains — most essential to the spirit of neurology in its modern history," in Anne Harrington, "Beyond Phrenology: Localization Theory in the Modern Era," in *The Enchanted Loom: Chapters in the History of Neuroscience,* ed. Pietro Corsi (Oxford: Oxford University Press, 1991), 207.

[33] Of course, what is important is, as the authors explain, "how these different elements are again and again (re-) arranged and linked in specific research settings, and how they are embedded in cultural expectations and values." Michael Hagner and Cornelius Borck, "Mindful Practices: On the Neurosciences of the Twentieth Century," *Science in Context* 14, no. 4 (2007): 507-510.

neuron, the nervous systems' autonomic functioning — none were nor remain as philosophically, psychologically, and socio-anthropologically polemical as the relationship of thought and subjectivity to cerebral biology. As the history of neuroscience narrated the long-privileged story of localization, it ultimately told the story of a predominantly nineteenth-century science, inaugurated at the outset by Gall's organology, criticized and reconfigured by French anatomist Pierre Flourens (in the name of Descartes, no less[34]), and then rearticulated in its scientific legitimacy just after the mid-century by neuroanatomist and physical anthropologist Paul Broca (in direct relation to socio-political tensions in mid-nineteenth century France[35]). Gall's severe localization of discrete mental faculties gave way, as German experimental psychologist Wilhelm Wundt wrote in his 1874 *Principles of Physiological Psychology,* to a generally settled and accepted "idea of a *relative localization* of functions,"[36] confirmed throughout the 1870s by notable physiologists including Gustav Fritsch, Edward Hitzig, and David Ferrier.[37]

Now while the history of cerebral localization concerns the specific problem of the nature of the brain's functions, the discourse ultimately has embedded within it an even larger theoretical problem of locality as such — not in terms of the philosophical question of how a presumably metaphysical concept like mind or intelligence can be located or situated within biological matter, but specifically in terms of what that situation does to the brain as a locale, a space that must in one way or another encapsulate not only mental processes, physiological functions, and biological organization, but also the possibility of the complete equivalence between these orders. In the localization of mental operations, the brain is not simply the material site in which those operations are situated, but also the topological locale in which mental and material ontologies can be united. The psycho-biology of localization embeds a topological conceit — that the brain is the place and, for the time being, the only place, where such a convergence is possible at all.

This topological conceit is perhaps why the history of localization has, to some measure, tended to formalize the brain in its relation to thought and subjectivity implicitly according to two philosophically loaded and polarized spatial models — the brain as a unity versus the brain as a disaggregated ensemble of differentiated parts. It is a dichotomy that emerges already in the seventeenth-century between René Descartes and Thomas Willis, the former employing the material unity of the pineal gland as justification for its ability to interface with the unity of the soul, while the latter distributing a series of mental functions throughout the brain's anatomical sub-divisions.[38] By the mid-eighteenth century, the brain was once again predominantly imagined as the space of organizational unity through the paradigm of the *sensorium commune* or common sensory, where the brain *in its entirety*, as an undifferentiated integrated mass, constituted the unified space in which sensory impressions could be combined into the singular

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[34] Flourens, who was writing from within the context of French spiritual eclecticism that, fixed around the work of Victor Cousin and Pierre Main de Biran, explicitly dedicates his *Phrenology Examined* to Descartes and the commitment to the soul's indivisibility within the body. See Edwin Clarke and L.S. Jacyna, *Nineteenth-Century Origins of Neuroscientific Concepts* (Berkeley: University of California Press, 1987), 273-285. Pierre Flourens, *Phrenology Examined,* trans. Charles de Lucena (Philadelphia, Hogan & Thompson, 1846) ; originally published as *Examen de la phrénologie* (Paris : Paulin, 1845).

[35] Paul Broca, "Remarks on the Seat of the Faculty of Articulate Language," in *Some Papers on the Cerebral Cortex,* trans. Gerhardt von Bonin (Springfield, IL: Charles C. Thomas, 1960). See Anne Harrington, *Medicine, Mind, and the Double Brain* (Princeton: Princeton University Press, 1987), chapter two.

[36] Wilhem Wundt, *Principles of Physiological Psychology,* trans. Edward Bradford Titchener (London: Swan Sonnenschein, 1910), 298.

[37] Robert Young, *Mind, Brain, and Adaptation* (Oxford: Clarendon Press, 1970), chapters 7 and 8.

[38] Alfred Meyer and Raymond Hierons, "On Thomas Willis's Concept of Neurophysiology," part 1, *Medical History* 9 (1965): 1-15. I discuss Descartes and Willis in Chapters Two and Three respectively.

experience of the "I."[39] As the historian and neurologist Walther Riese pointed out, the *sensorium commune* encompassed a "dialectical wavering" between two meanings of the term — on the one hand, "a simple ending of the nerves at a common end station," and the soul, mind, or the faculty of the *sensus communis* on the other.

It was against this premise of the *sensorium commune* that Gall was responding when he reimagined the brain as an anatomical mosaic, a collection of differentiated and independent sub-organs.[40] The era of nineteenth-century localization was the era of formalizing the brain as a space of differentiated parts, an internally divided organ. As Jean Charcot explained at the outset of his 1875 *Leçons sur les localisation dans les maladies du cerveau,* "The encephalon does not represent an homogenous organ, a unit, but rather an association, or a confederation, composed of a certain number of diverse organs. To each of these organs belong distinct physiological properties, functions, and faculties."[41] The premise of a unified brain, however, which never fully retreated from the scene of neuroscience, reappeared near the end of the century in the form of integrationist accounts of the brain and nervous system which viewed the brain as the place where the entire organism was holistically interrelate and arranged.[42] The first most rigorous theorizations emerge with the work of English neurologists John Hughlings Jackson in the late-nineteenth century and Sir Chalres Sherrington early in the twentieth, and were followed especially in Germany with a wave of holistic neurology.[43]

Alternative Topologies and Trajectories: Reconsidering the Space of the Brain

There is, however, more to a meticulous topological consideration of the brain than the formal oscillation between unity and disaggregation. Even the simplest topographical formulation of the brain that presents a coherent and relatively concrete spatial arrangement of the structure and function of the organ usually hides more complex topological configurations. A theoretically rigorous and historically situated analysis of some of modern neuroscience's more formative neuro-cerebral topologies amounts to giving up trying to *resolve* the relationship between subject and brain, and trying instead to understand how such attempted resolutions reconstitute the brain over and over again as a formal problem of space. This kind of analysis can yield new epistemological evaluations of the brain as an object capable of materially embodying multiple and even conflicting metaphysical and organizational orders, the sorts of paradoxical configurations that only a topological consideration of the brain's abstract spatiality could describe. This dissertation amounts to something like an historical ontology of the brain as a conceptual object of science and philosophy, from the standpoint of the complex ontologies encapsulated by the abstract space or topology of the brain. The notion of an historical ontology, appropriated recently by Ian Hacking, was first introduced by Michel Foucault to refer very

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[39] Riese and Hoff, "A History of the Doctrine of Cerebral Localization," 56. See also K.D. Keele, "The Search for the Sensorium Commune," in *Anatomies of Pain* (Springfield, IL: Charles C. Thomas, 1957), 55-101; Edwin Clarke and Kenneth Dewhurst, *An Illustrated History of Brain Function* (Berkeley: University of California Press, 1972), chapters 3-5; and Walther Riese, *A History of Neurology* (New York: MD Publications, 1959), 73-91.

[40] I examine this point more below and also in Chapter Four.

[41] Jean-Martin Charcot, *Lecture on the Localization in Diseases of the Brain,* trans. Edward Fowler (New York: William Wood & Co., 1878), 3.

[42] Walther Riese, "The Principle of Integration," *The Journal of Nervous and Mental Disease* 96, no. 3 (September 1942): 296-312.

[43] Sir Charles Sherrington, *The Integrative Action of the Nervous System,* 7th edition (New Haven: Yale University Press, 1947). For Jackson, see below. See also Harrington, *Reenchanted Science.*

generally to the conditions of possibility and acceptability which bring into historical being subjects, objects of knowledge, institutions, and discourses.[44]

A topological analysis can become an historical ontology of the space of the brain when we consider how abstract spatial formulations actually mediate the physical and organizational descriptions of the brain as well as the conceptual possibilities latent in those descriptions. On the one hand, the brain's material formulations have relied upon implicit spatial configurations which have, in turn, actually troubled the brain's material status. On the other hand, it is also possible to consider how the very materiality of the brain has developed in relation to certain neuro-cerebral topologies. As I suggested, a straightforward topography, the sort of spatial paradigm employed in the doctrine of localization, corresponds to a fairly coherent, concrete, and untroubled material composition of the brain. But topographical paradigms embed more complex and implicit topological formulations which are actually much harder to materialize, and which, when materialized, result in complicated even problematic accounts of the matter of the brain. In what follows, I provide an extended example of how the history of localization can be re-read from an alternative topological trajectory, and how such a re-reading can redefine some radical developments in the theory of the materiality of the brain.

Franz Gall and the Space of Difference

It is not enough, if one begins with Franz Gall, to sum up the theory of organology as the historical origin of the premise that the subject was entirely substantiated, and could therefore be fully accounted for, as the brain, and that the brain itself was internally modular and yielded a variety of functions on the basis of its intrinsic, material sub-divisions. It is essential not to overlook other implicit spatializations at work in Gall's writings.

Gall developed his organological views on the basis of French sensationalist philosophical medicine and German Romantic biology from the late eighteenth and early nineteenth centuries, in the context of which the nervous system and spinal cord had acquired primacy over the brain, as well as functional independence from it.[45] The nervous system was the unifying structure that gradationally bound organisms together, and the brain was only its final developmental outgrowth.

Gall was particularly influenced by Swiss naturalist and philosopher Charles Bonnet and German philosopher Johann Herder. By the end of the eighteenth century, Gall drew from Bonnet a belief in the organic plurality of the brain, and a conviction that specific actions must be given specific organizational structures.[46] From Herder, Gall derived the belief that a single

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[44] See for example, Michel Foucault, "What is Critique?" and "What is Enlightenment?" in *The Politics of Truth,* ed. Sylvère Lotringer (Los Angeles: Semiotext(e), 2007. For a detailed account of the development in Foucault's thought from archeology and the historical *a priori* to genealogy, see Beatrice Han, *Foucault's Critical Project: Between the Transcendental and the Historical,* trans. Edward Pile (Stanford: Stanford University Press, 2002). Ian Hacking discusses historical ontology in his book *Historical Ontology* (Cambridge, MA: Harvard University Press, 2002).

[45] Clarke and Jacyna, *Nineteenth-Century Origins*, chapter 5. For French sensationalist philosophical medicine see Martin S. Straum, *Cabanis: Enlightenment and Medical Philosophy in the French Revolution* (Princeton: Princeton University Press, 1980) and Anne C. Vila, *Enlightenment and Pathology: Sensibility in the Literature and Medicine of Eighteenth-Century France* (Baltimore: Johns Hopkins, 1998). For German Romantic biology see Timothy Lenoir, *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century German Biology* (Chicago: University of Chicago Press, 1982) and Robert Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002).

[46] Gall's organological orientation was already visible by 1791. See Erna Lesky, "Structure and Function in Gall," *Bulletin of the History of Medicine* 44, no. 4 (July/August 1970): 297-314. See also Claudio Pogliano, "Between Form and Function: A New Science of Man," *The Enchanted Loom: Chapters in the History of Neuroscience*, especially pages 151-157.

vital law structurally united all of nature.[47] From this, Gall established the primacy of the *ganglion*, the individual nervous unit that in aggregate comprised the plurality of the brain, but which separately was like an elementary and unitary nervous system.[48] It was on this basis that Gall was able to generate his organology: "Indeed, we believe that the total nervous system is a combination of many; that all these individual systems [*Systeme*] differ in their office; that the offices are related to the development of the organs; that more or less of a bond, and therefore or reciprocal influence, exists between all the individual systems."[49] When transposed into the terms of Gall's later physiological writings, the conclusion was reached that "the entire brain is not a single organ; that each of its integrant parts is a particular organ; and that there exist as many particular organs, as there are functions of the soul essentially distinct."[50]

Eventually, at the height of his thinking, Gall posited twenty-seven separate and independent sub-organs that corresponded to the twenty-seven possible powers of the human mind.[51] Gall's novel organology was equally an attack on the philosophical commitment to "the unity of consciousness (*moi*), the simplicity of sensation."[52] By delineating his twenty-seven innate mental functions, Gall was identifying what he took to be the true "primitive or fundamental powers of the mind,"[53] which were comprised of a set of "instincts, propensities, sentiments, and the determinate talents,"[54] and which essentially formed the self as a mosaic of

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[47] "Only one law rules all nervous systems…. everywhere origin, nourishment and gradual increase." Quoted in Lesky, 306. "Es herrscht nur *Ein Gesetz* in allen Nervensystemen ... Ueberall Ursprung, Ernährung und allmähliger Zuwachs." Franz Joseph Gall und Johann Kaspar Spurzheim, *Untersuchungen ueber die Anataomie des Nervensystem* (Hildescheim: Georg Olms Verlag, 2001), 60. In other words, generativity is found *in every place*.

[48] "Gall saw in each of these ganglia an individual, separate, independent nervous system, performing its own function even though connected through branchings to other systems," Lesky, "Structure and Function," 304-5. Gall signifies the historical transition to a bottom-up approach the brain, where the cerebrum is the last instance of a developed nervous system, not the first.

[49] Quote in Lesky, "Structure and Function," 309. „Wir glauben in der That, dass das gesammte Nervensystem aus mehreren einzelnen zusammengesetzt ist; dass alle diese einzelnen Systeme sowohl in ihrer innerrn Struktur, als in ihren Verrichtungen verschieden sind; dass die Verrichtungen mit der Entwicklung der Organe im Verhältniss stehen; dass unter allen den verschiedenen Systemen mehr oder weniger Verbindung, und folglich wechselseitiger Einfluss Statt habe" (Gall and Spurzheim, *Untersuchungen ueber die Anatomie des Nervensystems*, 399). This quoted is reproduced, translated into English from the French translation in Clarke and Jacyna, *Nineteenth-Century Concepts,* 227: "Indeed we believe that the whole collection of the nerves is made up of many specific systems; that these systems differ amongst themselves in their intimate structure as in their repective functions; that the functions or faculties are in direct proportion to the development of the organs appropriate to them; that there is more or less connection between the various apparatuses, and consequently reciprocal influence."

[50] Franz Gall, *On the Functions of the Brain and each of its parts: observations on the possibility of determining the instincts, propensities, and talents, or the moral and intellectual dispositions of men and animals, by the configuration of the brain and head, vol. 2: On the Organ of the Moral Qualities and the Intellectual Faculties and the Plurality of the Cerebral Organs*, trans. Winslow Lewis (Phrenological Library, Boston: March, Capen, and Lyon, 1835), 224. The English translation also goes by the title, *Works, in Six Volumes*. Vol. 1 is titled *On the Origin of Moral Qualities and Intellectual Faculties of Man, and the conditions of their manifestation*; Vols. 2-5 are *On the Functions of the Brain and each of its parts*; Vol. 6 is a review of anatomical literature.

[51] Gall, *On the Functions of the Brain,* vol. 3, 142, end of §3. Gall is clear that, "When I say that the exercise of our moral and intellectual faculties depends on material conditions, I do not mean that our faculties are the *product* of organization; this would be to confound conditions with efficient causes" (vol. 1, 173). The faculties are not caused by the organization; the latter is the *condition* of the former: "I call an organ, the material condition which renders possible the exercise or the manifestation of a faculty. According to this definition, it may be conceived that no exercise of a faculty is possible without an organ, but that the organ may exist without the faculty to which it belongs, being put in exercise" (vol. 1, 234).

[52] Ibid., vol. 3, 68.

[53] Ibid., 66.

[54] Ibid., 133. Gall even provided a methodological explanation of "the characteristic conditions which entitle an instinct, a propensity, a sentiment, a talent, to the appellation of fundamental, primitive, radical" (134). The

organically innate behavioral possibilities. Some of these instincts and propensities included the love of offspring, the sense of property [*Eigentumsinn*], the metaphysical depth of thought or aptitude for drawing conclusions [*Metaphysischer Tief-sinn*], the faculty of the relations of numbers [*Zeitsinn*], and benevolence.

As I mentioned, Gall was not only critical of the philosophical belief in the unity of the mind, but in its physiological correlate of the *sensorium commune* or the anatomical common sensory, and strove to move drastically away from the belief that the brain was the literal "rendezvous of all the nerves, the common center."[55] Rather than elaborating on the brain as a unifying site of commonality, Gall instead emphasized the role of *difference* in the brain: "that the different parts that constitute the brain arise, strengthen themselves, and terminate in difference places …. [T]hese different distributions of the nervous filaments of the brain, are destined for different functions."[56]

Gall's brain, indeed the entire nervous system that he described, was essentially composed of structural, internal differences, what he called a combination of individual and independent "systems" [*Systeme*].[57] Each elementary unit of the brain, each ganglion, was its own system, and which "forms, of itself, a peculiar whole," based "on the more or less perfect structure of [its] own organization."[58] While these elementary systems interacted and communicated with each other, it was nevertheless the organizational systematicity of each ganglion that fundamentally differentiated it from every other. The little systems were systematically different, so to speak: "By means of this arrangement, each particular nervous system has its appropriate function, and no one of them can supply another's function. The same law presides over the arrangement of the brain."[59] The holistic and internal systematicity of each sub-system maintained the organic as well as the functional discrepancy between them. For Gall, in other words, no unit could ever substitute for any other in the case of loss or damage,[60] and conversely, if any unit were ever to be injured, debilitating as a result its respective function, no other unit or function would incur any loss.[61]

The architecture of Gall's organological brain should not, however, be regarded as a simple composition of parts, but as something more akin to a monadic ensemble, an organizational coherence of indivisible but perfectly differentiable units. The self emerged synthetically on the basis of that coherence, *not* however by *bypassing* the structure of difference that constituted it, but instead by *incorporating* the difference, internalizing it somehow. Gall most remarkably writes:

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methodology is observationally-based and includes detecting: 1) the comparative temporal differences in the development of varying propensities (such as propogation); 2) when some qualities in a single person are enhanced while others in the same person are relatively weak; 3) when one organ or faculty is extremely active while others are totally incapacitated; 4) when all faculties/organs are active with the exception of a single one; 5) when only a single faculty suffers during mental disease; 6) the differences of faculties/organs between women and men; and 7) the difference presence of faculties/organs between species. "In all these instances we may admit the quality or the faculty in question to be a fundamental quality or faculty, a primitive, radical power. It is by no means necessary that all these conditions should be united; but the more there are of them, the better the independence, the speciality of the quality, or the faculty, and the existence of the organ will be proved" (Ibid., 135).

[55] Ibid., vol. 3, 78.

[56] Ibid.

[57] "Each particular nervous system is an independent system" (vol. 2, 58).

[58] Ibid., vol. 2, 66.

[59] Ibid., vol. 2, 242.

[60] "In no case do we see parts, not having the same action, replace each other in the execution of their respective functions." Ibid., vol. 2, 241.

[61] Gall is most emphatic about this when it comes to the division of the hemispheres, and the natural symmetrical division of the brain (which he takes as a natural confirmation of his theory of the divisibility of cerebral parts): "In other words, the functions may be disturbed or suspended on one side, and remain perfect on the other side" (vol. 2, 164).

> But your ME undergoes modifications always in harmony with the modifications of the organization. From the moment of your birth to the age of puberty, from this to old age, how many modifications take place in your tastes, affections, propensities, passions, and talents! There are cases, where, by an alteration of the organs, the ME is transformed into another ME; for instance, when a man believes himself transformed into a woman, a wolf, etc.; there are other cases, where the old ME is entirely forgotten or replaced by a new one; not an uncommon accident after severe disease, especially in cerebral affections. But the objection [that there is a unified and consistent ME], so captivating, is rather an illusion, so far as it seems to prove the independence of the mind on organization.[62]

Over and against the presumed singularity, continuity, and unchanging persistence of the philosophical *moi,* Gall proposed instead that the "I" emerges precisely in its differentiation from itself. The self, in other words, amounted to its own internal divergence, or a self essentially comprised of self-transformation and self-differentiation, a modification which was both inevitable as an attribute of human development, but which could also be defined psychopathologically. For Gall, simply put, the self was itself by virtue of differing from itself.

When Gall's organology is considered from an alternative topological standpoint — that is, a slight alternative from the common localization paradigm — then the space of the brain becomes nothing but an interrelated coherence of individuated differences, with the self arising from this apparently paradoxical configuration. The brain in Gall's organology can be understood to embody through its organizational plurality the possibility of conflicting states and discordant organizational orders; the self is not simply identified as a brain, but is instead determined through the structure of systematic difference according to which the brain is spatialized.

John Hughlings Jackson and Topological Inversions

Despite the criticism that organology and phrenology had little scientific merit, Gall's scientific influence within neurology cannot be denied. The general premises of organology extended, certainly not without criticism, to the thinking of several notable theoretical innovators of brain science in the mid-nineteenth century including English philosopher Herbert Spencer and his evolutionarily inclined views on cerebral localization.[63] Like Gall, Spencer believed that the nervous system's organizational divisions pointed to functional specializations, a "physiological division of labor," where the "separateness of duty is universally accompanied with separateness of structure."[64] However, unlike Gall, Spencer insisted that the only functions present in the nervous system were sensory-motor in nature (in contradistinction to Gall's twenty-seven faculties), and that any particular organizational center would coordinate a multiplicity of sensory-motor activities. Spencer's thinking and his elaboration of the premises of localization in turn had a direct effect on the work of English neurologist John Hughlings Jackson who, through some of Spencer's insights, was able to reconfigure substantially the very scope of localization as central paradigm in neuroscience.

Generally considered one of the most important neuroscientific thinkers from the period, Jackson ultimately converted Gall's structure of systematically divergent sub-organs into a

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[62] Ibid., vol. 3, 76.
[63] Robert M. Young, *Mind, Brain, and Adaptation*, chapters 5-6. I examine Spencer closely in Chapter Four.
[64] Quoted in Young, ibid., 201-202.

vertical hierarchy of differentiated yet nevertheless continuous levels of the nervous system.[65] In his 1887 essay, "Remarks on the Evolution and Dissolution of the Nervous System,"[66] Jackson put forward a central tenet, which he adopted in many ways from Spencer, that "every part of the nervous system represents impressions or movements, or both," and that, "the highest divisions of this sensori-motor mechanism, 'organ of mind' … represent impressions and movements of *all parts* of the body."[67] In a sense, the nervous system was self-referentially related to the body in which it inhabited, since its only function was *to represent* either the excitability or the motility of that body, and nothing else.[68] As Jackson explains, "To give an account of any [nervous] center is to give an account of the parts of the body it represents, and of the ways and of the degrees of indirectness in which it represents them."[69]

Jackson's notion of nervous "representation" was never meant to suggest ideation or any mental process as we might understand the term. He conceded that it was undeniable that the conscious perception of an object was accompanied by a correlative physical process or event in the brain. But it could not be said that this physical event consequently *represented* the object; this sort of description was only "morphological-physiological" in nature. To describe the nervous system's representational capacities was not to suggest that the brain represented the *object*, but that it simply represented the affections of the body in response to the object, namely "certain retinal impression and particular ocular movements — that is, an anatomico-physiological account of the physical process"[70] The nervous system represented by effectively encoding bodily affections. And insofar as the representation of an object was really just the representation of bodily movements and affections *acting in concert* — as we see from the example above, impressions on the retina *and* the movements of the eye — representation was synonymous with bodily coordination.[71]

Jackson's nervous system, moreover, was not a singular entity, but was divided into three stratified levels or centers, which progressed along a spectrum of evolutionary complexity. The lowest level was the least evolutionarily developed, and did, as Jackson explained, "menial work"; where as "the highest level, evolved out of it, becomes in great degree independent of it and is the anatomical basis of mind."[72] But despite their evolutionary difference, the levels were still deeply interconnected through the representational function of the nervous system. The lowest and most preliminary level, which for Jackson was centered primarily along the spinal cord, was able to represent the entire body most immediately and proximately. The next highest level, however, which included the sensory and motor regions of the brain, essentially enfolded the representational scope of the first level into itself; as Jackson writes, "it represents all parts of the body doubly indirectly."[73] Finally, the highest level of the nervous system, which included the pre-frontal and occipital lobes of the brain (the highest sensory and motor centers), subsequently enfolded the second-order representation of the body and therefore "re-re-represent

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[65] Chapter Four examines more generally the topology of the vertical nervous system throughout the nineteenth century.
[66] John Hughlings Jackson, "Remarks on the Evolution and Dissolution of the Nervous System," *The Journal of Mental Science* 33, no. 141 (April, 1887): 25-48. See also, Harrington, *Medicine, Mind, and the Double Brain*, chapter 7.
[67] Jackson, "Remarks," 29.
[68] After all, Jackson asks, "Are we to believe that the [cerebral] hemisphere is built on a plan fundamentally different from that of the motor [and sensory] tract?" Ibid., 34.
[69] Ibid., 32.
[70] Ibid., 42.
[71] Walther Riese, "The Principle of Integration," 298.
[72] Jackson, "Remarks," 48.
[73] Ibid., 29.

the body — that is, represent it triply indirectly”[74] So even though the levels differed on the basis of their evolutionary development, they were in fact deeply integrated insofar as the higher levels representationally encapsulated the “universally representing” scope of the lower ones.

Through the process of re-representing the lower centers, or representing them over again, the highest nervous centers simply re-constituted the lower center’s initial representations, but with greater complexity and detail. The higher centers added to the representations greater differentiation by accounting for a larger number of different and more particularized movements from a wider range of the body, while doing so in terms of the greater interrelation between movements and body parts.[75] As a consequence, higher levels were able to constitute more extended relations of coordination and cooperation for more parts of the body, whereas the lowest level could only represent corporeal affections singularly and independently, that is, not in terms of any interrelation.[76] The representation of lower levels could be directly compared to their higher level transpositions, so that “simplest movements of the limbs” in the lowest centers, for example, “become evolved in the highest centers into the physical bases of volition” and “centers for movements of the tongue, palate, lips, etc … are in the highest centers evolved into the physical bases of words, symbols serving us during abstract reasoning.”[77] Since the highest centers were the most “1) complex, 2) most special, 3) most integrated sensori-motor centers, with 4) most numerous interconnections,” they therefore comprised “the anatomical substrata of consciousness.”[78]

If representation referred to “an anatomico-physiological account of a physical process,” then its re-representation entailed a *coordinated* account of the anatomical-physiological account of the physical process; and its re-re-representation included the fully integrated or wholly *organismic* account of the coordinated account of the anatomical-physiological account of the physical process. At the highest levels, therefore, it was not simply the body which was represented, but the body understood from the standpoint of its complete interrelation with itself — that is, the body as a state of persistent self-organization, in other words, *an organism*. As Jackson writes,

> Using old-fashioned language, [the highest centers] are potentially the whole organism; the whole organism is ‘potentially present’ in them. They are the unifying centers of the whole organism, and thus the centers whereby the organism *as a whole* is adjusted to the environment.[79]

It is important to appreciate the topological complexity of Jackson’s neurophysiology. Jackson was no longer providing a simple theory of localization, of identifying specific centers in the brain that corresponded to specific functions. He was instead proposing, as Alexandr Luria pointed out, that “cerebral organization of complex mental processes must be approached from the standpoint of the *level* of their construction.”[80] Over and against Gall’s formation of a space

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[74] Ibid., 29-30.
[75] Jackson is clear that by “parts of the body,” he means “non-nervous parts.” See John Hughlings Jackson, “On the Comparative Study of Diseases of the Nervous System,” *Selected Writings of John Hughlings Jackson,* vol. 2, ed. James Taylor (New York: Basic Books, 1958), 399.
[76] What Jackson describes as “all parts of the body, animal and organic, ‘from nose to feet,’ in simplest, etc., combinations.” “A Contribution to the Comparative Study of Convulsions,” *Selected Writings of John Hughlings Jackson,* vol. 1, ed. James Taylor (New York: Basic Books, 1958), 349.
[77] Jackson, “Remarks,” 48.
[78] Ibid., 31-32.
[79] Ibid., 34.
[80] Luria, *The Working Brain,* 25.

of individuated and non-corresponding differences, the Jacksonian brain — taking account only of the highest centers — had become a space where the organism was topologically folded in on itself, where the organism's exterior and interior had become profoundly inverted.

On the one hand, the exteriority of the organism, or its corporeal periphery and the affections of that periphery in response to stimuli, was projected through the "triply indirect" re-re-representation into the most *interior* parts of the nervous hierarchy, namely the highest brain centers. On the other hand, and on the basis of the same process of integration, the interiority of the highest centers had been conversely projected outward into the *exteriority* of the body ("For my part I think the whole body is 'the organ of mind,'"[81]) and, most importantly, into the *absolute exteriority* of the environment itself. As Jackson writes, the highest centers, in their complexity, are "ever organizing" because they constitute the site "whereby new adjustments of the organism, as a whole, to the environment are possible."[82] The Jacksonian brain staged the topological inversion of the organism, where the organism has been turned inside-out, so to speak, so that the categories of interior/exterior were no longer fully distinguishable. And the brain was able to produce this sort of global topological effect on the entire organism precisely because "each unit of the highest centers is a miniature highest center, that is, represents in some degree the whole organism."[83]

The topological novelty of the Jacksonian brain is noteworthy in at least two additional respects. First, it is necessary to recall that the brain's ability to represent the body with greatest *differentiation* was actually predicated on the greatest *integration* of bodily representations — or the fact, in other words, that the nervous system was enfolded on itself. The levels, while evolutionarily differentiated, were not fully distinct since each level was preserved in the higher level, by virtue of being representationally encompassed within it. The higher level was a more complex version of the lower, differentiated but not different in a strict sense.[84] Therefore, the more integrated and co-located the nervous hierarchy and higher brain centers became, the more differences, discriminations, and modifications they were able to yield and make intelligible for the body, in terms of its affections, movements, and interrelation of parts. For example, as I cited earlier, Jackson writes that each unit of the highest brain centers acts as "a miniature highest center," that is, a part absolutely representative and therefore equivalent and interchangeable with every other part and the whole.[85] Nevertheless, he continues, "no two units [represent the organism] in just the same way (Factor Differentiation)."[86] In other words, the highest centers co-locate within each of their elementary units a broad representational equivalence of the body as well as a particularized discrimination of it. Each unit is both the same as every other, and yet also different.

In a sense, we can project a single topological trajectory from Gall to Jackson, in that for both the brain can be imagined as the space of a structure of differences and differentiations. While for Gall, the differences occupy discrete sub-divisions of the brain, for Jackson, the differences emerge from the brain's integrative quality. The Jacksonian brain seems to act as the site where difference, as a bodily and even psychological category, paradoxically emerges through the very process of incorporation, integration, and envelopment. And like Gall, Jackson

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[81] Jackson, "Remarks," 39.
[82] Ibid.
[83] Ibid., 35, n.1.
[84] Walther Riese writes, "This means that no fundamental or discriminative difference can be established between the centers of the different levels of the nervous hierarchy." And "although Jackson does not recognize a discriminative difference between the various centers, he arrives, nevertheless, at a real hierarchy." Riese, "The Principle of Integration," 299.
[85] For Jackson, these "units" are functional senori-motor arrangements.
[86] Jackson, "Remarks," 35, n.1

also defines the subject differentially, according to the inter-differentiated spatiality of the brain and nervous system. For Jackson, subjectivity was composed of a *duality* of consciousness, where an "object consciousness," or a common understanding of the workings of the mind and subjective experience,[87] was subtended by a "subject consciousness," or a deeper and "most unchanging" pre-condition "by which knowledge is possible."[88]

The second significant topological novelty emerging from Jackson's neurophysiology derives from the fact that the brain in its highest form, precisely by incorporating the lower levels, representationally encompassed multiple *evolutionary temporalities*. The Jacksonian brain situated and thereby made simultaneous the evolutionary periodization of the organism, signified by the three levels of the nervous hierarchy.[89] The organism's evolutionary past and present were linked and co-located in Jackson's integrative cerebral space. This space of evolutionary simultaneity corresponded to another temporal feature of the Jacksonian brain, namely the *temporalization* of the mind. By adopting a theory of parallelism, Jackson was clear that mental processes were completely different from neuro-cerebral processes. There was no interaction or direct relation between them, and mental states did not arise as functions of the brain. Instead, insists Jackson, they simply "occur *during* the functioning of the brain." In the case, for example, of visual perception:

> The visual image, a purely mental state, occurs in parallelism with — *arises during* (not *from*) — the activities of the two highest links of this purely physical chain (sensori-motor elements of highest centers) — so to speak, it 'stands outside' these links.[90]

Jackson set aside in scare quotes the figurative claim that the mind was located somehow outside the physical dimensions of the brain. Although the mind could not be situated within the material dimensions of brain, it was nevertheless identified as an occurrence that took place within the *duration* of the brain's activities. The brain could still be said to encompass the mind, but only by way of a temporal — not physical — encompassment, in the same way that it temporally encompassed the evolutionary multiplicity of the organism. The topological complexity of Jackson's neurophysiology not only inverts the dimensions of the organism, confounding interior and exterior, integration and differentiation, but it inverts the stasis and fixity of space itself, rendering the space of the brain a moderately temporalized locale.

The Logical Matter of the Brain: The Case of Warren McCulloch

By adopting an alternative topological standpoint to the more familiar spatial paradigm of localization, the brain can be shown to encompass more complex theoretical and material entanglements. Already, by simply reconsidering more meticulously the underlying neuro-

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[87] "A state of object consciousness is a thing to the different aspects of which we give the names will, memory, reason and emotion. In other words, there are not two things: (1) objects consciousness, and also (2) will, memory, reason, and emotion. The will, memory, reason and emotion of the moment may be said to make up the object consciousness of the moment." Jackson writes this in a different version of "Remarks on Evolution and Dissolution of the Nervous System," in *Selected Writings of John Hughlings Jackson,* vol. 2, 92.

[88] Ibid., 94. For more on the duality of consciousness, see Harrington, *Medicine, Mind, and the Double Brain,* 226-230. Over and against the duality of subjectivity, Jackson explains the differentiated nature of psychopathology as well: "That there are different *kinds* as well as different *degrees* of insanity is evident." "The Factors of Insanity," *Selected Writings,* vol. 2*,* 413.

[89] In "A Comparative Study of Convulsions," Jackson writes, "the lowest level of evolution is probably nearly the whole of the new-born infant's developed nervous system," *Selected Writings,* vol. 2, 351.

[90] Jackson, "Remarks," 37. Emphasis in original.

cerebral topologies in the work of two central thinkers in the history of neuroscience, the space of the brain can be seen to embody materially novel and even paradoxical relations of discrepancy and self-differentiation, as well as states of temporality or processes of temporalization. In other words, reexamining the history of neuroscience from a rigorous topological standpoint can drastically refashion what we imagine as the very materiality of the brain and nervous system, as well as help us understand the historical and theoretical development of new and radical conceptions of brain matter.

One such conception arose in the early 1940s during a period in which brains were to a large extent being recast in relation to information machines, which on their own had been either theorized or built since the seventeenth century.[91] This conceptual interdependency between brain, nervous system, and information machine developed as part of a wide-scale theoretical reassessment of the brain organized under a set of new scientific approaches to theories of behavior and information processing, dubbed *cybernetics*. It cannot be emphasized enough the foundational, indeed revolutionary role cybernetics played for the development of the mind and brain sciences of the later twentieth century.[92] To provide a sense of what cybernetics took to be the gravity of its conceptual contribution to brain and mind science, I cite the following extended passage:

> Ever since Galileo … our study of the world has been divided between the physical sciences, including chemistry and physiology, on the one hand, and the mental sciences, including logic and psychology, on the other. The rift widened with the years … yet we have been unable to bridge the rift. In vain, Hughlings Jackson delineated the lesions of the brain which prevented propositionalizing. And Sir Charles Sherrington, near the end of a life well spent in studying the physiology of the central nervous system, was forced to the conclusion that "in this world Mind goes more ghostly than a ghost." In the last few years the art of communication has given birth to a new science. It has formed its central concepts and extended its domain to include brains as part of the general field of Cybernetics. In its terms, Mind is the circuit action to be expected of a structure like the nervous system. This bridge is common ground for psychology and physiology."[93]

This passage from a 1949 essay called "How Nervous Structures Have Ideas" was co-written by one of the main architects of cybernetics, the neurophysiologist Warren McCulloch. McCulloch is one of several notable figures who laid the groundwork and theoretical scope of cybernetics, along with Norbert Wiener, John von Neumann, Heinz von Foerster, and others — the physicists, mathematicians, physiologists, and engineers who were responsible, in part, for reorienting a newly mathematized concept of information around problems of feedback and self-organization, and linking mental and perceptual operations to the tenets of computation.[94]

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[91] For example, Warren S. McCulloch and John Pfeiffer, "Of Digital Computers Called Brains," *The Scientific Monthly* 69, no. 6 (December 1949): 368-376. On the history of automata and calculating machines, see for example, Simon Schaffer, "Babbage's Intelligence: Calculating Engines and the Factory System," *Critical Inquiry* 21, no. 1 (Autumn 1994): 203-227 and Simon Schaffer, "Enlightened Automata," in *The Sciences of Enlightened Europe,* ed. William Clark et al. (Chicago: University of Chicago Press, 1999).
[92] Francisco Varela, et al., *The Embodied Mind,* chapter 3.
[93] W.S. McCulloch and W.H. Pitts, "How Nervous Structures Have Ideas," *Collected Work of Warren S. McCulloch,* vol. 2*,* ed. Rook McCulloch (Salinas: Intersystems Publications, 1989), 621.
[94] W.S. McCulloch, "Recollection of the many sources of cybernetics", *Collected Work of Warren S. McCulloch,* vol. 1*,* Rook McCulloch, ed. (Salinas: Intersystems Publications, 1989), 21-49.

Cybernetics itself encompassed a complex web of interdisciplinary research, which corresponded to a set of conferences sponsored by the Josiah Macy Foundation (referred to as the Macy Conferences on Cybernetics, 1943-54), and which cannot finally be reduced to a single set of research priorities, particularly given the extraordinary influence cybernetics had on scientific and social scientific research (and not to mention on the so-called second and third wave cybernetic research that followed).[95] The term "cybernetics" was coined by Norbert Wiener and popularized in his 1948 publication of *Cybernetics: or Control and Communication in the Animal and the Machine.*[96] Deriving from *kubernētēs,* the Greek root of "government," cybernetic research was essentially concerned with understanding the fundamental terms of biological regulation, and how to transpose those regulative parameters into mechanical terms. A major theoretical problem for cybernetics was how to transpose biological behavior, e.g., self-regulation or purposiveness, into the newly established mathematics of information theory (which treated information as a physically recognizable and mathematizable property) in order then to apply that information as codes and commands to a machine, which was computational to some degree.[97]

McCulloch, a trained physiologist and psychologist, additionally schooled in mathematics and electrical engineering from the time he spent with Norbert Wiener at the MIT Research Laboratory of Electronics, was not only one of the organizers of the Macy Conferences, but was one of the inaugurators of what turned out to be some of cybernetic's most significant premises. Specifically, in a 1943 paper, co-written by a frequent collaborator, the young mathematician and logician, Walter Pitts, titled "A Logical Calculus of the Ideas Immanent in Nervous Activity," McCulloch first presented the idea of the formalized, logical neuron. McCulloch and Pitts showed how neurons could be understood in logical, binary terms (as either active or inactive), and that the activity of neurons — individually and in relation to other neurons in a larger neural network — was governed by logical and statistical rules which could therefore be transposed mathematically.[98] It became, in a sense, possible to translate the physiological activity of the nervous system into the logical and mathematical constraints of information, and the implications were enormous. McCulloch himself understood this accomplishment as the link that would finally bridge the "rift" of Western science.

It is important to keep in mind, as the earlier citation suggests, that McCulloch saw the development of the logical neuron as a continuation of research that was specifically neurophysiological in nature, and that it resolved a set of fundamental neuroscientific impasses. It was not until the end of the nineteenth century, after cell theory had transformed the biological tenets of neuroscience, that the brain was recognized as being comprised of discrete neurons that played a significant part in the transmission or conduction of nerve impulses.[99] By 1906, Charles

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[95] Steve J. Heims, *The Cybernetics Group* (Cambridge, MA: MIT Press, 1991); Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, MA: MIT Press, 1996); N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999).

[96] Norbert Wiener, *Cybernetics: or Control and Communication in the Animal and Machine* (Cambridge, MA: MIT Press, 1948).

[97] Lily E. Kay, "Cybernetics, Information, Life: The Emergence of Scriptural Representations of Heredity," *Configurations* 5, no. 1 (1997): 23-91.

[98] Warren McCulloch and Walter Pitts, "A Logical Calculus of the Ideas Immanent in Nervous Activity," in *Embodiments of Mind* (Cambridge, MA: MIT Press, 1988), 19-39. Lily E. Kay, "From Logical Neurons to Poetic Embodiments of Mind: Warren S. McCulloch's Project in Neuroscience," *Science in Context* 14, no. 4, (2001): 591-614

[99] For the history of the neuron, see in particular Clarke and Jacyna, *Nineteenth-Century Origins,* chapter 3; Alberto Oliverio and Gordon M. Shepherd, "Neurons: The Cells of Thought," *The Enchanted Loom*; and Edward G. Jones, "Golgi, Cajal, and the Neuron Doctrine," *Journal of the History of the Neurosciences* 8, no. 2 (1999): 170–178.

Sherrington was already writing that neurons “like all other cells, lead individual lives — they breathe, they assimilate, they dispense their own stores of energy, they repair their own substantial waste; each is, in short, a living unit;” [100] and that they, perhaps most importantly, have “the power to spatially transmit (conduct) state of excitement (nerve-impulses) generated within them” specifically by virtue of “a surface of separation” between neurons — what Sherrington dubbed the “synapse.”[101]

For Sherrington and early twentieth-century neuroscience, the neuron had become the elementary conduit through which nervous conduction, and the messages of the nervous system, flowed. McCulloch’s “abstracted neurons,”[102] however, which were simultaneously real, biological objects as well as a propositional all-or-none, on/off logical states,[103] completely reoriented the very status not only of the neuron, but of the entire materiality of the brain. The logical neuron no longer simply *carried* or transmitted, but fully *constituted* in and of itself the information at a unitary scale — and in relation to a larger neural net — that both composed but also characterized the functionality of the entire nervous system. The logical neuron did not just conduct information, it *was* the information — a signal, at once an “embodied physical processes” but which nevertheless assumed “the logical properties of a proposition”: i.e., true/false, yes/no.[104]

The logical neuron was also the realization of what McCulloch had earlier in his career referred to as the “psychon,” a singular event that was at once psychical and cerebral, formal and physical. [105] McCulloch had, in a way, made the brain monadic in its elementariness; following Leibniz — as McCulloch himself did on this point — the neuron was considered the fundamental atom of human nature. Just as the monad was for Leibniz the initial indistinguishability of the event and the principle, of empiricalness and conditionality (monads, after all, “contain not only actuality, or the mere fulfillment of a possibility, but also an originating activity”[106]), McCulloch’s psychon-neuron was also understood as something of a “metaphysical point,” the singular confluence of multiple ontologies. McCulloch indeed transformed the conception of brain matter through the formulation of the logical neuron; the brain was simultaneously material and formal.

In 1948, McCulloch first presented a paper titled “Why the Mind is in the Head,” where he posited, as he would do many times, the brain’s fundamentally logical nature. The general problem for McCulloch turned in part on the probability of corruption or the general ratio of the

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[100] Charles Sherrington, *The Integrative Action of the Nervous System,* 1-2.
[101] Ibid., 17.
[102] Warren McCulloch, “The Postulational Foundations of Experimental Epistemology,” *Embodiments of Mind,* 369.
[103] “The postulated neurons, for all their oversimplifications, are still physical neurons as truly as the chemist’s atoms are physical atoms.” Warren McCulloch, “‘What’s the Brain that Ink may Character?’” *Embodiments of Mind,* 393.
[104] McCulloch and Pitts “How Nervous Structures Have Ideas,” 623.
[105] Since the essence of the neuron is to signal, McCulloch points out, “a signal has a double nature; it is a physical event… yet it is essentially capable of being true else false.” “Physiological Processes Underlying Pychoneuroses,” *Embodiments of Mind* , 373. McCulloch also writes, “In 1923 I gave up the attempt to write a logic of transitive verbs and began to see what I could with the logic of propositions. My object, as a psychologist, was to invent a kind of least psychic event, or ‘psychon’, that would have the following properties: First, it was to be so simple an event that it either happened or else it did not happen…. In 1929 it dawned on me that these vents might be regarded as the all-or-none impulses of neurons, combined by convergence upon the next neuron to yield complexes of propositional events.” “What is a Number that Man May Know It, and a Man, that He May Know a Number?” *Embodiments of Mind,* 8-9. See also Boden, *Mind as Machine,* vol.. 1, 182-194
[106] G.W. Leibniz, “New System of the Nature of Substances and Their Communication, and of the Union which Exists Between the Soul and the Body,” in *Philosophical Texts,* trans. R.S. Woolhouse and Richard Francks (Oxford: Oxford University Press, 1998), 145-46.

maintenance of information when an individual neuron was formalized as a logical input-output unit. It was assumed that a great deal of the loss of information, or corruption, in an organism was due to the complex and expansive coupling between the nervous system and other physiological systems, such as the muscular system. Information was lost, for example, when a signal traveled to the muscles since muscular tissue was not nearly as materially defined as the nervous system was. McCulloch, on the other hand, directed his attention to the corruption of information taking place within and throughout the nervous system alone — looking, in other words, at how probable it was that information was corrupted as it traversed the nerves and the neurons in the brain.

What he observed was that neuronal activity was extraordinarily — almost impossibly — synchronous with itself. The probability of corruption decreased as the brain demanded a greater level of simultaneity among its neurons: "In the nervous system, by repeatedly demanding coincidence we vastly increase the probability that what is in the output corresponds to something in the input."[107] According to McCulloch, even though "the eye relays to the brain about the hundredth part of the information it receives," the probability that this information was accidental or random, "is fantastically small, 2^{-100}, a billionth of a billionth of a billionth of a tenth of one per cent."[108] The brain's ability to process information in hundreds of parallel neuronal pathways in near total simultaneity ensured the theoretical veracity of the brain's capacity to receive, process, and abstract information.[109] Indeed, the brain was the only entity that could accomplish such a task, for if the mind was defined by the specificity of signals whose clarity or intelligibility was determined by this extensive synchronicity, then the mind could only be in the head, in other words, in this peculiar organ called the brain.

But how ultimately had the brain been transformed in order to satisfy McCulloch's demand that it become a mass of logical matter? This question was in some respects summed up by the very title of the essay: "Why is the mind in the head?" Why indeed? Why would the mind, however we may define it, or let it remain indefinite, be *in* anything at all, let alone in this particular thing?

> Because there, and only there, are hosts of possible connections to be formed as time and circumstance demand. Each new connection serves to set the stage for others yet to come and better fitted to adapt us to the world, for through the cortex pass the greatest inverse feedbacks whose functions is the purposive life of the human intellect.[110]

For McCulloch, the mind was *in* the brain, because the brain was a location, a "there, and only there," that seems to slip effortlessly, according to the demands of "time and circumstance," into an altogether *other* register of space, into a space which exceeds the relative rigidity of the brain's dimensional materiality. The brain by virtue of its surety of position — behind the face, below the scalp, within the skull — guaranteed, on the one hand, the mind's very situatedness (its existence was essentially predicated on the fact that it could be essentially pointed to) and, on the other hand, guaranteed that the mind exceed any absolute physical circumscription or strict and tangible positionality.

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[107] Warren McCulloch, "Why the Mind is in the Head," *Collected Works,* vol. 2, 654.
[108] Ibid.
[109] "We find that brains perform most operations in parallel, many times over, and then demand agreement before passing on their signals. For all these reasons, large numbers of neurons can be dead and one and the answer come [*sic*] correct." McCulloch and Pfeiffer, "Of Digital Computers Called Brains," 375.
[110] McCulloch, "Why the Mind is in the Head," 664-65.

If the mind and brain sciences in their historical development have, as it is commonly said, made mind into matter, tied subjectivity ontologically if not at least emergently to cerebral states, then it has, as McCulloch inadvertently demonstrated, come at a cost, and has made and perhaps always assumed something not fully or rigidly material of the brain. But by virtue of the surety, indeed the necessity, of its locality — not only that it localizes but that it is, on its own, a presumably coherent locale — McCulloch's logical brain became a space of flux, a *temporalized* matrix of only "possible connections," a formal structure of propositional relations which, through its contingency and fluctuating substitution with future relations that were only "yet to come," seemed always to be disorganizing the stable geometry that the brain's assumption of location would by definition demand.

McCulloch's logical brain had *materially* become equivalent to a topology of fluidity and flux, an oscillation between spatial structures and temporal relations. The logical brain seemed to spatialized a non-space, to stage a mind that was characterized by probabilities, temporalized possibilities, and the constant shifting, alteration, and differentiation of causal connections, feedbacks, and other spatialized relations. The material embodiment of differences and temporalizations that arose from the implicit cerebral topologies in the work of Franz Gall and John Hughlings Jackson form a historical and conceptual trajectory that most explicitly paid off in the logical neurophysiology of Warren McCulloch. With McCulloch, the brain's material ontology and topological complexity were united. The logical brain was theoretically and materially equivalent to a topology of radical re-spatializations and temporalizations, or conceptually and materiality circumscribed by a topology of organization and reorganization.

My assessment of McCulloch's theory of the logical brain deviates from typical assessments of cybernetic neuroscience, generally accepted to be the broad techno-organic hybridization of a theory of behavior and information processing that rendered indistinct human and machine.[111] McCulloch's neurophysiology was more than the programmatic computationalization of thought and the reproduction of that program in a machine. Despite McCulloch's formative association with the post-WWII transition to the techno-militarism of cold war information and engineering science, McCulloch's digital brain was not in essence a cyborg brain. It was not fully equivalent, in other words, to the biologized mechanics of command and control technologies, nor was it entirely equivalent to the mechanized biology of a military techno-soldier. The logical brain was more than the blurring of the human-machine distinction, more than just an "ill-understood variety of computing machines," despite McCulloch's own insistence.[112]

The logical brain was itself the very process of organization and reorganization as such. Its material-ontological *actuality* was equivalent to its *activity* of rearrangement and systematization, which as McCulloch pointed out, could even re-schematize the basic space-time syntax of nervous processes.[113] In its organizational liberty, affinities can be seen with present day descriptions of neuro-plasticity and neuro-genesis: "All learning … orders step by step an

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[111] For such readings, see Paul N. Edwards, *The Closed World,* especially chapter 6; Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Inquiry* 21, no. 1 (Autumn, 1994): 228-266.

[112] "*Mysterium Iniquitatis* of Sinful Man Aspiring into the Place of God," in *Embodiments of Mind,* 163. Of course, given the formative role a traditional cybernetic brain played in the development of cognitive-behavioral programs that remain inextricably linked with political militarism, the McCulloch brain as it is delineated here must be observed as a kind of aberrancy. Precisely in its difficulty to be *substantially* grounded in and of itself, the digital brain must fail to act as substratum to the political legacies that follow the post-war techno-rationalities, including the contemporary neuro-economies, neuro-legalities and the re-systematizations of criminality and socio-morality that make up the impending regimes of "neuro-politics" based on the pervasion of brain assessment technologies.

[113] "A net of neurons can convert any figure of simultaneous signals over a given number of neurons into a sequential figure of impulses over one neuron … thus exchanging space for time. Conversely, it may exchange time for space." McCulloch and Pfeiffer, "Of Digital Computers Called Brains," 374.

ensemble erstwhile chaotic…. This *change of state in our brains* that may happen to water in a moment of freezing goes merrily on in us as long as we can learn."[114] With McCulloch, the logical brain had, on the one hand, become extraordinarily concrete, at a material level, by virtue of the significance placed on the logical operations of the neuron. Indeed, since the simple binary action of the neuron represented the elementary activity of the entire nervous system, the logical brain was one of the most conceptually tangible brains in the history of neuroscience; and this is perhaps most illustrated by the fact that the logical brain could be conceptually and technically transposed into the construction and engineering of computers and other logical machines. Yet at the same time, given that the neuron had to be thought in abstract, logical terms, the very materiality of the brain needed to correspond to logical relations, stochastic possibilities, and organizational fluidities that were taking place within the space of the brain, processes that could only be expressed in the most abstract topological ways. The logical brain was as much concrete as it was intangible — the most explicit historical and conceptual manifestation of neuro-cerebral matter being entirely equivalent with abstract topological space.

Conclusion: Topology and Materiality

The extended example that I offered above is meant to demonstrate how the dominant spatializing paradigm of localization could be productively re-read from alternative and more rigorous topological standpoints. The brain, from the origins of early modern neuro-anatomy to contemporary theoretical neuroscience, has always been spatialized in complex and sometimes paradoxical ways. A single theory of neuroanatomy can be the source of multiple cerebral topologies, as I hoped to demonstrate in my analysis of Franz Gall.[115] But some spatial formulations of the brain actually cover over more complicated and more underlying topological possibilities, or more complex spatializations which are actually at work. For Gall, the topographic space of cerebral localization was subtended by a topological space of systematic difference, which was itself a harder sort of spatiality to articulate in material terms. It is my contention, however, that often the most complex topological formulations are what more fundamentally mediate the physical and material accounts of the brain and the conceptual possibilities therein. What my extended example demonstrates is the extent to which the brain historically adopted into the terms of its materiality and dimensionality the malleable contours of only topologically possible spatial arrangements. To prove that this formulation is valid in the context of a more general historical-conceptual analysis of modern neuroscience will be the overarching concern of the chapters that follow.

In the remaining chapters I will ask how some historically and scientifically central formulations of the materiality of the brain have relied upon underlying and occasionally paradoxical neuro-cerebral topologies in order to ascribe to the brain a set of extra-physical properties, to make it more than just a physical thing, in other words, and therefore to make it the place in which the human subject can be situated, defined, and expressed. I will show how some neuro-cerebral topologies central to the elaboration of important neurophysiological doctrines, such as Descartes' pineal doctrine and the later eighteenth-century conception of the *sensorium commune,* actually resulted in aporias when it came to determining the material nature of the brain and nervous system. But I will also show how it came to pass, particularly during the nineteenth century, that the materiality of the brain actually began productively to embody some material inconsistencies in order to be able to correspond with complex and dominant neuro-cerebral topologies. The neurophysiology of John Hughlings Jackson is an example of a

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[114] Warren McCulloch, "Finality and Form," *Embodiments of Mind,* 274, emphasis added.
[115] I offer an entirely different topological view on Gall in Chapter Four.

nineteenth century correspondence between the topology and materiality of the brain and nervous system, and I expand on this much more in Chapter Four.

Therefore, the trajectory I attempt to illustrate in the remaining chapters tells the story of the greater correspondence between the complex spatiality and the materiality of the brain. The question I wish to examine is at what point, in what ways, and according to what problems does the matter of the brain come to correspond and be transformed in relation to what the brain is asked historically, scientifically, and philosophically to encapsulate and stage. I would like to understand why it became necessary for the brain's materiality and dimensionality to embody properties that were spatial in only the most abstract topological sense. And in so being transformed, what had the brain become?

Warren McCulloch's neurophysiology is useful in the context of this dissertation because it comprises something like an historical and theoretical endpoint, where, as I have suggested, the brain's material dimensionality was imagined in only the most complex topological terms. To understand how this point was reached, it is necessary to know at what point it began. Over and against Norbert Wiener's insistence that Leibniz was the philosophical progenitor of cybernetics, McCulloch had asserted in his semi-autobiographical essay, "Recollections of the Many Sources of Cybernetics" that "cybernetics really starts with Descartes rather than with Leibniz."[116] The reasons he provided concerned Descartes' foundational role in the discovery of the concept of reflex, and in particular his theorization of the processes of coding and encoding that took place between the body and soul through the utilization of "figures" (which I discuss in the following chapter).

For McCulloch, Descartes was not the dualist often believe to have established the mind and brain sciences by severing them from each other. Indeed, Descartes was able to appreciate that the body, far from being an aggregation of brute matter, actually possessed a kind intelligence on its own, in the form of its intricate and automatized functionality. Descartes realized, McCulloch suggested, that the soul did not simply reign over the body, but that their interaction was a complicated negotiation between the quasi-intelligent organizational order of the body and a rational soul whose absolute independence from the body could be manifest in only a few, infrequent, and relatively difficult mental activities. Not only did Descartes emphasize the significance of the soul-body interaction, he even gave it a privileged site: the pineal gland — a place in the brain like no other, a domain that was as different from both the soul and the body as it was related to them. It is to be the starting point for a history of the problem of cerebral topology.

[116] McCulloch, "Recollection of the many sources of cybernetics," 26.

Chapter Two

MATERIAL TRANSLATIONS AND THE ECSTASY OF THE BRAIN: LOCATING THE HUMAN IN DESCARTES' NEUROANATOMY

The Space of the Human Subject in Cartesian Science

Shortly after the death of René Descartes in 1650, one of the greatest concerns for the Cartesian disciples was a topic about which the philosopher had said almost nothing: the precise status of the soul once the body, to which it was conjoined, finally died.[1] Descartes never spent much time elaborating on the particular nature of the soul's immortality, deducing it only by the fact that — as he writes in the *Sixth Meditation* — "I am really distinct from my body, and can exist without it."[2] The main problem in considering the nature of the soul without the body was that it was unrecognizable to some degree. While the soul was in possession of a set of faculties unavailable to any corporeal or material entity, including pure intellection, volition, and capacity for novel intuitions,[3] many important and distinctly *human* mental traits were a consequence of the body's role in the soul-body union, including sensation, imagination, and memory. A soul without a body would lose the ability to remember who it was; it could no longer be receptive in any sense to the world around it, or productive of new combinations of sensory images. Its activities would be restricted to the willed and infinitely repeated act — being unable to remember the repetition — of producing the only ideas to which the soul alone had access: namely, the idea of God and of its own existence. Such a soul would no longer be recognizably *human*.

Nevertheless, the Cartesian soul has been an important object of inquiry and concern in the history of Western philosophy, though mainly in terms of how its ontological certainty is deduced, grounded, and abbreviated in the metaphysical formulation of the *Cogito.* Even scholars less concerned with the question of the ontological and epistemological grounds of subjectivity in Descartes' metaphysics, opting instead to examine the process of sensory cognition in his theory of perception and psychophysiology, nevertheless take the soul to constitute an independent faculty division of the cognitive apparatus, in a sense maintaining a functional adherence to Descartes' dualism.[4]

Despite this centrality of adhering to the soul and the *Cogito* as the most valid formulation of the Cartesian subject*,* I nevertheless want to emphasize the importance of what

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[1] John Cottingham mentions the case of Louis de la Forge briefly in "Cartesian dualism: theology, metaphysicsc, and science," in *The Cambridge Companion to Descartes,* ed. John Cottingham (Cambridge University Press, 1992), 241.

[2] AT VII 78: CSM II 54. In his letter to Friar Marin Mersenne on November 25, 1630, Descartes explained that in his "little treatise on Metaphysics" he "set out principally to prove *the existence of God and of our souls* when they are separated from the body, from which their immortality follows" (AT I 182: CSMK 29). All references are to the standard Franco-Latin and English editions of Descartes complete works: Charles Adam and Paul Tannery, ed., *Oeuvres de Descartes,* 12 vols (Paris: J. Vrin, 1974-1982); hereafter cited as AT; John Cottingham, Robert Stoothoff, and Dugald Murdoch, ed., *The Philosophical Writings of Descartes,* 2 vols. (Cambridge University Press, 1985); hereafter cited as CSM I & II. The third volume of the preceding citation, by the same editors and translators, includes Anthony Kenny (Cambridge University Press, 1991), and is hereafter cited as CSMK.

[3] In a letter to Arnauld, Descartes explains, "Now for the mind to recognize this [repetition or recurrence], I think that when these traces were first made it must have made use of *pure intellect* to notice that the things which was then presented to it was *new and had not been presented before; for there cannot be any corporeal trace of this novelty*" (AT V 220: CSMK 356, emphasis added).

[4] See for example, Alison Simmons, "Descartes on the Cognitive Structure of Sensory Experience," *Philosophy and Phenomenological Research* 67, no. 3 (Nov., 2003): 549-579.

Descartes himself implicitly delineated as a distinctly *human* subject, a necessarily embodied mind identified in the *Meditation* as the mind-body "union" [*unione*][5] It is easy to forget that Descartes was not necessarily, or at least not only, constructing that idealized (rational and immaterial) modern-philosophical subject to which we give him credit (or attribute blame) as much as he was also attempting to demarcate the empirical-theoretical composition of a *human* subject. He was doing so according, on the one hand, to key metaphysical presuppositions and, on the other, to the intricacies of the body's corporeal realities — which presented a recognized complexity not easily reducible to mechanistic philosophy. Some scholarship has already pointed out how the human was a distinct analytical concept for Descartes, prompted by the notable reference near the end of the *Meditations* to "my whole self [*me totum*] insofar as I am a combination of body and mind [*corpore et mente sum compositus*]"[6] Scholars have argued that a strictly dualistic perspective would be inadequate to describe a specifically human subject as it would emerge from the substantial union of soul and body. Others have even proposed an ontological "trialism," suggesting that, if the *union* of soul and body were not in and of itself a substance entirely distinct from mind or matter, then at least the union would be an irreducible property that demanded an independent analysis.[7]

The ontological questions aside for the moment, it is nevertheless reasonable to identify a distinctly *human* subject in Descartes' combined metaphysics and science — a sort of physical-theoretical amalgam, outlined according to its ontological and epistemological finitude in the *Meditations* ("I am, as it were, something intermediate between God and nothingness, or between supreme being and non-being"[8]), but whose functionality was delineated in psychophysiological terms.[9] It is not necessary to oppose the formulation of a human subject with the classical conception of the Cartesian soul or *Cogito,* since it is both permissible and plausible to see how multiple models of the notion of "subject" could be equally present in the work of Descartes.[10] Nevertheless, in a very important sense, the Cartesian human is neither strictly metaphysical, nor strictly psycho-physical, and while it may be tempting to consider the *Cogito* as something of a philosophical relic, I will suggest below why Descartes' early modern articulation of a *human* subject is relevant for us today.

Unsurprisingly, Descartes' scientific writings, in particularly the theoretical physiology, provide the only real details pertaining to the key condition according to which a Cartesian human subject can be said to emerge: namely, the soul's actual union with the body. Unfortunately, Cartesian science has often been conceived of as a deleterious extension of Descartes' metaphysics in the sense of the violent disenchantment of nature it represents, in

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[5] AT VII 81: CSM II 56.

[6] AT VII 81: CSM II 56. Paul Hoffman argues that for Descartes the human is a being in itself, an individuated whole or unity greater than just the combination of soul and body in "The Unity of Descartes' Man," *The Philosophical Review* 95, no. 3 (July 1986): 339-370. Annie Bitbo-Hespériès mentions that Descartes was engaged in a new anthropology in "Cartesian Physiology," in *Descartes' Natural Philosophy,* ed. Stephen Gaukroger, John Schuster, and John Sutton (New York: Routledge, 2000), especially 368-373.

[7] John Cottingham, "The Mind-Body Relation," in *The Blackwell Guide to Descartes' Meditations*, ed. Stephen Gaukroger (New York: Blackwell, 2006). See also Lilli Alanen, "Reconsidering Descartes's Notion of the Mind-Body Union," *Synthese* 106, no. 1 (Jan., 1996): 3-20; and Daniel Garber, *Descartes Embodied: Reading Cartesian Philosophy Through Cartesian Science* (Cambridge University Press, 2000), 154-55.

[8] AT VII 54: CSM II 38.

[9] Steve Shapin suggests that Descartes' psychosomatic medicine exhibited properties that could resist a simple dualistic view of a person; see "Descartes the Doctor: Rationalism and its Therapies," *The British Journal for the History of Science* 33, no. 2 (June, 2000): 131-154, especially pages 147-148.

[10] Michel Foucault has described how Descartes work presents multiple modalities of subjectivity, including a form of the Stoic "meditative subject." See Foucault, "My body, this paper, this fire," and "Reply to Derrida," in *History of Madness,* trans. Jonathan Murphy and Jean Kkalfa (New York: Routledge, 2006), 550-590.

terms of the mathematical-physical modernization of the world, the mechanistic de-animation of the body, and the severing of body from the soul.[11] The deprivileging of Descartes' science had even begun, in fact, shortly after his death. Since if Nicolas Malebranche was indeed converted to Cartesianism in 1664 on the basis of his reading of Descartes' anatomical treatise, *Traité de l'homme,* and if his first act as a Cartesian was to disavow, for the sake of the metaphysics, the entirety of Cartesian science based on what at the time were deemed to be its unsustainable premises, then as historian Jacques Roger asserts, from its outset "Cartesianism was already no longer faithful to the spirit of Descartes."[12] Cartesian science has often been taken at best as a supplement to the metaphysics, and at worst a hindrance to it. Of course, nothing was perhaps more originally Cartesian than Descartes' theory of science — quite literally, in fact, since Descartes' turn to more metaphysical concerns occurs in 1629, during the second period of his scholarship.[13] Indeed, Descartes' science ought to be taken as a parallel theoretical pursuit, on equal footing, I would suggest, with the metaphysics. After all, to whatever extent the question of science was supplanted by Descartes' metaphysical turn, as Jean-Luc Marion points out the metaphysics of the *Meditations* was by no means intended to negate or occlude either the *mathesis universalis* or Descartes' more general method,[14] but was instead presented in part as a means by which to ground (or "root"[15]) Cartesian science more rigorously, while at the same time to ascribe to it a metaphysical force it could not have previously possessed.[16] As Descartes' physics and physiology continued to develop throughout the 1630s and 40s, they in turn shaped significant premises of his philosophy.[17]

Therefore, it is not simply to the metaphysics and to the direct account of the soul that we must look in order to understand the precise parameters of the Cartesian human — of the

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[11] Of course aspects of Descartes' physics, specifically the theory of vortices, remained relatively "pre-modern," so to speak. See Alexandre Koyré, "Newton and Descartes," in *Newtonian Studies* (Chicago: University of Chicago Press, 1965).

[12] Nicolas Malebranche, *Philosophical Selections,* ed. Steven Nadlter (Indianapolis: Hackett, 1992), vii. Jacques Roger, *The Life Sciences in Eighteenth-Century French Thought,* trans. Robert Ellich (Stanford: Stanford University Press, 1997), 123.

[13] Stephen Gaukroger, *Descartes: an intellectual biography* (Oxford: Clarendon Press, 1995), especially chapters 3-6.

[14] Descartes' conception of method in the *Discourse of Method* is understood as an extension of the major premises of his *Regulae ad Directionem Ingenii.* See Daniel Garber, "Descartes and Method in 1637," in *Descartes Embodied*. For the significance of method in early modern philosophy, especially as it relates to Descartes, see Graukroger, *Descartes: an intellectual biography,* 111-115. Generally, the notion of method is the reduction of a proposition to simpler assumptions, leading finally to an initial, self-evident intuition, on which, deductively, new propositions can be built. *Mathesis universalis,* on the other hand is concerned specifically with order and the science of ordering. See for example John A. Schuster, "Descartes' *Mathesis Universalis,* 1619-28," *Descartes: Philosophy, Mathematics, and Physics,* ed. Stephen Gaukroger, John Schuster, and John Sutton (Sussex: Harvester Press, 1980). The two concepts were linked but not absolutely identical in the *Regulae.* See Garber, "Descartes and Method in 1637" for more on the differences.

[15] As Descartes writes in the prefaces to the *Principles of Philosophy,* "Thus the whole of philosophy is like a tree. The roots are metaphysics, the trunk is physics, and the branches emerging from the trunk are all the other sciences, which may be reduced to three principal ones, namely medicine, mechanics, and morals." AT IXB 14: CSM I 186.

[16] Jean-Luc Marion, "Cartesian Metaphysics and the Role of the Simple Natures," *The Cambridge Companion to Descartes*. Marion suggests, however, that in so doing, the metaphysics reveals itself as the sole means by which the foundations of certainty could ever have been reached. Daniel Garber disagrees to an extent arguing that nothing of the original method is present in the *Meditation.* See Garber, "Descartes and Method in 1637," in *Descartes Embodied.* But Garber does point out how Descartes imagined "that the program of the *Meditation* is not an autonomous philosophical project, but the prelude to a larger scientific program," in "Semel in Vita: The Scientific Background to Descartes' *Meditations," Descartes Embodied*, 223.

[17] Gary Hatfield, "Descartes' Physiology and its Relation to His Psychology," in *The Cambridge Companion to Descartes.*

rational, willful, living, and fully embodied agent in the world. The metaphysics in general and the dualism in particular comprised the antecedent conditions which delimited the ontological possibility of the human as both mind and extended matter. But while the dualism was a requisite for the description of the human subject, it was not necessarily the description itself. It is necessary instead to look at the details of the union of the soul and the body, not as a reiteration of the dualism but as an account of a complex economy taking place across the Cartesian ontological divide, an economy based both on the interaction of soul and body as well as on the maintenance of the radical incommensurability between them. Such an examination would also keep in mind that according to Descartes, the human body was not simply brute matter, but a quasi-intelligent and systematically automatized entity functioning independently of the soul.

What is perhaps most important in understanding Descartes' implicit notion of a distinctly human subject, is acknowledging the one very specific site in which the union of soul and body was staged — that is, the brain. My concern, therefore, will be with how the brain in Descartes' psychophysiology as well as in his metaphysics became the site and operation of the soul-body interchange, and with understanding the specific processes involved in that interaction. The brain as it was anatomized and theorized by Descartes — and because it was that "certain part of the body where [the soul] exercises its functions more particularly than in all the others"[18] — constituted the central site of the physical-metaphysical composition of the human subject because it provided the only terms of the union of the soul and body and ultimately encompassed the only processes that were involved. Descartes was in some senses sketching the contours of a problem that he would not himself have even been able to articulate, since the Cartesian human subject was in some ways more metaphysically encapsulated by the brain than we are today, even as the discourses of modern neuroscience are close to overtaking the entire meaningful scope of the contemporary notion of the self.

But it was not, for Descartes, simply the brain that encapsulated the very conjoining of body and soul — it was not "only by the brain" that the mind was corporeally and physically affected, but rather "one small part of the brain,"[19] namely, the pineal gland. This little cone-shaped bulb of nervous tissue (thus the Latin, *conarium*), no bigger than a pea and tucked away in what was for Descartes the effective center of the brain, performed a function whose immensity truly belied its paltry size. By virtue of a capaciousness that no other material or even conceptual Cartesian object possessed, it staged the operational commensurability between Descartes' two ontologically incommensurate domains. By constituting the site of an absolutely metaphysical encounter too expansive to be satisfied or delimited by mind or matter alone, the pineal gland, I will argue, was ultimately a problem of *space*. In other words, what sort of *space* was the pineal gland such that it could be as metaphysically capacious as it was? How could this little gland make room for such an extraordinary encounter?

The pineal gland was not simply the place where soul and body met in an uncomplicated convergence and interaction. Rather, as I will show, the pineal gland was the very *site* of the *problem* of the unity between soul and body; it was the space that encompassed whatever mutuality could exist between the soul and the body, but it also constituted the *gap* or separation that defined their incommensurability. In the pineal doctrine, discussed primarily in the early though posthumously published, *Traité de l'homme,* and in the final work, *Les Passions de l'Ame*, what at first appears to be an account of the singular anatomical site that fully demarcated any and all interchanges between a body and soul becomes instead a complex meditation on locality, materiality, and the final divisibility of matter and mind.

[18] Descartes opens paragraph 31 of *Les Passions de l'Ame* with this line. AT XI 352: CSM I 340.
[19] *Sixth Meditation*. AT VII 86: CSM II 59.

The unity of soul and body, the very question of the human subject, plays out in and as Descartes' theory of the brain; but this unity and interchange does something very peculiar to the brain itself — to the brain and, specifically, the pineal gland, as a material entity and a space or locale where different ontologies converge. This suggests that the human subject was not itself a simple entity in Descartes' work, not an easy account of the soul's effect on and affectedness by the body. At the center of such a precarious union, at the site of the pineal gland, a set of concepts including matter and space become something other than what they are, and what Descartes had imagined them to be. In order to offer an understanding of what it means to describe a Cartesian *human* and *embodied* subject, it is first necessary to recognize the precarious theoretical obligations this places on the brain as both the object and site of the ontological negotiation of soul and body.

The Pineal Gland: Material Constraints and Ontological Instabilities

An analysis of the pineal gland, the seat of the soul, in its relationship to Cartesian psychophysiology must find its natural place somewhere in the middle of Descartes' metaphysical dualism, which can itself be summed up with the following lines from *Les Passions de l'Ame:* "We have no conception of the body as thinking in any way at all"[20]; "there is nothing in us which we must attribute to our soul except our thoughts"[21]; and "the soul is of such a nature that it has no relation to extension, or to the dimensions of other properties of the matter of which the body is composed."[22] It is by virtue of this ontological schism that Descartes' role specifically in the history of brain science, not to mention in theories of corporeal experience that take the human body as the agent of psychic and mental life, is taken to be flawed.[23]

Despite Descartes' theoretical division, the soul was always figured in some kind of relation to the body or corporeal space. So that while the soul may not indeed have had any relation to extended matter, still it could not fully, according to Descartes, avert a fundamental relation to some aspect of the body's dimensionality. While he more cautiously suggested in the *Meditations* that "the whole mind *seems* to be united to the whole body" [*toti corpori tota mens unita esse* videatur][24] by the time he wrote *Passions*, the relation was more emphatic: "[the soul] is related solely to the whole assemblage of the body's organs." [25] This relation, which specifies the precise parameters of the possible, if only still provisional corporealization of the soul, should not be taken as anomalous or contradictory to Descartes' earliest positions. He was not, in spite of everything, an entirely divisive metaphysician and there are early instances of a more robust ontological inclusivism. For example, in his early *Regulae ad Directionem Ingenii* [*Rules for the Direction of the Natural Intelligence*] written between 1620 and 1628, but never published, Descartes insisted that it is difficult to identify a distinctly *human* understanding that might somehow exist in absolute isolation from the set of other mental faculties that were, through and through, corporeal in nature.[26]

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[20] AT XI 329: CSM I 329.
[21] AT XI 342: CSM I 335.
[22] AT XI 351: CSM I 339.
[23] Thus the title of neurobiologist Antonio Damasio's *Descartes' Error: Emotion, Reason, and the Human Brain* (New York: Avon Books, 1994).
[24] AT VII 86: CSM II 59.
[25] AT XI 351: CSM I 339.
[26] "As for ourselves, there are only four faculties which we can use for this purpose [of knowing], *viz.* intellect, imagination, sense-perception and memory. It is of course only the intellect that is capable of perceiving the truth, but it has to be assisted by imagination, sense-perception and memory if we are not to omit anything which lies

The pineal doctrine, in specific relation to Cartesian metaphysics, is best thought of more as a combined theoretical and empirical problem, rather than as the scientific elucidation of a metaphysical assumption. The pineal doctrine was itself a late formulation of the classical doctrine of the seat of the soul, which throughout much of antiquity and the Middle Ages had been presented as variations of a ventricular theory — that the rational soul rested in one of the cavities of the brain's ventricular system, typically along with the *sensus communis* and the imagination, which occupied the other ventricles.[27] This general and prolonged doctrine segregated the brain into a set of divisions that, in terms of the cerebral topology that it produced, blurred the brain's fundamental ontological status by making each of the divisions concurrently and indistinctly physical as well as immaterial. This was reinforced in many ways by the fact that the ventricle was, from the standpoint of the relative solidity of the brain, an open space filled with fluid. What followed this doctrine in the sixteenth and early seventeenth centuries was a greater anatomical focus on the cerebral convolutions and the sites that were thought directly to produce or somehow at least to motivate the production of the animal spirits — the speculative and ethereal molecules that facilitate the physical operations of the brain and body. Descartes' focus on the pineal gland, that "certain little gland which lies near the middle of the substance of the brain, just at the entrance to its cavities,"[28] orchestrating the flow of animal spirits, should historically be understood within the context of this ventricular-anatomical trajectory, and one that continued to bear the traces of the ontological confusions from which it genealogically emerged.

Nevertheless, the novelty and noteworthiness of the pineal doctrine was a consequence of the specific functionality Descartes attributed to the gland. He was not the first to observe the pineal gland as an anatomical subdivision of the brain, but he was the first to assign to it such a significant role. While the soul was conjoined to the totality of the body, still it was in the pineal gland where the soul's functions were "more particularly" manifest, and through the pineal, in effect, that the soul could act on and be affected by the body. Not only, therefore, was the pineal the site where the body and soul could interface, but through its role as the central intermediary and conductor for the flow of all animal spirits, it was the organ that facilitated many of the body's own self-sustained mechanical operations that could transpire independently of the soul.[29] It was the first true modern axis of a philosophical-physiological subject.

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within our powers" (ATX 411: CSM I 39). For Descartes, memory, imagination and sense-perception are all faculties rooted in corporeal-material processes.

[27] See Max Neuburger, *The Historical Development of Experimental Brain and Spinal Cord Physiology Before Flourens,* trans. Edwin Clarke (Baltimore: The Johns Hopkins University Press, 1981), 25-30; and Stanley Finger, *Origins of Neuroscience: A History of Explorations into Brain Function* (Oxford: Oxford University Press, 1994), 18-23. For accounts of the *sensus communis,* both philosophical and anatomically in relation to Descartes see Edwin Clarke and Kenneth Dewhurst, *An Illustrated History of Brain Function* (Berkeley: University of California Press, 1972); Dennis L. Sepper, *Descartes's Imagination: Proportion, Images, and the Activity of Thinking* (Berkeley: University of California, 1996), especially chapter 1; David Summers, *The Judgment of Sense: Renaissance Naturalism and the Rise of Aesthetics* (Cambridge University Press, 1987), especially chapter 5. K.D. Keele, "The Search for the Sensorium Commune," *Anatomies of Pain* (Springfield, IL: Charles C. Thomas, 1957).

[28] AT XI 129: René Descartes, *The World and Other Writings,* ed. Stephen Graukroger (Cambridge, 1998), 106. Hereafter cited as *WW.*

[29] This is the basis of the premise according to which Descartes is thought to have originated a general notion of reflex action. This premise has been disputed in terms of the psycho-physiological concept of reflex that is refined in the eighteenth and nineteenth centuries; see Georges Canguilhem, *La formation due concept de réflexe aux XVIIe et XVIIIe siècles* (Paris : Presses Universitaires de France, 1955). Still it suffices to say that according to Descartes, the human body is largely, almost nearly, autonomic, in two senses. The first refer to the activities performed as a result of the learned operations of the body, as is evident from this most remarkable passage from *L'Homme*: "But the effect of memory that seems to me to be most worthy of consideration here is that, without there being any soul present in this machine, it can naturally be disposed to imitate all the movements that real men — or many other

Of course, while it was the specified functionality of the pineal gland that made Descartes' doctrine so notable, the articulation of that functionality raised the greatest problems. After all, the pineal had to enable the operational compatibility of the soul and body, but it had to do so while ensuring their metaphysical incommensurability. The gland needed from the start to possess a sort of double essence, as a physical site that could nevertheless maintain and facilitate an openness with what was extra-physical. But how exactly could the pineal, still corporeal, do what the body was on its own not technically able to do, which was to enter directly into the economy of the soul? Furthermore if the soul was indeed related "*solely* to the *whole assemblage* of the body's organs," and if the pineal gland was the precise site of this relation, then was the singular pineal gland somehow also equivalent to the organizational totality of the body? And if so, how could such an equivalence be possible? This line of thinking will require a reconsideration of the pineal that exceeds typical understandings of Descartes' mechanical materialism.

In order to consolidate the pineal gland's integral role in his theoretical psychophysiology, Descartes conferred upon it several significant philosophical as well as anatomical characteristics. First and foremost was the fact that the pineal was situated in "the most interior [*la plus intérieure*] part of the brain."[30] This exceptional interiority should not only be understood in strictly physical terms — that the gland, unattached except by a stem, was positioned directly in the middle of the organ. Instead, the pineal, in its greatest anatomical interiority, came to be figuratively linked with the fundamental interiority of thought itself, defined in the *Principia Philosophiæ* as "everything which we are aware of as happening within us."[31] In this sense, it is important to keep in mind that the anatomical or physiological register was not the only one in which the pineal gland was operating. The gland displayed, in addition to its biology, a set of extra-biological capacities that relied in many ways on its morphological characteristics alone. That is to say, the strictly formal attributes of the gland in terms of its structure and position contributed to its function in mediating the body-soul economy.

Therefore, the interiority of its anatomical position tied the gland formally to "the most interior" aspect of subjectivity, namely thought. As a consequence of this point alone, we might consider how the pineal gland possessed and activated its extra-physical attributes and whether, from the start, it should have even been called a strictly material entity. On the other hand, Descartes took advantage of the fact that the pineal was located not only in the middle of the brain, but in the middle of its hemispheric divide, acting as the exception to the brain's and body's two-sided symmetry.

> Apart from this [pineal] gland, there cannot be any other place in the whole body where the soul directly exercises its functions. I am convinced of this by the observation that all the parts of our brain are double, as also are all the organs of our external senses…. But insofar as we have only one simple thought about a

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similar machines — will make when it is present" (AT XI 185: *WW* 157). The second sense of the body's automaticity refers to an independent functionality arising only from the particular arrangement and organization of its bodily organs. Such a formulation appears in *Description of the Human Body,* where Descartes writes, "It is true that we may find it hard to believe that the mere disposition of the bodily organs is sufficient to produce in us all the movements which are in no way determined by our thought" (AT XI 223: CSM I 315).

[30] AT XI 352. Catherine Malabou detailed this significance of "*la plus intérieure*" in the context of a seminar, titled "On Wonder from the Passionate Soul to the Emotional Brain: Affects in Philosophy and Neurobiology Today." Department of Rhetoric, UC Berkeley, Spring 2008.

[31] AT VIIIA 7: CSM I 195. In the *Passions,* Descartes also writes, "It is easy to recognize that there is nothing *in us* which we must attribute to our soul except our thoughts" [*Il est aisé de connaître qu'il ne reste rien en nous que nous devions attribuer à notre âme, sinon nos pensées*] (AT XI 342: CSM I 335).

> given object at any one time, there must necessarily be some place where the two images coming through the two eyes … can come together in a single image or impression before reaching the soul… We can easily understand that these images or other impressions are unified in this gland….[32]

The gland's singularity and unity in the midst of the body's dual symmetry allowed it to perform, as the *sensus communis,* the function of unifying the multiplicity of sensory data, a function which had long been attributed to various subdivisions of the brain. Descartes was, after all, by no means the first to ascribe a metaphysical formalism to anatomy. Nevertheless, the totality of the pineal gland's formal characteristics more and more ensured its relation of isomorphic resemblance to the soul. The soul was, after all, the essence of unity as such, and in its greatest physical interiority, the pineal gland was discursively confounded with the soul "whose whole essence or nature is simply to think."[33] Furthermore, when Descartes described the pineal gland as the "only solid part in the whole brain which is *single,*"[34] he not only meant that it was not divided like the brain's double hemispheres, but that it was simple and *indivisible;* Descartes never described the pineal gland in terms of its parts or subdivisions, always addressing it as if it were a total entity.[35] From the outset, this isomorphic relation between the gland and the soul established the basis by which the pineal could accomplish what the body on its own could not, and further suggests that the pineal gland existed in a certain state of oscillation, as far as its ontology was concerned, between the two modes Cartesian substance.

If, however, the pineal gland were able formally to transcend entirely its material state, then we would have to affirm its correspondence to the theoretical tenets, for example, of a much later Romantic biology, where the formal conditions according to which living matter was organized not only systemically cohered all life, but in that systemic coherence, bestowed an ideational significance to nature and organized matter. But unlike Romantic *Naturphilosophie,* the pineal gland was metaphysically obliged to abide by the terms of Cartesian materialism, in which "the nature of matter, or body considered in general, consists … simply in its being something which is extended in length, breadth and depth."[36] It therefore does not suffice to say that the nature of the pineal's organization, in terms of its form and position, was enough to put the gland into the direct relation it indeed had, and must have had, with the soul. A straightforward formal correspondence cannot be fully justified in the light, and weight, of Descartes' materialism, and it may not be entirely accurate to say simply that the pineal was granted spiritual access solely as a result of its soul-like physical analogy.

In fact, the pineal gland's material fixity is precisely what rescues it from complete physical dissolution, since the soul, as Descartes writes in the *Discourse on Method*, "does not require any place," despite its ontological certainty.[37] The soul, in other words, was without location or spatial positionality; it was not *in* the body to be sure, but it was also not *outside* the body either. The soul was in and of no place. If the pineal gland were formally to correspond too closely to the soul, then it would, precisely on the basis of its physical features and positionality

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[32] AT XI 353: CSM I 340.
[33] *Discourse on Method,* AT VI 33: CSM I 127.
[34] He writes this in a letter to Mersenne, December 24, 1640. AT III 264: CSMK 162.
[35] Stephen Voss has identified the ways in which the pineal gland deviates from other material entities, based on how it does not conform to Descartes' "microreductionism." See Stephen Voss, "Simplicity and the Seat of the Soul," in *Essays on the Philosophy and Science of René Descartes,* ed. Stephen Voss (Oxford University Press, 1993). For Voss, this is what renders the pineal gland "deeply inexplicable" (134). My point is not to abandon the pineal gland for this reason, but to try to understand the dimensions of its inexplicability.
[36] *Principles of Philosophy,* AT VIIIA 42: CSM I 224.
[37] AT VI 33: CSM I 127.

alone, come to be equivalent with what was without any sense of location at all. This would be a strange and precarious equivalence, one which would be predicated on the possibility that the formal organization of matter alone could allow for an abstraction beyond the point of any measure of space. On the other hand, however, the soul was not entirely devoid of spatial referentiality, since as I noted earlier, it was "related solely to the whole assemblage of the body's organ." As Descartes writes in *Passions,* this

> is obvious from our inability to conceive of a half or a third of a soul, or of the extension which a soul occupies. Nor does the soul become any smaller if we cut off some part of the body, but it becomes completely separate from the body when we break up the assemblage of the body's organs.[38]

The soul, although without extension, size, shape, or position, nevertheless cohered in something akin to the organizational totality of the body — that is, the body not as an accumulation of discrete parts but as an organizational whole, in the totality of which a soul was present. Descartes continues, "the body is a unity which is *in a sense indivisible* because of the arrangement of its organs,"[39] which inverts an earlier sentiment from the *Meditations:* "There is a great difference between the mind and the body, inasmuch as the body is *by its very nature always divisible*, while the mind is utterly indivisible."[40]

Ultimately the pineal gland's morphological resemblance with the soul was not *tout court* the condition by which living matter entered into an interchange with the intellect. The resemblance simply opened the door to what Descartes calls the body's "intermixing"[41] with something that, while neither within, without, nor tantamount to the body, was nevertheless *of* the body in a very different dimensional sense. But in what sense was the soul *of* the body? How is it possible to describe this relation of the soul's corporeal belonging or the body's spiritual possession? Although the pineal gland was an anatomical object, it would be wrong to assume that its only noteworthy relationship was with the soul. For despite its materiality, it nevertheless had a curious relationship with the body properly understood. To understand how the soul could be *of* the body, it is necessary to turn, initially though perhaps counterintuitively, to the pineal gland's own relation with the body, or to put it another way, to an aspect of the body's own relation to itself.

In *Traité de l'homme, Passions,* and in other texts that took up the subject of anatomy directly, Descartes described the distribution of the nervous system as a sinuous network of conduits that extended throughout the entirety of the body. In *Passions,* for example, he writes, "There is the marrow, or internal substance, which extends in the form of tiny fibers from the brain, where they originate, to the extremities of the parts of body to which they are attached."[42] Each nervous conduit could be isolated as a single linear thread extending from one of the many tubules that extended out from the brain and which carried within them the animal spirits. Descartes describes the overall system and function of the nerves and nervous conduits according to two overlapping metaphors — the pipes of a church organ and the hydraulic pipelines of a fountain. The first metaphor provided an overview of the function of the nervous transmission of animal spirits:

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[38] AT XI 351: CSM I 339-340.
[39] AT XI 351: CSM I 339, emphasis added.
[40] AT VII 85-86: CSM II 59, emphasis added.
[41] "Mêlé" in French; "permixtum" in Latin.
[42] AT XI 337: CSM I 333.

> You can think of our machine's heart and arteries, which push the animal spirits into the cavities of the brain, as being like the bellows of an organ, which push air into the wind chests; and of external objects, which displaces certain nerves, causing the spirits from the brain cavities to enter certain pores, as being like the fingers of the organist, which press certain keys and cause the wind to pass from the wind chests into certain pores.[43]

In this general picture of the nervous economy, the animal spirits, which are rarified in the heart and from the blood,[44] rise up to the brain where they are effectively stored in its cavities.[45] External stimulation in the form of sensation immediately moves a nerve which leads directly and continuously from a sensory organ to the brain. This stimulation mechanically induces the animal spirits to flow into the pores of the brain in order to be distributed back into the nervous conduits of the body.

The hydraulic metaphor — that "the nerves of the machine that I am describing can indeed be compared to the pipes in the mechanical parts of [the grottoes and fountains in the royal gardens]"[46] — is evident in Descartes' own example of what later is referred to as his incipient account of reflex. In a sense, the hydraulic metaphor arises from a slightly more detailed account of nervous transmission. According to Descartes, nervous fibers, which are like pipes or conduits, can extend from the innermost part of the brain throughout the entire body in the form of sensory nerves. If one nerve is stimulated painfully, as in the example of a fire burning one's foot, the entire nervous fiber, like a thread, is "pulled," which opens a pore in the brain located at the end of the thread. Animal spirits flow like water into the pore, and therefore down through the painfully stimulated nervous conduit, "some to the muscle that serve to pull the foot away from the fire, and some to the muscle that make the hands move and whole body turn in order to protect itself."[47]

But this metaphor is slightly misleading, since Descartes was clear to say that the linearity of the nervous conduit did not indicate a causal chain. In other words, nervous activity was not meant to be not an afferent or efferent set of chain reactions occurring between an extremity and the brain, one which would constitute a temporal delay from the time of stimulation to the time of sensation and reaction. The brain was not moved a moment after a peripheral stimulation took place; rather this process was instantaneous such that both periphery and brain reacted *simultaneously:* "When [sensory fibers] are moved, with however little force, they *simultaneously* pull on the parts of the brain from which they come."[48]

Therefore, in the example of fire burning the foot, pain is felt because, as Descartes explains, the animal spirits are pervasive: "they never stop in any place, and as some of them enter the brain's cavities, others leave it through the pores in its substance."[49] These animal spirits permeate the nervous conduits at all times, and cause the conduits' internal fibers always to remain "completely free and extended" — which is to say, in an extremely responsive and unrestrained physical state — such that, "if anything causes the slightest motion in the part of the body where one of the fibers terminates, it thereby causes a movement in the part of the brain

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[43] *The Treatise on Man,* AT XI 165: *WW* 140.
[44] Ibid., AT XI 130: *WW* 106.
[45] See *Passions,* Part I, paragraph 10, AT XI 334-35: CSM I 331-32.
[46] Ibid., AT XI 131: *WW* 107.
[47] Ibid., AT XI 141: *WW* 117.
[48] *Treatise on Man,* AT XI 141: *WW* 117, emphasis added.
[49] *Passions,* AT XI 335: CSM I 332.

where the fiber originates."[50] When the nervous thread in the foot is stimulated and "pulled" by the fire, it is also stimulating and pulling the other end of the thread in the brain. Those animal spirits that converge onto the pineal gland or seat of the soul in order to produce the feeling of pain are not those which originated in the foot, but were those already at the opposite end of the nervous thread. In Cartesian physiology, the brain was not *reacting to* the body's sensory affections; it was reacting *along with* the peripheral sensory organs and, in a sense, *as* the body's physical response. Of course, the corresponding reaction was not predicated on the will of the soul since, "besides causing our soul to have various different sensations, these various movements in the brain can also act without the soul, causing the spirits to make their way to certain muscles rather than others, and so causing them to move our limbs."[51]

In the early *Regulae,* Descartes described this simultaneity between the brain and the corporeal periphery through the analogy of a writing instrument:

> When an external sense organ is stimulated by an object, the figure which it receives is conveyed *at one and the same moment* to another part of the body known as the 'common' sense [i.e., the pineal gland], *without any entity really passing form the one to the other*. In exactly the same way I understand that while I am writing, at the very moment when individual letters are traced on the paper, not only does the paper move, but the slightest motion of this part cannot but be *transmitted simultaneously to the whole pen.* All these various motions are traced out in the air by the tip of the quill, even though I do not receive of anything real passing from one end to the other.[52]

Descartes then immediately asks, "Who then would think that the connection between the parts of the body is less close than that between the parts of the pen?" In its state of internal simultaneity, the body was arranged in a state of complete self-proximity. Despite its extended nature, from head to foot in other words, a human body was not only arranged as an organizational whole, but every one of its movable and affectable parts was essentially simultaneous with, and in this sense temporally proximate with the brain, despite the spatial segregation. In this sense, any action performed on a peripheral and discrete part of the body was redoubled in the brain and, as the passage above specifies, specifically on the pineal gland.

As Descartes asserted, in nervous stimulation in the form of an external sensation, such as vision, the image of an object struck and stimulated the optic nerve at the same instant in which it struck the pineal gland. The pineal did not receive a substituted version of sensory stimulation (a representation in a weak sense). Instead it received that activity as directly as the sensory organ did, "without," as Descartes writes above, "any entity really passing form the one to the other." In this way, the pineal gland virtually redoubled that sensory organ and, in effect, every other nervous terminus. As a consequence of this physiological intra-bodily simultaneity, the pineal gland constituted the virtual redoubling of every nervous affection that could take place throughout the entire body — every stimulation, sensation, or motion that would require the function of the nerves and animal spirits. It would be wrong to consider the pineal gland as a kind of homunculus. It was instead the entire nervous body re-instantiated into a sub-organ that could not properly be said to be composed of a differentiation of parts. In essence, the Cartesian brain, ultimately the pineal gland, by virtue of its temporal proximity with the entirety of the

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[50] *Passions,* AT XI 337: CSM I 333.
[51] *Passions,* AT XI 338: CSM I 333. Only in the case of movement do animal spirits "flow" into muscles in order to inflate them.
[52] AT X 414: CSM I 41. Emphasis added.

body did not simply redouble the body, but in so doing, re-posited a spatially differentiated assemblage of organs into a spatially indistinguishable unit. The pineal gland effectively re-presented the body's affections, whether volitional or passive — re-presented not in the sense of symbolically signifying the body, but in the sense of *re-locating the body* — displacing it, projecting and virtualizing it — *within itself*.[53]

Consequently, despite its morphological analogy with the soul, the pineal gland remained anchored in its material corporeality. And yet, its corporeality was not entirely commensurate with the body properly understood, since while it was a discrete sub-organ in the middle of the head, it was also the re-presentational and virtual reiteration of the entire body as an organization of parts. Only in this way could the soul, through the pineal gland, be united to "the whole assemblage of the body's organs."

In this sense, the pineal gland, the true Cartesian brain, was a necessary third term between the soul and the body — morpho-analogically related to the former, virtually and reiteratively related to the latter. Still, this third term constituted the sole location of the psychophysiological and metaphysical encounter between the soul and body, and while it somehow had to give room to this exchange, it still remains unclear with what sort of capaciousness it was able to do so. In the following sections, I will attempt to draw out the specific details of the encounter of body and soul, but not before drawing out two additional and very significant attributes of the pineal gland.

Cerebral Fictions and Fortifications

Descartes attributed to the pineal gland a set of significant additional properties that, while not entirely related to its precise functionality in mediating the interaction of the soul and body, nevertheless provide a more complete picture of the nature and role of this material and theoretical object within Descartes' broader system. One particular attribute appears briefly and faintly in a 1640 letter to Friar Marin Mersenne. In it, Descartes addressed a letter Mersenne had sent him from a French physician, Christophe Villiers. Villiers had made comments critical of Descartes' pineal doctrine, suggesting that one of the weaknesses of the argument was the fact that the pineal can suffer injury and harm no differently than the rest of the brain. "This is no reason why it should not be the principal seat of the soul," responded Descartes. "Although it is very small and very soft, it is situated in such a well-protected place that it is almost immune from illness."[54] Descartes was referring to the pineal's location, at nearly the exact center of the brain, as the condition of its protection and fortification. While the description is brief and easy to overlook, it is actually rooted in some very significant aspects of seventeenth century brain anatomy, as well as in some underlying aspects of Descartes' metaphysics.

First, it would not have been uncommon, particularly throughout the seventeenth century, to describe the brain according to metaphors of security and protection. A particularly noteworthy example of this kind of analogy appears in English physician, Humphrey Ridley's 1695 *Anatomy of the Brain.* Although he was an averred anti-mechanist who essentially rejected the pineal doctrine, Ridley nevertheless described the brain as "like a Castle, divided into many

[53] In *The Description of the Human Body,* Descartes explains that the body is comprised of an arrangement of organs which give to it an automatic set of movements neither dependent on nor related to the soul. These include the motions of the heart and blood, the motions involved in general nutrition, and those giving rise to organic development. Not only do they not depend on the soul, but they seem to operate independently of the brain and nerves; to say that the pineal redoubles the body, I mean that it redoubles the *nervous* body, the body which can rightfully be said to be *embodied* subjectively in the sense of being felt and moved.
[54] AT III 123: CSMK 149.

Towers or places of defense" and structurally "designed for its greatest safety."[55] It is important to keep in mind that, unlike other organs in the body, the brain could not for explanatory reasons be likened through analogy to many technical instruments or mechanical processes in the physical world. It lacked immediate isomorphy to recognizable objects as well as any distinct motion or observable physical operation, outside of secretion and blood circulation. The brain's precise functions remained opaque, and so it should not be surprising that the brain's structural complexity — namely its convolutions — was assigned a very general functionality that corresponded to both the operative epistemological and baroque political doctrines of the period — namely the centralization and safeguarding of sovereign reason. Through the figure of the castle, Ridley took the brain to be both bastion and fundament for reasoning built upon a design that could stave off the evils of physical illness or harm.

Although Descartes employed no explicit fortress-like metaphors of security, stability and solidity to describe the necessarily supple yet sheltered pineal gland, nevertheless such metaphors abounded within and to an extent propped up his system in a more general sense. The essence of Cartesian philosophy itself was, as a theoretical project, devoted less to imputing reason into subjects, than it was to ensuring the stability of fundamental and general principles. Indeed, the expressed objective of the *First Meditation* is "to establish anything in the sciences that was stable [*ferme* in French, *firmum* in Latin] and likely to last."[56] The thematic of stability, fixity, and certainty referred throughout the primary philosophical and methodological texts as much to the foundational principles being sought as to the regulative practice involved in seeking them. Metaphysics then, in essence and as a meditative practice,[57] was equivalent to the construction of a firmament, in the sense of a stable principled ground but also as an ideational vault that held soundly like the heavens above Descartes' head and to which he could always turn when any current principle seemed no longer to be valid.

Indeed, in the introductory lines of the *First Mediation* Descartes explains, "I realized that it was necessary, once in the course of my life, to demolish everything completely and start again right from the foundations…. Once the foundations of a building are undermined, anything built on them collapses of its own accord."[58] In the *Meditations,* Descartes sought to isolate an immovable ground — "just one thing, however slight, that is certain and unshakeable"[59] — which ultimately became the *cogito,* the formulation of ontological equivalence between a thinking and existing I. Upon discovering it at the end of the *Second Meditation*, Descartes decided to "stop here and meditate for some time on this new knowledge I have gained, so as to *fix it more deeply in my memory.*"[60] Given that memory was a distinctly cerebral faculty,[61] the statement can be rephrased to say that Descartes sought at the end of the *Second Meditation* to deposit his newly discovered stable ground of certainty within the recesses of a brain that could offer the same protection to it as it could to the well-protected pineal gland. It is reasonable to presume that the pineal gland would act in no other way than in accordance to the steady substratum of Cartesian metaphysics, as the place, in other words, that would stabilize, hold firm,

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[55] He continues, "If perchance any evil should happen to one or both the foremost Lobes, yet the latter, for that they are separated, may avoid the contagion of the neighboring and farther spreading of evil." Humphrey Ridley, *The Anatomy of the Brain* (London: Printed for Sam. Smith and Benj. Walford, 1695), 91

[56] AT VII 17: CSM II 12.

[57] On this point see Dennis L. Sepper, "The Texture of Thought: Why Descartes' *Meditationes* is Meditational and Why it Matters," in *Descartes' Natural Philosophy.*

[58] AT VII 18: CSM II 12.

[59] AT VII 24: CSM II 16.

[60] AT VII 34: CSM II 23, emphasis added.

[61] "I shall content myself with telling you more about how the traces are imprinted on the internal part of the brain, marked B, which is the seat of memory," *Treatise on Man* (AT XI 177: *WW* 150).

and consequently secure a potentially precarious encounter between body and soul, thereby ensuring the possibility of an embodied and specifically *human* subjectivity.

The second important attribute of the pineal gland is related to the extremely conjectural, nearly fictive, nature of its operations and role within the mind-body divide. Descartes in a fairly systematic way engaged in the strategic deployment of different categories and modalities of artifice, conjecture, and even fiction as the means by which to construct both his metaphysics and science. Some of these speculations and imaginings functioned quite famously as important formal and thematic elements of particular texts. In the *Meditations,* for example, Descartes specifically employed the methodological fiction of an evil demon who deceives Descartes into believing his experiences are real: "I shall think that the sky, the air, the earth, colors, shapes, sound and all external things are merely the delusions of dreams which he has devised to ensnare my judgment"[62] (this is a second-order fiction, really, as Descartes imagined an evil demon imagining him and his reality). This ruse was meant to be the technique by which the absolute indubitability of the *cogito* was achieved, an illusion not only by which certainty was discovered, but also by which illusion itself could be regulated and ordered. On the one hand, Descartes employed the ruse of the evil demon to combat the true epistemic threat of the dream — whose visions "are like paintings, which must have been fashioned in the likeness of things that are real"[63] — an illusion so illusory, that there was no way to confirm whether or not we were dreaming (which led Descartes simply to assumes that we were through the ruse). On the other hand, the ruse is not only productive in discovering the certainty of the *cogito* but, in the *Third* and *Fourth Meditations*, in confirming the subject's epistemic and ontological finitude. It was this finitude which in the *Sixth Meditation* was made equivalent to the human subject's corporeal nature. And so the bodily senses, which in the *First Meditation* were occasionally deceptive and illusory, became the necessary erroneousness of the human subject's corporeally finite essence — sensory illusion, in other words, ultimately acquired its proper place in the metaphysical order of the subject.

In Descartes' physiology, the strategy of the fictive was ascribed quite directly to the body itself, as a machine of simulation, a theater of effects built on hidden causes.[64] The body was presented as a device on view, the manifestation of uncanny spectacles which in the *Traité de l'homme* were initially likened to the artificial fountains in grottos and royal gardens built on concealed mechanisms that "unwittingly cause the movements which take place before [visitors'] eyes."[65] For Descartes, the body's theatricality assumed a simulative prowess in that, on its own, "without there being any soul present in this machine, it can naturally be disposed to imitate all the movements that real men — or many other similar machines — will make when it is present."[66] This simulative proficiency of the body was also present in the *Meditations* where it arose as more of a transgression, or the momentary glimmer of an *anthropological* danger — a threat to the very category of human itself: "If I look out of the window and see men crossing the square … do I see any more than hats and coats which could conceal automatons?"[67] Descartes was only able to "*judge* that they are men" by virtue of "purely mental scrutiny," a perception of

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[62] AT VII 22-23: CSM II 15.
[63] AT VII 19: CSM II13.
[64] Dennis Des Chene and Victoria Kahn have commented on the theatricalization of the Cartesian body. See Victoria Kahn, "Happy Tears: Baroque Politics in Descartes' *Passions de L'Âme*," in *Politics and the Passions, 1500-1850,* ed. Vitoria Kahn, Neil Sccamano, and Daniela Coli (Princeton: Princeton University Press, 2006) and Dennis Des Chene, *Spirits and Clocks: Machine and Organism in Descartes* (Ithaca: Cornell University Press, 2001).
[65] AT XI 131: CSM I 101.
[66] AT XI 185: *WW* 157.
[67] AT VII32: CSM II 21.

the mind alone; the eyes, caught up in the body's imitative theatricality would be fooled and that, as we saw above, was itself a necessary condition of the metaphysical error of the body.

In another example, Descartes weaved together the theme of artifice along with the formal problem of stability and fixity. In a 1646 letter to Princess Elizabeth, Descartes presented his critique of Machiavelli's *The Prince,* starting with his initial rebuke of Machiavell's unwillingness to distinguish the legitimate versus illegitimate acquisition of power: "If you are building a house on foundations insufficient to support high thick walls, the wall will have to be low and insubstantial; and similarly, those who have gained power by crime are usually compelled to continue their course of crime."[68] The true and good prince, on the other hand, "should be immovable and inflexible"[69] both in his moral fortitude and in his adjudication of decisions of the state. In his emphasis on self-control and self-governance as a requisite for political governance, Descartes was not only revealing his inclinations towards baroque politics and ethical neo-Stoicism, but he was also suggesting that the question of sovereignty was not a political question per se.[70] The sovereign, what Descartes in the *Discourse on Method* called the "wise law-giver," [71] was less a distinctly political figure, but an analogue of unshakeability itself — grounded, like metaphysics, on perpetual stability and, not unlike the brain, on the confidence of security and protection.

Descartes made in the letter a series of declarations as to the scope of a sovereign's political power, not the least of which was the fact that sovereign power was itself the very index of moral right ("God gives the right to those to whom he gives power"[72]). And with this power, and towards his enemies, the sovereign, "has virtual license to do anything," including "[joining] the fox with the lion and use artifice as well as force."[73] The sanctioning of a kind of political artifice was additionally characteristic of the baroque political and neo-Stoically ethical dimensions of Descartes' thinking. However, while Descartes did sanction political artifice, he did specifically prohibit one notable practice in the political arts, namely the use of a certain kind of political "deception" [*tromperie*] which was described as particularly "contrary to society."[74] He was referring to the idea of *feigning* friendship or love [*feindre d'être ami … feindre d'aimer*], as a pretense and means for destroying one's enemy. To instrumentalize "too sacred" [*trop sainte*] a virtue like friendship or love through this particular ethical-political *fiction* was for Descartes such an offense against the moral-political order that anyone who committed such a transgression "deserves to be disbelieved and hated by those whom he afterwards genuinely wishes to love."[75]

But Descartes' overall use of artifice was also employed less as a thematic or formal device, and more as an explicitly and quite important *methodological* strategy, particularly in his scientific writings. Descartes relied heavily on the strategy of conjecture and hypothesis — a sort of theoretical imagining predicated on the plausibility of a conjectural claim — when valid

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[68] AT IV 486: CSMK 292.
[69] AT IV 490: CSMK 294.
[70] See Kahn, "Happy Tears."
[71] "Peoples who have grown gradually from a half-savage to a civilized state, and have made their laws only in so far as they were forced to by the inconveniences of crimes and quarrels, could not be so well governed as those who from the beginning of their society have observed the basic laws laid down by some wise law-giver" (AT VI 12: CSM I 116).
[72] AT IV 487: CSMK 293.
[73] AT IV 488: CSMK 293.
[74] AT IV 488: CSMK 293.
[75] AT IV 488: CSMK 293.

inductions were not possible, or when absolute certainty could not entirely be achieved.[76] Although such conjectural hypotheses were directed towards considering the ways in which nature *could* possibly behave, and not in adjudicating nature's true behavior, they nevertheless needed to account for, or at least be plausibly compatible with the actual facts of empirical observation.[77] Descartes most notably employed these conjectural ploys in his primary book on physical nature, *Le Monde* (also called *Treatise on Light*) which included as its second part, the *Traité de l'homme*. Early in *Le Monde,* Descartes attempted to render viable some of his proposed and speculative formulations on the nature of matter by conjuring up and narrating a hypothetical universe in which his formulations could be valid. He writes,

> Many other things remain for me to explain here, and for my own part I would be happy to add a number of other arguments to make my opinions more plausible [*plus vraisemblables*]. But so as to make this long discourse less boring for you, I want to wrap up part of it in the guise of a fable [*dans l'invention d'une fable*], in the course of which I hope the truth will not fail to manifest itself sufficiently clearly….[78]

It is hard not to notice the rhetorical transition from the language of hypothetical plausibility to the language of fables and fabrications. There is, in some sense, a thin line between the methodological strategy of hypothesis or guessing, and the category of fiction and fabulation. Their equivalence, however, in Descartes' scientific writings was predicated on the plausibility, viability, and compatibility of the claim in the face of empirical observation.

The pineal gland was similarly something of a conjectural device — a hypothetical formulation which would seem to account for both the general operation of nervous function and also represent the anatomical part of the body best suited to join with a simple and indivisible soul. Indeed, in *Traité de l'homme,* like in *Le Monde,* Descartes stipulated the entirely conjectural and imagined nature of the human for whom he was providing a physiological account. In fact, the "human" body under analysis in the extant treatise was not even human at all. Descartes did not offer a treatise on *human* physiology but, as he explicitly stated at the outset, on a body which was nothing but a fabricated imitation that simply happened to conform exactly to our own bodies. The body in question in the text was a contrivance, the fiction of a soulless automaton "which God forms with the explicit intention of making it as much as possible like us" and which is composed of parts "just like those parts of our own bodies having the same names."[79]

The entire treatise, then, was conjectural insofar as it was presented as a set of highly probable claims, but about an entirely imagined body fabricated by God to resemble ours. The fictive nature of the pineal gland was situated within the overall methodology of artifice by

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[76] Gary Hatfield discusses Descartes' belief in the legitimacy of conjectural hypothesis in his willingness to accept less than absolute certainty when it came to claims about the physical world. See Gary Hatfield, "Science, Certainty, and Descartes," *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association,* Volume 2 (1988): 249-262.
[77] Larry Laudan, "The Clock Metaphor and Hypothesis: The Impact of Descartes on English Methodological Thought, 1650-1670," in *Science and Hypothesis: Historical Essays on Scientific Methodology* (Dordrecht, Holland: D. Reidel, 1981).
[78] AT XI 31: *WW* 21. For a brief analysis of how hypothesis is functioning here, see Desmond M. Clarke, "Descartes' philosophy of science and the scientific revolution," *The Cambridge Companion to Descartes,* 260-65. Sylvie Romanowski discusses the ambivalence between fiction and hypothesis specifically in this cited passage in "Descartes: From Science to Discourse," *Yale French Studies* 49 (1973): 96-109.
[79] AT XI 120: *WW* 99-100. See Des Chene, *Spirits and Clocks,* 155.

which the *Traité de l'homme* was written. The plausibility of the gland, however, was predicated not only on the observable facts of nervous functions, but also on the metaphysical requisite of the soul as simple and indivisible. In this sense, the pineal doctrine successfully needed to account for the observable operations of the brain and nervous system, but it also needed to comprise a fiction of an entirely different order. The pineal gland had to be the imagined site of a nearly unimaginable encounter between soul and body, something like an anatomical "*invention d'une fable*" to account for the soul-body union, which Descartes *promised* to outline in its entirety, but which he never did. The pineal doctrine was a fable that ultimately encompassed what remained a historical fiction in Descartes writings, by virtue of its absence. In this sense, the pineal gland's fictive nature corresponded to its security, its condition of being well-protected. The gland safeguarded an encounter, the union of soul and body, and the production of a human, embodied subject. It safeguarded the encounter, but it also secured it in the sense that it need to ensure the maintenance of the distinction between soul and body, that the different ontologies involved in this encounter could be united, but never confounded. The gland was doubly fictive — a scientific conjecture that secured a union which was fantastical in its own right.

In the next sections, as I delineate the specific mechanisms involved in the union of soul and body — on the basis of Descartes' available descriptions — I will argue how the pineal gland takes on an entirely different status of fiction, one which was not otherwise present in any of Descartes' writings. I will focus in these next sections on the particular status of the *spatiality* of the gland itself. In order to stage the encounter between soul and body, this small and supple subdivision of the brain needed to exhibit a particularly expansive capaciousness in order to situate the very convergence of incommensurable ontologies. And yet, since the pineal gland was by virtue of its mediating status something of a third term between the soul and the body, the space of the gland needed also to comprise the gap which separated soul from body, metaphysics from physics. Looked at in this way, the pineal gland possessed an entirely different fabular status — not the conjectural plausibility of satisfying either neurophysiological observations or the doctrine of the soul's simplicity and indivisibility, nor even the plausibility related to the pineal gland's organizational reduplication of the body. I refer to a moment at the heart of the union between soul and body, when the very material and functional essence of the pineal gland transitions from being conjecturally plausible to unavoidably and even necessarily impossible.

Figurations, Translations, and the Space of the Encounter

Descartes only outlined one actual mechanism to describe the metaphysical encounter by which soul and body interacted via the pineal gland, and it was based in part on a theory of sensory-perception formulated as early as the *Regulae ad Directionem Ingenii.* In the *Regulae,* Descartes made use of an early wax metaphor: "Sense-perception occurs in the same way in which wax takes on an impression from a seal."[80] Descartes continues:

> It should not be thought that I have a mere analogy in mind here: we must think of the external shape of the sentient body as being really changed by the object in exactly the same way as the shape of the surface of the wax is altered by the seal…. This is a most helpful way of conceiving of these matters, since nothing is more readily perceivable by the senses than shape, for it can be touched as well as seen.[81]

[80] AT X 412: CSM I 40.
[81] AT X 412-413: CSM I 40.

Indeed, shape was for Descartes an all-encompassing perceptual parameter, "that is involved in everything perceivable by the senses." Descartes extended the applicability of shape even to seemingly qualitative perceptual attributes, like color: "Whatever you may suppose color to be, you will not deny that it is extended and consequently has shape."[82] Shape simply defined the delineation of any physical affection that could occur in a sense organ; and since a sense organ was substantially only extended matter, Cartesian sense-perception was reducible to the distinguishable *form* of a particular physical impression. Descartes added that a peripheral bodily impression also impressed its shape upon the site of common sense, which in the *Regulae* was not explicitly identified as the pineal gland.

It is instead in *Traité de l'homme* where Descartes elaborated on the role of the pineal gland in the dynamics of the impression of forms. As I discussed above, impressions that were incurred sensibly at the perimeter of the body simultaneously resulted in animal spirits being "trace[d] on the inside surface of the brain" and consequently traced "on the surface of gland H," or the pineal gland's exterior surface.[83] Every sentient occurrence that transpired for the body (e.g., perception, activity, passivity, etc.) left a "trace" of itself in the form of what Descartes called a "figure" on the surface of the gland. By introducing the animal spirits as the intermediaries that effectively transposed the shape of impressions throughout the nervous system, Descartes replaced the earlier language of impressed shapes for that of traced figures. But the turn to a language of traced figures (and, on occasion, "images") did not transform these physical impressions to imagistic representations. Instead,

> by figures I mean not only things that somehow represent the position of the edges and surfaces of objects, but also anything which, as I said above, can give the soul occasion to sense movement, size, distance, colors, sounds, smells, and other such qualities; and even things that can make it sense pleasure, pain, hunger, thirst, joy, sadness, and other such passions.[84]

The traced figure changed the details of Cartesian sense-perception, without changing the underlying operation. The very same affection that impressed the sensory organ was simultaneously manifest on the pineal gland's surface where, rather than being physically impressed onto the pineal's exterior, was instead traced there by the ethereal though still material animal spirits as an image or projection. How a bodily affection like hunger or odor could be traced as a figure onto any surface emerges from a premise that had gone unchanged since the *Regulae* — namely, that all affections of the body are material in nature, and are as such comprised of changes to the state of extension, and thereby shape. The shape, figure, or image of hunger, for example, would simply be a particular form that somehow reflected the material state of nutritive want.

The mid-twentieth century neurophysiologist and cybernetician, Warren McCulloch, imagined this to be "probably the first coding theorem,"[85] suggesting that for Descartes, particular figures actually coded or programmatically signified certain physical conditions. McCulloch's assessment might initially seem valid, particularly given this significant passage

[82] AT X 413: CSM I 40-41.
[83] AT XI 176: *WW* 149. In *Traité de l'homme,* Descartes refers to the pineal as "gland H" in order to make reference to accompanying visual diagrams.
[84] AT XI 176: *WW* 149.
[85] Warren S. McCulloch, "Recollection of the many sources of cybernetics," *Collected Work of Warren S. McCulloch,* vol. 1, ed. Rook McCulloch (Salinas: Intersystems Publications, 1989), 25.

where Descartes explains the final step in the dynamics of the pineal gland's interaction with the soul:

> Now among these figures, it is not those imprinted on the organs of external sense, or on the inside surface of the brain, that should be taken as ideas [*qui doivent être prises pour les idées*], but only those traced in the spirits on the surface of the gland H, where the seat of imagination and common sense is. That is to say, only these should be taken as the forms or images *[les formes ou images*] which, when united to this machine, the rational soul will consider directly [*considérera immédiatement*] when it imagines some object or senses it.[86]

The figures or forms traced onto the surface of the pineal gland were what the soul received as ideas, and these ideas were what the soul took into account in the perception of bodily affections. Descartes emphasized the category of *idea:* "I wish to apply the term 'idea' [*sous le nom* d'idée] generally to all impressions which the spirits are able to receive as they issue from gland H."[87] This is to say that animal spirits could either trace figures onto the pineal gland's exterior surface as they entered the brain cavity, or receive them as they exited, which would suggest that the soul traced figures as well onto the metaphysical interface which was the pineal's outer surface.

Descartes' early use of the term *idea,* specifically in *Traité de l'homme* was intended — as was the notion of the "traced figure" in relation to the earlier "impressed shape" — to be a material and corporeal category: "And note that the idea of this movement of bodily parts just consist in the way in which the spirits flow from the gland, and thus it is its idea that is the cause of the movement."[88] It is important to remember that the term "idea" as Descartes employed it in his early neuroanatomy referred to a corporeally bound image and should be differentiated from a strictly intellectual *thought,* [89] the latter being the essence of an immaterial soul ("The soul is conceived only by the pure intellect" [*l'entendement pur*][90]). This distinction corresponds to the metaphysical continuum, espoused not only by Descartes, that led from the senses, which were always corporeal and material, to reason, which was absolutely immaterial. In the context of a classical epistemology, reason and sense were mediated by the imagination or its epistemological equivalent, common sense (with memory being a kind of derivative of both). Imagination and common sense, usually still corporeal, prepared material sensory impressions for some sort of abstract reasoning, usually by introducing into those sensory impressions an initial condition of generalizability — i.e., that discrete impressions could be expanded beyond the confines of their initial experience in order to be repeated in novel contexts and re-expressed in new, even fictional, combinations.[91]

Since for Descartes, every act of subjectivity was ultimately reducible to thought, to imagine was nevertheless still to think: "Our soul … is known to us merely through the fact that it thinks, that is to say, understands, wills, imagines, remembers and has sensory perceptions; for

[86] AT XI 176-77: *WW* 149.
[87] AT XI 177: *WW* 149-50.
[88] AT XI 181: *WW* 153.
[89] Emily Michael and Fred S. Michael, "Corporeal Ideas in Seventeenth-Century Psychology," *Journal of the History of Ideas* 50, no. 1 (January-March 1989): 31- 48.
[90] AT III 692: CSMK 227.
[91] Dennis L. Sepper provides an expansive account of the development of Cartesian imagination from the *Regulae* and its philosophical relegation and theoretical reorientation in the *Meditations* and *Passions* in *Descartes's Imagination*.

all these functions are kinds of thoughts."[92] The imagination and therefore the ideas generated within it remained within the province of the soul, even though they must be differentiated from a purely intellectual mode of thinking. It is the soul that both "applies itself to imagine something non-existent — as in thinking about an enchanted palace or a chimera — and … applies itself to consider something that is purely intelligible and not imaginable — for example, in considering its own nature."[93] The imagination for Descartes was the soul's most corporeal mode of subjective participation — one among its many powers, but a power which it nevertheless needed to avoid when considering certain thoughts that demanded the "pure intellect" alone: "Trying to use one's imagination in order to understand these ideas [of God and of the soul] is like trying to use one's eyes in order to hear sounds or smell odors."[94] It is for this reason that the anatomical pineal gland was more directly the seat of imagination and common sense (still within the province of the soul) rather than the seat of *reason*. Of course, Descartes remained ambivalent on the distinction, as he explained in a letter to Mersenne from December 24, 1640: "[The pineal gland] must necessarily be the seat of the common sense [*le siège du sens commun*], i.e., of thought [*la pensée*], and consequently of the soul."[95]

It follows that within the context of Descartes' psychophysiology, the *ideas* generated in the imagination were to some degree equivalent to the material *figures* or images traced by animal spirits onto the surface of the pineal gland, since the soul generated empirical ideas precisely by virtue of the figures it received; but the ideas were clearly not identical with those figures. The figure only became an idea once it had passed through the surface of the pineal — that is, passed beyond its materiality — and had entered the domain of the soul, but not without losing its tie to the corporeal world. Ideas were corporeally or materially restricted thoughts — empirical representations, or as Descartes explains, "the images of things"[96] — or whatever, in other words, could be transposed back onto the surface of the pineal as a figure in order to be received by the animal spirits. If figures acted as codes, then ideas were their most immediate decipherment, and while such an assessment does not fully immaterialize the idea into a pure intellectual act, it does ascribe to it a somewhat extra-material power.[97] The Cartesian idea, then, straddled the physical-metaphysical divide.

Yet to reduce fully the figure-idea relationship to matters of codes and decipherments, as McCulloch would suggest, does not finally clarify the murkiness that surrounds the specific mechanics of the pineal gland's interactivity with the soul. Such a reduction only transposes that interactivity, along with the general problem of matter versus meaning (figure versus idea, body versus soul), to the surface structure of the pineal gland itself. After all, it is not only the morphology of the pineal gland's physical and locational correspondence to the soul, as I suggest above, that constitutes the condition of their interaction. Now, as I pointed out, it was the two-dimensional space of the gland's exterior surface that comprised the actual site of the metaphysical encounter between body and soul, in terms of figures and ideas. From the outset, then, the interaction between the pineal gland and the soul could be simply transposed into the nuanced semantic distinction between "figure" and "idea," or onto the even finer distinction between "image" and "idea" which from an etymological point of view, would hardly be a

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[92] *Description of the Human Body and All its Functions,* AT XI 224: CSM I 314. See also Part 1, §9 of the *Principles of Philosophy,* "What is meant by thought?" AT VIIIA 7: CSM I 195.
[93] *The Passions of the Soul,* AT XI 344: CSM I 336.
[94] *Discourse on the Method,* AT VI 37: CSM I 129.
[95] AT III 264: CSMK 162.
[96] *Meditations on First Philosophy,* AT VII 37: CSM II 25.
[97] Steven Nadler describes how the term idea tends to have two vacillating meanings for Descartes — pure mental acts and empirical representations. "The Doctrine of Ideas," in *The Blackwell Guide to Descartes' Meditation.*

distinction at all. The activity and passivity of the soul in relation to the body depended, therefore, on a delicate navigation from figure to idea, and on the question as to how such a navigation across the pineal's surface would be possible, and how consequently it could altogether re-spatialize the gland.

The question begins with an analysis of the site of figuration itself, namely the surface of the gland. The exterior surface must be understood as acting in a double capacity. On the one hand, it constituted a kind of written surface on which the figure was "traced" [*tracer*] or "imprinted" [*imprimer*]. Indeed the gland itself was "composed of very soft matter which is not joined to or part of the substance of the brain,"[98] making it pliant enough to receive a mark. Its suppleness, however, was not so permanent as to prevent those figures from being erased shortly after being traced. Permanent pliability — which is to say, the condition of memory — was a feature reserved for the solid portions of the brain, not the pineal gland.[99] Figures imprinted onto the gland's inscriptive surface were intelligible to the soul as the ideas belonging to the imagination and common sense; the very act of inscription, in other words, idealized those figures. On the other hand, more than just a written surface and precisely because the figures were never to be preserved, the exterior wall of the pineal gland also acted along the lines of a metaphysical threshold, the true and final boundary separating body from mind. Still this boundary was not fully impenetrable, otherwise figures would be prevented from being traced in the first place and therefore received and transposed as ideas. The *limited penetrability* of the boundary was therefore the first condition enabling the navigation from figure to idea, or from matter to meaning. It made possible, in other words, the representational capacity by which a figure could bring about an idea. But in what exactly did this navigation, this movement from figure to idea, consist?

When Descartes described the seal's physical impression in wax in the *Regulae*, he was clear that he did not have "a mere analogy in mind." Assuming that the function of the "figure" in *Traité de l'homme* was relatively equivalent to the function of "shape" in the *Regulae,* we can further assume that Descartes was once again not speaking analogically, which is to say, not speaking *figuratively* of the figure. But Descartes did explain, that by figure he meant "not only things that somehow represent the position of the edges and surfaces of objects, but also anything which, as I said above, can give the soul occasion to sense." In *La Dioptrique* (1637), written a few years after *Traité de l'homme,* Descartes reiterated the same premise of sense-perception, that "objects which we perceive by our senses really send images of themselves to the inside of our brain [*envoient véritablement leurs images jusqu'au dedans de notre cerveau*]."[100] In *La Dioptrique,* however, Descartes expanded the representational scope of "image" just as he did the representational scope of "figure" in *Traité de l'homme.* He writes, "We must at least observe that in no case does an image have to resemble the object it represents in all respects," and that the human mind "can be stimulated by many things other than images — by signs and words, for example, which in no way resemble the things they signify."[101] In this sense, the "figure/image" was even able to possess the representational scope of the linguistic sign.

But what could possibly constitute the representational scope of a figure, if not a logic of resemblance that was emblematic, iconic, diagrammatic, formal or physical in nature — consisting in other words of some measure of space, extension, structure, proportion, etc? In order to work out the navigation from figure to idea, it becomes important to ascertain in what

[98] *Treatise on Man,* AT XI 179: *WW* 152.
[99] While I do not directly discuss memory, John Sutton provides an analysis of Cartesian memory in chapter 3 of *Philosophy and Memory Traces: Descartes to Connectionism* (Cambridge: Cambridge University Press, 1998).
[100] AT VI 112-113: CSM I 165.
[101] AT VI 112: CSM I 165.

other ways a *figuration* can convey meaning, especially meaning in the expansive sense of linguistic signification. On this point Descartes was essentially silent; he offered neither explanation for nor clarification of the figure-idea relation. Scholars have attempted to determine the precise function and meaning of these figures as either the raw data on the basis of which the soul made a calculation or as a process of semantic signification or sign-based representation.[102] To suggest that the figure was already semantic, or instead that the figure was simply a datum on the basis of which the soul employed epistemic powers already ascribed to it only reinforces Descartes' dualism without necessarily accounting for the traversal across it.

I propose instead to disregard Descartes' caution against analogy and consider that it was precisely by virtue of a fundamental analogy, which is to say a *figurative* operation, that Descartes' figures could exceed the representational scope of resemblance alone. Descartes, after all, was heavily reliant on the explanatory function of analogy quite generally as a rhetorical strategy in his scientific writings.[103] If Descartes' neuroanatomical figures functioned as would *figures of speech*, as a metaphor for example, then their primary function would be simply one of traversal and the transferral of meaning — a literal *circumlocution*. I argue that this is quite literally the only way to account for a traversal across the ontological divide of Cartesian dualism. The "figures" corresponded to something akin to a conceptual *translation* [*translatio*], a term that would have possessed a number of significant meanings in the mid-seventeenth century. *Translatio* was the Latin term for both metaphor and transfer[104] — as interrelated as both those notions already were — and so it denoted on the one hand a rhetorical figure of speech (i.e., *metaphora*) during the Renaissance and the early modern period;[105] but it also denoted a literal transfer of physical entities and conceptual ideas. We should keep in mind that when Descartes in the *Principia Philosophiæ* defined the concept of motion "in the strict sense" [*proprie sumptus*], he defined it as "the transfer of one piece of matter [*translationem unius partis materiæ*]"[106] from one vicinity to another.[107] *Translatio* also had a distinctly political meaning as well, in the sense of the transferral or transmission of power or supremacy from one dominion to another; and while the medieval and very early modern political notion of *translatio imperii* — or the continuous and uninterrupted permanence of universal governance, historically united and rooted in Roman rule[108] — was no longer in historical circulation, still *translatio* did not lose its political dimensions. The French "*translation*" in the first edition of the *Dictionnaire de l'Académie française* from 1694 was defined, first as a physical transport, then as the celebratory transferral of the body or relics of a saint, and then in relation to "authority and power, when it is transferred from a town or nation to another."

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[102] For example, Nancy Maull, "Cartesian Optics and The Geometrization of Nature," in *Descartes: Philosophy, Mathematics, and Physics,* and John W. Yolton, *Perception and Reality: A History from Descartes to Kant* (Ithaca: Cornell University Press, 1996).

[103] Peter Galison offers a nice example in regards to Descartes' theory of light in "Descartes's Comparisons: From the Invisible to the Visible," *Isis* 75, no. 2 (June 1984): 311-326.

[104] See Brian Vickers, "Francis Bacon, Feminist Historiography, and the Dominion of Nature," *Journal of the History of Ideas* 69 no. 1 (January 2008): 117-141.

[105] Katherine Park, Lorrain J. Daston, and Peter Galison, "Bacon, Galileo, and Descartes on Imagination and Analogy," *Isis* 75 no. 2 (June 1984): 287-89.

[106] AT VIIIa 53; CSM I 223.

[107] For more on this point, see Edward Slowik, "Descartes, Spacetime, and Relational Motion," *Philosophy of Science* 66 no. 1 (March 1999): 117-139.

[108] For *translatio imperii,* see Marian Rothstein, "Etymology, Genealogy, and the Immutability of Origins," *Renaissance Quarterly* 43, no. 2 (Summer 1990): 332-347; and Carey J. Nederman, *Lineages of European Political Thought: Explorations Along the Medieval/Modern Divide from John of Salisbury to Hegel* (Washington D.C.: The Catholic University of America Press, 2009), chapter 11.

To understand the imprinted figures as *translatio* is to understand them as the very conditions of the transfer or traversal between ontological dominions, but only according to a fundamental *figuration* or circumlocution, such as a *metahpora* or displacement and dislocation of meaning. The figures, as a figuration or a *translatio*, already constituted the delicate navigation across the pineal gland's surface threshold. From the outset, the figure was always a *translatio,* already the very possibility of the idea. If we can understand the imprinted figures as *necessarily* figurative and translational, even despite Descartes' prohibition against analogy, then, for example, the relationship between "figure/image" and "idea" becomes one of a very flexible synonymy.

It is no doubt unsettling that the theoretical efficacy of the neuroanatomical figure requires and constitutes a discursive parenthesis within Descartes' psychophysiology, where the anatomical-metaphysical framework reveals a fundamentally figurative — I would even say fabular — reinforcement. It is this figurative traversal, this *translatio,* staged along and across the pineal gland's surface threshold that constitutes what I earlier referred to as a fiction unlike any other that exists in Descartes' writings — an instance of fabulation that entirely exceeds all other employments of artifice. However, accepting that the movement from figure to idea is of an order of fiction so entirely unlike the stated possibilities of artifice that it constitutes something of a parenthesis in the metaphysics and psychophysiology, would be a doubtless contravention of an authorized Cartesian explanation of the legitimate movement from matter to meaning; rejecting it, however, would mean assuming an explanatory lacuna directly at the site of the pineal surface itself, since no other explanation is available.

Yet, curiously, acceptance and denial are one and the same. Keep in mind that the pineal's exterior surface essentially marks the fundamental metaphysical interval between mind and body — that is, the final boundary and barrier. It is a boundary, though, that is supposed to constitute the stable and secured setting on which a necessary interaction between the soul and the body is staged. However, this surface boundary is also a quasi-penetrable writing surface, on which is traced a very peculiar set of markings — that is, a set of figurations which already constitute their own ability to be displaced through the pineal wall and beyond materiality itself. In this sense, the pineal gland's surface is in every sense an explanatory lacuna, an empty space, for two reasons: 1) if we reject this radical fable of the figurative *translatio* that takes place across the surface, opting instead for a legitimate explanation, we will be left with no clear account at all, and the surface becomes a dark site, an explanatory black box; but 2) if we accept it, then we account for the traversal on the basis of a tropological disparity — that the surface-space is filled and crossed by a *translatio,* a figurative *disarticulation* in the sense of a discursive parenthesis*,* a philosophical lacuna, within Descartes' theoretical psychophysiology.

Consequently, the pineal gland's writing surface receives and gives space to a *translatio* that crosses through the surface boundary, and across the mind-body divide. But if a *translatio* holds the anatomical order together with the metaphysical, that is, if figuration holds together the body with the soul — which I argue it can and must — then it does so by introducing a solicitous and radical fiction into the entire anatomical framework, a fabulation which exists nowhere else in Descartes' system. In a sense we must employ Descartes' own disposition towards artifice, but we must do so by introducing a fable of figuration that entirely exceeds Cartesian psychophysiology altogether — a kind of ontological catachresis: a fundamental metaphoric abuse, at once the production of a meaningful relation that could not have been otherwise generated.

Through the *translatio* of the neuroanatomical figure inscribed on the pineal's exterior wall, the surface-barrier gives space to its own violation, as it were. The surface constitutes the condition by which it is itself bypassed, *circumlocuted,* but not directly perforated. The figuration of *translatio*, then, instantiates an alternative penetrability of the pineal gland's surface. And that surface, it could be said, makes possible its own peripheralization, which is to say its own marginalization or ability to be circumnavigated in the first place. The mind-body boundary is effectively traversed without being broken, transgressed without transgression, so to speak, in a movement that can no longer be understood within the economy of artifice, nor within the metaphysical suppositions of Cartesian psychophysiology itself. If *translatio* is what traverses Descartes' dualism, then the pineal gland is an ontologically *transitive* entity — the only one in Cartesian philosophy.

Conclusion: From Translation to the Ecstasy of the Brain

As I argued at the outset, the pineal gland must secure and stabilize the order of the human subject, since the human is essentially a union that, first and foremost, is situated directly in the space of the gland itself. But in order to constitute that order, the gland, as I have attempted to show, must literally embody some fundamentally disordered, indeed transitive states, starting, for instance, with the deep ontological indeterminacy it is forced to adopt, a substantial confusion of mind and matter. But the state of greatest disorder quite literally is staged directly on the exterior surface of the gland itself. In a way, the pineal surface is something of a metaphysical border, which must be presumably regulated and stable — it is here where the mind-body exchange is truly secured, even though Descartes never directly described the exchange itself. But as I have suggested, it is precisely the pineal surface which gives way to its own quasi-penetration by giving space to figures which, I argue, must be understood neither as signs nor geometrical shapes, but as a figuration or a *translatio,* in other words, as a fabulation and tropological disparity constituting the only condition for the movement between ontological domains.

It is, I believe, only the transgressing circumlocution of a fundamental *translatio* that can account for the traversal of mind-body. The traversal and metaphysical exchange — that is, the condition of the soul-body union and thus of the human subject — is actually made possible by a lacuna or a discursive parenthesis of a deeply translative moment which greatly exceeds the order of conjecture, artifice, and fiction which Descartes will otherwise employ throughout his writings. As a consequence, the power of the pineal surface-border is weakened precisely because the delicate navigation from figure to idea leads instead to a circumnavigated disarticulation, a neither sanctioned nor prohibited production of meaning which rests first and foremost on the force of a *translatio.* The border is, in a sense, disregarded. But at the same time, the very production of meaning from image to idea was dependent on the border in the first place as an inscriptive surface.

What I want specifically to call attention to is how the space of the pineal gland, specifically its exterior surface, in the final analysis and by virtue of staging a *translatio* is nothing but a *space that gives space to a displacement*. Here I emphasize the literal sense of the term "translation," as a carrying-over, a metaphor and dislocation of meaning. The pineal is comprised of a spatiality that can only be thought of in an abstract, topological way: a transitive space — a spacing. I suggested earlier how the pineal gland was, in relation to the mind and body, something like a theoretical third term. After all, the gland was related to the soul through morphological analogy, and to the body as a virtual reiteration. It was connected to both, without being definitely or simplistically connected to either. In a way, the pineal gland constituted a formal confusion between the Cartesian soul and body insofar as it morphologically analogized the former while virtually redoubling the latter. Moreover, within the very dynamics of the metaphysical encounter it enabled, the pineal becames a distinct and definable site of exchange, but only by virtue of constituting a space of displacement and re-location.

In its analogical, virtual, and figurative relation to the body and the soul, the pineal gland is nothing but *one space moving to another,* the re-situation of body and soul within the gland itself and therefore the re-situation of each in and as the other, though never completely and always through a necessary confusion. The pineal gland is nothing but a fable, a catachrestic metaphor, a *translatio* — it must be in order to secure the order of exchange, the order of the human, which it must encapsulate. This is why I would call the translative pineal gland a radically ex-static space, the space between and the spacing across — transient, transgressive, and transitive.

The pineal gland can in the end be designated as the material ecstasy of the brain, a rapture or transport, both across the dualism but also outside the bounds of Descartes' psychophysiology. The pineal is a radical ecstasy which must exceed even the deepest movement of the passions. The idea of ecstasy has appeared, albeit in a critical fashion, in the work of Jean-Luc Marion. In *Cartesian Questions,* Marion examines the phenomenologically oriented view of the *cogito* as representational intentionality, where the thinking *ego* is always directed at a particular object of phenomenal cognition, or the *cogitatum.* Marion believes that this interpretation of *cogito, ergo sum* has been employed by many of Descartes' most significant philosophical interpreters, including Kant, Nietzsche, Husserl, and Heidegger.[109] But this kind of intentional, representational thinking, Marion argues, produces an ecstasy of thought itself, in the sense that the *ego* in the act of thinking is always displaced into and as the object of thought: "The *cogito,*" writes Marion, "intrinsically structured by intentionality, includes within itself its necessary other, the *cogitatum*."[110] And therefore, as Marion explains, "phenomenological intentionality ecstatically exiles the *ego* from itself."[111] This ecstasy of the ego from itself as the object of cognition, intrinsically imputed into representational cognition through even the faintest and most implicit phenomenological intentionality, constitutes an aporia that Marion seeks to resolve. This is not the place to detail Marion's argument, except to say that he proposes a reconsideration of the ethical but also auto-affective dimensions of the soul (particularly through the category of generosity) which, for Marion, yields non-intentional (and thus non-ecstatic) representations.[112]

Marion was critical of certain phenomenological interpretations of the *cogito, ergo sum* formulations because he was wary of the aporia of ecstasy which could result at the heart of representational cognition. I do not deny that the *material* ecstasy I am describing in relation to the brain — that the brain, or rather the pineal gland, is a radically ex-static space, a spacing or an ontological *translatio* between soul and body — can resulting an equally perplexing aporia. I do not deny that the nature of the brain must remain to some extent in excess of Descartes' philosophical physiology, as a literal circumlocution or discursive parenthesis. Indeed, I argue that the brain *must* take on this sort of transitive ontological state, that it must not in any sense be felt or experienced, either by the Cartesian scholar, or by the Cartesian, human subject. Since it is precisely within the ecstasy of the brain — along its spacing and ontological *translatio* — that the *me totum,* the combined mind-body union of human subjectivity is staged. In this way, the ecstasy of the brain is akin to a metaphysical-physiological *synapsis,* what we understand today

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[109] Jean-Luc Marion, *Cartesian Questions: Methods and Metaphysics* (Chicago: University of Chicago Press, 1999), 117.
[110] Ibid., 97.
[111] Ibid., 99. "Representation, which by intentionality ecstatically separates what is thinking from what is thought, *noesis* from *noema,* can never conjoin them, even if it uses the same term in both cases to refer to them," (ibid., 103).
[112] "The aporias of an ecstatic interpretation of the *ego cogito, ego sum* deriving from representation and intentionality would thus be dissolved in the immediacy of the auto-affection accomplished by generosity," (ibid., 117).

as the non-experienced gap in the very materiality of the brain, which nevertheless makes experience possible.

If the Cartesian human is indeed as metaphysically encapsulated by the brain as I suggest, then this encapsulation is possible only so long as the brain constitutes the transgression of that encapsulation — the ex-stasis and dislocation of its own anatomical space. A return to Cartesian neuroanatomy is significant because it allows us to chart the history of the human subject's metaphysical obligation to cerebrality, or to the obligation that, if corporeal and embodied, the subject is first and foremost cerebral. To better understand what has become today the unquestioned equivalence of subject and brain, it is not enough to chart the history of that equivalence, but to understand the theoretical preconditions which compel it. Descartes' substance dualism circumscribes the brain as the primary site where the human subject is directly predicated. But that circumscribed brain and the even more specifically delineated pineal gland constitute nothing but a transitive and translative space — a spacing across the dualism which can also constitute the gap between. The hidden cost of the human subject's earliest metaphysical circumscription in and as a brain is that the brain cannot, in and of itself, *be* anything at all; that it must, in other words, abide by an ontological indeterminacy; that it secures the mind-body union through a displacement and transgression of meaning that is, in the first instance, translative, metaphoric and thus entirely fabular. The cerebral, or pineal, basis of the Cartesian human is ultimately constituted on a radical fiction, the original myth of cerebral subjectivity.

Chapter Three

GIVING SHAPE TO THE COMMON BRAIN: *SENSORIUM COMMUNE* AND THE DISPERSIONS OF THE BRAIN IN EIGHTEENTH-CENTURY NEUROSCIENCE

Introduction

The early modern conceptual development of the science and natural philosophy of the brain and nerves, the period between 1650 and 1750, was marked by a deep though infrequently expressed ambivalence towards the brain. The ambivalence was due to the fact that the brain demarcated, according to the very perimeter of its anatomical boundaries, nothing but the gap in the understanding of what ultimately could provide the terms of commensurability between the mental and physical dimensions of the human subject. On the one hand, the development of modern physiology in the seventeenth and eighteenth centuries directed much attention to the study of the nervous system because it was the brain and nerves that were thought to be mediating the relationship between the body and the soul, and could therefore offer a fuller understanding of how matter and immaterial powers more generally could be related, rendered equivalent, or simply subsumed, one within the other. On the other hand, the brain was as much an early reigning topic of modern physiology, as much as it was, something of an absent sovereign.[1]

The brain in the period of the late seventeenth and early eighteenth century was marked by a kind of conceptual disappearance. The profusion of scientific and philosophical positions vis-à-vis mind and materiality, particularly throughout the eighteenth century, and the general mystery around the brain's precise functionality often led to the organ's relatively diffuse status, being articulated only through alternative and better understood conceptual frameworks or according to a vague definition of living matter. In this chapter, I will examine the diffuse status of the brain throughout the eighteenth century. I will do so, however, in order to suggest that the relative conceptual opacity surrounding the brain was actually integral to its theoretical elaboration during the mid-to-late eighteenth century, particularly in terms of how the brain was imagined simultaneously to display a decentralized capacity throughout the body while also and paradoxically comprising the very unity of the nerves.

I begin the chapter by describing the varied nature of the brain's conceptual retreat and its subsequent diffusion into seventeenth and eighteenth century accounts of nervous power and theories of living matter. The brain's conceptual intangibility, I suggest, was indexed by its discursive ethereality. But in the sections that follow, I show how the brain's conceptual intangibility was materialized in the concept of the *sensorium commune.* The *sensorium commune* must be read as a correlate to the popular eighteenth century notion of "organization," which was often employed to define the nature of a living being, in part because the notion blurred the distinctions between the material and conceptual dimensions of life. In being defined as the *sensorium commune,* the brain's conceptual diffusion translated into an indefinite materiality, reorienting what could count as the very space and matter of the brain.

I outline the precise terms of the brain's strange materiality through an extended analysis of the mid-eighteenth century writings of the Scottish physician, Robert Whytt, recognized in the history of neuroscience as an early progenitor of the theory of reflex action and as the figure who first instigated the brain's decentralization by demonstrating the independence and automaticity

[1] For a brief outlines of the primacy of the nervous system from the late seventeenth through early nineteenth century, see Edwin Clarke and L.S. Jacyna, *Nineteenth-Century Origins of Neuroscientific Concepts* (Berkeley: University of California Press, 1987), introduction.

of nervous functions throughout the body. The historical decentralization of the brain through the greater emphasis on the spinal cord and alternate nervous centers has been well documented. What I will show, however, is how much Whytt's neurophysiological decentralization depended on an initially paradoxical formulation of the very materiality of the brain, one which was already conditioned by the original diffusion and conceptual-material opacity of the organ. I conclude the chapter by examining the implications of the brain's decentralization, particularly in the work of English physician James Johnstone who first theorized the autonomic nervous system in the late eighteenth century.

The eighteenth century science and natural philosophy of the brain typically imagined the nerves to be an extension of cerebral matter, a conception which was reversed in the following century, when the brain was taken as the final (and thus most hierarchically organized) development of the nervous system.[2] The eighteenth-century brain was not only conceptually dispersed but also anatomically distributed. As I will show, many thinkers took advantage of the brain's conceptual and material dispersions when attempting to account for it as an object that could effectively blur material and immaterial categories. The challenge of this chapter rests on the fact that I am attempting to chart a doubly abstracted concept: the brain, whose anatomical materiality was already imagined in abstraction, and whose abstraction was further protracted discursively, materially, and, as I will ultimately show, ontologically.

The Early Impasse of the Brain

The Danish naturalist, Nicolaus Steno, whose name has been associated with the inauguration of a modern and anatomically oriented view of the brain, opened *De cerebri anatome,* his long essay devoted to neuroanatomy and first read in Paris in 1665, with the following lines: "Instead of promising to satisfy your curiosity concerning the anatomy of the brain, I confess sincerely and publically here that I know nothing about it. I wish, with all my heart, that I might be the only person to have to speak thus."[3] What followed was a critical appraisal of the speculative tendencies of mid-to-late seventeenth century neuroanatomy, particularly in the work of the two most prevalent figures of this period, René Descartes, and the English physician Thomas Willis, along with an appeal for a new programmatic commitment to experimental methods of acquiring anatomical knowledge: "Since the brain is a machine, we need not hope to discover its artifice by methods other than those that are used to find such for other machines…. I mean the dismantling of all its components, piece by piece, and consideration of what they can do separately and as a whole."[4]

Steno's provocation that we do not know the brain, that it held only the status of a theoretical lacuna, and that no such true knowledge had emerged from the work of the more notable seventeenth-century anatomists of the nervous system, Descartes and Willis, is more meaningful than even Steno knew. Of course, no two figures did more to reorient early modern theories of neuroanatomy than Descartes and Willis, particularly in the extent to which both identified the physical substance of the brain as the site of its functionality.[5] Both held, albeit differently, that only the physical matter of the brain, and its anatomical structure more

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[2] I examine this nineteenth-century inversion in the following chapter.

[3] Nicolaus Steno, *A Lecture on the Anatomy of the Brain* (Paris: Royal Privilege, 1669); printed in *Nicolaus Steno's Lecture on the Anatomy of the Brain* (Copenhagen: Forlag & Busck, 1965), 121. See Max Neuburger, *The Historical Development of Experimental Brain and Spinal Cord Physiology before Flourens,* trans. Edwin Clarke (Baltimore: Johns Hopkins University Press, 1981), 22-23.

[4] Steno, *Lecture,* 139.

[5] Neuburger, *Historical Development,* 10. For the historical significance of this isolation in the theory and philosophy of the human subject see Fernando Vidal, "Brainhood, Anthropological Figure of Modernity, *History of the Human Science,* 22, no. 1 (2009), 5-36.

generally, comprised the necessary condition for both the physiological orchestration of nervous functions, and for the mental and affective states that could consequentially arise.[6]

Up until this point, and particularly during the late Middle Ages and early Renaissance, a trend which had persisted since Galenic physiology from the third century was to situate the gamut of epistemological categories, including reason, memory, imagination, and common sense, into the four ventricles or open, fluid-filled cavities of the brain. Locating the metaphysical categories of soul and mind within what were imagined to be the brain's own physical gaps ensured that the faculties could be materially circumscribed, without necessarily identified as physical in and of themselves.[7] Still, for Steno, Descartes and Willis could not provide a complete anatomical account of the brain, perhaps because for both, cerebral anatomy and physiology was ultimately oriented towards accommodating a set of prior metaphysical commitments to the soul.

I have described in the previous chapter the ways in which Descartes' conceived of the pineal gland as a formal reiteration of the simplicity and indivisibility of the soul.[8] The brain and nerves formally replicated, to a degree, the metaphysical operations of reason and a logical theory of sense perception. And Descartes' general orientation to the subject of the brain and nerves was extremely formative, for despite the controversies emerging shortly after his death that surrounded his theories of physics and some of his anatomical positions, particularly his theory of reproduction, Cartesian neuroanatomy remained influential up until the mid-eighteenth century.[9] It was a central intellectual source for much of the neuroanatomy and neuromuscular physiology of the late seventeenth and early eighteenth century in the work of Steno, the Dutch naturalist Jan Swammerdam, the Italian mathematician-turned-anatomist Giovanni Alphonso Borelli, and the prominent chemist, botanist, anatomist and teacher at the University of Leiden, Herman Boerhaave.[10] While no one espoused a distinctly Cartesian theory of the brain and nerves, Descartes was almost always read.

Indeed, Thomas Willis was also something of a reader of Descartes,[11] although this is not entirely evident from his commitment, over and against Descartes' *mechanical* model of nervous function, to the *chemical* role of the blood and the animal spirits in the functioning of the nerves; Willis described the processes by which the blood was fermented, and from which animal spirits were irrigated and then radiated like the rays of light into muscles where their chemical ignition

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[6] Robert Martensen, "When the Brain Came Out of the Skull: Thomas Willis (1621-1675), anatomical technique and the formation of the 'cerebral body' in seventeenth century England," in *A Short History of Neurology: The British Contribution 1660-1910,* ed. F. Clifford Rose (Oxford: Butterworth Heinemann, 1999), 22-25.

[7] Neuburger, *Historical Development,* introduction and chapters 1 & 2; Julius Rocca, *Galen on the Brain: Anatomical Knowledge and Physiological Speculation in the Second Century AD* (Leiden: Brill, 2003), see especially "Appendix One: The doctrine of ventricular localization;" K.D. Keele, "The Search for the Sensorium Commune, *Anatomies of Pain* (Springfield, IL: Charles C Thomas, 1957); Edwin Clarke and Kenneth Dewhurst, *An Illustrated History of Brain Function* (Berkeley: University of California Press, 1972).

[8] Stephen Voss discusses the point outright in "Simplicity and the Seat of the Soul," in *Essays on the Philosophy and Science of René Descartes,* ed. Stephen Voss (Oxford University Press, 1993).

[9] Jacques Roger discusses the conquest of Cartesianism throughout the scientific world, starting at around 1670. Cartesian cosmology maintains its popularity until around 1720, and Cartesian anatomy is influential until around 1745. See Jacques Roger, *The Life Sciences in Eighteenth-Century French Thought,* trans. Robert Ellrich (Stanford University Press, 1997), especially Part II.

[10] Mary A.B. Brazier, *A History of Neurophysiology in the 17th and 18th Centuries: From Concept to Experiment* (New York: Raven Press, 1984), especially chapters three, five, and eight. For more on Boerhaave, and Descartes' influence, see Peter J. Koehler, "Neuroscience in the Work of Boerhaave and Haller," in *Brain, Mind and Medicine: Essays in Eighteenth Century Neuroscience,* ed., Harry Whitaker, C.U.M. Smith, and Stanely Finger (New York: Springer, 2007), especially 219-220.

[11] Alfred Meyer and Raymond Hierons, "On Thomas Willis's Concepts of Neurophysiology," part 1, *Medical History* 9, no. 1 (January 1965): 1-15, p. 4. The authors cite others who make similar claims.

induced muscular contraction.[12] Despite Willis' emphasis on experimental techniques, and his general refinement of the anatomical details of the brain, he offered nothing essentially new about the nature of the brain itself. While Willis does not, as Descartes did, formally analogize the morphology of the parts of the brain to metaphysical and epistemological operations, he nevertheless imagines the *materiality* of the brain and nerves in speculative terms, revealing a subtle adherence to the primacy of metaphysical concepts which needed to be anatomically arranged, but never reoriented as a consequence of the theorized physiology. Willis, for example, distributed central faculties, including common sense, memory and imagination throughout a number of respective anatomical locations, including the corpus striatum, cerebral cortex, and corpus callosum. He also speculated as to the actual cause of these mental powers, employing a discourse centered on little more than the abstracted set of motions and vectors of the animal spirits:

> It seems, that the Imagination is a certain undulation or wavering of the animal Spirits, begun more inwardly in the middle of the Brain, and expanded or stretched out from thence on every side towards its circumference: on the contrary, the act of the Memory consists in the regurgitation or flowing back of the Spirits from the exterior compass of the Brain towards its middle.[13]

Willis, moreover, believed that the human had two souls, the first being a corporeal or sensitive soul, one that humans shared with animals.[14] Invoking an Epicurean conception of the *anima* that Descartes had earlier attempted to eliminate, Willis' corporeal soul was essentially material and entirely co-extensive with the body itself. It constituted the body's motions and overall sensitivity, specifically by virtue of the chemical economy of the animal spirits; for this reason it was, in substance terms, identified only ephemerally as an ethereal flame or fire.[15] The second soul was rational and entirely immaterial, "created immediately of God," but also likened to an ephemeral substance, since it was, as Willis asserted, "poured into" the brain in the first instance of human conception.[16] So while Descartes, more than anyone, demonstrated implicitly what Steno explicitly emphasized — that the brain was essentially nothing but a *problem,* the site in which a question of the relation between the mental and material could only apprehensively be resolved — Willis nevertheless corroborated the point through his chemical speculations and, more so, through the *ephemeralizations* of the nature of the brain's actual materiality.

As Steno had asserted, the brain was less the place of the mind as it was the space or gap in our understanding, a point which was summed up and accentuated more than two decades later in an equally significant, though brief and faint reference to the brain, made by one of

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[12] George Canguilhem, *La formation du concept de réflexe aux XVIIe et XVIIIe siècles* (Paris : Presses Universitaires de France, 1955), 65-70. Georges Canguilhem, *A Vital Rationalist : Selected Writings from Georges Canguilhem*, ed. François Delaporte (New York: Zone Books, 1994), 182-189. See also Raymond Hierons, "Willis's Place in the History of Muscular Physiology," *Proceedings of the Royal Society of Medicine* (April 4, 1964): 687-692.

[13] Thomas Willis, *The Anatomy of the Brain and Nerves*, ed. William Feindel (Birmingham: Classics of Medicine Library, 1978), chapter 10, 91.

[14] John P. Wright, "Locke, Willis, and the Epicurean Soul," in *Atoms, Pneuma, and Tranquility: Epicurean and Stoic Themes in European Thought,* ed., Margaret J. Osler (Cambridge University Press, 1991), 239-258; Ann Thomson, *Bodies of Thought: Science, Religion, and the Soul in the Early Enlightenment* (Oxford: Oxford University Press, 2008), chapter 3; Robert L. Martensen, *The Brain Takes Shape: An Early History* (Oxford: Oxford University Press, 2004), 135-149.

[15] Roy Porter, *Flesh in the Age of Reason* (New York: W.W. Norton, 2003), 55-60.

[16] Thomas Willis, *Two Discourses Concerning the Soul of Brutes, which is That of the Vital and Sensitive in Man* (London: Thomas Dring, 1683), 42.

Thomas Willis' own students, the author of one of the most important treatises on mind and knowledge from the end of the seventeenth century.[17] In his *An Essay on Human Understanding* (the well-known second edition appears in 1694), the philosopher and physician John Locke, while outlining aspects of his theory of sense, bestows a telling label onto the brain, mirroring its theoretical and material opacity. He writes, "There are some ideas which have admittance only through one sense, which is peculiarly adapted to receive them," and that only the "organs, or the nerves which are the conduits … convey [sensations] from without to their audience in the brain, *the mind's presence-room* (as I may so call it)."[18]

In a certain respect, Locke, who in the same seminal texts introduced the possibility that some matter might indeed possess the capacity to think, nevertheless abbreviated and literalized Steno's criticism that the brain was an empty space, a theoretical and scientific lacuna, a normally vacant room whose only amenity was to afford the mind the place to make its presence and to receive the formal visitations of the senses. By the end of the seventeenth century, the brain was already being imagined according to a diffuse and quasi-absent status, in part because of the extent to which neurophysiology tended to formalize the brain and nerves according to a theory of knowledge and a logic of sense and understanding; and in part because the brain itself, as the site of the commensurability of material and mental properties could at best only accommodate an extremely apprehensive consolidation between what continued to act as the two ontological registers of the human. From a certain standpoint, throughout the seventeenth and early-eighteenth centuries, the rational mind and even the life-imbuing soul was a more palpable entity than the brain could have ever been.

Cerebral Diffusions, 1650-1750

Developments by the mid-seventeenth century in the science and natural philosophy of the animal economy as well as on the nature of living matter introduced new frameworks through which the brain could be imagined. These frameworks, however, did little to provide conclusive formulations of the brain itself, and tended more often to nurture the brain's conceptually diffuse nature. For example, the mystery of the brain was augmented by a more robust picture of the workings of the nerves, particularly in terms of how they facilitated the general motility of the animal body. The conception of neuromuscular physiology underwent a complete renovation within a ten year window, from 1660 to 1670, when the common belief, espoused by Descartes and Willis that muscles expanded when tensed, was reversed. The observation that muscle mass actually decreases upon contraction was defended by a number of English medical thinkers, including the physicians Walter Charleton and Francis Glisson, and it was famously presented as an experiment before the Royal Society in 1669 by Jonathan Goddard.[19] At approximately the same period of time, if not slightly earlier, the Dutch naturalist Jan Swammerdam was also revising the theory of neuromuscular contraction in a set of notes that would only be discovered and disseminated over half a century after his death by Herman Boerhaave. Swammerdam, however, not only asserted that, "The muscles themselves, when contracting, are not in the least inflated or swollen, but rather they lose their thickness," but that, perhaps most significantly,

[17] For the link between Willis and Locke and their similarly Epicurean conception of a material soul as the basis of life, see Wright, "Locke, Willis, and the Epicurean Soul."
[18] John Locke, *An Essay Concerning Human Understanding,* II: iii, 22-24 (Oxford: Oxford University Press, 1975), 121, emphasis added.
[19] Hierons, "Willis's Place."

> It may, I think, be fairly concluded, that a simple and natural motion or irritation *of the nerves alone* is necessary to produce muscular motion, whether it has its origin in the brain, or in the marrow, or elsewhere.[20]

Swammerdam believed the nerves were the sole agents in muscular contraction, that they possessed a certain motive force that would enable muscles to be induced into action.[21] Swammerdam was not alone in the emphasis on the primacy of an independent nervous power.

Interest arose by the start of the eighteenth century in the particular substance of nervous transmission, prompted in part by a frequently cited reference to a passage in Isaac Newton's *Principia* from 1713. In the last paragraph of the final "General Scholium," Newton explained that while he had described the power of gravity, he had not yet "been able to deduce from phenomena the reason of these properties of gravity."[22] While not making any capricious hypotheses about the nature of gravity itself, Newton nevertheless ended with some brief remarks about what he called "a certain very subtle spirit pervading gross bodies and lying hidden in them." It was a spirit that exerted and manifest itself through a number of curious physical phenomena — including, for example, when "electrical [i.e. electrified] bodies act at greater distances, repelling as well as attracting neighboring corpuscles," or insofar as "all sensation is excited, and the limbs of animals move at common of the will, namely, by the vibrations of this spirit being propagated through the solid fibers of the nerves."[23] In this sense, the nerves were themselves conduits of what Newton imagined to be an underlying physical substance and activity of nature.

The conjecture was formative, and by the middle of the century, Newton's brief conception of nervous transmission generated a number of reconsiderations about the nerves themselves.[24] At the outset of his 1749 *Observations on Man,* English philosopher David Hartley made specific use of Newton's doctrine of nervous vibration, explaining that

> external objects impressed upon the senses occasion, first in the nerves on which they are impressed, and then in the brain, vibrations of the small, and, as one may say, infinitesimal, medullary particles. These vibrations are motions backwards and forwards of the small particles; of the same kind with the oscillations of pendulums, and the tremblings of the particles of sounding bodies.[25]

The primacy of nervous power was also imagined as a very general electrical theory of nervous conduction, which was not, strictly speaking, Newtonian. In the 1730s, the English chemist Stephen Gray conducted experiments on the electrical conductivity of human bodies, describing

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[20] Jan Swammerdam, *The Book of Nature, or the history of insects,* with "The Life of the Author" by Herman Boerhaave, trans. Thomas Flloyd (London: C.G. Seyffert, 1758), 124, emphasis added. See also Mary A.B. Brazier, "The Problem of Neuromuscular Action: Two 17th Century Dutchmen," in *Historical Aspects of the Neurosciences: A Festschrift for Macdonald Critchley,* ed., F. Clifford Rose and W.F. Bynum (New York: Raven Press, 1982).
[21] For an account of Swammerdam's neuromuscular theory in relation to his general psycho-physiology see Franklin Fearing, "Jan Swammerdam: A Study in the History of Comparative Physiological Psychological of the 17th Century," *The American Journal of Psychology* 41 (July 1929): 442-459.
[22] Isaac Newton, *Philosophical Writings,* ed. Andrew Janiak (Cambridge University Press, 2004), 92.
[23] Ibid., 93.
[24] For an extended account of the various definitions of nervous power or nervous force throughout the seventeenth and primarily eighteenth centuries, see Stanley W. Jackson, "Force and Kindred Notions in Eighteenth-Century Neurophysiology and Medical Psychology," *Bulletin of the History of Medicine* 44, no. 5 (Sept./Oct. 1970): 397-410; 44, no. 6 (Nov./Dec. 1970): 539-554.
[25] David Hartley, *Observations on Man: His Frame, His Duty, and his Expectations,* Fourth Edition (London: J. Johnson, 1801), 11.

in one experiment how a single electrical circuit was drawn through the bodies of a serially arranged group of young boys:

> Then they stood so much farther as not to let their coats touch by about an inch, and then exciting one of them to attract, the other received not the least degree of attraction. I then bid one boy put his finger upon the other boy's wrists, and then he immediately became electrical.[26]

Admittedly, Gray's experiments concerned the electrical conductivity of animate bodies in general, rather than the specific conductivity of the nerves. Nevertheless, they directly influenced the writings of the French physicist, Cartesian, and *Abbé*, Jean-Antoine Nollet, whose writings on electricity were some of the most widely read in the eighteenth century, and who in his 1746, *Essai sur l'électricité des corps,* wrote, "The attractions, repulsions, and other electrical phenomena are the effects of a subtle fluid that moves throughout a body that has been electrified."[27] It would not be until near the end of the century when Luigi Galvani in his 1791 *Commentary on the Effects of Electricity on Muscular Motion* theorized the nature of "animal electricity," and the belief that this "subtle fluid" was specifically transmitted by the nerves: "Such a structure indeed, and that composition of the nerves, will bring it about that they can perform both functions, namely of conducting the neuro-electric fluid and at the same time of avoiding the effusion thereof" throughout the entire body.[28]

The primacy and force of nervous power was also imagined outside of the vibrational and electrical paradigms, particularly in the notable work of the Swiss physiologist Albrecht von Haller, whose physiological writings from the middle of the eighteenth century, and those of his students, comprised some of the most significant and central physiological writings of the period. Haller essentially rejected the doctrine of vibrations and electrical transmission, even though his specific account of nervous function remained something of a mystery as he imagined the nerves to transmit a fluid which was,

> an element of its own kind unlike anything else. An element too subtle to be grasped by any of the senses, but more gross than fire, or ether or electrical or magnetic matter, since it can be contained in channels and restrained by bonds, and moreover is clearly produced out of and is nourished by the food.[29]

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[26] Stephen Gray, "Two letters from Mr. Stephen Gray to C. Mortimer containing father accounts of his experiments concerning electricity, *Phil. Trans.* 33 (1733): 402. I. Berhard Cohen gives the Gray article an alternate citation in "Neglected Source for the Life of Stephen Gray (1666 or 1667-1736)," *Isis 45* (1954): 41-50. Cohen lists the article as *Phil. Trans.* 37, no. 426 (Nov and Dec 1732), Item I, 397-407

[27] « Les attractions, répulsions, et autres phénomènes électriques, sont les effets d'un fluide subtil, qui se meut autour du corps que l'on a électrisé ». Jean-Antoine Abbé Nollet, *Essai sur l'électricité des corps* (Paris : Frères Geurin, 1746), 67. For the development of the theories of electricity, and the competing conceptions which arose in the mid-to-late eighteenth century between Nollet and Benjamin Franklin, see Jessica Riskin, *Science in the Age of Sensibilty: The Sentimental Empiricists of the French Enlightenment* (Chicago: University of Chicago Press, 2002), chapter three.

[28] Luigi Galvani , *Commentary on the Effects of Electricity on Muscular Motion*, trans. Robert Montraville Green (Cambridge, MA: Elizabeth Licht, 1953), 64. For a brief encyclopedic account of Galvani, see Miriam Focaccia and Raffaella Simili, "Luigi Galvani, Physician, Surgeon, Physicist: From Animal Electricity to Electro-Physiology" in *Brain, Mind and Medicine.*

[29] Albrecht von Haller, *Elementa Physiologiae* (Lausanne, 1762), quoted from Michael Foster, *Lectures on the History of Physiology During the Sixteenth, Seventeenth, and Eighteenth Centuries* (Cambridge University Press, 1901), 297.

Haller is perhaps most recognized for having designated a special property of nervous function in one of his earliest texts, first read in 1752, *On the Sensible and Irritable Parts of Animals.* This was the property of sensibility, the property by which the nerves could be specially differentiated from the rest of an animal's organic parts, even though Haller was by no means the first to make this designation which was originally Galenic at least. Nevertheless, Haller described the nervous system as an independent sub-division of the overall economy of the animal body, and the only part of the body which was sensitive, able to be consciously sensed and perceived as a feeling by the soul. Haller drew a distinction between the material sensitivity of the nerves and the material "irritability" of the rest of the body, the property which defined all the other and specifically non-conscious motions of the body, including its contractions, convulsions, and general motility; irritability was for Haller a property of the muscular fibers alone.[30] In invoking the concepts of sensitivity and irritability — the boundary of consciousness being the only provision that essentially differentiated the two — Haller was ultimately drawing from a long physiological tradition of defining the susceptibility, reactivity, and autonomous motility of animate matter. Irritability specifically was a concept delineated in the mid-seventeenth century writings of the English physician Francis Glisson who, as an Aristotelian vitalist, imagined an indwelling *spiritus insitus* to reside in all flesh, muscles and nerves, by the means of which the activity and reactivity of the entirety of the body would be possible.[31] Irritability for Glisson, from whom Haller explicitly drew the concept, was a term that described the power of all animate matter.

Late seventeenth and eighteenth century materialism came to depend on concepts like sensibility, irritability, and related notions such as sympathy, sentiment, or physical affinity and correspondence in order to describe what differentiated living matter from the rest of the physical world, namely the special susceptibility and activity of the animal body and its ability to be affected by a variety of stimuli and to respond in a relatively autonomous and semi-intelligent way to that stimulation. This materialist standpoint defined a general horizon of thinking adopted by many which was able to span major conceptual divides that otherwise marked this historical period, particularly the divide between mechanistic and vitalist materialism. Up until the mid-eighteenth century, mechanism was the most prominent theoretical standpoint for describing the living body. From the mechanistic point of view, the body was an aggregate of causally related and concomitant elementary units of a material substance which could be measured and calculated with absolute mathematical precision. The body as machine, an idea typified by Descartes, was a conception that arose in relation to the emerging mathematical sciences of optics, physics, and mechanics. Of course, mechanism does not fully account for the entirety of available anatomical theories, and the various vitalistic tendencies that pervaded natural history since antiquity cannot be overlooked, especially throughout the seventeenth century with figures

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[30] Albrecht von Haller, *On the Sensible and Irritable Parts of Animals,* in *The Natural Philosophy of Albrecht von Haller*, ed. Shirley A. Roe (New York: Arno Press, 1981). See also Anne C. Vila, *Enlightenment and Pathology: Sensibility in the Literature and Medicine of Eighteenth-Century France* (Baltimore: Johns Hopkins University Press, 1998), chapter 1. See also Koehler, "Neuroscience in the Work of Boerhaave and Haller," 225-228.

[31] See Brazier, *A History,* 57. Some classical texts on Glisson include Walter Pagel, "The Reaction to Aristotle in Seventeenth-Century Biological Thought: Campanella, van Helmont, Glanvill, Charleton, Harvey, Glisson, Descartes," *History, Philosophy, and Sociology of Science,* vol. 1*,* ed. E.A. Underwood (Oxford: Oxford University Press, 1953): 489-509; Walter Pagel, "Harvey and Glisson on Irritability with a Note on Van Helmont," *Bulletin of the History of Medicine* 41, no. 6 (November-December): 497-514; and also Owsei Temkin, "The Classical Roots of Glisson's Doctrine of Irritation," *Bulletin of the History of Medicine* 38, no. 4 (July-August, 1964): 297-328. See also Thomson, *Bodies of Thought,* chapter 3.

such as Jean Baptiste van Helmont and Claude Perrault.[32] Still, by the mid-eighteenth century, the mechanistic understanding was confronted more pervasively by vitalistic alternatives that understood the living body as an organized and indivisible whole, whose organizational property was both seemingly purposive and entirely related, like a principle, to both the sensibility and the vitality of the organism.[33]

The eighteenth century in particular saw the rise of a general conceptual orientation towards sensibility and its synonyms, either as the theoretical consideration of the susceptibility and reactivity of living matter in writers including Haller, Denis Diderot, Charles Bonnet, and the physicians of the Montpellier school of medicine; or as a sensualist-empiricist orientation towards a philosophy of subjectivity, marked especially by Étienne Bonnot de Condillac and Claude-Adrien Helvétius.[34] Living matter, to some extent, presented something of a challenge to a universal, and typically mechanical, conception of physical substance, particularly the living matter that comprised the brain and nervous system and which had for many thinkers on the subject an important and intimate proximity with soul or mind. This is perhaps why in his 1688 *Free Inquiry*, Robert Boyle, while describing human bodies as “hydraulico-pneumatical engines”[35] nevertheless stays clear of the specific question of the human soul — “I thought I might, for others’ ease and my own, be allowed to set aside the considerations of it” — in order not to risk a topic which would no doubt have troubled his formulations about the general powers and motions of physical bodies.[36]

In some senses, eighteenth century materialism, as dependent as it was on developments in the physiology of the nervous system, did little to actually re-orient the brain and nerves in any significant conceptual way. The very category of living matter — particularly in relation to the brain and nervous system — was not such a clear-cut conceptual boundary. It was not uncommon, when the living matter of the brain and nerves were described, that they would actually be considered in a kind of analogy to a set of epistemological categories and functions.[37] Indeed, some of the most notable materialists, particularly in the eighteenth century, imagined, as their philosophical and scientific forerunners did, the material processes of the nerves and indeed of the body in general, in analogy to a logical theory of sense and mind — as a linear transmission of sense resulting in a final combination of impressions in the form of judgment. This constituted an important conceptual constraint on the actual articulation the very *matter* of the brain, and accounts for another rationalization for what I have described as the brain’s conceptual diffusion.

A noteworthy example is *Observations on Man*, in which Hartley emphasized “the uniformity and continuity of the white medullary substance of the brain, spinal marrow, and

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[32] Georges Canguilhem, “Aspects of Vitalism,” in *Knowledge of Life,* trans. Stefanos Geroulanos and Daniela Ginsburg (New York: Fordham University Press, 2008). Franklin Fearing, *Reflex Action: A Study in the History of Physiological Psychology* (Cambridge, MA: MIT Press, 1930), chapter 1. See also Thomson, *Bodies of Thought*, 86-95.

[33] Of course the shift was not absolute, nor was it a reification of animism. See Sergio Moravia, “From *Homme Machine* to *Homme Sensible:* Changing Eighteenth-Century Models of Man’s Image,” *Journal of the History of Ideas* 39, no.1 (Jan-March 1978): 45-60.

[34] Vila, *Enlightenment and Pathology,* especially chapters 1 and 2; Riskin, *Science in the Age of Sensibility*, especially chapter 1. See also Peter Hanns Reill, *Vitalizing Nature in the Enlightenment* (Berkeley: University of California Press, 2005), particularly chapter 3.

[35] Robert Boyle, *A Free Inquiry into the Vulgarly Received Notion of Nature* (Cambridge: Cambridge University Press, 1996), 139.

[36] Ibid., 18.

[37] See Karl M. Figlio, “Theories of Perception and the Physiology of Mind in the Late Eighteenth Century,” *History of Science* 13, no. 3 (September 1975): 177-212.

nerves,"[38] a continuity that corresponded to and also enabled the analogical continuity of epistemic functions, from sensation to perception, and to the formation of an idea. And while Hartley did concede the anatomical complexity of the general structure of the nerves and brain, it was a concession framed within the impossibility of actually accessing the physiological details of the brain itself:

> It is reasonable also to think, that the nerves of different parts have innumerable communications with each other in the brain … and that many phenomena, particularly those of the sympathetic kind, are deducible from these communications. But as it seems impossible to trace out these communications anatomically, on account of the great softness of the brain, we must content ourselves with such conjectures as the phenomena shall suggest.[39]

At almost the same time Julien Offray de La Mettrie argued in *L'homme machine* that the soul — "but an empty term" — could only be described in a material sense, equivalent only to the body's physicality or structural arrangement: "But since all the soul's faculties depend in such a way on the proper organization of the brain and the entire body, they are evidently nothing but that organization itself: and in this way the machine is well elucidated!"[40] For La Mettrie, universal matter was divided between an organized and an unorganized state, while an "inciting and impetuous principle" of motion was bestowed on the former alone,[41] which found its proper place in the brain.[42] And yet, La Mettrie conceded at the end of his essay, "the nature of motion is as unknowable to us as it the nature of matter," and by consoling himself "to ignore how simple and inert matter becomes active and organized [*composée d'organes*]," he reclassified the brain, in all its materiality — indeed, precisely as a consequence of its materiality — as an unknowable object. The brain was, on the one hand, an inscrutable material arrangement, even though it was, on the other, the source of the "emanation" [*émanation*] of the rest of the body and its vital functions.[43] In this sense, and precisely on the basis of its materiality, the brain accounted for a twofold diffusion — conceptually withdrawn and yet materially distributed, a diffusion echoed in the growing legibility of the nervous system over cerebral anatomy and the theoretical opacity of the materiality of subjectivity.

Indeed, two decades later, in his *System of Nature,* the German-French materialist and atheist Paul-Henri Thiry, Baron d'Holbach reiterated Hartley's and La Mettrie's position, describing man as "nothing more than a long series, a succession of necessary and connected motion, which operates perpetual and continual changes in his machine" and which included as part of its foundation "causes contained within himself, such as blood, nerves, fibres, flesh,

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[38] Hartley, *Observations,* 16.
[39] Ibid., 19.
[40] Julien Offray de La Mettrie, *L'Homme Machine,* in *Man a Machine* (La Salle, IL: Open Court: 1991), 56, my translation. For a useful account of La Mettrie's philosophy and philosophical development, see Ann Thomson, *Materialism and Society in the Mid-Eighteenth Century: La Mettrie's* Discours Préliminaires (Genève, Librairie Droz, 1981). See also Thomson, *Bodies of Thought*, 180-189.
[41] « Qu'on m'accorde seulement que la matière organisée est douée d'une principe moteur, qui seul la différencie de celle qui ne l'est pas. » La Mettrie, *L'Homme Machine,* 70.
[42] "The principle exists and has its seat in the brain at the origin of the nerves, by which it exercises its reign on all the rest of the body." Ibid., 61, my translation. It is in this sense that La Mettrie assets that "the soul is but a principle of movement, or a sensible and material part of the brain" (Ibid., 65).
[43] "One can without fear of error see [the soul] as the mainspring of the entire machine, which has a visible influence on all the other springs, and seems even to have been made first, such that all the others are but an emanation of it," (Ibid., 65, my translation).

bones, in short, the matter, as well solid as fluid, of which his body is composed."[44] This chain of matter and motion, however, need, for Holbach, to remain conceptually abstracted and somewhat indistinct. Only in this way could the baseline matter of the body — initially "inert, insensible, animate" — undergo the proper "continual attraction" and be "continually combining itself" to the point of becoming "an active whole, that is living, that feels, judges, reasons, wills."[45] Indeed, Holbach conceded, as Hartley and La Mettrie did, that the material complexity of the human verged on inexplicability.

All this is to say that in a number of different ways, the brain by the mid-eighteenth century submitted to a kind of conceptual retreat, or a diffusion into alternative conceptual schemes and frameworks related quite generally to the physiology of the nerves and the philosophy of matter. Precisely in those contexts, the organ of the mind maintained the lacunal status that Steno had earlier identified and that Locke had indexed, a status that came to define the opacity of the very nature of the brain's materiality. The goal of the remainder of this chapter is to understand the details and developments of the brain's conceptual diffusion, and in what senses it reoriented what could count as the very space and matter of the brain. No doubt, the brain's functionality was being imagined in relation to the bodily arrangement of nerves, delineated in greater and greater systematic ways. But as I will show, it was actually the brain's conceptual diffusion that made possible its discursive and theoretical pervasiveness, especially in terms of how the brain was incorporated within the expanded conceptualization of the nerves in mid-to-late eighteenth-century neurophysiology. This analysis, however, depends on discovering how the brain was understood as being part of an important conceptual paradigm within eighteenth-century life science — namely, the paradigm of vital organization.

In the following sections, I will discuss how the brain itself — in terms of both its anatomy and its functionality — became imagined by the mid-eighteenth century according to a theoretical framework of the vital organization of life and living processes. I will discuss how physiologists deploy the concept of "organization" to reimagine the nature of living matter, though often in complex and ambiguous ways. By imagining the brain as an *organization*, in the sense that it was meant for certain, particularly vitalist, physiologists, the brain could be both anatomically materialized, while also maintaining a materiality that was vague and in some senses not entirely physical. The brain became the very site or space which staged the complexities and even the paradoxes of the concept of organization. Organization helped resolve the problem of the brain's diffusion, but it did not do so by centralizing or by drawing together a unified and fully coherent picture the brain. Rather the framework of organization which implicitly shaped the brain in this period both legitimated and consolidated the nature of its *decentrality* in and as the material body.

Relocating the Brain in the *Sensorium Commune*

The brain's conceptual diffusion was synonymous particularly throughout the eighteenth century with a widespread designation: the *sensorium commune*. In this sense, and particularly by the mid-century, the brain was imagined in its entirety to be an undifferentiated mass, an organic whole, functionally equivalent with the power of combining and generating a unified, singular experience and self.[46] The *sensorium commune* had long been the ever-changing anatomical site whose theoretical function was to unify and make coherent the particularity of

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[44] Paul Henry Thiry, Baron d'Holbach, *The System of Nature or the Laws of the Moral and Physical World,* vol. 1, trans., H.D Robinson (Kitchener, Ontario: Batoche Books, 2001), 42.
[45] Ibid., 43.
[46] Clarke and Jacyna, *Nineteenth Century Origins,* 212-220.

diverse sensory impressions.[47] *Sensorium commune* and *sensus communis* were synonymous to a degree. The *sensorium commune* tended to refer to the anatomical site where the *sensus communis*, generally a faculty, would have been located.[48] The term *sensorium commune* would have circulated more frequently in the context of late medieval and early modern brain anatomy, up until the eighteenth and even nineteenth centuries. But even the nominal distinction between *sensorium commune* and *sensus communis* was not necessarily strictly held if, for example, the site and faculty were identical. Descartes, for instance, referred to the anatomical pineal gland, according to its function, as the *sensus communis*.[49] The specific faculty of the *sensus communis* was tantamount to the non-ideational combination of sensory impressions which could produce something along the lines of a sensate judgment. The ability to derive unified commonality among varied and singular sensory forms involved a process of extrapolation and generalization that expanded an impression beyond the limits of its sensate particularity by making it, for example, repeatable in new contexts and re-expressible in innovative and semi-abstracted combinations and forms.

The *sensorium commune* was not only a concept relevant to physiology or psychology, since prominent examples of the use of the notion occur in eighteenth-century political thought as well.[50] Immanuel Kant, for example, famously described the concept of *sensus communis* in the first part of the *Critique of the Power of Judgment* as an intrinsically generalizable or systematic mode of judgment, a "communal sense," universal in its subjectivity, which "takes account (*a priori*) of everyone else's way of representing in thought." [51] Kant's deployment of the *sensus communis* — and the transcendental conditions of the necessarily apparent and imputed systematicity of experience by which *sensus communis,* a mode of reflective judgment, is defined in the third *Critique* — was linked directly to the conception of socio-political unity, to which Kant assigned the particularly weighty eighteenth-century notion, "organization."[52]

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[47] K.D. Keele, "The Search for the Sensorium Commune;" David Summers, *The Judgment of Sense: Renaissance Naturalism and the Rise of Aesthetics* (Cambridge, 1987), chapter 5 especially. See also Georges Canguilhem, *La formation du concept de réflexe aux XVIIe et XVIIIe siècles* (Paris, Presses Universitaires de France, 1955), chapter 5; and Figlio, "Theories of Perception and the Physiology of Mind in the Late Eighteenth Century."

[48] On the long history of the physiological situatedness of the *sensus communis,* see R.K. French, *Robert Whytt, the Soul, and Medicine* (London: The Wellcome Institute of the History of Medicine, 1969), chapters 8-12.

[49] René Descartes, *Oeuvres de Descartes,* vol. 7, ed. Adam and Paul Tannery (Paris: J. Vrin, 1974-1982), 86. Hereafter cited as AT.

[50] For the rise and political mobilization of the term "common sense" in England, for example, see Sophia Rosenfeld, "Before Democracy: The Production and Uses of Common Sense," *The Journal of Modern History* 80 (March 2008): 1-54

[51] Immanuel Kant, *Critique of the Power of Judgment,* trans. Paul Guyer and Eric Matthews (Cambridge University Press, 2000), (§40, 5:293), 173.

[52] Kant writes, in a footnote, "In the case of a recently undertaken fundamental transformation of a great people into a state, the word organization has frequently been quite appropriately used for the institution of the magistracies, etc., and even the entire body politic." Kant, *Critique of the Power of Judgment,* 246, (5:375) n. 1. Hannah Arendt, emphasized the political dimensions of Kant's *sensus communis* in *Lectures on Kant's Political Philosophy* (Chicago: University of Chicago Press, 1992). In *The Human Condition* (Chicago: University of Chicago Press, 1958), Arendt explains that "common sense occupies such a high rank in the hierarchy of political qualities because it is the one sense that fits into reality as a whole our five strictly individual senses and the strictly particular data they perceive. It is by virtue of common sense that the other sense perceptions are known to disclose reality and are not merely felt as irritations of our nerves or resistance sensations of our bodies" (208-209). Other useful and notable examinations of *sensus communis* in the third *Critique* include Paul Guyer, *Kant and the Claims of Taste* (Cambridge, MA: Harvard University Press, 1979); Henry E. Allison, *Kant's Theory of Taste* (Cambridge: Cambridge University Press, 2001); Gilles Deleuze, *Kant's Critical Philosophy: the Doctrine of the Faculties,* trans. Hugh Tomlinson (Minneapolis: University of Minnesota Press, 1984), and Jean-François Lyotard, "*Sensus communis:* The Subject in *statu nascendi*," in *Who Comes After the Subject?* ed. Eduardo Cadava, Peter Connor, and Jean-Luc Nancy (New York: Routledge, 1991).

Jean-Jacques Rousseau provided a noteworthy deployment of *sensorium commune,* with fidelity to its anatomical sense, similarly in order to define, but also to criticize, the idea of a natural or given sense of socio-political unity. Rousseau used the concept early in his *Geneva Manuscript* where, drawing from the presumptions of his *Second Discourse,* he argued against the idea that a natural sympathy invariably drew people together into a social whole. He writes,

> If the general society did exist somewhere other than in the systems of Philosophers, it would be, as I have said, a moral Being with qualities separate and distinct from those of the particular Beings constituting it…. There would be a universal language which nature would teach all men and which would be their first means of mutual communication. There would be a kind of *sensorium commune* which would connect all the parts.[53]

For Rousseau, there was no natural, physiological power (no such *senorium commune*) that could give space to social unity; the socio-political order, for Rousseau, was a kind of artifice, since a natural socio-political consensus of people was simply impossible.[54]

It suffices to say that the concept of *sensorium commune* was throughout the eighteenth century a conceptually overloaded notion, even though it did possess a relatively consistent definition, linked to the concept of unity. Although political deployments of *sensus communis* or *sensorium commune* functioned figuratively, often in order to produce an analogical or metaphorical picture of socio-political unity, in the context of neuroanatomy, the *sensorium commune* directly named the brain's material unity, while also accounting explicitly and literally for the material conditions for the immaterial unity of the self.

By the middle of the eighteenth century, for example, many thinkers, including Haller, Hartley, and La Mettrie, to name but a few,[55] imagined that the brain *in its entirety* constituted the *sensorium commune* and its correlative faculty. Before then, the location of the faculty *sensus communis* had shifted historically, though by the late Middle Ages it was commonly located within the brain, and by the seventeeth century, it was rarely ever located anywhere else, giving the brain (or one of its anatomical sub-divisions) the frequent pseudonym of *sensorium commune*. The eighteenth-century tendency to imagine the whole brain as the *sensorium commune* was itself a shift away from the tendency of seventeenth century neuroanatomy that followed historically but also to an extent doctrinally, a medieval ventricular tradition, by assigning the *sensus communis* to only a portion of the brain.[56] In this sense the brain had been, and in the seventeenth century continued to be the physical embodiment of an entire metaphysical-epistemological continuum, a contiguous anatomical arrangement of a metaphysical gradation (a concentricity if not a direct continuity[57]) leading from the *sensus*

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[53] Jean-Jacques Rousseau, *Geneva Manuscript,* in *The Collected Writings of Rousseau,* vol. 4, ed. Roger D. Masters and Christopher Kelly (Hanover: Darmouth, University Press of New England, 1994), 78. I have modified the translation from "a kind of central nervous system," since in the French, Rousseau describes it as "*une sorte de sensorium commune*."

[54] For more on this point, see David Bates, "Beyond nature: Rousseau's cybernetic body politic and the state of war."

[55] For La Mettrie's of the term, see Thomson, *Bodies of Thoughts*, 188.

[56] "The sensorium commune was localized in the pineal gland by Descartes; the corpus striatum by Willis; the corpus collosum by Lancisi, le Peyronie, and Bonnet; the centrum ovale by Vieussens; the septum lucidum by Digby, the cerebellum by Drelincourt." George Mora, "Cabanis, Neurology and Psychiatry," in Pierre-Jean-Georges Cabanis, *On the Relations Between the Physical and Moral Aspects of Man,* vol. 1, (Baltimore: Johns Hopkins University Press, 1981).

[57] Summers, *Judgment of Sense,* 94.

communis, where sensory impressions were unified, to the imagination and ultimately to the faculty of reason.

Haller's neurophysiology provides one of the best eighteenth-century examples of how the brain was imagined, in its entirety, as the *sensorium commune,* and in what sense this formulation was integral in providing the physiological basis for a theoretical account of a unified self. Haller referred interchangeably to "the brain or common sensory,"[58] and identified the majority of the brain's anatomical bulk — in particular, the inner white matter — as the functionally equivalent and unified basis of vital and mental operations:[59] "The seat of the mind, if it be material, must be where the nerve first begins its formation or origin."[60] Locating the unifying function of the *sensorium commune* in the entirety, or near-entirety, of the brain was of great metaphysical significance for Haller, and for any thinker who espoused such a position vis-à-vis the brain. As Haller writes in *On the Sensible and Irritable Parts of Animals,* the unifying function of the *sensus communis,* housed as it was within the anatomical unity of the brain as the *sensorium commune,* ensured the maintenance of a singular, undivided, and self-conscious "I":

> The soul is a being which is consciousness of itself, represents to itself the body to which it belongs, and by means of that body the whole universe. I am myself, and not another, because that which is called I, is changed by *everything* that happens to my body and the parts belonging to it. If there is a muscle, or an intestine, whose suffering makes impressions upon another soul, and not upon mine, the soul of that muscle or intestine is not mine, it does not belong to me. But a finger cut off from my hand, or a bit of flesh from my leg, has no connection with me, I am not sensible of any of its changes, they can neither communicate to me idea or sensation; wherefore it is not inhabited by my soul nor by any part of it.[61]

Sensibility and subjectivity were identified in and as an indistinguishable totality — the metaphysical "I" — which was more or less equivalent to the totality of the brain, an organ that appeared anatomically whole. It would make sense, then, that anatomical disruptions to the brain would result in total mental debilitations:

> When any more considerable or large portion of the brain suffers a compressure, either from blood, water, schirrus, an impacted bone or other mechanical causes, there follows perpetually either a disturbance of all the faculties of the mind, or else a delirium, vertigo, madness, stupidity, or an incurable sleepiness; all which disorders cease upon removing the compressing cause.[62]

Of course, on the same basis, the brain's totality was the basis of a process of substitutive reorganization in which a nerve, for instance, which grew out of a damaged section of the brain was "not always deprived of its use" insofar as "its office may, in some measure, be continued

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[58] Albrecht von Haller, *Dr Albert Haller's Physiology,* vol. 2 (London: W. Innys and J. Richardson, 1754), 110.
[59] Clarke and Jacyna, *Nineteenth Century Origins,* 215-16.
[60] Haller, *Dr Albert Haller's physiology,* vol. 1, 309-310. See Koehler, "Neuroscience in the Work of Boerhaave and Haller," 222-223, 229-230.
[61] Haller, *On the Sensible and Irritable Parts of Animals,* 678.
[62] Albrecht von Haller, *Dr Albert Haller's physiology, Vol. 1* ibid., 307.

entire by the fibers, which it receives from the opposite side, even after those of its own side are destroyed."[63]

In the larger context of neurophysiology, however, the conceptual use of *sensorium commune* was not simply an example of the merely underdeveloped nature of the science of the brain, or a symptom of the fact that the brain's anatomical sub-divisions and physiological complexity had not been fully worked out. Even though the *sensorium commune* did ultimately render the brain something of a material correlate to the formal unity of the "I," as Haller's neurophysiology makes clear,[64] the *sensorium commune* also provided the brain with a different sort of conceptual breadth that has not as of yet been fully examined. In order to draw out how the conceptual framework of the *sensorium commune* productively reoriented the concept of the brain, it is necessary to understand how exactly the *sensorium commune* acted as a unifying space — and therefore it is necessary to understand how *sensorium commune* was intimately tied to the eighteenth-century notion of organization, in the specific sense of the organization of life and living matter. From that standpoint, it will become possible to see how the *sensorium commune,* the theoretical synonym for eighteenth-century brain, exhibited properties that were at once radically productive but also deeply aporetic.

The Common Space of Cerebral Organization

The *sensorium commune* was an open concept, deployed physiologically, psychologically, and politically in order to define a process of unifying organization, a process that could yield unity from diversity. It was effectively a substitute for the notion of organization itself, an idea central to much of the psycho-physiological and political discourses of the eighteenth century. The eighteenth-century brain was typically a space of organizational unity, and the significance of the brain's organizational capacity was that it could stage within itself the unification of material and immaterial attributes. But, as I will show, far from being a resolution to the question of how matter could be imbued with immaterial properties, the underlying organizational capacity of the *sensorium commune* made it a conceptually productive but materially aporetic formulation of the brain.

Fewer notions were as pervasive throughout the life sciences of the eighteenth century as that of organization. The term fulfilled a multitude of functions throughout the period — so many, in fact, that it has been described as nothing more than an extended metaphor, functioning more to provide the semblance of discursive unity to the life sciences rather than to elucidate any particular attribute of a living being or animate matter.[65] For example, the concept shows up more cryptically than clearly in *Nouveaux éléments de la science de l'homme,* the 1778 text by the Montpellier physician Paul-Joseph Barthez, which provided one of the more elaborate accounts of physiological vitalism from the late eighteenth century. Barthez's system revolved around a theorized vital principle, which while "strictly united to the organs," nevertheless possessed functions having "an intimate connection with those of the soul."[66] Such a vital principle yielded a "primordial" lawfulness that would constitute regulative relations of consensus throughout the physical body that could not, in themselves, "be attached to any

[63] Ibid., 319. In this sense, as Peter Reill points out, Haller who was a proponent of mechanism, ended up displaying a number of vitalistic tendencies, not the least of which was the power of non-volitional irritability. See Reill, *Vitalizing Nature,* 130 and Robert Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (The University of Chicago Press, 2002), 313.
[64] And as Karl Figlio stresses in "Theories of Perception."
[65] See Karl Figlio, "The Metaphor of Organization: An Historiographical Perspective on the Bio-Medical Sciences of the Early Nineteenth Century," *History of Science* 14 (1976): 17-53.
[66] Paul-Joseph Barthez, *Nouveaux éléments de la science de l'homme,* 3e édition, vol. 1 (Paris : Germer Baillière, 1858), 69.

mechanical cause."[67] This physical and causal exceptionalism of Barthez's vital principle took on a peculiar dimension when he, in a presumably recognizable but unnamed reference to Leibniz, described "a sort of *pre-established harmony* between the affections of the vital principle and the organization of the body that it animates."[68] Vitality for Barthez was "harmonized" — that is, if I can indeed draw on Leibniz, always causally and metaphysically congruent — with the *organization* of the body. The body's organization, being neither the strict materiality of the organism nor its soul in a rigorous sense, was linked to vitality according to a continuously antecedent ontological synchrony — a relation quite different than how the vital principle was otherwise linked to the organs or the functions of the soul. Barthez's invocation points both to the profundity but also the relative inexplicability of the notion of organization.

Nevertheless, organization has been touted, most famously by historian and philosopher Georges Canguilhem, as the notion that did most to conceptualize life and the living being throughout the eighteenth and nineteenth centuries; so it is possible, and no doubt important, to offer some brief historical and theoretical remarks about how the notion of organization assembled and subtended the concept of the living being throughout the late seventeenth and eighteenth centuries and, eventually, the concept of life itself as it emerged by the start of the nineteenth century.[69] For example, organization received perhaps its most extensive articulation within the context of vitalist medicine and physiology of the mid-to-late eighteenth century, having been emphasized most notably by Georges-Louis Leclerc Comte de Buffon when in his multi-volume *Histoire naturelle,* first appearing in 1749, he declared, "Our existence, therefore, is an effect of organization."[70] The term had a general and historically non-restricted scope. It was not a principle in any strict sense, and so consequently not rigorously or always bound up with a specifically contextualized set of related philosophical and scientific principles, rules, or conventions. To consider organization as the logical framework of the living being requires relinquishing the commitment not only to a specific scientific philosophy but even to large-scale historical-epistemological divisions of life science.

Even Descartes, the so-called father of physiological mechanism, in Article 30 of his late *Passions of the Soul* from 1649 posited that "because of the arrangement of its organs" the body "is one and in some sense indivisible,"[71] a definite reversal of the emphasis on the mechanistic divisibility of the body presented in the *Sixth Meditation*. The emphasis on a body's indivisible totality (for Descartes, this is true only of the human body), arising as a consequence of the formality of its internal arrangement of parts, was one of the more common attributes of living organization, and one bearing no strict historical specificity. A little more than a century later, Diderot's *Encyclopédie,* published shortly after Buffon's *Histoire naturelle,* analogously defined

[67] Ibid., vol. 1, 431.
[68] Ibid., vol. 1, 119, emphasis in original.
[69]Georges Canguilhem, "Le tout et la partie dans la pensée biologique," *Études d'histoire et de philosophie des science,* 5e édition (Paris : Librairie Philosophique J. Vrin, 1983), 319-333; *A Vital Rationalist,* trans. Arthur Goldhammer, ed. Francois Delaporte (New York: Zone Books, 2000), 80-86.
[70] Georges-Louis Leclerc, Comte de Buffon, *Natural History, General and Particular,* trans. William Smellie (London: Cadell, 1812), vol. 2, 354. For more on Buffon and the mid-18th century origins of Enlightenment vitalism, see Reill, *Vitalizing Nature in the Enlightenment*, chapter 1; and see also chapter 3 for the emphasis on the notion of organization.
[71] « [Le corps] est un et en quelque façon indivisible, à raison de la disposition de ses organes qui se rapportent tellement tous l'un à l'autre que, lorsque quelqu'un d'eux est ôté, cela rend tout le corps défectueux » (AT XI, 351). I have briefly modified the standard translation from *The Philosophical Writings of Descartes,* vol. 2, ed. John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge University Press, 1985), 339, which reads, "For the body is a unity which is in a sense indivisible because of the arrangement of the organs."

organization in a short entry as the "arrangement of parts that constitute the animated body."[72] And Georges Cuvier at the start of his 1817 multi-volume *Le Règne Animal,* defined life as a formal (as opposed to material) property of a living body, a combination of structure and vital motion he named "organization" that arose from "a great number of dispositions" internal to the tissues and fluids of the organism such that "every organized body" possesses but "one proper form … so that, in every being, the life is a whole [*un ensemble*], resulting from the mutual action and reaction of all its parts."[73] (By 1819, "organization" combined with the entry "organized body" comprised nearly 50 pages of definition in the French *Dictionnaire des sciences médicales*.)

In a sense, organization is useful in the extent to which it can be understood as one of the primary conceptualizing forces of life and living beings for over two centuries, and somewhat ineffective precisely in its historical generality. Even during the eighteenth century, during the period of its greatest emphasis, the notion of organization tended to flatten some of the common conceptual and scientific divides that marked up that period — including debates around pre-formationism and epigenesis, or the shifting attitudes towards mechanism, animism, and vitalism — and essentially linked figures who would otherwise be thought of as bearing a certain scientific-theoretical incompatibility. Georg Ernst Stahl, for example, the Halle physician and foundational animist who reacted against physiological mechanism from the late seventeenth and early eighteenth centuries (recognized for coining the modern notion of "organism") described organized and animated bodies as entirely regulated by a immaterial soul, that nevertheless acted as an "organic, or rather organizing energy" [*energia organica seu potius organizans*].[74] The animal body, or "*organismus formalis*" was both an instrument and an effect of this formative force, and its organization was the very manifestation of the soul's physical agency.

The Stahlian soul instantiated the self-regulating movements of vital fluids and processes that maintained the health and vitality of an organized body in a manner formally similar to what Canguilhem much later described as the "circular reciprocity" intrinsic to an organized body.[75] The motif of circularity to describe living organization is longstanding and particularly familiar throughout the eighteenth century. An especially explicit emphasis is made by another Montpellier physician and vitalist, Théophile Bordeu, whom Diderot portrays in *Le Rêve de d'Alembert.* In his 1752 *Recherches anatomiques sur la position des glandes et leur action,* Bordeu described the circulatory economy of a living being as comprised of a concentric arrangement of "particular circulations" of blood, distributed throughout the subdivisions of the body, but always in relation to a general circulation. These particular circulations are "if we dare say so, like little circles that culminate in a larger one. We have gotten accustomed to making use of this denomination, circle, to express how a part of the body, although it receives blood by means of the general circulation or is comprised of the largest blood vessels, still possesses a

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[72] *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, par une société de gens de lettres,* vol. 11, ed. Denis Diderot and Jean Le Rond d'Alembert (Genève : Cramer, 1772), 629.

[73] Georges Cuvier, *Le Règne Animal, distribué d'après son organisation pour servir de base a l'histoire naturelle des animaux,* 3e édition, 1e tome, (Bruxelles : Louis Hauman, 1836), 8-9. *The Animal Kingdom: Arranged After its Organization, Forming a Natural History of Animals and an Introduction to Comparative Anatomy,* trans. William Benjamin Carpenter (London: W.H. Allen & Co., 1890), 5-6.

[74] Cited in Tobias Cheung, "Regulating Agents, Functional Interactions, and Stimulus-Reaction-Schemes: The Concept of "Organism" in the Organic System Theories of Stahl, Bordeu, and Barthez," *Science in Context* 21, no. 4 (2008), 495-519. For more on Stahl's theory of the soul's role in the body's organizing self-generativity, see Francesco Paolo de Ceglia, "Soul Power: Georg Ernst Stahl and the Debate on Generation," in *The Problem of Animal Generation in Early Modern Philosophy,* ed. Justin E.H. Smith (Cambridge: Cambridge University Press, 2006), 262-284.

[75] Canguilhem, *Vital Rationalist,* 83.

particular circulation."[76] Even Haller, as much as he was an ardent anti-animist and strict critic of the Stahlian legacy and certain vitalist thinkers throughout the eighteenth century, defined organic life as "a perpetual circumrotation, segregation, and remixture of the various links or particles that compose a warm fluid, which we call blood carried on betwixt two springs: viz. the heart or vital main spring and the encephalon or animal spring."[77] Haller, to some degree, adopted a conception of the circularity of the vital economy, without explicitly emphasizing the nature of "organization" itself.

Of course, it is important to admit that the term "organization" often referred, in a somewhat empty fashion, to nothing but the structural composition of animate matter, without making any detailed claims as to the nature of that composition. Organization was often the designation that would simply differentiate living from non-living bodies. It was a term that could alleviate the need for an author to justify or explain why matter would be divided in this way at all, as we saw with La Mettrie[78]; or it would enable an author to propose, obliquely or not, the exceptional, non-physical basis for the nature of living matter, as is the case with French philosopher and naturalist Pierre Louis Moreau de Maupertuis.[79]

But it is not enough to concede merely that organization was an all-purpose discursive category or even an empty concept. Indeed, the connection between *sensorium commune* and organization cannot be drawn out until the concept of organization is analyzed in a bit more detail. For despite its pervasiveness as a concept, we can pinpoint a number of definable characteristics, so long as we are willing from the outset to allow organization to encompass extremely complex, even paradoxical formulations about living matter. As Canguilhem aptly wrote, "the model of the organism is the organism itself."[80] From this standpoint, organization already denotes the indistinguishability between the formal and material nature of the organized body, straddling to an extent the conceptual and empirical boundaries of a living being. As we think about the notion of organization, it is important to consider how the concept fundamentally altered the conception of living matter; that while it was presented as a resolution to the question of how brute matter could be imbued with the formal attributes of life, organization may have instead introduced more inconsistencies into the equation; and that, most importantly, the brain itself could be, as the *sensorium commune* the most exemplary manifestation of the logic but also the paradoxes of organization.

Organization, first and foremost, tended to be imagined according to a deviation from a physical and mechanical causality. Such a deviation is already apparent in the entry on organization in Diderot's *Encyclopédie:* "The organization of a body once established is the origin of organization in all other bodies."[81] In this brief passage, organization bears a striking self-propagating feature, which as a process produces, among other things, itself as a continued process and form. The organization of a living being is essentially its own self-organization, a manifestation of self-causality that received its most explicit philosophical formulation in Kant's *Critique of the Power of Judgment,* when he described an organism as a natural end, which is to say, teleological in its own self-formation: the organism "must be related to itself reciprocally as

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[76] Théophile de Bordeu, *Œuvres Complètes de Bordeu,* ed. Richerand, vol. 1 (Paris : Caille et Ravier, 1818), 187
[77] Haller, *Dr Albert Haller's physiology* vol. 2, 466.
[78] Ann Thomson refers to La Mettrie's very general employment of the term organization, "without reference to any particular theory of this structure, mechanical or otherwise," in *Materialism and Society*, 45, n. 50.
[79] Maupertuis writes, famously, "We will never explain the formation of any organized body according to the physical properties of matter alone." Pierre Louis Moreau de Maupertuis, *Système de la Nature : essai sur la formation des corps organisés* in *Œuvres de Mr. de Maupertuis,* Tome Second (Lyon : Jean-Marie Bruyset, 1756), 155-156
[80] Canguilhem, « Le tout et la partie dans la pensée biologique, » 333.
[81] *Encyclopédie,* 629.

both cause and effect, which is a somewhat improper and indeterminate expression."[82] German biologist Carl Friedrich Kielmeyer made almost the same claim at almost the same time, in his 1793 Göttingen lecture *Über die Verhältnisee der organischen Kräfte unter einander in der Reihe der verschiedenen Organisationen* [*On the Relation of Organic Forces*], when he claimed that the organs of an organism were "so united that each becomes mutually cause and effect of the other."[83] While the formulation received its greatest emphasis in the rise and popularization of the doctrine of epigenesis from the 1760s through 1790s, initiated most famously by Caspar Friedrich Wolff,[84] there was always a tendency for organization, imagined as the framework of life and living beings, to bear traces of a self-formative or self-enactive structure or capacity, that the organism was somehow inscribed within the circular economy of its own self-relation.

Of course, for Kant, the causal deviations of an organism, because they contravened the general principles of experience, could only be experienced as a regulative concept, that is, in analogical terms. No such metaphysical-epistemological delimitations existed for physiologists at the time, particularly those who have been philosophically imagined in some relation to Kant, including Kielmeyer and, notably, German biologist Johann Friedrich Blumenbach. It was Blumenbach who in his 1786 *Institutiones Physiologicae* referred to the body as "a system of organized matter,"[85] and who insisted "that all living organized bodies possess, from their earliest efforts at organization to the closing glass of their existence, a peculiar power perpetually active, perpetually efficacious, the immediate destination of which is, first, to mold the bodies in which it resides into their native and specific forms by the mysterious process of generation, to preserve them afterwards from destruction by the ceaseless function of nutrition."[86] This power, both the essence but also basis for the body's organized state, Blumenbach famously called the *nisus formativus* or *Bildungstrieb,* "not so much a cause as a perpetual and uniform effect … of certain physical phenomena." The body for Blumenbach was its own self-effect, its own process of self-propagation, while the underlying and originary causes of which (the fundamental sources of the *Bildungstrieb*), like attraction and gravitation, "are notwithstanding still involved in more than Cimmerian darkness."[87]

In addition to its peculiar causality, and analogous to it, organization was, secondly, understood according to an internal spatial entanglement between the formal totality of the organism and its constituent parts. Here, Kant was most theoretically articulate. The indistinguishability of causes and effects is equivalent to the indistinguishability between the parts and the whole: "It is required that [an organism's] parts reciprocally produce each other, as far as both their form and their combination is concerned, and thus produce a whole out of their own causality, the concept of which, conversely, is in turn the cause of it."[88] The parts are the cause of the whole which they bring about by aggregate, and yet they are conversely the effects of the whole whose form they finalize. The premise of the indistinguishability of the aggregated

[82] Kant, *Critique of the Power of Judgment,* 244, 5:372.
[83] Quoted in Richards, *The Romantic Conception of Life*, 241.
[84] See Shirley Roe, *Matter, Life, and Generation: Eighteenth-Century Embryology and the Haller-Wolff Debate* (Cambridge: Cambridge University Press, 1981). An additionally useful account is available in Helmut Müller-Sievers, *Self-Generation: Biology, Philosophy, and Literature around 1800* (Stanford: Stanford University Press, 1997).
[85] Translated as Johann Friedrich Blumenbach, *Elements of Physiology,* trans. Charles Caldwell (Philadelphia: Thomas Dobson, 1795), 32.
[86] Ibid., 176.
[87] Ibid., 177. For more on Blumenbach and Kielmeyer, see Richards, *Romantic Conception,* chapters 5 and 6; and Timothy Lenoir, *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century German Biology* (Chicago: University of Chicago Press, 1982), especially chapter 1.
[88] Ibid., 245, 5 :373.

parts of an organism, and the organism's totality, was visible in Barthez's *Nouveaux éléments* when he defined the animal body according to the pervasiveness of a vital principle which ensured both "the intimate *correspondence* that ties together all the parts of the body" as well as "the *individuality* that the body of each animal receives from its life principle."[89]

The indistinguishable and inter-causative relation of parts to whole that typically described the organization of animate bodies led also to a third tendency: organization was imagined as the coalescence of unity and diversity, an ensemble whose sub-division of differentiated parts somehow managed to maintain their distinction despite the unity that they produced and into which they were incorporated. This was well demonstrated through a particularly salient metaphor that was deployed in a number of physiological and even political contexts throughout the mid-eighteenth century, namely the metaphor of the swarm or cluster of bees.[90] One particularly well-recognized instance of the metaphor was used by the character of Théophile Bordeu in Diderot's 1769 *Le Rêve de d'Alembert.* Diderot, a reader of the actual Bordeu and highly influenced by his physiology, did not invent Bordeu's actual use of the metaphor, since Bordeu had relied on it seventeen years earlier in his *Recherches anatomiques:*

> We compare the living body … to a swarm of bees that gathers into a ball and hangs in a cluster from a tree; we do not disagree with a well-known ancient who described the viscera of the lower abdomen as *animal in animali;* each part is, in these terms, probably not an animal, but a kind of individual machine that contributes, in its own way, to the general life of the body. In this way, to follow the comparison to the bees, the cluster is in its entirety attached to a branch of a tree by the action of a good many bees who must act together in order to hold on well; there are those who are attached to the first group, and so on, all competing to form a strong enough body, each however according to its separate and particular action. If one comes to yield or act too vigorously, he will disturb the entire mass in a particular direction; but when they all conspire to huddle together, mutually to embrace one another in the necessary order and proportions, they compose a whole that subsists until it is disturbed. [91]

This well-known passage is typically invoked as a model to demonstrate the language and figurations of vital organization, particularly to highlight the pattern of co-centricity that linked the individual bees to the entire cluster. What I want to emphasize, however, is how Bordeu's metaphor schematically outlines a feature of vital organization that in its most rigorous formulation supposes the simultaneity or, more specifically, the superimposition of unity and diversity. The cluster exists at once as both a totality of indistinguishable bees as well as an aggregate of discrete organisms whose individuality, although incorporated into the cluster, is by no means lost. The quasi-paradoxical nature of the co-location of unity in/as diversity is equivalent to the manner by which organization structures the living organism's inter-entanglement of both space and causality. Organization, therefore, in its most extended sense — that is, when the notion is pushed to its furthest conceptual extreme — comprised a kind of

[89] Barthez, *Nouveaux éléments,* v. 1, 128.
[90] Vila, *Enlightenment and Pathology,* 71.
[91] Bordeu, *Œuvres Complètes,* vol. 1, 187. Of course the metaphor of the swarm of bees is long-standing, and frequently utilized in mid-to-late eighteenth century physiology. For more on Bordeu, see Vila, *Enlightenment and Pathology,* chapter 2. My translation of the passage from Bordeu differs from Vila's (71). It is also different from the one offered by Reill, *Vitalizing Nature in the Enlightenment,* 133. For more on Bordeu, see Moravia, "From *Homme Machine* to *Homme Sensible*."

metaphysical exception for the living being in terms of its underlying causality, spatiality, and self-identity/difference. Organization would therefore need to be recognized as comprising something of a disruption to a set of metaphysical premises that tended to regulate the modern conception of physical phenomena, including the consistency of space and time, and the coherency of identity, as something of an implicit and radical conceptual horizon against which the living being was imagined when it was described in organization terms. This is not a surprising formulation since the organization and systematicity of life is usually what defines the terms of its fundamental productivity and creativity, as one of the bases by which life is defined in exceptional terms.

Here, however, is where the relation between organization and *sensorium commune* emerges. Bordeu's metaphor of the cluster of bees most notably suggests that organization is a framework, a singular order, that actually gives space to a plurality of individual sub-orders. When Bordeu applied the metaphor back to the organic body, he described these sub-orders as organs with their own individual "districts and actions," presumably — to draw from the earlier passage by Bordeu — a concentric relation of smaller "circles" situated within the more general circular economy of life. This would suggest that the organized and living body actually comprises a plurality of organizational orders, present at once in a single organized whole. While such a plurality could describe, for example, the relation of the order of organs to that of the whole organism, the plurality of organizational orders could also make the leap beyond the strictly physiological aspects of the living body, and take advantage of the other organizational attributes of certain living beings — namely, human beings — for whom organization was a paradigm that not only described physiology, but also subjectivity and even society. Such a leap, however, could not lose sight of the fact that it would be predicated on the quasi-paradoxical nature of organization as a framework that co-locates in/as itself a plurality of organizational orders, of diverse "districts" and distinct "little circles." In this way, organization was all along a potentially paradoxical state of living matter itself.

The *sensorium commune* constituted an organizational encompassment of this sort. It was in some senses a reiteration or alternative materialization of vital organization, in terms of one particular property: namely, the co-location not of unity and diversity narrowly, but the more general co-location of the various conditions of the human. As I will show in the following section, with a particularly salient example from the period, the *sensorium commune* was a material-conceptual arrangement used to define the brain, but which ultimately deployed the seemingly complex, even paradoxical, capacity of vital organization to give space to what could not otherwise seem to be capable of being brought together. In a narrow sense, the "common" sensory made commensurate the diversity of sensory experiences; but in a more profound sense, the brain was the "commonalizing" space, par excellence, in the period of the eighteenth century.

From this standpoint, the organizational plurality available to the *sensorium commune* allowed it to "resolve" the problem of the coalescence of material and immaterial properties, but by virtue of resolution that was only thinly anatomical. And in this way, the *sensorium commune* became something of a conceptual reservoir available to thinkers who were committed to varying and often distinctive metaphysical approaches to questions of life and living matter. One particular example includes the natural philosophical writings of Swiss naturalist Charles Bonnet who employed the concept of *sensorium commune* to stage an encompassment which was simultaneously anatomical, reproductive, and also metaphysical. Bonnet, although a friend and intellectual compatriot to Haller, did not entirely imagine the brain in the same terms Haller did. Instead, Bonnet located the *sensorium commune* in the *corpus callosum,* the part of the brain located between the left and right hemispheres, connecting them to each other. In his 1760 *Essai analytique sur la facultés de l'âme,* Bonnet made a set of seemingly anomalous claims about the brain, in terms of his preformationist theories of reproduction, which are actually intelligible in light of the more general account of *sensorium commune* I suggested above. This suggests that even in Bonnet's writings, the brain presented the ability to make common*,* or to co-locate multiple ontologies — physical and immaterial — as no other worldly object could, and consequently to present a profound imbricative or encapsulating capacity, not unlike vital organization in its ability to co-locate multiple organization orders.

Near the end of the *Essai,* Bonnet addressed the transformative development between the caterpillar and the butterfly, and his preformationist account of the encapsulation or interconnection [*emboîtement*] of developmental forms along the chain of being to states of greater perfection. For Bonnet, generation and death did not represent the finite production of new beings or the termination of old ones, but the development of pre-existing structures and the conditions of the metamorphoses into those future existences.[92] The butterfly acquired new sensations and organs in its new form, and lost those belonging to those of its earlier caterpillar state; but it was the insect's persistent soul that represented the continuity of the organism between its different states. Bonnet in turning the analogy to the human, asks, "Is man really what he appears to us to be? … Is death not for man a preparation to a sort of metamorphosis that lets him enjoy a new life?"[93] Bonnet explains, "If death is not the expression for the duration of our being; if our soul must be united one day to another body in order never to be separated from it, there is some probability that this body already exists in miniature in the present body in which the soul currently resides."[94]

The brain was the only object according to Bonnet capable of ensuring the continuity and the memory of the soul from one body to the next, either through some "preordination, that our current brain contains another one within it, on which it makes lasting impressions and which are then destined to develop in an another life" or because the brain of a new body would "contain the right fibers to recount that memory of the previous life to our soul."[95] The brain was assigned a highly imbricative capaciousness, being able to contain both the continuity as well as the differentiability from one life to the next. What is interesting is that this capaciousness leads us directly to Bonnet's description of the *corpus callosum,* which was supposed to be the technical *sensorium commune* in the very narrow sense of Bonnet's neuroanatomy. Bonnet writes, "We are able therefore to conjecture with some plausibility, that the *corpus callosum* familiar to us, is not the true seat of the soul, but the envelope [*Enveloppe*] of this seat, by which the seat is attached to the entire nervous system, as it is attached by the *corpus callosum* to the entire animal machine."[96] The *corpus callosum* becomes the site of the commonality between body, soul, as well as the continuous reiteration of past and future states of the living being.

Reimaging the notion of *sensorium commune* in these complex organizational terms allows us to consider that if the space of the brain comprised the site of both the coalescence and also the discrepancy of a plurality of organization orders of the subject — in particular life and

[92] For more on Bonnet's theory of reproduction, and the influence particularly of Gottfried Leibniz on Bonnet's physiology, see François Duchesneau, "Charles Bonnet's Neo-Leibnizian Theory of Organic Bodies," in *The Problem of Animal Generation in Early Modern Philosophy;* and Olivier Rieppel, "The Reception of Leibniz's Philosophy in the Writings of Charles Bonnet (1720-1793)," *Journal of the History of Biology* 21 no. 1, (Spring 1988): 119-145.
[93] Charles Bonnet, *Essai analytique sur les facultés de l'âme* (Genève : Slatkine Reprints, 1970), 473. The edition is a reprint of 1760 edition (Copenhague : Freres Cl. & Ant. Philibert). Harry A. Whitaker and Yves Turgeon offer a brief account of Bonnet's conception of mental representation and memory in their relation to the structure and nature of nervous fibers in "Charles Bonnet's Neurophilosophy," in *Brain, Mind and Medicine.*
[94] Bonnet, *Essai*., 474.
[95] Ibid., 475.
[96] Ibid., 477-78.

mind — then the space of the brain itself could no longer be described as strictly *material* in any rigorous sense. As I will show, the brain could possess an extraordinary capacity *to commonalize*, so to speak — to offer an expansive capaciousness that could render continuous different orders of the human — not only on the basis of the paradigm of vital organization that it implicitly adopted, but also, because throughout the eighteenth century the material properties of the brain and nerves remained ill-defined.

In the following section, I show how the very space of the brain ceased to become a strictly or singularly material location, and became instead the site of the capaciousness of organizational orders, the common space of life, mind, and to some degree, society in the work of Scottish physician Robert Whytt. The brain was not simply one organ among others, not simply one anatomical or physical site among many. It was not simply one organic part whose causality and spatiality was blurred in relation to the other parts and to the organismic whole. The brain was instead an intricate topology capable of co-locating organizational orders like no other organ could — in particular, vitality and subjectivity, life and the mind.

The brain's capacity to integrate organizationally such levels of discrepancy provided an added meaning to the term, *sensorium commune.* What, indeed, was the scope of the *sensorium commune's* capacity to render common? How can we describe the organizational topology of a physical organ that could stage and give space to such relations of continuity and discrepancy? In the work of Robert Whytt, the brain was not a central mechanism that adjudicated the interrelation between levels of organization, but was instead an organizational plurality, at once the interconnection, unity, and discrepancy of the multiple vital and subjective orders and levels of the human.

Robert Whytt and the Common Brain: Life, Mind, and the Foundations of the Social

Although the brain throughout the seventeenth century was often compared to a fortress or castle that could house the sovereignty of the rational soul — an allusion that was fitting of the extent to which processes of reasoning were being historically allied in this period with the function of sovereignties and states[97] — still the brain was not always, even in this period, the central engine of reasoning and thinking for the human. Indeed, the brain's decentralization was explicitly solidified as a consequence of the neurophysiology of the mid-to-late eighteenth century.[98] In the later part of the century, the greater articulation of a theory of the automatic reflex powers of the nerves and the emerging theorizations of an autonomic nervous system placed increasing emphasis on the spinal cord and organized nervous centers dispersed throughout the body; the brain's role was in some senses restricted.

The Scottish physician Robert Whytt is recognized in the history of neuroscience as one of the earliest articulators of an automatic nervous system and a restricted or decentralized brain.[99] Whytt, not unlike Haller and many other materialists from the period, emphasized the sensible properties of a nervous system that was essentially unified. The unity, as I will show, was tantamount to a material *sympathy* between the nerves, but motivated by an immaterial power, which resulted in the automaticity and independence of many nervous functions throughout the various distributed regions of the body. That said, Whytt never actually de-

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[97] Michel Foucault, *Security, Territory, Population: Lectures at the Collège de France, 1977-1978,* trans. Graham Burchell (New York: Palgrave, 2007), see Lectures Ten and Eleven, and especially 285-287.
[98] The well known histories of reflex include, Canguilhem, *La Formation;* Fearing, *Reflex Action*; see also Clarke and Jacyna, *Nineteenth-Century Origins,* chapter 4. For an account of the development of the autonomic nervous system, see Clarke and Jacyne, *Nineteenth-Century Origins,* chapter 7.
[99] See for example Julius Rocca, "William Cullen and Robert Whytt on the Nervous System," in *Brain, Mind and Medicine*.

emphasized or de-privileged the brain in any sense. In fact, the brain was an object and concept that was actually quite central to Whytt's physiology — it had a primacy no other object could match. What I will show is how Whytt's neurophysiology could at once centralize and decentralize the brain, precisely in order to enable it to encompass a series of other capacities and organizational orders; this has much to do with Whytt's employment of the notion of *sensorium commune* in the organizational terms I described above. While Whytt is considered a significant but still slightly marginal figure in the history of the science and discourse of the brain, this section is meant to show the radicality of Whytt's thinking in reorienting what could possible be thought of as the matter and the space of the brain.

At the pinnacle of his professional career, Whytt was elected as President of the Royal College of Physicians in Edinburgh in 1763, eleven years after his election to the Royal Society and just three years before he died in a coughing fit, the final episode of long-lived but unidentified nervous-digestive illness.[100] He remains a difficult figure to position: his work is situated somewhere between the two conceptual poles that would have characterized the philosophical spectrum of nervous physiology at the time — the animism characteristic of the followers of Stahl; and the mechanistic approach chiefly represented by Haller, perhaps Whytt's harshest critic and rival.

Because Whytt's seminal *An Essay on the Vital and Other Involuntary Motions of Animals,* published in 1751,[101] displayed both animistic and mechanistic tendencies, and because he relied on several somewhat outdated medieval accounts of the soul's coextension with body,[102] he became the object of criticism from almost every quarter, each side decrying Whytt as representative of the opposing school, a point Haller demonstrated when he condemned Whytt as nothing more than "the most modern [patron] of the doctrine of the soul governing the body," a theory Haller claimed to "have refuted by several arguments." [103]

Still, Whytt's *Essay* was well-received and prominent in Edinburgh and even more so in Continental Europe.[104] It is, of course, unsurprising that Whytt's theory of the human body would be far more delicate than Haller's account suggests. For Whytt, a human body was essentially an organized system composed entirely of nervous sensibilities and vital motions that were animated by "an immaterial sentient principle."[105] While Haller had characterized the nervous system as only an independent portion of the bodily economy, restricting its functionality to sensibility alone, and assigning the body's contractions, convulsions, and apparent motility — its "irritability" — as a property only of its muscular fibers,[106] Whytt, on the other hand, understood the systematicity of the body as the complete proliferation of nerves to all its parts and of nervous function to all its activities.[107] Haller and others may have disagreed with

[100] French, *Robert Whytt*, chapter 1.
[101] Robert Whytt, *An Essay on the Vital and Other Involuntary Motions of Animals* (Edinburgh: Hamilton, Balfour, and Neill, 1751).
[102] French, *Robert Whytt,* chapters 8-11.
[103] Haller, *On the Sensible and Irritable Parts of Animals*, 670. For a brief account of the disagreement between Whytt and Haller in relation to muscular activity, see Eugenio Frixione, "Irritable Glue: The Haller-Whytt Controversy on the Mechanism of Muscle Contraction," in *Brain, Mind and Medicine.*
[104] Christopher Lawrence, "The Nervous System and Society in the Scottish Enlightenment," in *Natural Order: Historical Studies of Scientific Culture,* ed. Barry Barnes and Steven Shapin (Beverly Hills: Sage Publications, 1979).
[105] Whytt, *Essay,* 324-25.
[106] See Haller, *On the Sensible and Irritable Parts of Animals,* ibid. See also Vila, *Enlightenment and Pathology,* chapter 1.
[107] "The nerves are those small cords, which rising from the brain and spinal marrow, are distributed to every part of the body…. The nerves communicate sense and a power of motion to the body." Robert Whytt, *Observations on the Nature, Causes, and Cure of those Disorders which have been commonly called Nervous, Hypochondriac, or*

Whytt on the physiological premise of sensibility and whether the nervous system accounted for every one of the body's functions, but it was Whytt's alleged animistic leaning — his reliance on an "immaterial sentient principle" — that acted as the unqualified source of Haller's condemnation. However, the particularly regulative and *material* nature of that principle actually constituted the historical novelty of Whytt's *Essay.*

Whytt did not believe a soul simply regulated the body's activities. Even though "the soul is equally present in the extremities of the nerves through the whole body as in the brain," in those extremities "it is only capable of feeling or simple sensation" which we should not understand as a conscious or rationalizable perception.[108] As Whytt asserts, the soul, in the extremities, "does not act as a rational but as a sentient principle." In this sense the sentient principle responded passively and sensibly to stimuli and affections, and, given the way it animated the nervous body, it organized that body to act in a pseudo-mechanical fashion in order to respond, usually curatively, to a stimulus or affection. This was the basis of Whytt's undefined but generally attributed theory of reflex action, and consequently the automaticity of the nervous body. Otherwise put, an intelligent soul need not directly govern a body whose materiality alone could be made to act in a self-regulative manner. Whytt deviated in important ways from a strict animistic theory of the sovereignty of the soul over the body, because for Whytt, the body was functionalized and automatized by a sentient principle but not directly bound to a soul's constant governance.

Whytt was clear that, while the presence of the sentient principle throughout the body was, in effect, the body's state of complete nervous sensibility, it was not the sort that could always be perceived by a subject: "The stimulus causing the vital motions is unperceived by us, not only on account of its gentleness, but also because we have been accustomed to it from the earliest period of our lives."[109] In a very narrow sense, Whytt divided the nervous system along the lines of what aspects of its activity and passivity could enter into the scope of conscious experience and volition — what could be felt and acted upon, in other words — and what would necessarily remain beyond or outside the threshold of subjectivity. However, even though he divided the vital functions from the subjective and rational ones, they were, nevertheless two continuous outgrowths of the same singular sentient principle, which was "equally the source of life, sense, and motion as of reason."[110]

Vitality and subjectivity, therefore, were continuous without being identical: "I am inclined to think the *anima* [vital, sentient soul] and *animus* [rational mind], as they have been termed, or the sentient and rational soul, to be only one and the same principle acting in different capacities"[111] The distinction was to some degree dependent on where in the body the principle would be active. The question of the *location* of the continuity between vitality and subjectivity is not a simple one. Whytt tells us that "the soul is not confined to an indivisible point, but must be present at one and the same time, *if not* in all the parts of the body, *yet, at least*, wherever the nerves have their origins."[112] I highlight the tentative nature of the Whytt's phrasing, "if not … yet at least" — the tentativeness foreshadows a larger problem of locating the continuity of anima and animus.

Hysteric, to which are prefixed some remarks on the Sympathy of the Nerves, Third edition (Edinburgh: J. Balfour, 1767), 1, 3.

[108] Cited in French, *Robert Whytt,* ibid., 155.

[109] Whytt, *Essay,* 296.

[110] Whytt, *The Works of Robert Whytt,* (Edinburgh: Balfour, Auld, and Smellie, 1768; reprint Birmingham, AL: The Classics of Neurology and Neurosurgery Library, 1984), 152-53.

[111] Whytt, *Essay,* 281-82.

[112] Ibid., 380. Emphasis added.

To begin with, the sentient principle, by animating the whole body, cohered and entirely composed the body's sensible and organized *systematicity*. As Whytt explains, "The human body ought not be regarded … as a mechanical machine … but as a system, framed indeed with the greatest art and contrivance; a system!"[113] In this sense, the sentient principle was present throughout the entire body. But Whytt continues: "Nay, while, in man, the brain is the principle seat of the soul, where it most eminently displays its powers; it seems to exist so equally through the whole bodies of insects, as that its power or influence scarce appears more remarkable in one part than another."[114] By juxtaposing the brain to the insect, Whytt suggested that what manifested itself in the human brain as a mental capacity was *in essence* the very same sentient principle that animated the simple motility and sensibility of an insect. The organizational simplicity of the insect, however — that the insect was nothing more than a total body — restricted it to a state of sentience alone. The human, on the other hand, seemed to be composed of not one, but two general organizational orders (i.e., life/sensibility and reason), which was a structural distinction that corresponded to the dichotomy between brain and body, since in the brain, the sentient principle arose as reason, and not mere sensibility. The body (human, but also insect) had an entirely independent functionality from the mind, or in effect from the brain, since an insect had no "brain," or seat of reason, to speak of. Consequently: "actions which necessarily follow an irritation of our muscles, or any uneasy sensation in the body, are not performed by the mind, in consequence of any previous ratiocination."[115]

The sentient principle was initially described by Whytt as the continuous, but differentiated relationship between vitality and reason; the space of the former was the systematicity of the body, while the space of the latter was the brain, which was itself already organizationally enfolded within the body's systematicity. In this sense, the sentient principle itself divided the body along the threshold of experience, a distinction that for Whytt determined whether "a man may in general and with propriety, be called conscious" of any affect or activity happening to or within the body.[116] This division into disparate organizational orders constituted one of the earliest modern accounts of the epistemological stratification of the nervous system. The nervous system, in other words, did not only comprise a continuous, differentiated progression along the developing order of subjectivity and knowledge, as "the sole instruments of sensation"[117] on the one hand, and the seat of the soul on the other. It also included an entire order of involuntary actions as I have mentioned. By structuring the body on the basis of a vital systematicity that was at once continuous with the very faculty of a conscious self — and by identifying that systematicity with the material network of nerves, Whytt not only conferred to the nerves the epistemological (and non-epistemic) diversity of both conscious volition and involuntary motion, but he conferred that diversity to subjectivity itself. The indistinguishable link of subjectivity to the body's systematic unity (the body being "a system far above the power of mechanics" whose parts "truly act in a circle"[118]) becomes the condition according to which Whytt's implied framework of subjectivity has internalized, so to speak, the nervous system's epistemological divide. Whytt's conscious subject was, in other words, not simply situated over and against unconscious processes, but was saturated by and incorporated within them

[113] Ibid., 324-25.
[114] Ibid. 380.
[115] Ibid. 308. Similarly, Whytt writes, "Yet we think it a very clear point, that the mind does not, as Dr. Stahl and others would persuade us, preside over, regulate, and continue the vital motions, or upon extraordinary occasions, exert its power in redoubling them, from any rational views, or from a consciousness that the body's welfare demands her care in these particulars." Ibid., 285.
[116] Ibid., 299.
[117] Whytt, *Observations*, 30.
[118] Ibid., 270.

particularly during moments when a subject encountered excessive stimulation: “There is not a *voluntary* muscle in the body whose motion does not become *involuntary*, as often as it is either directly, or from its consent with some neighboring part, affected by any considerable stimulus.”[119]

I return to the relation of the brain and the body — two spatializations of the sentient principle, that were nevertheless enfolded in one another. In one of his later texts on nervous pathology, *Observations on the Nature, Causes, and Cure of those Disorders which have been commonly called Nervous, Hypochondriac, or Hysteric*, from 1762, Whytt emphasized the fundamentally linked nature of the *entirety* of the nervous system, a link predicated on a relation of *sympathy*, or the formal and structural affinity of nervous parts: “Our bodies are, by means of the nerves, not only endowed with feeling, and a power of motion, but with a remarkable sympathy, which is either general and extended through the whole system, or confined in a greater measure to certain parts.”[120] Indeed, the concept of sympathy had always played a large part in the study of the human body, and Whytt helped shore up the significance of this concept in Scottish medical thought in the mid-to-late eighteenth century.[121] For Whytt, all the nerves were essentially linked, precisely because they were unified under/as the sentient principle. They were not, however, linked in any material sense, but were rather linked *sympathetically*, which for Whytt was synonymous to being linked organizationally or systematically, bound together by virtue of the activity of the sentient soul.[122] Sympathy, then, was another way of naming the body’s systematic sensibility.

It is important to highlight what exactly Whytt emphasized about this sympathetic affinity, repeatedly referred to as a “remarkable sympathy.” Specifically every sensible, though not necessarily felt, part of the body “has a sympathy with the whole” even though individual nerves “have certainly not the smallest communication with one another;” and that the “sympathy between every individual nerve and the whole system, will be readily allowed to be owing to the mediation of the brain.”[123] Whytt prioritized the brain within the body as the place where, when the soul was manifest, it was manifest specifically as a set of mental powers. In some ways, the brain staged not only the affinity but also the very indistinction between the whole nervous body and its parts. The brain was held apart from the body, but it was also continuous with the body precisely because it was where the body’s totality and indivisibility was staged (an indivisibility, I should add, that did not exclude the brain). Although it initially seemed that the brain was enfolded within the systematic totality of the body, it turns out that it is the brain that actually mediated the sympathy of nerves, which therefore made that systematicity possible in the first place. It makes more sense to say that the body was enfolded within the brain, since it was brain that mediated the body’s systematicity.

Now while the brain for Whytt mediated the body’s sympathetic systematicity, it did not do so on any mechanical or material basis, nor was the mediation a consequence of any particular sub-anatomical division of the brain itself:

> Sympathy depends upon a principle that is not mechanical; and that, to suppose it may be owing solely to the particular situation, arrangement or connection of the medullary of the brain … is as unreasonable, as to imagine that thought may be

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[119] Ibid., 283, emphasis added.
[120] Whytt, *Observations*, 10.
[121] Christopher Lawrence, “The Nervous System and Society in the Scottish Enlightenment.”
[122] Sympathy as a concept, however, is particularly employed by Whytt to describe instances of illness or pathology, insofar as sympathy is not simply a reaction to a sensible affection, but a curative reaction to a damaging stimulus.
[123] Whytt, *Observations*., 10, 41, 57.

> the result of a motion among the particles of the animal spirits, or other subtile matter in the brain.[124]

Whytt was clear in his relatively elusive and ill-defined assertion that the sympathetic interconnectivity of the body had no physical explanation and referred only "to the brain itself, and to that sentient being which animates our whole frame."[125] Whytt referred to the brain in its entirety, as an object whose functionality or significance was predicated on its total organization — one of the specific attributes of conceiving of the brain as the *sensorium commune,* or common sensory. I have highlighted, providing an example from Haller, how the brain was imagined as a common sensory, and how it enacted the unifying function which has often gone by the name *sensus communis.* For Whytt, the situation was slightly more complicated. The property of the *sensus communis* was equally presented in Whytt's neurophysiology. For Whytt the "commonalizing" capacity was entirely related to his notion of sympathy, which was more than a structural affinity, but a manner of "consent" (or *con-sensus*) between individual and differentiated nerves.[126] This "commonalizing" consent was an activity as much present in the brain as it was throughout the entire body. Whytt writes in a significant passage:

> All the nerves don't at last terminate in a point, but in a large space of the brain; wherefore the consent between them cannot be deduced from their contiguity, but must be owing to a sentient principle, which is present at least wherever the nerves have their origin, and which accordingly as it is variously affected, produces motions and changes in different parts of the body.[127]

Were the nerves to have united at some single point, they would effectively have composed a single anatomical entity, and nervous consent would simply be the result of the essential *material identity* between nervous parts. It was instead the sentient principle which made this consent possible — the sentient principle was tantamount to the *con-sensus* of different nerves, and the principle, along with its consensual function, was "present," as we see, "*at least* wherever the nerves have their origin," which is to say, "in a large space of the brain."[128] What is most curious about the above passage is the reference to that "large space of the brain" within which the nerves are effectively held apart, but within which the sentient principle was somehow present, enabling their consensual relation.

That "large space" had to serve a couple very general and even counterintuitive *topological* functions. It needed, on the one hand, to be the place where the mediation of nervous sympathy was originally staged. At the same time, it needed also to constitute an intervention or interruption into the otherwise complete material unity or strict physical interconnection of the nerves of the body. That "large" mediating and convergent space where the nerves met (but not fully) was, simultaneously, a space of an entirely different order: that large space is technically also constitutive of an interruptive *interval* or *gap* between a *strictly physical* economy of the nerves. Sympathy or the systematic relation of nerves was for Whytt predicated on the *immaterial* nature of the sentient principle which had to be "of a nature different from, and of

[124] Ibid., 56, n. 1.
[125] Ibid., 72.
[126] Canguilhem discusses Whytt's formulation of *sensorium commune* in *La formation du concept de réflexe,* 101-107.
[127] Whytt, *Essay,* 255.
[128] Whytt interchangeably uses "sympathy or consent," *Observations,* 30.

powers superior to mere matter."[129] And yet, that sentient principle also had to be present in the brain.[130] But how else could we describe the presence of the sentient principle in the brain, if that "large space" did not also already constitute an entirely different kind of space, that is, an interruptive gap in the body's physical unity and strictly *material* economy? The only kind of space in which the sentient principle could be situated was one that was, to some degree, defined as extra-material. It was perhaps the very nature — or necessity — of the brain's topology to acquire such an extra-material status in order to introduce into the sympathetic system of the nerves an economy of consent predicated on an immaterial force.

The brain's own organizational configuration, I would say, forced a space — "a large space" but also a gap — into and between the strict continuity of matter. In its extra-materiality, the brain encompassed the total arrangement of the nerves as a consensual system. In this way the space of the brain fulfilled the capaciousness requisite for the sentient principle, and consequently the mind and the *common* or *communal sensus* of the entire nervous system. This is perhaps the very reason why Whytt interchangeably referred to both the brain and mind as the *sensorium commune* in his writings.[131] They have, in essence, acquired a certain topological equivalence as the very same space that gave room to the sentient principle and the sympathetic consent of the nerves — in a space, of course, that was only a topological configuration, an interruption of a material economy, or to be more blunt, an impossible space for the brain, strictly speaking, to possess.

That interchangeability played out quite directly for Whytt as he blurred together sensible and epistemological categories, as a function of the unity of mind and body — for which no room could be easily made. As I mentioned earlier, one of the primary conceptual functions of the *sensus communis* from Aristotle up to Kant was to unify sensory impressions, an operation that was meant only formally to replicate the act of judgment but also to precede it at the pre-intellectual level of the senses. The *sensus communis* could, in effect, enact sensory judgments — affirmations, combinations, and negations — both immediately and pre-cognitively. A variation of this idea was taken up in a very different way particularly by Roman authors and again in early eighteenth-century England (Lord Shaftesbury's essay on *sensus communis* being the prime example[132]) where it became something tantamount to a (pre-political) socio-ethical judiciousness, comparable perhaps to a moral sense which was also extra-cognitive even through it was not directly related to sensibility as a psycho-physiological problem.[133] Whytt described a similarly adjudicative property of the body, primarily by analogy to a moral sense, and specifically in regards to the body's nervous-sympathetic ability to respond appropriately and curatively against an encumbering stimulus:

> Since the Deity seems to have implanted in our minds a kind of sense respecting Morals, whence we approve of some actions, and disapprove of others, almost instantly, and without previous reasoning about their fitness or unfitness … so methinks, the analogy will appear very easy and natural, if we suppose our minds

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[129] Whytt, *Essay.*, 255-256.

[130] Whytt restates the point in the *Essay:* "The soul is not confined to an indivisible point, but must be present at one and the same time, if not in all the parts of the body, yet, at least, wherever the nerves have their origins; i.e., it must be, at least, diffused along a great part of the brain and spinal marrow" (380).

[131] For example, in the *Observations:* "the brain or *common sensorium,*" (307), and "the mind or *sensorium commune"* (213-214).

[132] Anthony Ashley Cooper, Third Earl of Shaftesbury, "Sensus Communis, an Essay on the Freedom of Wit and Humour in a Letter to a Friend," in *Characteristics of Men, Manners, Opinions, Times,* ed. Lawrence Klein (Cambridge: Cambridge University Press, 2004), 29-69.

[133] Summers, *Judgment of Sense*., 106; Rosenfield, "Before Democracy;" Shaftesbury, "Sensus Communis," 48.

> so formed and connected without bodies, as that, in a consequence of a stimulus affecting any organ, or of any uneasy perception in it, they shall immediately excite such motions in this or that organ, or part of that body, as may be most proper to remove the irritating cause; and this, without any previous rational conviction of such motions being necessary or conducive to this end.[134]

The analogy to a kind of moral sense, which "approves" and "disapproves" instantly on the basis of no prior reasoning, suggests that the body's sympathetic processes, and the *con-sensus* that it both assumed and enacted, displayed a non-cognitive adjudicating function. In other words, for Whytt the entire body performed a non-rational sensible judgment, a corporeal *sensus communis*.

My point is that the brain succeeded (at a cost) in becoming an organizational topology that situated a total *common space,* in which the sentient principle could arise as a force — a force that instantiated both the mind and nervous sympathy in a relation of organizational continuity or unity. There is, however, an additional order that the *common space* of the brain was able to stage, and this was the space of an incipient *social* order. In his 1762 *Observations,* Whytt writes,

> We have seen above, that there is a remarkable sympathy, by means of the nerves, between the various parts of the body; and now it appears that there is a still more wonderful sympathy between the nervous systems of different persons, whence various motions and morbid symptoms are often transferred from one to another, without any corporeal contact or infection. In these cases, the impression made upon the mind or *sensorium commune* by feeling others in a disordered state, raises, by means of the nerves, such motions or changes in certain parts of the body as to produce similar affections in them: and hence it is, that the sight only of a person vomiting has often excited the same action in others … that yawning is propagated from one person through a whole company….[135]

Whytt described how the "violent affections" or passions of the mind could directly affect the physiology of the brain and so, consequently, the entire nervous economy in such a way as to induce certain nervous pathologies including "mania or melancholy."[136] Whytt conceded, however, that "in what manner the passions, or the morbid matter of the nervous diseases change the state of the brain or *common sensorium,* and occasion such disorders is entirely unknown."[137] He refused to speculate on the principles that linked mind and brain, even thought he had to a degree assumed their equivalence by ascribing to the brain a topological formulation that rendered it extra-physical to a degree. By supposing the affectability of the brain as a consequence of mental states, Whytt was able to describe something akin to a neuro-social sympathy, on which he never elaborated more.

The brain's topological extra-materiality allowed it to give space to the sentient principle, and thereby to the mind and to the total consensus of nerves. It was, however, also on the basis of this topological exception that the brain could stage a kind of primitive sociality, a first order social affinity with others. The *sensorium commune* has indeed become *radically* common, the space of an organizational coherence of vitality, subjectivity, and sociality. But the important point is the paradoxical necessity that in order to become a space of dispersion or distribution

[134] Whytt, *Essay,* 288. Emphasis added.
[135] Ibid., 213-214.
[136] Whytt, *Observations,* 307.
[137] Ibid.

among the nerves, it actually needed to become the very protraction, we could say the *spacing-out*, beyond an economy of matter itself. The brain's capacity to make-common and unify (sensibly, corporeally, and now socially) was predicated on a profound protraction of its own spatiality, and from its own materiality. It has become, or perhaps always was, an impossible organ of unity.

Whytt's *sensorium commune* was able to stage a social sympathy and presumably to afford a subsequent social unity according to a cerebral topology that rendered the brain spatially aporetic, protracted beyond the terms of its own materiality. In a way, Whytt provided, not so much an Enlightenment neuro-politics, but something more like a proto-neuro-sociality. This category has received a great deal of attention in contemporary neuroscience, especially with the popularization of the mirror neuron.[138] Whytt's physiology implies that neuroscience may have always believed that the brain could stage an immanent commonality and sociality. And yet, the underlying formulations in his physiology also suggest otherwise. His neuro-sociality is, after all, inadvertently inscribed within the very impossibility of its own formulation. It is circumscribed, in other words, by a cerebral topology which certainly makes possible a theory of social unity, so long as one doesn't mind the aporia of that cerebral space.

Whytt actually and inadvertently demonstrates that the brain could situate the organizational unity of vitality, subjectivity, and sociality only as an abstracted topological space, having ultimately abandoned its strict adherence to physical materiality, becoming an impossible organ of unity, so to speak. For Whytt, the brain's radical protraction fulfills the deeply diffuse conceptual status of the brain. This protraction, essentially a synonym of *sensorium commune*, adopted an organizational capaciousness which, by incorporating into the space of the brain the plurality of orders according to which the human subject was typically defined, radically dispersed and distributed the brain not only into/as the body (and into/as the social body), but consequently beyond the terms of any stable or rigid physicality. In this sense, the protraction, the radically "common" nature of the brain was as much disruptive as it was productive: *disruptive* in the sense that it constituted a conceptual excess which forced the brain to acquire a somewhat unfeasible material status; *productive* because it motivated the historical and scientific decentralization of the brain, as I will discuss in later sections.

Brains within Brains: Emmanuel Swedenborg and Alternative Distributions

Robert Whytt was not alone in imagining the brain in the mid-eighteenth century as an organizationally diffuse and radically protracted space. The mid-eighteenth century philosopher, naturalist, and mystic, Emanuel Swedenborg shared, but in some ways also complemented, Whytt's account of the brain, broadening how we can additional consider the brain's dispersive topology. Although primarily known for his theological philosophy and eventual turn towards mysticism, Swedenborg was an accomplished natural philosopher, traveling throughout Europe during 1730s and 40s in order to research work on natural history, mineralogy and physiology.[139] Publications from this time period included the *Opera Philosophica et Mineralia* (*Philosophical and Mineralogical Works*) and multiple volumes that comprised *Oeconomia Regni Animalis* (*The Economy of the Animal Kingdom,* or *The Economy of the Reign of the Soul*); they were completed by 1745, after which time Swedenborg underwent his well known mystical conversion, a transformation that in no way negated these preceding scientific writings.

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[138] Giacomo Rizzolatti and Corrado Sinigaglia, *Mirrors in the Brain: How Our Minds Share Actions and Emotions,* trans., Frances Anderson (Oxford: Oxford University Press, 2006).

[139] Ernst Benz, *Emanuel Swedenborg: visionary savant in the age of reason,* trans. Nicholas Goodrick-Clarke (West Chester: Swedenborg Foundation, 2002); see especially chapter 4.

Unlike Whytt, Swedenborg was neither a physician nor clinician, having apparently never partaken in any direct medical experimentation. In a certain respect, Swedenborg was something of a Cartesian in terms of his treatment of natural philosophy.[140] That is, he was effectively a spiritual philosopher who believed that natural science must nevertheless be independently understood, not merely as something which could be subsumed under a general metaphysical rubric, but something which could be autonomously examined and verified to be on its own harmonious with fundamental metaphysical principles. Therefore, like Descartes, Swedenborg felt it was of great philosophical importance to investigate the principles regulating the major mid-eighteenth century sciences, including physics and astronomy (in his *Motion and Position of the Earth and Planets*), chemistry, and animal physiology (including generation, sensory physiology, rational psychology). And similarly to Descartes, Swedenborg's methodological approach involved the application of theoretical speculation onto a rigorously examined archive of the available scientific writings.[141] Such an approach is most evident in his primary physiological work, the multi-volume *Oeconomia Regni Animalis.* During the 1740s Swedenborg also wrote an independent treatise on the brain titled *De Cerebro,* initially an extension of the *Oeconomia Regni Animalis*,[142] which was on its own never published in his lifetime. Unlike Descartes, however, Swedenborg's philosophical physiology and particularly *De Cerebro* remained virtually unknown; also unlike Descartes' neuro-anatomy, *De Cerebro* was able to anticipate major developments in neuroscience by nearly a century, including the primacy of the exterior cortical substrate of the brain as the basis of mental activity, at a time when physiology looked to the interior medullary white matter as that privileged site.[143]

Swedenborg occupies a strange place in the history of the science and discourse of the brain. He is considered a retroactive contributor to neuroscientific knowledge, his significance being recognized by the end of the nineteenth century, but his contributions never actually having an influence during the time in which he was writing.[144] Swedenborg's scientific marginalization had in part to do with the fact that his declarations about the brain were somewhat untenable with what could be said in neurophysiology during the mid-eighteenth century; he was, it seems, as much a prognosticator in the field of natural philosophy as he was

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[140] Inge Jonsson's intellectual history of Swedenborg's scientific career and indebtedness to Descartes is elaborated in *Visionary Scientist: The Effects of Science and Philosophy on Swedenborg's Cosmology* (West Chester: Swedenborg Foundation, 1999). Jonsson explicitly refers to Swedenborg as Descartes' disciple on page 38. For Swedenborg's Cartesian training see page 23, and also chapters 2 – 4 for general elaboration of Swedenborg's dependence on Cartesian philosophy.

[141] The editor and translator of Swedenborg's *De Cerebro,* Rudolf Leonard Tafel, aptly wrote in his 1882 preface, "Swedenborg's theory of the brain is therefore in reality an embodied system of philosophy; and yet a system which is not an arbitrary creation of the human mind, and independent of the facts of the human body, but a system in which philosophy and the solid facts of science, theory and practice, are so intimately blended that you can scarcely tell where the facts end and where the theory begins." Emanuel Swedenborg, *The Brain: Considered Anatomically, Physiologically and Philosophically,* trans. R. L. Tafel (London: James Speirs, 1882), xxvii.

[142] Specifically, the introductory chapters to Part II of the *Oeconomia.* See Jonsson, ibid., 51.

[143] See for example, Neuburger, *The Historical Development*, especially chapter 9, "Haller's Influence on Experimental Physiology of the Brain and Spinal Cord," pp. 118-152. Swedenborg also anticipated the localization of the motor cortex and of certain intellectual processes to the frontal lobes; see in particular Stanley Finger, *Origins of Neuroscience: A History of Explorations into Brain Function* (Oxford: Oxford University Press, 1994), 30; Lawrence C. McHenry, *Garrison's History of Neurology: Revised and Enlarged with a Bibliography of Classical, Original and Standard Works in Neurology* (Springfield: Chares C. Thomas, 1969), 108; and Ulf Norrsell, "Swedenborg and Localization Theory," in *Brain, Mind and Medicine.*

[144] Neuburger himself wrote in Swedenborg's contributions; see *Historical Development,* 220, n. 30. Charles G. Gross devotes an entire chapter to Swedenborg's farsighted neuroscience, titled "Emmanuel Swedenborg: A Neuroscientist Before His Time," in *Brain, Vision, Memory: Tales in the History of Neuroscience* (Cambridge, MA: MIT Press, 1998).

considered a visionary in the context of his spiritual theology. However, from the standpoint of the account of the brain I have offered so far, and the analysis of Robert Whytt specifically, I want to argue that Swedenborg's theory of the brain was actually quite fitting to the period in which he was writing. Swedenborg was by no means an anomaly and was offering an account of the ontologically dispersed state of the brain, to which Whytt provided an important historical context. Swedenborg was not offering a visionary account of neuroscience, but was instead describing underlying aspects of the eighteenth-century brain with greatest clarity.

For Swedenborg, the brain or *sensorium commune* was something of a theoretical corollary to a larger philosophical doctrine of the soul. Just as the soul was the middle term that mediated what Swedenborg in *De Commercio Animae et Corpus* (*The Intercourse between the Soul and the Body,* 1769) described as the spiritual world inhabited by spirits and angels and the natural world inhabited by men,[145] the brain occupied a similar mediative role between the soul and the rest of the animal body. (As Swedenborg stresses in the early *De Mechanismo animae et corporis* (1734), God and all which is infinite does not act but "through media into the finite…. It does not rain except by mediation of nature; man does not do anything except by the mediation of nature … he does not think except by media; the soul does not expand itself into any will (*velle quoddam*) except by media."[146])

In order to fulfill its mediating function between the spiritual world and the "grossest finites"[147] of an organic body, the soul (being for Swedenborg finite as well as both material and immaterial[148]) was located within the brain and, specifically, in the *whole* brain, since, "there is no part in the whole brain where the soul is not."[149] In this sense, like Whytt, Haller, and others, the brain was an equipotent singular organ and material correlate for a unified rational soul,[150] such that, as Swedenborg explained in his 1734 *Outlines of a Philosophical Argument on the Infinite,* "it resides in no one place or spot, but is ubiquitous in all parts of the brain, in none of which is it self-dissimilar, but always most self-similar, and cannot operate differently in one part from what it does in another."[151]

The animated ubiquity of the *sensorium commune* rendered it a true philosophical whole, since, as Swedenborg writes, "there is no more perfect form in nature than that of the cerebrum." However, the brain's perfection was not entirely predicated on its organizational totality, but also on the fact that "this organ is divided into hemispheres, and these again are subdivided into convolutions, larger and smaller" thereby exemplifying the "harmony of all things, a mutual respect and dependence."[152] Indeed, the brain was an organizational totality that, much like the structure of vital organization discussed above, was comprised of a series of sub-orders or sub-organs. The most privileged sub-order of the brain was that of the exterior cortical substrate of

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[145] Emanuel Swedenborg, *The Nature of the Intercourse between the Soul and the Body* (New York: American Swedenborg Printing and Publishing Society, 1898).
[146] Emanuel Swedenborg, *On the Mechanism of the Soul and the Body* in *Scientific and Philosophical Treatises (1716-1740),* ed., Alfred Henry Stroh (Bryn Athyn: Swedenborg Scientific Association, 1992), 136.
[147] Ibid.
[148] For the soul's finitude, see Swedenborg, *On the Mechanism,* 129. For the material/immaterial nature of the soul, see Emanuel Swedenborg, *The Economy of the Animal Kingdom,* vol. 2, part 2, trans. Augustus Clissold (London: Walton and Mitchell, 1846), 300.
[149] Swedenborg, *On the Mechanism,* 140.
[150] Martin Ramström, *Emanuel Swedenborg's Investigations in Natural Science and the Basis for his Statements Concerning the Functions of the Brain* (Uppsala: University of Uppsala, 1910), 35.
[151] Emanuel Swedenborg, *Outlines of a Philosophical Argument on the Infinite, and the Final Cause of Creation; and on the Intercourse between the Soul and the Body,* trans. James John Garth Wilkinson (London: Walton and Mitchell, 1847), 144.
[152] Ibid., 49, §47.

the brain; it was the site where Swedenborg claimed the soul was most particularly situated, despite the brain's spiritual ubiquity, because of the material subtlety of cortical substance. Cortical substance was identified as the soul's most privileged or at least most active site, its "first determination," the true synonym of the *sensorium commune*.[153]

From an organizational standpoint, the cortex was further divided into little cerebral-nervous bundles or globules which comprise "the ultimate unit of the brain," and which constituted each "a sensorium in particular, just such as the brain is in general."[154] For this reason, these little globules or the cerebrum were dubbed the diminutive "cerebellulum" (cerebellula, pl.), an additional diminution of "cerebellum," which already meant "little brain." Each was "like a brain in miniature,"[155] like "little *sensoria*" that together comprised the common *sensorium*.[156] The brain's spatial totality was wholly divisible, into parts that were nevertheless little wholes in themselves. Now, while the individual cerebellula combined as units into clusters that combined again into larger and larger groups ultimately forming the entire cerebral mass, the brain was not simply an aggregate of differentiated parts, since the soul was equally present in one cerebellulum as it was in another, as it was in the whole brain. The brain for Swedenborg was in a way dispersed within itself, being as much itself in every individual cerebellulum as it was in its combined totality.

The significance of the cerebellular doctrine rested in how it allowed the brain to become the soul's mediating instrument. The brain was not after all simply divided in itself, but it was instead equivalent to its own self-divisibility, internally dispersed such that every individual cerebellulum was a particular instantiation of the brain in full. It is on this basis — on the basis of the brain's internal self-dispersion — that we can understand how the brain could also become the soul's distribution throughout the entire body. From the start the brain was given an elevated status; as a metaphysical agent of the soul, it persisted within a different, extra-material register of causation, making it a corporeal substance unlike any other. This causative privilege allowed the brain to act as the "link and uniting medium" of soul and body,[157] and "therefore the mediating cause of all the determinations of the soul."[158] As Swedenborg writes, "The soul *weaves and forms* its body or organism by means of the cerebrum," which it does "according to the idea or ideal in itself."[159] The brain sutured the body, fabricating its very materiality, for which reason the brain, according to Swedenborg, "may also be denominated the general weaving or textorial organ."[160]

However, the success by which the brain could act like the loom of the soul, "the general formative organ of the body and its organs,"[161] was dependent on its radically dispersive topological configuration. The brain, again, was as much itself in its entirety as it was in each individual cerebellular unit, simultaneously itself in itself as well as in its own self-divisibility. Swedenborg had already outlined some very curious features of the brain's general spatiality, from a physical standpoint, describing the various fluctuations of its size and shape as a byproduct of its activity. He described, for example, the mutability of nerve fibers beginning and

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153 Swedenborg, *Economy of the Animal Kingdom,* 293, 295.
154 Swedenborg, *Economy of the Animal Kingdom,* 290.
155 Swedenborg, *The Brain,* 54, §58.
156 Swedenborg, *Economy of the Animal Kingdom,* 290-91.
157 Swedenborg, *The Brain,* 67, §84.
158 Ibid., 71, §87.
159 Ibid., 61, §73, emphasis added.
160 Ibid., 94, §104.
161 Ibid., 96, §104q.

ending in the cortex in addition to dimensional fluctuations in the size of the brain itself.[162] But he also described a specific spatial characteristic which was not entirely physical:

> The cerebrum, besides, is so partitioned and convoluted that it may be moved, i.e., unfolded and refolded as a whole and also as to its component parts … for there is nothing in the cerebrum which is not encompassed or surrounded by its own space, and in this manner connected with the neighboring parts, so that it may be expanded either in conjunction with them or separately…. This is the reason why, upon one part of the cerebrum being obstructed, the remaining parts nevertheless perform their vital functions.[163]

To say that the brain was entirely encompassed and surrounded by its own spatiality is also to say that it has incorporated every possible topological variation of itself into itself. It remained self-identical regardless of any spatial configuration, division, or distribution it assumed, as we see in the passage above. Having become its own self-dispersion, it was rendered de-centered, but in its very centrality — a brain made up of little brains, to be sure, but also a brain that was no less itself in its sub-division than it was in its entirety. It was precisely through the brain's dispersive topology that the soul could weave the fabric of the body, to have its ends "successively unfolded in the body; where they again exist simultaneously."[164] Swedenborg presented a variation of the protracted brain, and did so by rendering it an explicit organ of dispersion, and consequently an even more radical organ of unity.

Interestingly, Swedenborg's model of dispersed brain played out in his theological writing, which itself possessed a central social dimension. In his early *De Mechanismo animae et corporis,* Swedenborg described how, analogous to the way the brain situated a multiplicity of little brains, "every part in an animal may give some new animal."[165] From any part or sub-division of any animal and animated entity — including an animal's seed, carcass, or even excrement — a plurality of new animals could emerge. This curious variation on preformationism was not, however, a result of the *material* power of animal life, but was instead predicated on the radically expansive nature of the soul, an expansiveness so great that it exceeded the animal body proper. But since the expansion of the soul was dependent on the "textorial" power of the brain, then, as Swedenborg explained, "every moment there proceed such things as may present animal fetuses; but in order that a similar thing may be presented, *it must proceed from the brain*, and from medullary part of it."[166] The brain's textorial expansiveness encompassed not only the animal's body but its very perpetuation in new generations of its own species and novel productions of entirely different sorts of organisms.

Swedenborg's later and more well-known mystical text *Heaven and Hell* (1758) subtly incorporated a social dimension into the expansive commonality of the brain. The text is an enumeration of the spiritual world, described according to an analogy to the natural world and to the very form of the human. For example, Swedenborg explained that the spiritual world was divided into three heavens, concentrically arranged and hierarchical in relation to one another,

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[162] "The faculty of receiving, perceiving, and thinking consists in this, that the fibers are able to undergo infinite states of mutation, and that each mutation corresponds to an idea." Ibid., 78. "The brain, besides, while in a state of wakefulness, frequently change its states; for at one time it rises higher and is swollen, and at another time it is lower and compressed…. It is borne upwards and swells, when a man is angry, proud, or joyful; but it subsides and is compressed in states of grief, sadness, fear." Ibid., 52, §54.
[163] Ibid., 50, §49.
[164] Ibid., 95., §104q.
[165] Swedenborg, *On the Mechanism,* 141.
[166] Ibid., 142, emphasis added.

and corresponded to both the form and the interiority (i.e., the "mind and disposition") of the human.[167] Each heaven in turn was divided into larger and smaller societies of angels, organized around the particular quality of goodness and love possessed by them, and also arranged concentrically and hierarchically.[168]

The pattern of organizational concentricity continued, as Swedenborg described how "each society is a heaven in a smaller form, and each angel in the smallest form," but that despite this organizational distribution, all of heaven remained self-identical "comparatively like civil and military officers and attendants in a royal palace or castle, who, although dwelling apart in their own quarters or chambers above and below, are yet in the same palace or castle, each in his own position in the royal service."[169] This internal distribution of the heavens, identical to itself even as it was divided in itself was not unlike the plurality of little brains by which the brain was composed, and through which the body and the multiplicity of new animals was produced. It was, after all, the brain that Swedenborg described as the soul's "court and palace chamber, from which it looks around on all things belonging to it, and determines them to act in agreement with its intuition."[170] The analogy to the brain and cerebellula continues as Swedenborg explained how each heavenly society bore "a heavenly form like that of heaven as a whole,"[171] just as an angel was "a heaven in the smallest form," because "the interior things which belong to his mind are arranged into the form of heaven."[172] More importantly, however, the entirety of heaven for Swedenborg, with its society of angels, was entirely present in the human form, and in the human's organizational indistinguishability between whole and part.

Swedenborg's cerebellular doctrine, and the organizational structure it produced in the human as a multiplicity of little but continuous parts — little brains and the plurality of new organic forms — was not simply the reflection, but the very instantiation of a spiritual social order, even the actual and anatomical distribution of heavenly societies hierarchically throughout the body: "The angelic societies, of which heaven consists, are therefore arranged as the members, organs, and viscera are in man, that is, some are in the head, some in the breast, some in the arms, and some in each of their particulars.[173] The human form was, quite literally, a heavenly body politic, whose orderly regulation corresponded to a heavenly governance,[174] but whose organizational composition was based upon the brain and the cerebellular, or little brain, doctrine.

Dispersions of Unity and James Johnstone's "Little Brains"

The historical decentralization of the brain was defined as the belief that alternate centers throughout the nervous system, such as the spinal cord, possessed a functionality independent of the brain as well as the conscious perceptions and volitions that tended to be located within the cerebral hemispheres; and that on occasion these nervous centers could produce actions that the

[167] Emanuel Swedenborg, *Heaven and its Wonders and Hell: From Things Heard and Seen,* trans. John C. Ager (West Chester: Swedenborg Foundation, 1995), 26-32.
[168] Ibid., 33-37.
[169] Ibid., 38.
[170] Swedenborg, *The Brain*., 67, §84.
[171] Swedenborg, *Heaven,* 38.
[172] Ibid., 39.
[173] Ibid., 70. Earlier, Swedenborg writes, "Heaven like a man is arranged into members and parts, and these are similarly named. Moreover, angles know in what member this or that society is. This society, they say, is in a certain part or province of the head, that in a certain part of province of the breast, that in a certain part or province of the loins, and so on." Ibid., 47.
[174] Swedenborg explains that all governance, earthly and spiritual "look to the public good as their end, and in that good to the good of the individual," (Ibid., 152).

brain proper and the more developed mental processes could not. The development of reflex action or, as I will describe in this section, the development of the autonomic nervous system are historical examples of the brain's functional decentralization. I want to suggest, however, that at some level the brain's decentralization did not mark a historically emergent deprivileging of the organ. I have argued in the preceding sections that the brain, even in its centrality and precisely because it was the space of a supposed organizational unity, was already itself materially and ontologically dispersed. Through the work of the English physician James Johnstone, one of the earliest architects of the concept of an automatic nervous system, we can see how the brain's own self-dispersion translated into a scientifically coherent account of the brain's decentralization.

The notion of "little brains" as the basis for conceiving the organizational protraction of the brain was actually somewhat wide-spread. While the term was very generally proposed by the Dutch anatomist Jacque-Bénique Winslow as early as 1732 to describe the autonomy of the sympathetic nerves, it was outlined most recognizably by James Johnstone starting in the mid-to-late 1760s. Johnstone was heavily influenced by Whytt, but was himself quite influential on late-eighteenth century neurophysiology as well as on the work of French anatomist Xavier Bichat.[175] Johnstone theorized the function of the *ganglion,* an autonomous nerve center, part of what was being theorized (as a consequence in part of Whytt's physiology) as an entirely independent nervous system regulating the vital functions alone. Not all the bodily nerves were the same, and while some serviced the will and the rational soul, only the ganglionic nerves made the automatic and involuntary motions of, for example, the heart and viscera possible.[176] It was for this reason that Johnstone argued that ganglia were, "subsidiary brains, or analogous to the brain in their peculiar office,"[177] stating more directly elsewhere that they "may justly be considered as little brains."[178]

Johnstone believed that nervous ganglia possessed two particularly significant attributes that enabled them to render certain physiological operations "uniformly involuntary."[179] The first was that the ganglia acted as inhibitory mechanism, actually blocking the power of volition from reaching certain organs: "The determinations of the will are, as it were intercepted, and prevented from reaching certain parts of the body, by the means of Ganglions."[180] The ganglia were only present in the parts of the body over which a subject had no direct control. Their inhibitory power was, for Johnstone, an intrinsic attribute essential to them, since if a ganglion were present in a specific sensory nerve, it "would have equally hindered the conveyance of any sensible impression to the mind."[181] While the ganglia were "analogous to the brain in their peculiar office," they also delimited the office, function, and force of the *sensorium commune* itself, by literally prohibiting it from accessing certain organs and physiological operations, and by allowing the *sensorium commune* to receive only a very confused and indeterminate sensation from the organs and processes within a particular ganglion's control.

The second significant attribute of the ganglion is that the "little brain" appellation was not simply nominal or descriptive — ganglia did not merely act similarly to the brain, but in fact constituted an organizational extension of it. As Johnstone writes, "A new nervous organization,

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175 Clarke and Jacyna, *Nineteenth-Century Origins,* 327-332.
176 Neuburger, *Historical Development,* 165.
177 James Johnstone, "Essay on the Use of the Ganglions of the Nerves," *Philosophical Transactions* 54 (1764): 178.
178 James Johnstone, "History of the Fetus born with a very imperfect brain; to which is subjoined a supplement of the essay on the use of Ganglions," *Philosophical Transactions* 57 (1767): 131.
179 Ibid., 181.
180 Ibid., 182.
181 Ibid.

analogous to the brain, probably takes place in them**.** Respecting their uses, *ganglions* are the origins of the nerves, sent to organs, moved involuntarily."[182] They are, quite literally, little brains spread throughout the body, which, like the central brain, form the source and principle of the nerves under their direct control. By reproducing, or reiterating the organizational logic of the brain, while also maintaining an operational autonomy, the ganglia for Johnstone were organizationally subsumable under the brain, but functionally discontinuous from it. But their reiterative or "analogous" nature cannot be overlooked. In a sense, what the distribution of the ganglia indicates is that the brain's organizational logic had become entirely dispersed throughout and as the physiological body — not a decentralization, but a distribution of centralities — even as the brain itself had become restricted in scope. The ganglia expanded the *sensorium commune's* organizational topology, making the body entirely common to itself, even as they put the brain in its place, so to speak. In this way, the entire body became something of a *cerebral unity*, but without actually being unified by the brain — self-unified but without a centralized site of unification of which to speak.

Johnstone, in contrast to Whytt, made no reference to any social dimension of the nervous system, as palpable as one might seem for the brain-ganglion relationship. Still, the question of Whytt's neuro-sociality, as I introduced it above, is not irrelevant here. In a sense, what I have been discussing all along is the brain's ability to give space to a larger commonality, the ability of the *sensorium commune* to render radically common from the standpoint of organizational orders. What becomes evident, no doubt with Whytt and more so with Johnstone, is the extent to which the power of the *sensorium commune* to render common came with the topological cost of over-extending the brain itself. Or, what amounts to the same thing, the commonality of the brain from the outset could not be imagined but in accordance to a logic of organization which could never entirely assign to the brain a strict or rigorous materiality.

Nevertheless, the dispersion of centralities evident in the work of Johnstone must be understood as a *productive* reconfiguration of the brain's radical protraction in Whytt's neurophysiology. The *sensorium commune,* already a synonym for the brain's conceptual diffusion at the start of the eighteenth century, embodied an organizational topology that rendered the organ a radically "commonalizing" space, and therefore an object dispersed beyond any strictly physical sense. But it is precisely according to the brain's deep dispersion that I argue we must read the scattering of autonomous "little brains" throughout the body — as a dispersion of centralities that rendered the body, and therefore the embodied subject, a *cerebrally* unified whole, but according to a brain which could never in any rigorous sense materialize itself.

Conclusion: The Emergence of the "Neural Man"

By the mid-to-late eighteenth century the human subject was not only defined by a material embodiment, an account of subjectivity that was in the first place corporeal, but an embodiment which was almost entirely neural. The subject was cerebral from head to toe, so to speak. No more an explicit reminder of this was available in the period than in the writings of Jerome David Gaub (Hieronymus David Gaubius), the former student and, as professor of chemistry and medicine at the University of Leiden, eventual successor to Herman Boerhaave. Between 1747 and 1776*,* Gaub wrote, published, and revised a pair of medical-philosophical discourses on the passions and the general relationship between the mind and body; titled *De regimine mentis,* they were meant to outline the role of the physician who, with a proper metaphysical understanding of the mind and physiological understanding of the body and their

[182] Johnstone, "History of the Fetus," 131.

interaction, could provide the most proper management of what Gaub identified as the "whole man." *De regimine mentis* not only historically bracketed the publications of Whytt's *Essay* and Johnstone's work on the ganglion, but it productively recapitulated the question of the brain's topological dispersion as I outlined it above, while also constituting one of the first explicit episodes of what would eventually become the formal equivalence between subject and brain.

In the essays, Gaub defined man according to the dual categories of mind and body, but because mind and body "interpenetrate and dissolve in each other," and because any aspect or part of the human was always a mixture of both,[183] he was willing to consider them as conceptual abstractions of a singular human being.[184] As Gaub writes, "no disturbance, no really important change, can arise in one part [either mind or body] that will not sooner or later affect the other and, what is more, be communicated to the whole man."[185] Gaub importantly set up the task of identifying the precise nature of the interpenetration of the mind and body; the goal of *De regimine mentis* was in part to determine what could count as the intermediating basis for these two categories.

The intermediating agent for Gaub was what he called, drawing from an originally Hippocratic concept, the *enormôn,* or stimulating force and agent of arousal. In general, mind and body both independently exhibited some sort of *enormôn,* or the "source of the impetuosity so characteristic of both emotions and bodily movements."[186] The mental *enormôn* — "something in the mind that is different from the ordinary power of reflective thought … yet not completely devoid of thought" — referred most coherently to the emotions or the generally e-motive nature of mental processes which while eruptive and potential excessive to reason, where not strictly speaking irrational.[187]

The body had a correlative *enormôn,* which Gaub identified as the entirety of the nervous system, that which was most "deserving of the name life itself," the primary principle of corporeal motion. Since the bodily *enormôn* was situated most directly in the place where the nerves originated, i.e. the brain, Gaub insisted that "this part might without impropriety be termed *the neural man."* The rationale for this formulation is important, since it represents an early coinage of a term that has come to stand in for an absolute correlation between the human subject and its brain.[188] By neural man, Gaub did not mean that man was in essence neural. He believed the term was appropriate because the brain, distributed as the entire nervous system, "could present a simulacrum or skeletal image of a man," a quasi-homuncular reiteration of the human, or, as Gaub continues, "a kind of man within a man."[189] The neural man was essentially the virtual image and reiteration of human form and function, as what made up the mediating site between mind and body, while also and independently comprising the body's involuntary vital motions.

The conceptual significance of the "neural man" formulation, however, emerges in relation to what I have been describing in this chapter as the conceptualization of the brain as a radically distributive and encapsulating space. For Gaub, the brain was the neural man precisely

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[183] L.J. Rather, *Mind and Body in Eighteenth Century Medicine: A Study Based on Jerome Gaub's De regimine mentis* (London: Wellcome Historical Medical Library, 1965), 34.
[184] Ibid., 70.
[185] Ibid., 56.
[186] Ibid., 60.
[187] Ibid. Gaub writes, "The *enormôn,* or driving force, of the mind is described here as a partly rational, appetitive, impulse, at rest a large part of the time and called into action only when the mind conceives the idea of something good or bad, desirable or undesirable," (Ibid., 62).
[188] Consider the very title of French neurobiologist, Jean-Pierre Changeux's 1983, *L'Homme Neuronal* (Paris: Fayard).
[189] Ibid., 64.

because it was a distribution into the system of nerves or, what amounts to the same thing, the brain's self-extension into a form that reiterated human morphology. As the "man within" the brain was first of all an *inward dispersion* of the human within itself — an internalized redoubling. At the same time, the brain comprised a radically *outward* dispersion, extending to and encapsulating the vital processes including circulation, respiration, and digestion; but also encapsulating — and this is the more complex point — the mind itself.

Gaub was not a strict materialist, and indeed the second essay that comprises *De regimine mentis,* originally written in 1763, opens with a critical review of La Mettrie. As such, Gaub did not reduce the mind to brain and nerves, and concedes only that the brain "has a very close relationship to the mind."[190] But the brain as the body's *enormôn* was never linked to the mind in its rational sense, but to the mental *enormôn.* When Gaub wrote that mind and body interpenetrate each other, he meant that they did so by their mutual *enormôn.* In fact the mental *enormôn* was linked not only to the *voluntary* aspects of the nervous system, but also to the involuntary and vital functions of the body. As Gaub asks,

> Is it not inevitable that as soon as a sufficiently severe disturbance arises in the mind not only will a violent impulse at once be transmitted to the organs of sense and voluntary motion, but also that the whole body will be affected in turn by its force and persistence?[191]

In fact by the time Gaub wrote the second essay of *De regimine mentis*, the mind was quite explicitly divided in two — between a rational, coherent, and uniform side and an inconstant, confused and impetuous side.[192] What was initially defined as the mind's emotive *enormôn* became by the time Gaub wrote the second essay an altogether independent subdivision of the mind that Gaub likened to an instinct or appetitive drive, and to which he ascribed "quasi-rational," curative, and nutritive capacities.[193] The mental powers in *De regimine mentis* not only included thought and emotion but, as Gaub writes, "the services of the mind extend even further," in order to include the drive to heal and maintain bodily health.[194] Respiration became an example of a process simultaneously enacted and regulated by the mental and bodily *enormôn;* in the act of breathing it is impossible to distinguish which side dominates, and the respective *enormôn* are rendered equivalent.

Gaub's "neural man" formulation in some senses named the equivalence or indistinction between the mental and bodily *enormôn.* In this way, it was more than a simply *material* dispersion, but a distribution that encapsulated the extra-materiality of the mind. The *historical* significance of the "neural man" formulation, however, emerges in relation to the fact that *De regimine mentis* presented one of the first historical classifications of man as distinctly neural, even if only nominally so. Gaub's "neural man" — the "man within man" — was the modern neural subject who had not yet fully emerged. The neural man was an important historical precursor to, and the mark of the inevitable emergence of, the category of the neural subject and the ultimate equivalence of subject and brain. Nevertheless, it is a precursor predicated on what must necessarily have been from the outset the radically dispersed topology of the brain. What links the neural man to today's cerebral subject is not the *expanse* of the brain — its anatomical breadth, which over time, would be brought to a greater level of scientific elucidation — but an

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[190] Ibid., 65.
[191] Ibid., 69.
[192] Ibid., 123.
[193] Ibid., 161, 165.
[194] Ibid., 165.

altogether different kind of vastness and spatiality. What links these two notions is the brain's dispersed topology, its protraction and distribution within, as well as its overflow beyond, its own materiality.

Chapter Four

SPACING THE MATTER OF THE BRAIN: VERTICALITY, REFLEX, AND NEW CEREBRAL MATERIALIZATIONS IN NINETEENTH-CENTURY NEUROSCIENCE

Introduction: The Space and Matter of the Brain

Modern formulations of the brain and the nervous system have relied upon complex and abstract spatial schematizations in order to define the intricate operations and objectives of neurophysiology. These often implicit topologies index not only the brain's biological complexity, but its conceptual overextension as a space that must encapsulate and embody numerous anatomical and conceptual possibilities and even divergent ontologies. Even the most concrete formulations of the space of the brain as a localizable topography of biological structures with corresponding psychological functions often hide more complex topological configurations which cannot in themselves be expressed in coherent or tangible material terms.

For Descartes, the topological problem was centered on the spatiality of the pineal gland, as the space that could properly stage the ontological conjoining of body and soul into a distinctly human subject. The pineal gland was no ordinary anatomical region, but had to take on an ontologically transitive and ecstatic dimensionality, a topological configuration that could not entirely cohere with a Cartesian conception of matter. The pineal gland was no longer the topographically identifiable material seat of the soul located at the center of the brain. It became instead a translational *spacing* across the matter-soul divide, at once an exception to Descartes' materialism, and yet a productively new conception of the space of the brain that linked together Descartes' philosophy and physiology.

From the end of the seventeenth century to the early-to-mid eighteenth century, the brain underwent a kind of conceptual retreat. It was defined either directly according to a relatively diffuse definition of living matter, or indirectly through an increased emphasis on the pervasive functionality of the nervous system. The brain was conceptually and materially dispersed, and this dispersion was embodied in the topology of the *sensorium commune,* or the abstract space of organizational unity. Many notable neurophysiologists, including Albrecht von Haller and Robert Whytt, imagined that the brain materially unified and substantiated the theoretical unity of the subject by constituting the space not only in which sensory perceptions were unified, but where the vital, mental and even social properties of the subject were all brought together and "rendered common," so to speak. But in order to do this, the brain exhibited another sort of aporia concerning its own state of matter. The brain was rendered materially protracted to some degree — dispersed beyond the limits of its own materiality in a dispersion that was also a dispersion *of* its material unity in the form of the conceptual development of the theory of nervous ganglia identified as "little brains" proliferating throughout the entire nervous body.

It was not uncommon for some historical neuro-cerebral topologies to produce material incongruities and even aporetic formulations of neurological matter. But from the start of the nineteenth century, a spatial paradigm emerged that partially resolved the problems of neuro-cerebral materiality. The paradigm was that of a vertical hierarchy of continuously related levels of nervous organization and complexity. In this relatively familiar spatial paradigm, the brain was positioned at the highest end of a vertical spectrum of nervous organization, typically as both an outgrowth and finalization of it. Lower levels would include incrementally less developed nervous centers, and higher centers were associated with cognitive processes; but it was both the continuity but also discrepancy between levels quite generally that would account for why certain levels were more traversable than others. This conception of the brain and nervous system was pervasive but often implicit in its formulation, as the English neurologist H. Charlton Bastian demonstrates in his 1880 *The Brain as an Organ of Mind.* He asserts the necessity of

> including under the term "Mind" a multitude of unconscious nerve actions occurring in the Brain. For it is impossible to draw any valid line of demarcation between many unconscious nerve actions taking place in the brain of many or any lower animal, and others (with which they are continuously or genetically related) in the spinal cord, or in any of the ganglionic masses in different parts of the body. The division of the Nervous System into Brain, Spinal Cord, and Sympathetic System is one which, though justifiable enough on anatomical grounds, is much less so from a physiological point of view.[1]

This broad spatial paradigm bypassed some of the earlier material aporias of the brain, but mainly because the aporias could be distributed to other, lower neural levels. The brain, we must remember, became an object of greater and more precise anatomical and physiological study throughout the nineteenth century — and, indeed, the nineteenth-century doctrines of localization only bolstered what appeared to be the material specificity and functionality of the brain throughout the period.[2] Neuroscientific research was also becoming linked to wider and more quantitative physiological examinations. For example, the functional and histological examination of the nerve cell made up a large portion of neuroscientific knowledge, and was closely linked to the more general study and elaboration of cell theory in the early to mid-nineteenth century.[3] Many developments within neurophysiology broadly understood were significant for, but were also directly aided by the rise of quantitative psychology and experimental psychophysiology particularly in Germany from the 1830s through 1880s. These included new theories of sensory perception, which took seriously the critique that sensory-perception was simply given (as opposed to constructed by sensory nervous processes), as well as advances in the measurability of psychophysical interactions.[4]

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[1] H. Charlton Bastian, *The Brain as an Organ of Mind,* Third edition (London: Kegan Paul, Trench & Co., 1882), 151.

[2] Informative intellectual and scientific histories of the doctrines of localization include Walther Riese and Ebbe C. Hoff, "A History of the Doctrine of Cerebral Localization," parts 1 and 2, *Journal of the History of Medicine* (Winter 1950): 50-71; (Autumn 1951): 439-470; Michael Hagner, "Aspects of Brain Localization in Late XIXth Century Germany," in *Essays in the History of the Physiological Sciences,* Claude Debru, ed., Clio Medica 33 (Amsterdam: Rodopi B.V., 1995); Anne Harrington, *Medicine, Mind, and the Double Brain* (Princeton, 1987); Robert Young, *Mind, Brain, and Adaptation in the Nineteenth Century* (Oxford: Clarendon Press, 1970); and Edwin Clarke and L.S. Jacyna, *Nineteenth-Century Origins of Neuroscientific Concepts* (Berkeley: University of California Press, 1987), chapter 5. See Claudio Pogliano, "Between Form and Function: A New Science of Man," in *The Enchanted Loom: Chapters in the History of Neuroscience* (Oxford: Oxford University Press, 1991); Anne Harrington, "Beyond Phrenology: Localization Theory in the Modern Era" in *The Enchanted Loom;* Anne Harrington, "A Feeling for the 'Whole': the Holistic Reaction in Neurology from the *Fin de Siècle* to the Interwar Years," in *Fin de Siècle and its Legacy,* ed. Mikuláš Teich and Roy Porter (Cambridge: Cambridge University Press, 1990); Michael Hagner, "Skulls, Brains, and Memorial Culture: On Cerebral Biographies of Scientists in the Nineteenth Century," *Science in Context* 16, no. ½ (2003): 195–218; Michael Hagner, "Cultivating the Cortex in German Neuroanatomy," *Science in Context* 14, no. 4 (2001): 541–563; Michael Hagner, *Homo Cerebralis: Der Wandel vom Seelenorgan zum Gehirn* (Frankfurt am Main: Insel Verlag, 1997); Robert M. Young, "The Functions of the Brain: Gall to Ferrier (1808-1886)," *Isis* 59 no. 3 (Autumn 1968): 250-268.

[3] Georges Canguilhem, *Knowledge of Life,* trans. Stefanos Geroulanos and Daniela Ginsburg (Fordham University Press, 2008), chapter 2; Clarke and Jacyna, *Nineteenth-Century Origins,* chapter 3.

[4] I examine the "sign theories" of sensory perception in the work of Hermann Lotze and Hermann von Helmholtz below. For a useful account of German scientific and physiological psychology, in relation to British and American

This vertical paradigm, however, introduced an entirely new problem in relation to the topological complexity of the nervous system. It was no longer the space of the brain that encapsulated the greatest difficulty. The problem was centered instead on the site of the individual, abstract nervous level, or, more specifically, the site of the movement between levels — that is, the space of the emergence from lower to higher which either traversed or otherwise negotiated the conceptual thresholds by which levels were separated. The central spatial problem of this chapter will be the micro-topology of the space between levels that ultimately composed the vertical spatial paradigm of the brain and nervous system. This problem will be examined within a number of different scientific and historical contexts, including German scientific psychology and psychophysiology from the early to mid-nineteenth century as well as British biological psychology and neurology which made up what might be considered the other major school of European thought concerning mind and brain during the period.[5] I will suggest in this chapter that it was at the lowest levels of nervous operations that the movement between levels — or the problem of emergence and threshold-crossing — was resolved. It was at these lowest levels where the conditions of the possible and general traversal between levels were staged, and as a consequence the brain itself was relieved of the task of having to situate the original emergence of mental and affective categories on its own.

No doubt, a variety of generally topographic models of the brain emphasized the brain's role in situating the highest-level intellectual and affective dimensions of subjectivity, whether discretely, relatively or holistically. The German experimental psychologist Wilhelm Wundt represented the virtually unquestioned position of the mind and brain sciences when, in his 1874 *Grundzüge der physiologischen Psychologie,* he posited the general, though admittedly indefinite conclusion, "that the intelligence, the higher affective processes, and the compound voluntary actions are conditioned upon the integrity of the cerebral hemispheres."[6] However, in an important respect, the brain was nothing but the product of the organizational complexity of the nervous system, and not the origin of it. The brain did not need to justify the emergence of psychology from biology, because the lowest nervous levels and processes were already staging this emergence. Therefore, the most pressing topological problem concerning the brain during the period of the nineteenth century actually concerned a material spatialization that was not even taking place in the brain; perhaps this is the very reason why the brain could so easily be imagined according to a number of far more tangible and straightforward topographical spatial paradigms.

Important to the analysis of the micro-topology of the space between neuronal levels is the concept of reflex, but not as it was employed in its more conventional psychophysiological sense, as a synonym for the mechanical automaticity of the body. [7] Reflex was, after all, imagined as a complex theoretical process that could encapsulate numerous psychophysiological

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psychology see Gary Hatfield, "Psychology: Old and New" in *The Cambridge History of Philosophy 1870-1945,* ed. Thomas Baldwin (Cambridge: Cambridge University Press, 2003).

[5] See Hatfield, "Psychology: Old and New." As Hatfield points out, the psychologist Théodule Ribot wrote two major intellectual histories of nineteenth century psychology; the first was organized around British psychology and second around German psychology. Théodule Ribot, *English Psychology* (New York: D. Appleton and Company, 1874); Théodule Ribot, *German Psychology of Today,* trans., James Mark Baldwin (New York: Charles Scribner's, 1886).

[6] Wilhelm Wundt, *Principles of Physiological Psychology,* trans. Edward Bradford Titchener (London: Swan Sonnenschein, 1910), 284.

[7] The classical texts on the history of the psycho- and neurophysiological development of reflex include Franklin Fearing, *Reflex Action: A Study in the History of Physiological Psychology* (Cambridge, MA: MIT Press, 1930) and Georges Canguilhem, *La formation du concept de réflexe aux XVIIe et XVIIIe siècles* (Paris: Presses Universitaires de France, 1955); see also Clarke and Jacyna, *Nineteenth-Century Origins,* chapter 4.

operations, including the *coordination* of sensory and motor nervous processes, and the *transmission* of nervous information throughout the body. Both of these functions encapsulated a neurophysiological emergence from a lower to a higher state — a kind of *physical* abstraction within which intelligible (that is, no longer merely material) properties were observable. Reflex was one way of accounting for the separation and traversal — or the *spacing* — between levels, according to a topology that complicated the strictly material formulation of reflex itself. As I will suggest at the end of the chapter, the micro-topology of reflex and the emergence or spacing between levels did not avoid material aporias. However, because the aporias were isolated to such a low-level process within the vertical paradigm, the brain could become free to orchestrate effortlessly the organization of matter and intelligence.

Nineteenth-Century Neuro-Cerebral Spatializations

Organology: from Unity to Plurality

Franz Gall's theoretical-anatomical "organology" marked the start of the nineteenth century science of the brain, and with it the possibility that the nervous system and the brain were systematically divisible and, more controversially, that their organicity was equivalent to an array of mental and psychological faculties. In his multi-volume master work, *Functions of the Brain,* published first in 1822, Gall's primary focus was in delineating the specific nature of those faculties, and in insisting that they corresponded to the very materiality of the systematic sub-divisions of the brain. Gall's organology, however, said essentially nothing in regards to the precise mechanisms by which anatomical regions could be translated into psychological functions. Even a speculative theorization of how biological matter and psychological dispositions and temperaments could be ontologically linked was avoided.[8] And so by the end of the nineteenth century, when even institutional neurologists had forgotten the craniometric and phrenological traditions that had emerged from Gall's writings,[9] promulgated mainly through his later collaborators and disciples including Johann Spurzheim and George Combe, and when they referred to Gall's organology as the debut of "the modern era in cerebral localization,"[10] they imagined modern brain science to be founded on the scientific and philosophical identification of subjectivity and the brain that Gall explicitly articulated, even though the identification remained, in the *Functions of the Brain,* relatively unaddressed.

Although a transitional figure from the eighteenth to the so-called modern institutional neurophysiology of the nineteenth century, Gall was more anchored in older anatomical and philosophical traditions against which he opposed himself, rather than to the newer experimental approaches to cerebral localization which he presumably inaugurated. Gall's localizing efforts were not necessarily any less arbitrary and speculative than those carried out by many of his predecessors, which accounts for the absence of explanation to describe the precise mechanisms linking brain anatomy and brain function. Gall along with many eighteenth-century physiologists faced the persistent problem that unlike other physiological processes such respiration, digestion, circulation, the brain and nerves could not be entirely imagined in analogy to other technical,

[8] Young, *Mind, Brain and Adaptation*, 28-29. See chapter 1 of this dissertation for more on Gall's organology.

[9] For an historical account of the science of measuring brains and skulls, particularly for the purposes of producing racial and social stratifications of intelligence, see John Carson, *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750-1940* (Princeton: Princeton University Press, 2007), especially chapter three.

[10] Charles K. Mills, "A glance at the history of cerebral localization with some considerations regarding the subdivisions of the areas of representation of cutaneous and muscular sensibility and concrete concepts." Reprinted from the Proceedings of the Philadelphia County Medical Society (Sept 30, 1904), 1. Harvard, Phil 6962.12. Mills was a Philadelphia neurologist, and founded the Philadelphia Neurological Society in 1884, becoming president of the American Neurological Society in 1923.

mechanical or generally non-corporeal processes.[11] The brain displayed little in way of mechanical operation, and so determining what the brain actually *did* relied on conjecture and abstraction, and then even poorly so, as Gall somewhat starkly explains:

> There are in the brain neither muscles nor levers for motion; there are no excretory canals, no external apparatus, no extension, no relaxation, no concussion or oscillation of fibers, no refraction of the rays of light, no vibration of air, no liquid in motion. The functions of the nerves and of the brain differ essentially from every other function of organized parts; they are of a peculiar nature, beyond the reach of our senses and our imagination.[12]

What reveals Gall's eighteenth-century commitments more than anything else, however, was that organology assumed a specific philosophical-anatomical objective: to unseat what was for Gall the reign of the sovereign, metaphysical "I," dominant among eighteenth-century philosophy, and its neuroanatomical correlate of the unified brain, otherwise referred to as the *sensorium commune.* Gall expressed concern with the philosophical premise of a simple, unified self as well as the unified material brain which was imagined to subtend it physically. Gall instead sought to incorporate the plurality of dynamic psychological considerations — including development, pathology, and the sheer variation of temperament — into an otherwise epistemologically stable sense of self. He believed that this psychological dynamism was the only consequence of grounding the subject materially in cerebral and nervous organization. Proponents of the simple mind doctrine, for example, were wrong to exclude from their definition of what constituted a self the "the examples of stupidity, madness, delirium, in short of the derangement of all the functions, in consequence of a defective organization, of the diseases of the brain, of intoxication, etc.".[13]

The self was for Gall too varied and modifiable an entity ever to be summed up by the abbreviation of the simple and unified "I." For if it was, and indeed, if neuroanatomy verified the simplicity and unity of the self through the simple unity of the brain, then, asks Gall, "Why does not the entity act in a new-born infant? Why is its action dependent on the development of the organs? And why does it sink into dotage, when age has brought decrepitude, and impaired the powers of the organs?"[14] There is no way that the brain, as a homogenous *sensorium commune,* "could present phenomena so different, and manifest moral qualities and intellectual faculties so various and so dissimilar."[15] Gall's response, then, was to define the subject according to an array of psychological faculties and to distribute that array across the brain, itself imagined as an ensemble of systematically discrete sub-organs. If Gall's organology inaugurated the nineteenth-century science of cerebral localization by spatializing the brain as a horizontal topography of modular anatomical regions and functions, then it did so in relation and response to a set of distinctly eighteenth-century concerns.

The "Vertical" Nervous System

There was, however, an entirely different and distinctly nineteenth-century spatial paradigm of the brain and nervous system embedded in the doctrine of organology. This spatial

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[11] Georges Canguilhem, *A Vital Rationalist* (New York: Zone, 1994), 92.
[12] Franz Gall, *On the Functions of the Brain and Each of its Parts,* trans.Winslow Lewis, vol. 3 (Phrenological Library, Boston: March, Capen, and Lyon, 1835), 90-91.
[13]Ibid., 79.
[14] Gall, *Functions of the Brain,* vol. 2, 258.
[15] Ibid., 248.

conception took the brain and nervous system to be a vertically structured hierarchy of levels of nervous complexity and organization, beginning at the most elementary orders of nervous structure and function, and proceeding in terms of complexity to the spinal cord, medulla oblongata, cerebellum and cerebrum accordingly. The vertical spatialization linked together the entire nervous system and brain, and to that combined anatomical and physiological framework were interweaved the affective and mental dimensions of subjectivity, in a way that a simple structure-to-function correlation paradigm could not facilitate. While this kind of vertical conceptualization became prevalent in nineteenth-century neuroscience, it had important origins in neurophysiological developments across the eighteenth and nineteenth centuries. It also found important confirmations in some traditions of German physiology and embryological biology at the end of the eighteenth and start of the nineteenth century — which emphasized the reducibility of life to the formal nature of living organization, teleological functions, and somewhat abstract causative and regulative vital forces — as well as in more robust theories of evolution that emerged in the middle of the century.[16]

Prior to the nineteenth century, neuroanatomists ascribed development primacy to the brain, and imagined that it was the origin and source from which the nerves extended. This view was integral to the idea that the brain was in its entirety the *sensorium commune.* By the nineteenth century, this view was reversed, and the brain was imagined instead as the final and most recent development of the nervous system. By the end of the eighteenth century, the nervous system had acquired a conceptual independence from the brain, in part because it was being understood according to a functional autonomy that had hitherto been ascribed to the brain alone. It was the brain's fundamentally dispersed nature that both enabled it to be imagined as a profoundly "common" space, but also that allowed the concept of autonomic nervous system to be developed as a dispersion of "little brains," particularly in the work of James Johnstone.

Precipitated in part by the mid-eighteenth century writings of Robert Whytt, Johann Unzer in his 1771 *Principles of Physiology* described how some of the more significant anatomical subdivisions of the nervous system "perform in the motor nerves the office of the brain in relation to the external impressions," in part because they "deflect" these impressions independently and beyond the scope of perception and will to other nerves, typically for the sake of an immediate motor response.[17] Sixteen years later Jiří Prochȧska in his *Dissertation on the Functions of the Nervous System* wrote that the *sensorium commune,* a category typically reserved to the brain alone, actually "seems not improbably to extend through the medulla oblongata, the crura of the cerebrum and cerebellum, also part of the thalami optici, and the whole of the medulla spinalis, in a word it is co-extensive with the origin of the nerves."[18] The entirety of the *sensorium commune* was for Prochȧska endowed with the automatic and autonomic capacity to "[reflect] sensorial into motor impressions,"[19] and, perhaps more importantly, some ganglia and nervous plexuses that were not technically part of the *sensorium commune* nevertheless possessed "special *sensoria"* which still allowed them to reflect external impressions into movement.[20] The *sensorium commune's* functional independence and

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[16] Robert J. Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002), especially chapters 5-7, 9. Timothy Lenoir, *The Strategy of Life: Teleology and Mechanics in Nineteenth-Century German Biology* (The University of Chicago Press, 1982), chapters 1, 2, and 6. James L. Larson, "Vital Forces: Regulative Principles or Constitutive Agents? A Strategy in German Physiology, 1786-1802," *Isis* 70, no. 2 (June 1979): 235-249.

[17] John Augustus Unzer, *The Principles of Physiology* (1771) and George Prochaska, *A Dissertation on the Functions of the Nervous System* (1787), trans. and ed. Thomas Laycock (London: Sydenham, 1851), 215-16.

[18] Ibid., 430.

[19] Ibid., 431.

[20] Ibid., 438.

automaticity actually extended beyond the limits of what was anatomically defined as the *sensorium commune* itself.

Throughout the early nineteenth century, the conception of nervous system's autonomy and automaticity expanded particularly as the independent sensory-motor powers of the spinal cord were elucidated. Physiologist François Magendie and anatomist Charles Bell independently demonstrated that the sensory-motor processes could be localized in the spinal cord alone.[21] And by the mid-1830s, Marshal Hall had outlined the first modern conception of reflex action by delineating three different functional sub-divisions of the nervous system: the sentient and voluntary structure of the brain and spinal cord, what was dubbed the cerebrospinal axis; the "true" reflexive or "excito-motor" structure of the spinal cord alone; and lastly the vegetative functionality of the ganglionic nerves.[22] The concept of reflex was integral to the psychophysiology during the period, not only because it became the general formulation for the automaticity of nervous processes, but because it was the concept that generally named the passage from self-regulated physical processes to elementary forms of psychological experience, such as low-level sensations, as I will discuss below.

Nevertheless, the conception of the automatic and autonomic nature of the nervous system was significant precisely because it reversed the order of primacy between the brain and the rest of the nervous system. Organizational and functional complexity was generally ordered the stratified along a continuous progression from lower, vital nervous functions to higher functions associated with mental processes. The nervous system was, in effect, vertically stratified, and this conceptual spatialization was important because it productively linked together the vital and proto-sentient capacities of some nervous centers to the mental functions of the brain.

Moreover, the verticality facilitated a comparative analysis between humans and animals. English anatomist Richard Grainger, an advocate of Marshall Hall, who in his 1837 *Observations on the Structure and Functions of the Spinal Cord* not only described the reflexive processes of the spinal cord but also attempted to identify a specialized "reflex nerve," wrote, "The cerebro-spinal axis, of the lower animals, is, in all essential particulars, the exact analogue of the brain and spinal cord, in man."[23] Explicitly invoking the work of comparative anatomist Friedrich Tiedemann, Grainger continued, "There is a perfect identity of parts, in the encephalon of the human embryo, and the permanent organs which constitute the perfect brain of fishes, reptiles, birds, and mammalian."[24] The rise of comparative anatomy in the early nineteenth century illustrated that a vertical spatialization and stratification of the nervous system could describe more consistent similarities among species in terms of their basic physiological functions. Animals differed only in terms of the degree of their complexity and organization, sharing low-level traits but differing at the higher levels of nervous development. The vertical paradigm was additionally bolstered by German Romantic physiology in the early part of the

[21] Clarke and Jacyna, *Nineteenth-Century Origins,* 110-112; Young, *Mind, Brain and Adaptation,* 78-80. See also Owsei Temkin, "The Philosophical Background of Magendie's Physiology," *Bulletin of the History of Medicine* 20 (1946): 10-35; and H. Campbell Thomson, "The Work of Sir Charles Bell in Relation to Modern Neurology," *Brain* 48, no. 4 (December 1925): 449-457.

[22] Marshall Hall, *Lectures on the Nervous System* (Philadelphia: Carey & Hart, 1836). See Clarke and Jacyna, *Nineteenth-Century Origins,* 114-156.

[23] Richard Dugard Grainger, *Observations on the Structure and Functions of the Spinal Cord* (London: Samuel Highley, 1837), 106-7.

[24] Ibid., 107.

period which argued for the anatomical reducibility of vital and mental functions to the simplest and most unifiable physical structures of the nervous system.[25]

Franz Gall's organology presented one of the earliest accounts of the conceptual verticality and hierarchy of the nervous system and brain. Reversing the common eighteenth-century belief in the primacy of the brain, Gall was from the outset very insistent that "the nerves of the organs of the senses, and the medulla oblongata are not a prolongation of the encephalon [and] that each particular nervous system is an independent system."[26] It is comparative anatomy, Gall asserts, which

> teaches us with certainty, that the organ of the faculties of the soul is not limited to any portion of the cerebral substance; it teaches us, that it is only the hemispheres which establish the most essential difference between man and the different species of animals, and between the different individuals of the same species, in relation to the moral and intellectual forces.[27]

The vertical nervous system was fundamentally inclusive of all living organization — it could, in other words, account for the organic relatedness of all living beings, while also accounting for the exclusivity of the human generally speaking, as well as the stratified difference among humans as well. For Gall, the real differences along the progression of relatively advanced species was marked only by the increase "in number and development" of the "integrant parts of the cerebrum" — in other words, organic complexity of the brain and higher nervous structures. In all other ways, animals and humans were effectively the same, dissimilar only according to a single difference: the presence in the human brain of the anterior-superior and superior regions of the frontal cortex — the literal and figurative highest point of the brain — within which the most advanced mental faculties were situated.[28]

In some senses, Gall's conception of a vertical nervous system could account for what his doctrine of organology explicitly could not — that is, the link between the brain's organic anatomy and its functionality. While organology, and the entire historical trajectory of cerebral localization that emerged after it, strove to render equivalent the brain's matter with mental and psychological processes, it was ultimately the implicit vertical spatialization that made that equivalence possible — this was true not only for Gall, but also for the physiologists, psychologists, and philosophers who employed and elaborated on a vertical spatialization of nervous levels. Specifically for Gall, the passage from material anatomy to the psychological dimensions of subjectivity was bridged by the supposed conceptual continuity that the vertical topology set into place. The "moi" was defined according to instincts and propensities — including the instinct to propagate and self-defend, or the faculty of memory and spatial relation — that were related initially to the vital maintenance of the organism and species; and the anatomy was defined according to an organizational systematicity that possessed formal and even conceptual attributes.

As I will show throughout the rest of the chapter, the vertical ascent that connected the brain to the general nervous system blurred, and in a very tentative sense, resolved the psycho-physical gap between physical structures and processes and psychological states. This verticality was elaborated, by the end of the nineteenth century, into an explicitly hierarchical and

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[25] Erna Lesky, "Structure and Function in Gall," *Bulletin of the History of Medicine* 44, no. 4 (July/August 1970): 297-214. Clarke and Jacyna, *Nineteenth-Century Origins,* chapter 2.
[26] Gall, *Functions of the Brain,* vol. 2, 58.
[27] Ibid., 20-21.
[28] Ibid., 235.

evolutionary-based spatialization of nervous levels, ascending from lower to higher strata of organization, complexity, and abstraction. But in so being elaborated, a new topological problem emerged as it never had in any prior period: namely, question of the *space* separating one level from the next, and the micro-topology of the conceptual threshold that separated one level from the next.

Above and Below: Verticality and the Threshold

Because the vertical conceptualization of the nervous system emphasized the hierarchical continuity between levels of nervous complexity and organization, and therefore between highly organized nervous matter and low-level psychical processes, the spatial paradigm was understood by many psychologists and physiologists throughout the nineteenth century to provide a resolution to the problem of psychophysiological continuity. But the theoretical resolution to the problem of psychophysiological continuity needed, in order to be successful, to contend with the micro-topology of the space or threshold separating one level from the next. Indeed, the notion of the threshold — specifically the discrete yet continuous threshold separating bodily and mental processes — was an important category in the German psychophysical research of E.H. Weber and Gustav Fechner, with roots in the early philosophical psychology of Johann Herbart. What the independent psychophysical elaboration of the notion of the threshold sought to demonstrate was that even the most metaphysically saturated conception of the threshold — namely, the mind-body threshold — was entirely resolvable or at least negotiable at the lower, physical levels alone.

The concept of threshold, and the role it played in a generally vertical schematization of psychological processes, received its earliest elaboration in the metaphysical psychology of Johann Friedrich Herbart. Herbart was one of the most influential philosophical psychologists of the early nineteenth century. He both attempted to rehabilitate a metaphysical psychology, while also articulating the possibility of a truly scientific, even mathematizable understanding of the mind and the relations of mental representations, which directly influenced the experimental and physiological psychologies and theories of sensory perception that emerged in the following decades, even though Herbart said little concerning the physics of bodily actions.[29] Herbart's writings were particularly noteworthy for the introduction of the concept of the threshold, that is, the theoretical barrier according to which higher and lower mental levels were divided.

Herbart's 1816 *Lehrbuch zur Psychologie* provided a complex mechanical-dynamic view of the mind as a relation of representations, grounded on a metaphysical substrate of ontological "Reals."[30] For Herbart, mental representations had a mechanical relation of force and resistance in relation to one another, in the sense that opposing representations dynamically counteracted one another and could not simultaneously inhabit consciousness. The counteraction did not eliminate the opposing representation, but rather inhibited or suppressed it. The inhibition of a representation from, or conversely its presentation within, consciousness was schematically defined as its position above, below, or along a "threshold of consciousness"[*Schwelle des Bewusstseins*]:

[29] Gary Hatfield, *The Natural and the Normative: Theories of Spatial Perception from Kant to Helmholtz* (Cambridge, MA: MIT Press, 1990), 109-110, 117-128. Ribot, *German Psychology,* chapter 1.

[30] For more on Herbart, see Edwin G. Boring, *A History of Experimental Psychology* (New York: D. Appleton, 1929), 238-250; Harald Höffding, *A History of Modern Philosophy,* trans. B.E. Meyer, vol. 2 (New York: Dover, 1955), 248-259; G.F. Stout, "The Herbartian Psychology," *Mind* 13, no. 51 (July 1888): 321-33852; no. 52 (October 1888): 473-498.

> A concept [*Vorstellung*] is in consciousness insofar as it is not suppressed, but is an actual representation. When it rises out [*sich erhebt*] of a condition of complete suppression [*völliger Hemmung*], it enters into consciousness. Here, then, it is on the threshold of consciousness.[31]

All representations struggled to rise into consciousness, and they did so by suppressing other counteracting representations. The relation of oppositional force between representations operated according to an economy of equilibrium and movement, or what Hebart refers to as the "statics and mechanics of the mind."[32] Every representation had a calculable "static point," which amounted to the quantity of force possessed by a particular representation such that, should the same amount of force be opposed to it by another representation, both would be held in a relation of equilibrium along the threshold of consciousness. Otherwise, representations were counteracted with either a greater or lesser degree of force, resulting in full inhibition or conscious presentation. This economic mechanics of a representation was likened to the behavior of a buoyant object that could, by force, sink below [*unter sinken*] or rise above [*erheben*] the surface of water, [33] but also, in the literal sense of a mechanics, the movement of representations was entirely translatable into mathematical terms.

While Herbart defined what he took to be the unified soul according to a duality of functions — thinking and feeling — he did not mean that it should be imagined as an aggregated accumulation of differentiated faculties. The soul was not, in some Platonic sense, an ascension of higher and lower functions, faculties, or powers.[34] Rather, the soul, and so the self, possessed a topological verticality defined only according to the schematization of the consciousness threshold, and the mechanics of force by which concepts were either inhibited or presented in relation to it. The notion of the threshold comprised a limit that demarcated an abstract "above" and "below" and which, in effect, corresponded to an epistemological stratification of a self, who, although entirely ideational, could never always be conscious of every idea.

Herbart was something of the first modern theorist of a vertically theorized threshold, even though the threshold only marked a difference of lower and higher mental states. The theories of sensory perception which emerged only a couple of decades later, partly in relation to Herbart, incorporated the threshold as a regulative premise, as what defined the relationship between physical events and mental activity. The early psychophysical researcher, Ernst Heinrich Weber, affirmed the regulative premise of the psycho-physical threshold in the very first proposition of his 1834 *On the Sensitivity of the Touch Sense:*

> The various parts of the touch-organ are not equally sensitive to the spatial separation of two simultaneous points of contact… for it is a property of the touch-organ that it can always distinguish between two points set sufficiently far apart, even if it cannot distinguish between them when too close together.[35]

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[31] Johann Friedrich Herbart, *A Text-Book in Psychology,* trans. Margaret K. Smith (New York: D. Appleton, 1891), reprinted in *Significant Contributions to the History of Psychology, 1750-1920*, vol. 6 (Washington D.C.: University Publications of America, 1977), 13. *Lehrbuch zur Psychologie* (Amsterdam: E.J. Bonset, 1965), 12.
[32] Ibid., 11.
[33] Herbart, *Lehrbuch,* 14 (section 18).
[34] Herbart, *Text-Book*, 47. As Herbart explains, "All that has been cited gives no conclusive series of fixed difference either between humanity and animality, or between the higher and lower faculties," (Ibid., 51).
[35] E.H. Weber, *E.H. Weber on the Tactile Senses,* ed. and trans. Helen E. Ross and David J. Murray (Hove: Erlbaum [UK] Taylor & Francis, 1996), 32.

Weber wanted to understand the differences in tactile sensitivity across various regions of the body, and he accomplished his task experimentally by assessing the levels of sensitivity registered by the palms of the hands and the face, for example, over and against the thigh or back. Some regions displayed a greater sensitive acuity — the threshold of sensitivity in these regions was lower and only smaller differences of physical stimulus were needed in order for the stimulus to be felt. The two needle points of a compass, for example, could be felt as two distinct points when set closer together on the tip of the finger, than they could on the back, where they would only be felt as one. The threshold of tactile sensitivity of different parts of the body could be identified and indeed calculated, and the problem of the threshold took on a distinctly psychophysical form.

It was only in Gustav Fechner's 1860 *Elements of Psychophysics,* however, that the concept of the threshold reappeared explicitly as an important theoretical and methodological problem. "There is a certain paradox [*etwas Paradoxes*]," wrote Fechner, "inherent in the nature of the threshold [*Schwelle*]."[36] The paradox was defined in terms of the larger context of Fechner's project of determining the nature of the lawful interrelation between the physical and psychical dimensions of the human subject. For Fechner, "the psychic is to be considered a direct function of the physical," and the term "psychophysical" was to be bestowed on physical processes that "accompany or underlie … [or] stand in a direct functional relationship" to the psychic.[37] Fechner espoused an identity theory of mind and body, not uncommon during the nineteenth century, refusing to recognize the two as ontologically separate, even though they could never manifest a simultaneous co-presence. Fechner likened the physical and psychical dimensions to a circle that will appear concave or convex depending on whether the circle is viewed from inside or outside: "No one can ever observe mind and body simultaneously even though they are inextricably united, for it is impossible for anyone to be inside and outside the same thing at one time."[38]

In uncovering the pycho-physical link, Fechner looked to the relationship between felt sensations and the physical stimuli that induced them. The brain, while immediately connected to both, constituted the mediating circuit [*Nervenleitung*] that linked the stimulus and felt sensation. This relationship was lawfully determinable, in part because both the physical and psychical dimensions of the human depended functionally on some form of kinetic energy or active force [*Lebendige Kraft*]. Both the physical and psychical were bound to the laws and economy of kinetic force, a conceptualization which allowed for the possible transposition of the same kinetic energy from the physical to the psychical domain:

> Kinetic energy employed to chop wood and kinetic energy used in thinking — that is, in the underlying psychophysical processes — are according to what has just been said not only quantitatively comparable, but each can be transformed

[36] Gustav Fechner, *Elements of Psychophysics,* vol. 1, trans. Helmut E. Adler (New York: Hold, Rinehart and Winston, 1966), 205. *Elemente der Psychophysik,* (Amsterdam: E.J. Bonset, 1964), 246.
[37] Fechner, *Elements,* 9.
[38] Ibid., 4. Höffding elaborates: "Fechner's fundamental conception early led him to the conviction that the difference between the mental and the material cannot be a difference between two beings, the one non-material, and other non-spiritual…. The difference between them is phenomenal, and depends on the difference of standpoint taken by the spectator, not on difference of substance," *History of Modern Philosophy,* 528. And Boring confirms: "Fechner's view of the relation of mind and body was not that of psychophysical parallelism, but what has been called the identity hypothesis. The writing of an equation between the mind and the body in terms of Weber's law seemed to him virtually a demonstration of their identity," *History of Experimental Psychology*, 277.

> into the other, and therefore both kinds of work are measurable on their physical side by a common yardstick.[39]

That the entirety of the psychophysical circuit could be transformed and measured in physical terms alone meant that the psychophysical process was entirely available to mathematical description. The psychophysical law that Fechner proposed was based on an inverse proportional relation that defined the correspondence between stimuli and sensation — the difference between stimulus levels would have to increase exponentially in order to maintain a steady increase in the level of sensation.[40] Fechner's formula of *sensation = k log stimulus* expressed the logarithmic relationship between the stimulating excitation and the sensation, and it was precisely the mathematical standpoint that could bypass what was from a philosophical standpoint the paradox of the threshold.

Metaphysics could not resolve why an excitation that could not be felt at one level inevitably could be felt at only an incrementally higher magnitude; it could not, according to Fechner, describe the problem of the limit separating a physical event from its psychical manifestation. Mathematics, on the other hand, could directly articulate how "the magnitude of a sensation can be regarded as a function of stimulus magnitude."[41] Fechner felt the mathematical lawfulness of psychophysics explicitly resolved an obstacle within Herbart's mathematical psychology — namely of accounting for the functional relationship between a physical event and a sensation.[42] And unlike Herbart, Fechner's mathematical axiom articulated the continuity, indeed the relative (as opposed to absolute) identity, between the physical and psychical orders of the subject. It did so by breaking the physical and sensational into a set of logarithmically related levels of difference and differentiation.

Through his axiomatic assumption of the functional translation of the physical into/as the psychical (and vice versa), Fechner essentially defined subjectivity according to a scale of differences in the magnitude of physical excitations. The increasing scalar differences defined the eventual threshold-crossing transition into the realm of subjective feeling, ultimately producing an abstract topology, or spatial logic, of the subject wherein, drawing from Fechner's early geometric metaphor, the inside and outside of the circle have been rendered mathematically indistinguishable.

Fechner wanted to make the question of the threshold obsolete, by describing it as a characteristic of only the phenomenal — or apparent — relationship between physical and psychical states. At a fundamental level, the transferability of kinetic energy between mental and physical acts, as well as the mathematical articulation of the continuity of psychophysical interactions meant that no ontological limit or incommensurability needed to be assumed between nervous anatomy and the states of subjectivity based on them. While Fechner may not have in some fundamental sense fully resolve the problem of the threshold as he believed he did, he nevertheless demonstrated the important point that the psycho-physical threshold was already being partially resolved, if not at least bypassed at a physical level — that somehow physical and biological processes were on their own negotiating the more cumbersome and theoretically overloaded threshold separating biology from psychology. The theorization of the concept of threshold throughout the short history of German psychophysics posited the basic negotiability of the psycho-physiological threshold at the physical level. It did not, however, necessarily

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[39] Fechner, *Elements*, 36. This statement underlies Sigmund Freud's interest in Fechner in outlining some of the earliest formulations of what Freud will elaborate as the libidinal economy.
[40] See Ribot, *German Psychology,* 134-165.
[41] Fechner, *Elements,* 205.
[42] Ibid., 46.

provide an extended account of what the elimination of a strict psychophysical threshold or barrier would mean in terms of reimagining the structure and function of the nervous system. If the micro-topology of the space separating levels where now defined by a capaciousness that both discriminated yet rendered continuous one level from the next, how would such a micro-topology be expressed through and as the very materiality of the brain and nerves? To answer this question, I turn to mid-century British neuropsychology, and specifically to the psychophysiological theories of Herbert Spencer.

Nervous Levels and Vertical Abstractions: Herbert Spencer's Material Coordinations

Imagining the subject according to an abstract verticality — a conceptual hierarchy of ideas, excitative magnitudes, or degrees of organizational complexity — meant assuming some kind of continuity between "lower" and "higher" states, irrespective of what those states ultimately represented. However, the transposition of the vertical schematization onto the nervous system directly took on a new dimension in the context of British biological psychology and neurology during the 1850s through 1870s, epitomized in particularly by Herbert Spencer and his *Principles of Psychology,* first published in 1855. In the work of Spencer, and others, the nervous system was described as a deeply continuous hierarchy of levels of nervous activity and complexity which embedded a continuous transition — as opposed to a clear cut break or threshold — to psychical properties. This position was particularly reinforced by an important conceptual doctrine that reinterpreted the vertical hierarchy of the nervous system in a new direction — that is, the doctrine of evolution, which for Spencer assumed, on the one hand, an organic homogeneity among all organisms at the lowest levels and earliest stages of their development (what would eventually become heterogeneously differentiated at the higher, more advanced levels of development), and on the other hand, the fundamental continuity and indistinction between physiological process and psychological facts.[43] It was Spencer, after all, who most contributed to defining the function and mechanism of evolution in the specific context of the nervous system and nervous activity, and the later integration of evolutionary paradigms in the theory of nervous activity was Spencerian in nature.[44]

Spencer was emphatic that the doctrine of evolution he espoused not only eliminated the notion of a hard threshold, but accounted for the *material* emergence of the mental and psychical properties of an organism. "There can be no break," Spencer writes, "no change from one group of concrete phenomena to another without a bridge of intermediate phenomena."[45] The doctrine of evolution assumed a two-fold scale of vertical ascension, one which applied to the relation between species — "beginning with the low life of plants and of rudimentary animals" to "higher and higher kinds"[46] — and one which was embodied in every single organism itself. The evolutionarily oriented ascent was marked by both the increased complexity but also specialization of what Spencer called "the adjustments of inner relations to outer relations."[47] Spencer was referring to an organism's overall responsiveness to an environment, specifically in terms of its ability to orchestrate internal, bodily correspondences of sensory impressions and motor behavior to the correspondences between external phenomena. This "adjustment of inner

[43] Robert J. Richards, *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (Chicago: University of Chicago Press, 1987), chapter 6, especially pages 280-294. Ribot *English Psychology,* 124-193; Höffding, *History of Modern Philosophy,* 452-477; Robert M. Young, *Mind, Brain, and Adaptation*, chapter 5.

[44] An important example of an adopted Spencerian theory of nervous evolution is John Hughlings Jackson's seminal "Remarks on the Evolution and Dissolution of the Nervous System," *The Journal of Mental Science* 33, no. 141 (April, 1887): 25-48.

[45] Herbert Spencer, *The Principles of Psychology,* third edition, vol. 1 (New York: D. Appleton, 1897), 136.

[46] Ibid., 294.

[47] Ibid.

relations to outer relations" characterized the basic "intelligence" of the lowest forms of life, as much as it grounded the human capacity to reason. Every single organism was comprised of gradations of complexity and organization, which, for Spencer, were most directly represented by the privileged structure and function of the nervous system. These gradations incorporated all the evolutionary progressions, structures, and functions of lower forms. At the lowest levels, all organic life shared a relatively similar structure and functionality. As Spencer explains, "The senses in general have a yet deeper basis in those primordial properties of organic matter which distinguish it from inorganic matter…. [S]ensibility of all kinds takes it rise out of those fundamental processes of nutrition and waste — integration and disintegration — in which Life, in its primitive form, consists."[48]

In the *Psychology,* the nervous system comprised the central site and abstract terrain in which organic processes "[pass] without break from the phenomena of bodily life to the phenomena of mental life."[49] Although the gradational rise from one nervous level to a higher level was characterized by changes in the operations and arrangement of the nerves and nervous clusters, the rise was also equivalent to an increasing degree of intelligence. Intelligence was not a singularly defined concept, applicable only to human rationality, but presented "ascending gradations through the various types of sentient beings,"[50] precisely because intelligence for Spencer ultimately referred to the capacity to orchestrate correspondences with the environment. For this reason, "Intelligence has been shown to have the same nature and the same law from the lowest reflex action up to the most transcendent triumph of reason."[51]

The underlying operation of the nerves involved the co-ordination and integration of sensory and motor processes, starting from singular coordination of smallest and simplest processes and progressing to larger, compound co-ordinations, finally to even larger and "doubly compound" integrations. Lower-level co-ordinations brought together relatively homogenous kinds of processes — for example, sensitivity to a particular environmental stimulus, and a very general motion in relation to that stimulus — whereas the more progressive and developed integrations were simultaneously more heterogeneous and also more definite, in that they represented a more specialized correspondence between the organism and the environment. A more advanced organism would possess the ability to detect smaller differences in the simpler properties of things (for example, the differences in the sonic quality of pitch versus timbre), to respond through a more integrated arrangement of motions, and even to produce non-sensory cognitions about more complex properties in the environment (such as a more abstracted understanding of space and time relations, such as distance and direction or duration and simultaneity).[52] According to Spencer, the description of the simple behavior of an organism was already a psychological account at "the moment we inquire how there comes to exist within the organism a relation between [two different kinds of sensations] that in some way or other corresponds to the relation between [two related manifestations in the environment]."[53]

But the specificity of what Spencer had in mind through the concept of nervous co-ordination was integral to his psychobiological philosophy, since it ultimately explained the relation between lower and higher levels of complexity, and consequently the relation between the nervous system and the mind more generally. A particular set of nerves might constitute a low-level and simple sensory or motor capacity. This simple sensory or motor process would be

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[48] Ibid., 305.
[49] Ibid., 294.
[50] Ibid., 292.
[51] Ibid., 507. See Richards, *Darwin,* 280-283.
[52] Ibid., 331-.339
[53] Ibid., 133. Robert M. Young, *Mind, Brain, and Adaptation*, 167-172.

coordinated at a higher and more structurally and functionally complex nervous level with a different, but equally simple, sensory or motor process; the result would consist in the coordinated composition of both lower processes into a slightly more complex, more organized, integrated sensation or movement. These coordinated integrations arose, as Spencer explains, from "continuous repetition of experiences in which any two sensations are always joined, any two muscular contractions constantly performed together, or any perception uniformly followed by a special motion."[54]

Coordination can be understood as a *physical abstraction* of nervous functions which draws together discrete lower-level sensory or motor processes into a single, compound integration that unites the difference. Compound co-ordinations were linked with other compound co-ordinations at even higher nervous levels, producing nothing but an intricate organizational web of what were ultimately simple processes: "Compound impressions, as well as the compound motions guided by them, continually approach in their apparent characters to simple impression and simple motions. The coordinated elements of any stimulus or of any act ever tend towards union; and eventually become distinguishable from one another only by analysis."[55] The most important sort of nervous coordination was not occurring simply among sensory and motor processes independently, but between the two. Spencer presented the example of visual sensation in the production of the idea of space, and discussed in what sense this sort of sensory impression transitioned from an event that was simply physical, to one that was psychological:

> But a little consideration shows that something more is required than ability to perceive differences between the positions of images on the visual tract. Taken alone, these differences are meaningless. They come to have meaning only when they are severally connected in the organism with those differences of motion required to bring its surface into contact with the things seen. Mere ocular impressions do not of themselves give ideas of space. Such ideas are products of a growing experience which proves that these impressions are due to objects that can be touched by particular muscular adjustments.[56]

The idea of space was not generated through the difference of sensory impressions alone — through, for example, the perception of an external object's change of position, which already presumed a pre-established sensory coordination. The idea emerged instead through a higher integration of that sensory difference along with the difference in the organism's own motility in relation to that external object, which was itself a compound coordination of motor function.

The very same process of coordination and integration was also at the heart of the formation of ideas. As I said, coordination constituted something like a *physical* abstraction of simple processes; the continuity between lower and higher (ideational) processes was predicated on the continuity of the process of *abstraction*. Physical abstractions did not simply *become* ideational abstractions — they *already were so,* in the most minimal sense at least, because they were the generalization of simpler physical processes into a more integrated form. The process of coordination assumed something formalizable — that is, systematic or even minimally logical — about the physical matter of the nerves. This is why Spencer ascribed intelligence and psychology to the most basic organismic functions and states:

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[54] Ibid., 383. Robert M. Young, *Mind, Brain, and Adaptation*, 186-190.
[55] Ibid., 377.
[56] Ibid., 356.

> The moment we rose to a type of creature which adjusts certain organic relation to relations of which both terms are not presented to its surface, we passed into adjustments of the psychological order. As soon as there exists a rudimentary eye capable of receiving an impression from a moving object about to strike the organism, and so rendering it possible for the organism to make some adapted movement, there is shown the dawn of actions we distinguish as intelligent. As son as the organism, feebly sensitive to a jar or vibration propagated through its medium, contracts itself so as to be in less danger from the adjacent source of disturbance, we perceive a nascent form of the life classed as psychical.[57]

Coordinative abstractions and integrations, then, explained the gradational ascension from one nervous level to another. This process also effectively generated the very structural materiality of the nervous system, as coordination and integration constituted the organic and evolutionary development of neuroanatomy itself. Spencer described how higher-level co-ordinations generate the "intercalation" or interposition of new nervous levels and clusters between existing one, physical bringing about new nervous networks and, therefore, new associative possibilities.[58] The structure of a body's neuroanatomy developed in an ever growing web of complexity and associative re-coordinations, but with the relatively unifying meta-structure of a general hierarchy of nervous levels, the highest always being the most available to consciousness, and the lowest being the most automatic.[59] So, for example, the spinal cord itself consisted of nervous centers that automatically performed the large-scale and highly compounded sensory-motor coordination "of the actions performed by the skin and muscles of the trunk and limbs."[60] Above the spinal cord, both literally and functionally, was situated the *medulla oblongata,* "a center where the local centers concerned with nearly all parts of the body, are brought into communication,"[61] where for Spencer, automaticity bled into consciousness. Finally "the two great bi-lobed masses overlying the *medulla oblongata* and the sensory ganglia" — the cerebrum and cerebellum — ultimately constituted "centers in which these compound connections are united into connections still more compound, still more various, and still more numerous."[62]

Functional Integrations and Natural Unity: Bridging Gaps in British Neuropsychology

Re-presentation without Representation

For Spencer, the brain embodied the most organizationally complex integration of all lower centers — it was not a simple or reductive seat of consciousness, the site in which

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[57] Ibid., 391.

[58] "In asking how such higher co-ordinations are evolved out of lower ones, and how the structure of the nervous system becomes progressively complicated in such way as to achieve them, the cardinal fact to be remembered is that such higher co-ordinations are effected by *intercalations* of new clustered states between the original clustered states. Hence it is to be expected that in the nervous apparatus which achieves them, there must be intercalated plexuses of fibers and cells" (Ibid., 551, emphasis in original).

[59] "It does not follow, as it at first seems to do, that feeling are never located in the inferior nervous centers. On the contrary, it may well be that in lower types the homologues of these inferior centers are the seats of consciousness. The true implication is that in any case the seat of consciousness is that nervous center to which, mediately or immediately, the most heterogeneous impressions are brought; and it is not improbable that in the course of nervous evolution, centers that were once the highest are supplanted by others in which coordination is carried a stage further, and which thereupon become the places of feeling, while the centers before predominant become automatic" (Ibid., 105).

[60] Ibid., 56.

[61] Ibid., 45.

[62] Ibid.

consciousness inexplicably appeared. The brain did not entirely localize human experience, as Gall had earlier imagined. Indeed, the localization of consciousness was a complex issue for Spencer. While he affirmed the concept of localization in a very general way, therefore broadly affirming the overall *project* of phrenology,[63] his conception of localization was not the discrete and punctuated description of a one-to-one, structure to function relationship that phrenologists had proposed. Spencer adopted a more distributed model of localization, predicated on the coordinated web of nervous structures: "No one excited fiber or cell produces consciousness of an external object: the consciousness of such external objects implies excitement of a plexus of fibers and cells. And not only does this plexus of fibers and cells differ with every different object, but it differs with every different position of the same object."[64] Coordination and integration were processes that began at the lowest nervous levels, and proceeded to the highest cerebral organization. Consciousness, then, was distributed in an increasing degree along the vertical progression of consolidation and integrative complexity. In lower states — or for species whose highest states would be equivalent, for example, to a highly organized ganglion or even the human spinal cord — the highest coordinative centers correspond to something closer to an agency or a feeling, a general sentience. The brain did not cause or bring about consciousness; it did nothing but add another level of coordination and consolidation to already highly compounded sensory-motor integrations. It was simply the entity that rendered most functionally complex the already highly compounded sensory-motor integrations, a development that nevertheless accounted for the final evolutionary transition from animal proto-consciousness to the consciousness of a human.[65]

In this sense, one of the benefits of Spencer's vertical spatialization of the nervous system, brain, and mind was that it could be entirely described in functional terms. In other words, coordination and integration could be understood as the re-instantiation of simple processes in more general terms, bypassing altogether the descriptive problem of mind-body. Or, to put it another way, the problem of the progression from physical to psychical processes was not being staged in the brain, but was instead being staged as the micro-topologies that separated nervous levels — the spaces of coordination of physical abstraction by which more complex functions emerged from simpler ones. Such a view is evident in an analogy Spencer drew between the highly integrative and combinatory function of the brain and the mechanical, player piano. Spencer began the analogy first by describing a music box, which operated on the basis of a cylinder lined with pins that struck notes when spun to produce a melody. The cylinder effectively "represented" a melody, but the music box ultimately suffered from the technical restriction of being limited to the single melody built into it. Spencer contrasted this with the slightly more versatile mechanical or player piano, in which the music box technology was re-employed, but with the single important difference, that unlike the music box, the piano allowed for the infinite exchange of various "tune-boards" of pre-recorded notes and melodies. But, Spencer explained, the technical analogy to the player piano still did not properly describe the

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[63] Ibid., 574. See Richards, *Darwin,* 250-253.

[64] Ibid., 562. The conception of diffuse localization was not uncommon. In 1877, the Franco-American neurologist Édouard Brown-Séquard wrote, "My own view … is, that each function of the brain is carried on by special organs, but that those organs, instead of being composed of cells forming a cluster or a mass in one part, are composed of scattered cells diffused in many parts of the brain, in communication, of course, one with the other by fibers, and forming a whole by this union of fibers, but still so diffused that a great many parts of the brain — I would not be bold enough to say all parts — contain the elements endowed with each of the various functions that we know to exist in the brain," in "Aphasia as an Effect of Brain Disease," *The Dublin Journal of Medical Science,* (March 1, 1877), 212

[65] Or between groups of humans, as Spencer makes clear in his deeply stratified assessment of intellectual (and cerebral) difference between human races (581).

functional complexity of the nervous system — a very different sort of hypothetical player piano needed to be imagined.

In such a hypothetical piano, no hard operational distinctions could be assumed, as the different physical parts of this speculative piano must "have larger or smaller parts of their combinations in common,"[66] implying, for example, that multiple tune-boards would need to share melodic encodings. And, most importantly, to fully enact the proper neurological metaphor, the speculative player piano could not have, as its highest level, a simple store of pre-recorded melody tune-boards. Instead, "we must imagine kindred appliances of a higher order, which do not themselves elicit the harmonized melodies, but which re-combine in various ways, simultaneous and successive, the appliances that do this — represent, as it were, whole concerts of them specially arranged; and so on in still higher gradations."[67] The highest nervous levels, therefore — in this sense, the brain — were functional orchestrators, combining and recombining pre-recorded melodies and notes into the symphony of organismic intelligence. These higher levels simply encapsulated and reiterated, in greater complexity, the operations and encodings of lower orders. What Spencer suggested through the analogy of the mechanical piano was that the brain corresponded to a process of *re-presentation without representation*, or the re-instantiation of functional complexity. The brain re-presented, without necessarily initiating, the physical abstractions of sensory-motor coordinations that were taking place at the lowest levels. It could, in other words, become the great orchestrator of the organizational complexity of material and psychical processes, while relegating to the lowest levels the micro-topological problems associated to physical abstractions and the emergence of psychical states from coordinated physical processes.

Indeed, for Spencer there was one particular nervous level that embodied like no other the topological problem of the space of physical abstraction and psychical emergence — it was the nervous level that corresponded to the *reflex* processes of the nervous system. After all, reflex held an important philosophical value for Spencer, as he referred to it as what most directly bridged the evolutionary gap between biology and psychology: "Reflex action being the lowest form of psychical life, is, by implication, most nearly related to physical life: in it we see the incipient differentiation of the two."[68] Reflex corresponded to the space that both separated but also rendered continuous the most fundamental nervous level dividing the physical and the psychical dimensions of the organism. It was the biological resolution to what had once been the metaphysically irresolvable problem of the threshold. Reflex, as I will show in the following sections, was the coordinating space that staged the most important ascension and emergence along the vertical structure of nervous levels; and so it corresponded to a general micro-topology according to which the entire vertical architecture leading from the lowest nervous processes to the brain, and from the lowest psychical processes to intelligence, could be structured and held together. Reflex was the reason that the brain, in and of itself, did not need to be the space of the psychical emergence, but rather the space that re-presented that micro-topological feat.

Reflex Bridges the Gap

Some major aspects of Spencer's conception of nervous integration and evolution were incorporated by one of the most prominent neurologists of this period, Johns Hughlings Jackson.[69] Indeed, in an article from 1875, Jackson affirmed the *a priori* status of Spencer's

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[66] Ibid., 567.
[67] Ibid.
[68] Spencer, *The Principles of Psychology,* 428
[69] Robert Young argues that, in addition to John Hughlings Jackson's psychophysiology, Spencer formatively influenced the animal and comparative psychology of George J. Romanes and William James' functional

"hypothesis of Nervous Evolution" as well as the theory of cerebral reflex action elaborated by English neurophysiologist Thomas Laycock.[70] Jackson adopted a similarly vertical conception of the nervous system, but specified only three distinct levels of organizational complexity and evolutionary development. Jackson employed the explicit language of "representation," in the non-ideational sense that the nervous system encoded or instantiated sensory-motor affections of the body in relation to the environment. And like Spencer, nervous representations for Jackson functionally coordinated different bodily affections into slightly more abstracted physical processes. The lowest nervous levels represented the affections of the entire body; the middle level represented, or re-instantiated with greater complexity and more highly developed coordinating relations, the processes of the first level; and the highest level, which corresponded to the highest regions of the brain, essentially "triply represented" the entire body with even greater organizational specificity. The application of Jackson's vertical spatialization of the nervous system on the study of nervous disease and general neuropathology was extremely influential in altering the study of cerebral localization by reversing the methodological approach to brain and mind as being composed of discrete faculties. The only localizable functions would be sensory-motor processes and their coordinated relations, a point that Spencer first emphasized.[71]

Like Spencer, Jackson emphasized the automatic nature of the lower nervous functions, and described the automaticity as physiologically equivalent to a reflex action, what in the most preliminary sense meant the specific coordination of a sensory impression and motor response. Ultimately, even the highest cerebral functions were compounded integrations of lower, automatic, and independent integrations of this sort. But reflex actions were for Jackson not properties of the lowest organizational order alone. Indeed, certain cerebral processes also partook of the automaticity of nervous coordination. In other words, the brain was in many ways functionally reflexive — that is, it partook of an automaticity that was identical to the most basic reflexive coordinations happening in the lowest nervous levels. For example, the visual recognition of an object, including an object's color, shape and position in space, relied on the strong reflex action of high cerebral processes, as Jackson makes clear when he writes,

> The shape of an object is the relation of its several positions one to another; our knowledge of this relation is by movements, in this case ocular movements…. By currents passing from the highest sensory centers, so to speak, 'across' to the highest motor centers, and from these downwards … there is development of the movements of the eyeballs…. Here we have complete and strong reflex action, complete because all orders of centers, sensory and motor, are engaged; and strong, because the highest centers are in great activity.[72]

Jackson equates the physical event of the reflex action to nervous "currents" that "pass across" — thereby coordinating and integrating — sensory and motor centers. The importance of reflex,

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psychology; see *Mind, Brain, and Adaptation,* 191-210. For more on the relationship between Spencer and Jackson, see Walther Riese, "The Principle of Integration," *The Journal of Nervous and Mental Disease* 96, no. 3 (September 1942): 296-312.

[70] John Hughlings Jackson, "On Temporary Mental Disorders After Epileptic Paroxysms," *Selected Writings of John Hughlings Jackson,* vol. 1 (New York: Basic Books, 1958), 123.

[71] Anne Harrington, *Medicine, Mind, and the Double Brain* (Princeton University Press, 1987), chapter seven. Robert Young, *Mind, Brain, and Adaptation,* 204-210.

[72] John Hughlings Jackson, "Evolution and Dissolution of the Nervous System: Croonian Lectures Delivered at the Royal College of Physicians, March 1884," *Selected Writings of John Hughlings Jackson,* vol. 2 (New York: Basic Books, 1958), 70.

however, did not for Jackson rest simply on the fact that it coordinated, or at least named the coordination between sensory-motor centers, as the elementary building block of the process of integration. Reflex held an important philosophical value as well, which was not entirely Spencerian in origin.

Jackson, after all, derived much of his account of reflex from Thomas Laycock.[73] Laycock most famously extended the concept of reflex to account for the processes of the brain, in addition to those of the rest of the nervous system. Laycock espoused a Romantic biological view of the unity of nature, which translated in his neurophysiology as an indistinction between matter and mind and a general continuity of biological and zoological organization.[74] He argued for the unified functionality of the entire nervous system, and insisted that if reflex was a process that operated in the lower nervous levels, then it must also be a part of the brain's functionality as well, as a manifestation of the same, unchanged reflexive action.[75] As Laycock explains in an 1855 essay,[76] "I therefore soon reached this general conclusion that the brain being a congeries of ganglia, did not differ in its laws of action from the other ganglia of the nervous system; and in particular, that like the spinal ganglia, it was subject to the laws of *reflex* action."[77]

By arguing that the brain was operationally reflexive, Laycock was suggesting, like Spencer, that the same sensory-motor processes that regulated the rest of the nervous system also operated in an underlying fashion in the brain — that the brain simply re-presented the functions of the lowest levels of the nervous system. Laycock's claims were directed at proponents of a relatively familiar theory of reflex, represented primarily in the work of Marshall Hall and William Carpenter, that argued for a discontinuity between the reflex actions of the nervous system, and the mental functions of the brain.[78] Consciousness had typically been the phenomenon that marked the barrier between low-level reflex functions and high-level voluntary processes. But for Laycock, the brain did not constitute a cut-off point of reflex action simply because it gave way to conscious phenomena. In fact, as Laycock explains,

> although, as the organ of the conscious mind, its functions were carried on *with* consciousness, yet as being a series of ganglia analogous to the spinal, its functions might be, and often were, carried on *without* consciousness, or at least independently of the will, and of the accompanying sensations, if consciousness existed.[79]

The brain was, in its most fundamentally physical sense, reflexive; and since reflex bridged for Laycock (as it did for Spencer) the physical-psychical divide, reflex actions subtended the more developed functions of the brain, including emotions and the intellect.

Laycock elaborated philosophically, in a way other thinkers did not, why reflex held the power it did. Reflex lay at the heart of all organismic functioning, animal and vegetable, as a

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[73] J.M. López Piñero, "The Work of John Hughlings Jackson Part 1," *History of Psychiatry* 21 no.1 (2010): 85-95.
[74] Alex Leff, "Thomas Laycock and the Cerebral Reflex: A Function Arising From and Pointing to the Unity of Nature," *History of Psychiatry* 2 (1991): 385-407. See also L.S. Jacyna, "The Physiology of Mind, the Unity of Nature, and the Moral Order in Victorian Thought," *The British Journal for the History of Science* 14, no. 2 (July 1981): 109-132. Laycock lays out the general premises of his philosophical positions in the two-volume *Mind and Brain: or, the Correlations of Consciousness and Organisation* (London: Simpkin, Marshall, and Co, 1859).
[75] Leff, "Thomas Laycock," 395-397.
[76] Thomas Layock, "Further Researches into the Functions of the Brain," *British and Foreign Medico-Chirurgical Review* 16 (July-October 1855): 155-187.
[77] Ibid., 156.
[78] Leff, "Thomas Layock," 393.
[79] Laycock, "Further Researches," 156, emphasis in original.

"fundamental psychological phenomenon" which was, nevertheless, occurring physically because it represented nothing more than "the intelligent respondence to stimuli."[80] The law of reflex, therefore, "[applied] to every form of organism" as well as "to every kind of tissue … whether it be merely a congeries of cells."[81] Reflex was the expression of an underlying and unconscious natural intelligence and agency that ascribed to all living organization the teleological function of self-preservation and species continuation.[82] Since reflex was ultimately the expression of this natural intelligence, present even in the "primordial cell," the bodily economy of the animal would consequently be structured purposively around the reflex logic. As Laycock explains, "all the nerves … of special sensation at least (or, in other words, *all* sensory nerves…) have a common function and common principle of action."[83] Sensation was not simply defined as the receptivity of external impressions, but was made to be immediately equivalent to the activity of a motor response. Sensation became identical to, or at least indistinguishable from, a motor transmission — or, in other words, equivalent to a fundamental transmissive correspondence with a motor function. For Laycock, the aesthetic, sensory register and the order of movement and physical behavior were indistinguishable, and the unifying reflexive coordination between the two, as an expression of a natural intelligence, ensured their correspondence.[84]

Two decades later, Jackson described the "inestimable value" of Laycock's doctrine of cerebral reflex action, insofar as the doctrine allowed Jackson to describe not only the automaticity of low-level nervous functions, but also to describe the "mental automatism" of neuropathological disorders, including the abnormal, violent, and occasionally homicidal paroxysms of patients whose actions, though intelligent (in the sense of socially intelligible), were nevertheless entirely unconscious.[85] The underlying reflexive operations of the nervous system *and* the brain were always at play, coordinating and unifying sensory-motor processes, and bridging the physical-psychical barrier, irrespective of whether the subject was conscious of anything or not. In the end, it was reflex action that described the relation between the levels along the vertical ascension of the nervous system, brain and mind — either because it was synonymous with the process of nervous coordination and integration as Spencer imagined, or because it was the expression of the unity of nature, as was the case for Laycock.

But, Jackson, who adopted both points of view, highlighted an additional dimension to the role of reflex in the vertical paradigm of the brain and nervous system. Reflex was not just a sensory-motor coordination resulting in physical abstractions and psychical emergences; it was as Jackson explicitly pointed out also reducible to "currents passing … 'across'" the sensory-motor regions and processes of the nervous system. Reflex was a transmissive link, a literal bridge, generative of both functional integrations and organismic unity, between sensory-motor nerves as well as between the ascending levels of physical and psychical development. But if reflex constituted the micro-topology between nervous levels, then the question arises: how did the coordinative space of reflex affect and alter the materiality of the nervous system? How can we define the materiality of the topology, or the space, separating yet connecting nervous levels? The process of reflex demonstrated the extent to which the materiality of the nervous system was

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[80] Ibid., emphasis in original.
[81] Ibid.
[82] Ibid., 159.
[83] Ibid., 174.
[84] The reference to aesthetics is not inappropriate since Laycock in the same essay discusses the implications the notion of an unconscious natural intelligence has on the reception of art work, human figures, architecture and the general conception of beauty.
[85] Jackson, "On Temporary Mental Disorders," 122.

never strictly material, that the micro-topology of the space between nervous levels constituted a material space that was somehow already extra-material to a degree. In this respect, the micro-topology of the space between levels constituted a resolution to the problem of physical abstraction and psychical emergence, but only by marking out and instantiating a curious and potentially problematic conception of biological matter.

In order to understand better the materiality and, specifically, the extra-materiality of reflex, it will be necessary to turn briefly to another major conceptual deployment of reflex action during the nineteenth century — that is, precisely as "currents passing" along the abstract "across" of the nervous system. Reflex, in other words, was an underlying principle in important theorizations of nervous transmission during the period. In the following section I will examine the role of reflex in the context of two variations of how the nervous system was understood as being transmissive: 1) in terms of the inward reception and formation of sensory perceptions; and 2) as the basis for the outward expression of affective states. In the paradigm of nervous transmission, physical nerves conducted intelligible "messages" that yielded either the internal perceptions of the external world, or the externally legible manifestations of internal emotional states. I will show how the transmissive capacities of the nervous system blurred the distinction between the materiality of nerve conduction, and the intelligibility of the conducted information.

Transmissions of Intelligible Matter: Sensory Perception and Theories of Expression

Signals, Signs, Reflex

Although reflex constituted an independent field of neuroscientific investigation, it was always linked to the physiological study of how nervous messages were carried through the body.[86] The conception that the nerve was a hollow tube, transmitting a material messenger, such as an animal spirit, dominated the physiology of the nervous system until the early nineteenth century.[87] Cartesian neuroanatomy provided a very emblematic example of this conception of nervous transmission, in which the hollow nerves conducted the animal spirits that acted as both a motive force, inducing the muscles to motion, but also as actual messages, insofar as they were projected onto the wall of the pineal gland as "figures" for the soul to receive. Even at the end of the eighteenth century, when the nervous messenger was re-imagined in electrical terms, similar suppositions regarding the structure of the nerves were held. Luigi Galvani demonstrated the point in the *Commentary on the Effects of Electricity on Muscular Motion* from 1791, when he argued that the nerves were "so constituted that they are hollow within, or composed of some material suitable for conveying electric fluid."[88]

It was not until the early nineteenth century that nerves were generally described as solid and static — a development that corresponded to the predominance of the study of nerve

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[86] Clarke and Jacyna describe the history of nervous function across the late-eighteenth and early-nineteenth century in *Nineteenth-Century Origins,* chapter 5.

[87] Edwin Clarke, "The Doctrine of the Hollow Nerve in The Seventeenth and Eighteenth Centuries," in *Medicine, Science, and Culture: Historical Essays in Honor of Owsei Temkin,* ed. Lloyd G. Stevenson and Robert P. Multhauf (Baltimore: Johns Hopkins University Press, 1968), 123-141.

[88] Luigi Galvani , *Commentary on the Effects of Electricity on Muscular Motion*, trans. Robert Montraville Green (Cambridge, MA: Elizabeth Licht, 1953), 64. For a brief account of the decline of the hollow tube doctrine and the rise of the electrical theory of nervous conduction, see C.U.M. Smith, "Brain and Mind in the 'Long' Eighteenth Century," in *Brain, Mind and Medicine: Essays in Eighteenth Century Neuroscience,* ed., Harry Whitaker, C.U.M. Smith and Stanely Finger (New York: Springer, 2007). As historian and neurologist Mary Brazier explains, however, "the nerve impulse is not an electric current flowing down the length of the fiber, in the way that electricity passes down a wire, but is a progression of ionic changes whose electrical signs constitute the action potential." See Brazier, *Electrical Activity of the Nervous System,* fourth edition (London: Pitman Medical, 1977), 14.

electrophysiology. No longer was the nerve tube-like, and no longer could nervous conduction be imagined as the passage of discrete content through the nerves, like blood through the veins. But the question of conduction was never abandoned, even as the process of transmission during the 1840s and 1850s was conceptually and functionally disambiguated from the electrical phenomena that accompanied it. Marshall Hall, for example, in transposing the question of nervous conduction to reflex transmissions, wrote, "There is also a power in the incident and reflex nerves themselves. Without regarding this power as incidental with electricity, it may be considered as analogous to it, and as of a physical character as distinguished from all that is psychical."[89] A decade later in *The Senses and the Intellect* (published first in 1855), Alexander Bain described nervous force and neuro-transmissions generally as "of a *current* nature" such that "a power generated at one part of the structure is conveyed along an intervening substance, and discharged at some other part" — an action that was similar but not equivalent with electrical or magnetic forces.[90] But the actual and technical disambiguation of nervous conduction from electricity arose as a consequence of the work of Hermann von Helmholtz, who discovered that the speed of nervous transmission was far slower and than that of electricity per se, and Emil DuBois-Reymond who demonstrated conclusively that electrical activity did not comprise, but was only a sign of nervous function.[91]

Certainly, the power of the nerves were never entirely divorced from the idea of electricity; the general excitability of the brain and nerves could, for example, be shown to arise as a consequence of electrical stimulation, a demonstration physiologists Gustav Fritsch and Eduard Hitzig experimentally relied on in 1870 in order to confirm the cerebral localizability of certain motor functions.[92] Electrical excitation could artificially animate pathways of nervous conduction that, on their own, were naturally excited in one of two ways, according to the Fritsch and Hitzig: either "from the periphery, by way of reflex, or … from the center by way of volition or of the impulse of the soul."[93] Fritsch and Hitzig in particular espoused an implicit dualism that allowed them to bypass the theoretical problem of conduction itself; the conclusion, indeed the final sentence of their famous 1870 essay "Über die elektrische Erregbarkeit des Grosshirns" argued most definitively for the necessity of isolating "certain circumscript centers of the cortex" as the sites in which psychological functionality can be said "to enter matter or originate from it."[94] Their concern was around the question of whether the cortex displayed punctuate localized motor centers, and the authors did not actually discuss the question of how psychological functions, or general states of mental intelligibility, could possibly "enter" or exit biological matter.

When separated from the neurophysiological investigation of the electrical and chemical activity of the nerve itself, the science of nervous conduction had embedded within it the conceptual problem of how material signals could be generative of meanings or intellectual and

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[89] Marshall Hall, *New Memoir on the Nervous System,* (London: Hippolyte Baillière, 1843), 91.
[90] Alexander Bain, *The Senses and the Intellect,* second edition (London: Longman, 1864), 61-62, emphasis in original.
[91] Laura Otis describes the science of electrical conduction from the late eighteenth and nineteenth centuries, with particular emphasis on the role of Helmholtz and DuBois-Reymond and the metaphorical relation of electrophysiology to telegraphy, in "The Metaphoric Circuit: Organic and Technological Communication in the Nineteenth Century," *Journal of the History of Ideas* 63, no. 1 (January 2002): 105-128. See also Claude Debru, "Helmholtz and the Psychophysiology of Time," *Science in Context* 14, no. 3 (2001): 471-492.
[92] See Young, *Mind, Brain and Adaptation,* chapter 7, "Fritsch and Hitzig and the Localized Electrical Excitability of the Cerebral Hemispheres."
[93] Gustav Fritsch and Eduard Hitzig, "On the Electrical Excitability of the Cerebrum," in *Some Papers on the Cerebral Cortex,* trans. Gerhardt von Bonin (Springfield, IL: Charles C. Thomas, 1960), 77.
[94] Ibid., 96.

psychological states, even in the most incipient sense. This was, in some ways, the motivating question at the heart of psychophysiology itself, and few authors directly took up the question of how a transmission in itself could be meaningful. In *The Senses and the Intellect,* Bain quite explicitly emphasized the significance of the transmissive operations of the nervous system. He wrote,

> Supposing the corpora quadrigemina to be a center for the sense of vision, and impression passing to this center propagates a movement towards many centers … and through these various connections an extensive wave of effects may be produced, ending in a complicated chain of movements all over the framework of the body. Such a system of intercommunication and transmission of power is therefore an essential part of the bodily and mental structure.[95]

Nervous transmission was not, for Bain, incidental, but instead entirely constitutive of both bodily and mental processes and their interrelations: "When the mind is in the exercise of its functions, the physical accompaniment is the passing and re-passing of innumerable streams of nervous influence … it seems as if we might say, no currents, no mind."[96] The significance of the transmissive process meant that the organs of transmission were no more integral than the branches that carried the currents. Bain took this thinking to its logical conclusion by suggesting that the organ of the mind was not simply the brain alone but the brain connected as it was to the nerves, muscles, sensory organs, and the rest of the lower viscera. It was the entire system, as Bain wrote, of intercommunication and transmission that constituted the interconnectedness of body, brain, and mind through the most elementary processes of sensory-motor action.

Although Bain's position was not entirely generalizable, there nevertheless was a broader conceptual purchase in the mid-nineteenth century to the suggestion that nervous transmission, and the sensory-motor processes that such transmissions enabled, was at the heart of the psychophysiological question of the rise of intellectual and psychological states. This broader conception of nervous transmission linked together many related conceptual categories, including sensory-motor reflex as well as mid-century theories of sensory-perception. For example, by the early 1850s the psychophysiology of sense-perception had taken on a specific theoretical inflection through the elaboration of various "sign theories," which were central particularly to describing and linking the physiological and psychological dimensions of vision, and built quite fundamentally on certain conceptions of reflexive sensory-motor co-ordinations.

It was the empiricist sign theory [*Zeichentheorie*] of Hermann von Helmholtz that was most recognized during the period, although the theory was itself developed on the basis of the philosopher and physiologist Hermann Lotze's earlier philosophical-physiological "local sign" theory as well as on the nativist sign theory implicit in the doctrine of specific nerve energies provided by Helmholtz's former teacher, the physiologists Johannes Müller.[97] Helmholtz's sign

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[95] Bain, *The Sense and the Intellect,* 62.
[96] Ibid., 66.
[97] For an account of Helmholtz in relation to Müller and Lotze, see Timothy Lenoir, "The Eye as Mathematician: Clinical Practice, Instrumentation, and Helmholtz's Construction of an Empiricist Theory of Vision," in *Hermann von Helmholtz and the Foundations of Nineteenth-Century Science,* ed. David Cahan (Berkeley: University of California Press, 1993), 109-153. Hatflied describes more broadly the theories of vision and the psychological construction of visual space in Müller, Lotze, and Helmholtz in *Natural and the Normative,* 152-179. The use of concept of the sign in a theory of vision was not limited to Müller, Lotze, and Helmholtz, and Hatfield describes the use of signs in the visual theories of Johann Steinbuch and Caspar Tourtual in *Natural and the Normative,* 131-151. For a briefer account of Helmholtz's sign theory, see Otis, "The Metaphoric Circuit." Ribot offers an entire chapter on Lotze's local sign theory in *German Psychology of Today,* 68-95. See also William R. Woodward, "From

theory was predicated on an empiricist belief that vision was a learned and entirely empirical psychological phenomenon, and that seeing did not comprise an immediate imagistic apprehension of an external reality. Helmholtz first articulated the position in 1853, when he wrote, "the organs of sense do indeed give us information about external effects produced on them, but convey those effects to our consciousness in a totally different form, so that the character of a sensuous perception depends not so much on the properties of the object perceived as on those of the organ by which we receive the information."[98] What we sense, therefore, is not the object, but the particular ways in which our sensory organs have been materially organized in order to apprehend aspects of the world; as Helmholtz made clear, the same ray of sunshine manifests itself to our optic nerve as light, but to the tactile nerves under the skin of our arm as heat.

Sensory-perception was fundamentally mediated in that one did not perceive the world, but instead only perceived the body sensing or simply being affected by the world according to the particularities of its material organization. As Helmholtz wrote in 1878, "Physiological investigations teach that fundamental distinction does not completely depend on the type of external impression by which sensation is stimulated; rather, it is determined completely, solely, and exclusively by the sensory nerve that has been affected by the impression."[99] This was a point Helmholtz drew from Müller and the premise that sensory nerves do not produce a general "sense" but respond instead only according to their particular qualities or proper nervous energies.[100] Helmholtz asserted that in this way, "sensations are for us only symbols of the objects of the external world, and correspond to them only in some such way as written characters or articulate words to the things they denote."[101] The "striking analogy" to that other arbitrary "System of Signs," or conventional language, was meant to be quite robust, since mediated sense-perception — that is, perceiving only the body being affected by the external world — did not innately generate a coherent image of that world.[102] Instead, that image had to be, like conventional signs, learned by virtue of habituated associations and processes of mental induction that would eventually become automatic.[103]

For Helmholtz, the "image" of the world, in terms specifically of visual spatial perception, was ultimately constructed meaningfully from sensory perceptions which, like signs, only indexed the world in an associative as opposed to depictive way:

> Insofar as the quality of our sensations gives us information about the peculiarity of the external influence stimulating it, it can pass for a sign — but not for an image. For one requires from an image some sort of similarity with the object

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Association to Gestalt: The Fate of Hermann Lotze's Theory of Spatial Perception, 1846-1920," *Isis* 69 no. 4 (December 1978): 572-582. And Walther Riese briefly describes Müller's theory of specific nerve energies in "The History of Johannes Müller's Doctrine of the Specific Energies of the Senses: Original and Later Versions," *Bulletin of the History of Medicine* 37 (1963): 179-183.

[98] Hermann von Helmholtz, *Science and Culture: Popular and Philosophical Essays,* ("On Goethe's Scientific Researches") ed. David Cahan (Chicago: University of Chicago Press, 1995), 13.

[99] Helmholtz, *Science and Culture,* 345 ("The Facts in Perception," 1878).

[100] Riese, "Johannes Müller's Doctrine." Lenoir, "The Eye as Mathematician," 115.

[101] Helmholtz, *Science and Culture,* 14.

[102] Helmholtz, *Science and Culture,* 201 ("The Recent Progress of the Theory of Vision," 1868).

[103] As Helmholtz writes in his 1857 essay, "On the Physiological Causes of Harmony in Music," "The sensations of our nerves of sense are mere symbols indicating certain external objects, and it is usually only after considerable practice that we acquire the power of drawing correct conclusions from our sensations respecting the corresponding objects." *Science and Culture,* 66. Helmholtz also elaborates more on the analogy between learned sensory perception and language, linked around the concept of the sign, in "The Facts of Perception," *Science and Culture,* 354-55.

imagined…. A sign, however, need not have any type of similarity with what it is a sign for.[104]

The image of the world, then, was constructed psychologically through repetitive trials of associating visual sign-sensations to objects and object relations; but these trials also involved physical activity on the part of the subject in the form of ocular movements which further oriented the subject to the world. The construction of a spatial image of the world arose, therefore, on the basis of a bodily calculation emerging from the combination of a sensation and an ocular movement.[105]

This final significant point was indebted to Hermann Lotze's formative theory of local signs [*Localzeichen*], a philosophically inflected account of the psychophysiological production of spatial perception. The local sign, present in Lotze's writings from as early as 1846 to as late as 1879, was a way of mediating the metaphysical problem of how an immaterial and thus non-spatial soul could acquire material representations of the world, in a spatially extended sense.[106] For Lotze, sensation alone did not simply "give" the idea of space, and neither could that idea be immediately detected from the spatial arrangements that were physiologically afforded to the processes of vision — such as the dimensional display of images geometrically on the retina, or even the anatomical relations of proximity and position between the nerves. As a result, a distinctly non-spatial account of spatial perception was generated, one that argued for the "veritable reconstruction" of the idea of space,[107] and which entirely bypassed the question of the spatial extensiveness of the physical stimulation.[108]

The local sign, articulated most thoroughly by virtue of the *visual* perception of space, effectively referred to a sensory-motor coordination and a respective feeling which would immediately correspond to that coordination. As Lotze explains, "a bright light falls upon a lateral part of the retina…. [T]hen there follows a rotation of the eye until the most sensitive middle part of the retina … is brought beneath this light."[109] A sensory stimulation was always immediately followed by an ocular movement, which, as Lotze writes, "happens involuntarily, without any original cognition of its purpose…. We may therefore reckon it among the so-called reflex motions, which originate by means of an excitation."[110] The reflexive role of the immediate ocular movement towards the source of stimulation was vital to Lotze's theory; it was this reflex phenomenon that actually resolved the difficulty Lotze was having in deriving a non-spatial origin of spatial perception.[111] Reflex was the material key to the production of the conditions of spatial knowledge; as Lotze writes,

> This rotational movement [of the eye] takes place involuntarily, without consciousness of purpose and above all without consciousness of the muscular actions that must be combined in order to attain that purpose; we therefore have

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[104] Ibid., 347 ("The Facts of Perception").
[105] Lenoir, "The Eye as Mathematician," 122-123, 126-148. Hatfield, *The Natural and the Normative,* 174-176, 204-205.
[106] For the dates of publication of the theory of the local sign, see Woodward, "The Fate of Herman Lotze's Theory," 572, n. 2.
[107] Hermann Lotze , « De la formation de la notion d'espace » *Revue philosophique de la France et de l'étranger* 4 (1877) : 346.
[108] Hatfield, *The Natural and the Normative,* 159-160; Ribot, *German Psychology Today,* 75-89. Woodward, "The Fate of Herman Lotze's Theory," 573-576.
[109] Hermann Lotze, *Outlines of Psychology,* trans. Greorge T. Ladd (Boston: Ginn, 1886), 54.
[110] Ibid.
[111] Woodward, "The Fate of Herman Lotze's Theory," 575.

> grounds to regard this rotation as a reflex movement, generated without the soul's knowledge as a result of the irritation of sensible fibers in the retina and *transmitted* to the motor nerves of eye ball.[112]

The turning movement of the eye produced a linear vector arc across the eye itself, from the lateral point of stimulation before the eye turns (say on the upper right corner of the eye) to the center of the retina once the eye has completed its movement. This arc generated in the soul "a series of constantly changing feelings of position,"[113] or a set of feelings each corresponding to the slight difference in the momentary positions of the eye across the movement, and comparable, as Lotze explains, to "a feeling of the same kind as that by which we are, when in the dark, informed of the position of our limbs."[114]

These sequential feelings of the change of position of the eye were now associatively linked to that physical point of stimulation on the lateral part of the retina. Were that point to be stimulated in the future, not only would the eye once again reflexively move along the arc, but that series of constantly changing feelings of position would be immediately called to mind. That series of feelings would in the future, through its association, be occasioned by the stimulus, but it would nevertheless be independent of it.[115] This series of changing feelings of position in the soul constituted a local sign — in other words, a non-extensive (indeed, an *intensive*) mental sign or marker that localized an externally *extended* position and spatial relation. The local sign did not simply localize the arc, but rather the initial point of stimulation on the lateral part of the retina which first set the eye in motion. Ultimately, every point on the retina had associated to it a local sign, through the aggregation of which a mental picture of *extension* could be constructed by virtue of *intensive* feelings of changes in position within the soul.

For Lotze, while local signs could only be constructed through an empirical engagement with the world (namely the eye's motor response to stimuli), the actual ability to produce local signs was a capacity originally afforded to the physiology of vision[116] — and namely to the fact that sensory stimulation was always immediately coordinated with ocular movement, according to what Lotze above called the reflex *transmission* linking the sensory fibers to the movement of the eye. What is integral is that while the reflexive transmission of the eye did not simply produce the idea of space, the transmission did ultimately yield a localization which was nevertheless *ideational.* As Lotze writes, it was an activity of the imagination:

> What takes place in the nerves can only function in the service of *rotation*, that is to say, a phenomenon of the physical world; the psychical affections, that emerge from the nerves, only merit being called local signs, because they can only generate a *localization*, which is an act of the imagination, having no relation of resemblance to any sort of motion and not in any way measurable according to the notions of bodily mechanics.[117]

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[112] Lotze, "De la formation," 357, emphasis added.
[113] Lotze, *Outlines,* 56.
[114] Ibid.
[115] Ibid. Lenoir, "The Eye as Mathematician," 122; Hatfield, *The Natural and the Normative,* 160.
[116] "We attribute the early maturity [of an organism] to its ability to localize, and this may amount to the guarantee [*sûreté*] of a mechanism of reflex action, which forces the organism to promptly make its way towards objects situated in the direction of its axis of vision" (Lotze, "De la formation," 361).
[117] Lotze, "De la formation," 359, emphasis in original.

The physical reflex transmission, therefore, produced an imagined localization which was fundamentally different from, and in excess of any kind of mechanical physicality. The transmission that united the stimulation of the retina with the eye's rotation was equivalent not to the concrete idea of space, but to an ideational localization and the mental feeling of positional difference, a preliminary mental representation of a simple change in position so conceptually elementary and indeterminate that it amounted only to the feeling of one's position and relative motion in the dark. The transmission itself already crossed the body-soul barrier, thereby generating a kind of low-level meaning.

What was embedded in Lotze's local sign theory of spatial perception was that meaning arose or was already implicit in the very act of reflex transmission. The transmission was already equivalent to a material abstraction from nervous matter. In other words, it *materially* embedded the conceptual leap from a material to extra-material state. The biological structure and its psychical function had become fused, and the very *transmission*, to follow the etymology, was in itself a conveyance or passage across and beyond the physical threshold. Reflex was not simply a transmissive carrier of meaning but was, according to nothing more than its own physiology, already meaningful in the most minimal sense. In this sense, nervous conduction and the conducted message were no longer entirely distinguishable, and from the standpoint of nervous transmission, the underlying reflexive operations constituted a physical materiality that was more than material. This would certainly be the reason why reflex could constitute the very space of physical abstraction and psychical emergence; why it could, in other words, comprise the micro-topology that connected the most fundamental levels of the vertical paradigm of the nervous system — namely, the levels separating the physical and psychical dimensions of the organism. Reflex constituted a transmissive and coordinative physiological space in which neurobiological matter was something more than material.

An even more illustrative example of this point appears in another account of the role of reflex in nervous transmission. Several central theories of emotional expressivity throughout the nineteenth century relied upon a conception of the reflexively transmissive capacity of nervous system in order to describe how internal affective states could be registered externally as facial and bodily comportments. Such theories often defined externally manifest emotions and affective states as the immediate expressivity of the nervous system itself. In these cases, the reflexive transmission of the nervous system was not simply a physiological conduction, but also a communicative expression; and the materiality of nervous transmission embodied from the start the possibility of extra-material properties.

The Transmissive Expressivity of the Nervous System

The nineteenth century saw very direct accounts of the capacity of the nerves to generate a communicability that was transmitted or expressed directly and immediately, as a kind of primordial or proto-intelligibility. One such early formulation is given by Gall in his *Functions of the Brain,* and it was characterized as the natural and automatic expressivity of the nervous system. The anatomist was at pains to distinguish organology from what he characterized as a more vulgar physiognomy which was "not at all guided by the knowledge of anatomy and of physiology; the laws of the organization of the nervous system in general, and of the brain in particular, are unknown to [physiologists],"[118] Johann Lavater being Gall's primary example. Gall's organological project did not involve the vague hermeneutics of facial expressivity as a manifestation of a person's essential character. Organology assumed that the brain and nervous

[118] Gall, *Functions of the Brain,* vol. 5, 262.

system, constituted as a systematically interrelated aggregation of sub-organs, did not simply situate a collection of psychological faculties, but also displayed an immediate expressivity throughout the entire body. Gall argued that over and against physiognomy, organology afforded a *pathognomic* study of a person, or the ability of "judging a person by his gestures, by the whole habit of his body."[119] The nervous system displayed a fundamental and absolutely direct natural language or intelligibility — what Gall likened to pantomime [*la mimique*], or "the universal language of all nations and of all animals…. [Pantomime] accompanies language and strengthens its expressions; it supplies the defects of articulate language."[120]

Each sub-organ of the brain and nervous system, according to Gall, expresseed itself in the form of a pantomimic exterior manifestation — anything from a pattern of gestures and bodily contortions, to the general gait or posture of a particular person or animal.[121] This manifestation, however, was entirely communicable, and therefore constituteed "the natural language of organs; it is expression [*la mimique*], it is the language of gestures or of action, the pathognomic language."[122] In fact, Gall emphasized the general isomorphic relation between the general position of the sub-organ and the nature of its external expressivity, such that sub-organs situated in the inferior regions of the brain manifest themselves in/as the general shortening of the body, whereas the sub-organs in the superior regions would tend to elevate the body. Gall's account of the natural language of the brain and the nervous system was not simply an argument for the primacy of the natural language of direct physical action, as the historical and philosophical precursor to the invention of conventional, and therefore arbitrary and articulate language; it was not, in other words, a mere extension of the theories of the natural sign in the work of Etienne Bonnot de Condillac or Jean-Jacques Rousseau. The natural language of the nervous system was still imagined as a process of nervous transmission, a transport of meaning but in the sense of an *imprinting* from within, which would nevertheless be meaningful once manifest on the exteriority of the body:

> So far as the action of the internal organs marks durable traces [*empreintes durable*] on the exterior of man, it is right for us to draw from these marks, which are the results of this continually repeated action, inductions relative to the habitual occupations and the fundamental character of a person.[123]

The transmission of durable *impressions* from within as a kind of natural, but still legible, expression, resembled an early variation on a sign theory of nervous transmission with two important differences: Gall's natural-linguistic impressions had nothing to do with sensory perception and these durable impressions emerge from within as natural (not arbitrary) manifestations. These impressions or manifest signs concerned the natural legibility of the body and nerves, and had little to do with how the body and nerves determined the legibility of the exterior world. Still, it is possible to say that a very general conception of the sign, symbol or legible mark characterized very generally the nature of nervous transmission, and linked nervous matter to the conditions of a primordial intelligibility throughout the nineteenth century, even though the "direction" of that transmission fluctuated.

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[119] Ibid., 266.
[120] Ibid.
[121] "Each organ, however feeble its action, manifests itself externally and instinctively by certain movements of the muscles, by certain gestures, by certain exclamations or involuntary cries, by certain attitudes" (Ibid., 295).
[122] Ibid., 295. *Sur la fonction du cerveau* (Paris: J.-B. Baillière, 1825), 482-83.
[123] Ibid., 294 (English), 481 (French).

Not only did Gall's theory of the natural language of the nervous system need to be differentiated from eighteenth-century conceptions of the natural sign and the physiognomic doctrines prevalent at the end of the eighteenth and early nineteenth centuries (including the more notable "phrenologies" carried on by many of Gall's disciples), but it needed also to be differentiated from some of the anatomically grounded theories of emotional expressivity emerging in the nineteenth century, which were linked to the long-standing philosophical tradition of classifying the passions. A primary example is anatomist Charles Bell's *The Anatomy and Philosophy of Expression,* first published in 1806. For Bell, expression was little more than a material correlate of emotion:

> Are we not authorized to say, that expression is to passion what language is to thought: that as without words to represent ideas, the reasoning faculties of man could not be fully exercised, so there could be no violence or excess of passion merely in the mind, and independent of the action of the body? As our thoughts are embodied and the reasoning powers developed by the instrument of speech, the passions or emotions have also a corresponding organ to give them a determined character and force. The bodily frame, though secondary and inferior, comes in aid of the mind.[124]

The bodily frame, Bell asserted, not only acted as the incarnated vessel of the mind, but it was specifically the site where certain mental — that is, emotional — excesses were staged. For Gall, on the other hand, nervous matter displayed an incipient communicability and intelligibility, the transmission of which was another way of naming *the very expressivity of nervous matter* as the total-body physicality of the particular person or animal. In other words, Gall asserted that the nervous systems' pre-intellectual intelligibility was identical to the very transmission as and onto the exteriority of the bodily frame. Nervous transmission and nervous expressivity must be thought of as equivalent in this sense.

Furthermore, the natural language of the body for Gall was not only the outwardly transmitted expressivity of nervous matter, but it was also the *automaticity* of that transmission.

> It is in consequence of these laws, that, when, in man or in an animal, a fundamental force is strongly in action, the senses, the limbs, and the head execute certain determinate movements, without the animal or the man having any deliberate consciousness of them. These movements are, therefore, a purely automatic language, and for that reason generally intelligible.[125]

The automaticity of the expression of the brain and nerves meant that the natural language of nervous matter was not tied to consciousness and deliberation. This natural expressivity was intelligible without being intelligent, so to speak — communicable and legible without being mental or strictly psychological. The automaticity of nervous expression was an early reference to the reflex operations of the nerves, during a period that preceded the institutionalization of reflex as an isolated concept. Nevertheless, for Gall, it was this reflexive automaticity that was equivalent to the immediacy of the transmission and expression of the brain's natural language, and so also to the intelligibility of that expression. We might say that the reflexive transmission of the nerves was the expressivity of the nervous system itself. The natural language was not

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[124] Charles Bell, *The Anatomy and Philosophy of Expression, as Connected with the Fine Arts,* Fifth Edition (London: Henry C. Bohn, 1865), 198.

[125] Gall, *Functions of the Brain,* 271, (*Sur la function,* 444).

carried *through* the nervous system like a message through a conduit. Instead as Gall proposed, the nervous system was always in the process of expressing, transmitting and impressing itself onto and as the exteriority of the bodily frame automatically and immediately. The nervous system did not therefore carry a natural language; it *was in its very materiality already that language.*

It was not for another few decades that the convergence of reflex and expressivity received any explicit elaboration. A notable example of such an elaboration can be found the work of Ivan Sechenov, the Russian neurologist and predecessor to Ivan Pavlov. Sechenov, who received his training in Europe primarily under Emil DuBois-Reymond but also under Helmholtz and even Claude Bernard, published an essay in 1863 titled "Reflexes of the Brain." In it, Sechenov argued for the primacy of reflex in all aspects of human action, from the involuntary and voluntary aspects of human physical sensitivity and movement to even the most complex emotional and intellectual properties according to which the human was defined.[126] What is notable about the essay is that at its outset, Sechenov defined all human activity according to the externally identifiable and behaviorally classifiable mechanism of reflexive-muscular movement. He writes,

> The infinite diversity of external manifestations of cerebral activity can be reduced ultimately to a single phenomenon: muscular movement…. [A]ll the properties of the external manifestations of brain activity described as animation, passion, mockery, sorrow, joy, etc., are merely results of a greater or lesser contraction of definite groups of muscles, which, as everyone knows, is a purely mechanical act.[127]

Ultimately, even intellectual states as well as the inhibitions of reflexive pathways were nevertheless defined in this same reflexive-mechanical fashion, and the external or muscular expressivity of even the most highly developed activities were ultimately reflexive transmissions of some sort.[128] Indeed, the brain for Sechenov was little more than a mechanism that "if brought into action by a certain cause, ultimately produces a series of external phenomena which are expressions of psychical activity."[129] Reflex, therefore, constituted a transmission that did not simply carry meaning, but which constituted meaning in its very transmission. Reflex — in the sense of a sensory-motor coordination — not only constituted the basic operations of the nervous system, but it was what comprised the external expressivity of the subject.

Less than a decade later Charles Darwin published *The Expression of the Emotions in Man and Animals* (1872), in which expression was defined as a physiological manifestation or externalization of a mental or emotional condition.[130] Darwin explained that most animal and human expressivity arose from the habituation of voluntary actions in response to certain mental

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126 Sechenov defines reflex as "merely a combination of a primary sensory nerve fiber and a primary motor nerve fiber connected by two nerve cells." Ivan Sechenov, *Reflexes of the Brain,* trans. S. Belksy (Cambridge, MA: MIT Press, 1965), 26.
127 Ibid., 3-4.
128 Ibid., 84-86. Sechenov develops the concept of the reflexive inhibition of other reflexes.
129 Ibid., 3.
130 Charles Darwin, *The Expression of the Emotions in Man and Animals* (Chicago: University of Chicago Press, 1965). For a useful examination of Darwin's *Expression,* See Sarah Winter, "Darwin's Saussure: Biosemiotics and Race in *Expression,*" *Representations* 107 (Summer 2009): 128-161. My account of nervous expressivity corresponds to Winter's in that we both read nervous expression as neither a natural sign nor as a conventional, that is, linguistic sign; nevertheless, my reading differs from Winter's, insofar as she emphasizes that the nervous expression is still ultimately semiotic. See in particular Winter, "Darwin's Saussure," 143-146.

states, emotions or even situations; or it emerged as the inversion of those habituated actions in response to the antithesis of an otherwise recognized thought, emotion or situation. What underlay expressivity, however, was physiological reflex, or "the excitement of a peripheral nerve, which transmits its influence to certain nerve-cells, and these in turn excite certain muscles or glands into action." And as Darwin stressed, "many reflex actions are highly expressive."[131]

Darwin also specified that animals and humans enact a separate sort of bodily action, one recognized as expressive, but which was nothing more than the "direct result of the constitution of the nervous system."[132] Darwin was elaborating the production of an entirely biologically expressivity — one not mediated, or at least not entirely mediated by habit or association. Darwin conceded that this subject of direct nervous expression was "very obscure," and both "rare and abnormal," since he could ultimately afford only three examples of what such a direct action would consist: 1) the loss of color in the hair in response to terror or grief; 2) the trembling of muscles, often in response to fear; and 3) the secretions of certain glands and the alimentary canal (in other words, salivation and the secretion of bile). All other examples of direct nervous expression Darwin presented in combination with habituated actions.[133]

However, Darwin explained that all cases of direct nervous expression began with the excessive buildup of nervous "force" that needed necessarily to be discharged from the nerve cell — a point Darwin derived from Spencer.[134] That excessive nervous force was then "transmitted in certain directions, dependent on the connection of the nerve cells,"[135] and could ultimately, like a chain reaction, come to affect and irritate the whole nervous system. These transmissions were expressible externally according to the three examples above or else the transmissions would follow more habituated nervous pathways in order to be externally expressed. For Darwin, the most habituated and familiar pathways for advanced animals related to facial movement and respiration: "Consequently the facial and respiratory muscles, which are the most used, will be apt to be first brought into action."[136]

What we see most directly in Darwin's *Expressions,* but also in Sechenov and Gall, was that reflex transmission was itself a kind of intelligible expressivity, a movement between sensory-motor centers and bodily coordination to be sure, but also a movement *from* the biological to the psychical. The most integral point was that reflex did not simply bridge the physical and psychical dimensions of the organism — it was the term that ascribed an intelligible property to the very materiality and physical activity of the nervous system. This is not to suggest that the nervous system produced a natural meaning or language, but, more importantly, that the nervous system itself, through the designation of reflex, staged something more akin to the indistinction between biological and psychological categories. Reflex was, according to its transmissive capacities, not only biological space, but the spacing that separated, united, and even rendered indistinct material and intelligible attributes. In this sense, reflex constituted the micro-topology wherein neurobiological matter could be more than material, the space where physical abstractions and psychical emergences could be directly staged.

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131 Darwin, *Expression,* 35.
132 Ibid., 66.
133 Darwin also explains that the direct actions of the nervous system could have arisen as inherited instincts. See Winter, "Darwin's Saussure."
134 Ibid., 71.
135 Ibid., 66.
136 Ibid., 71.

Conclusion: The Spacing of Neurological Matter

The vertical nervous system was a hierarchically organized continuity of physical functions and psychical states, and it was ultimately hinged on reflex in the most general sense. As the coordinative and transmissive interrelation of the nervous system, reflex corresponded to a micro-topology that could link together one nervous level to another because it could *materially* resolve the problem of uniting the physical and psychical dimensions of the organism. However, the resolution was predicated on the fact that the materiality of reflex processes from the outset comprised a topology that encapsulated extra-material properties — as a spacing between and across the physical-psychical threshold. The nervous system, it turns out, was more than just organized matter: neurological (reflexive) transmission was already an expressivity, and sensory-motor (reflexive) coordination constituted an incipient physical abstraction. The interstitial micro-topology of reflex was, therefore, also a problem — but a containable one. The vertical paradigm of the hierarchical nervous system and the very possibility of the brain's varied localizable capacities throughout the nineteenth century were hinged on the work being performed within the micro-topology separating and linking the lowest and most primordial physical-psychical levels of the nervous system. Nervous materiality at these interred levels was not a simple arrangement of anatomical structures and physiological processes, not a set of isolatable anatomical spaces and physiological motions, but was more dynamically a series of spacings — that is, separations and traversals — first across the distance of the neural body in the sense of sensory-motor coordinations and transmissions, and second across the psycho-physical threshold itself. Since these material spacings could be staged at the lower, reflex levels, the potential and consequential aporias of neurological matter could be sequestered, so to speak, and isolated away from the brain. The brain could as a consequence be simply the beneficiary — instead of the source — of the emergence of psychical properties from material processes.

In previous chapters, I argued that some neuro-cerebral topologies have yielded subtlety aporetic conceptualizations of the very materiality of the brain. I would not argue that the neuro-material spacings encompassed by the micro-topology of reflex were any less paradoxical. The difference lies in the fact that the nineteenth-century conception of a concretely functioning brain which localized, either discretely or holistically, the mental and affective dimensions of subjectivity appears to have depended on those aporias. Although nineteenth-century neuroscience was marked quite prominently by theories and debates around localization, and while there was a general consensus that the highest mental, affective, and voluntary processes depended on the cerebral hemispheres, it was not the brain itself which staged the emergence of these psychical or intelligent capacities. The brain relied on the "resolution" of such emergences at lower levels of the vertical paradigm of the nervous system.

Indeed the success of the topographic conceptualization of brain, and the stability of vertical topological conception of nervous system and the organism depended entirely on a micro-topological "resolution" to the problem of physical abstraction and psychical emergence which was, as I have argued, not a resolution in any tangible sense. The micro-topology of the spaces between levels, or the spacings of the reflex action circumscribed a materiality that was always more than material, and thereby instantiated a new aporia: the necessary spacing of neuro-cerebral matter. But it was an aporia capable of being situated within the empirical constraints of nineteenth-century neuroscience, precisely because it could be isolated in the lowest crypts of the neurological body, rather than in the more controversial presence room of the brain.

Admittedly, the topological complexity of reflex was more than just a hidden conceptual excess. In some cases by the end of the century it was entirely acceptable for reflex to be the concept and process that materially configured the organismic conception of animal life in the end of the nineteenth century. John Dewey's 1896 "The Reflex Arc Concept in Psychology" was an attempt to transform a restricted and linear conception of reflex as a stimulus-response mechanism into the terms of his functional psychology. Reflex for Dewey should ultimately refer to a more complex "circle of coordination" of which the organism was not only always a part, but in which the organism was so deeply embedded that coordination already determined in advance to what sort of stimuli the organism could even possible respond in the first place.[137] As Dewey writes,

> What we have is a circuit, not an arc or broken segment of a circle. This circuit is more truly termed organic than reflex, because the motor response determines the stimulus, just as truly as sensory stimulus determines movement.[138]

A decade later, in his 1906 *The Integrative Action of the Nervous System,* the English neurologist Charles Sherrington not only identified reflex as one of the operative processes of all life — "the effect of any reflex is to enable to the organism in some particular respect to better dominate the environment"[139] — including the unicellular organism; but he also defined the physical organism "like the world surrounding it" in the abstract as "a field of ceaseless change."[140] Indeed the very rise of organismic theories of life, and the related holistic doctrines in neurology, could be understood as emerging conceptually from the fact that underlying topological complexities of the brain and nervous system forced aporetic formulations of neuro-cerebral and even organic matter that neuroscience eventually learned to accept as it were.[141]

The verticalized paradigm of the nervous system was a major spatial schematization throughout the nineteenth century, though it has been downplayed by the historical and conceptual focus on localization. But this spatial paradigm hid a far more troubling micro-topological problem, unrelated to the emerging discourses of the topographic functions of the brain. Indeed, it was within the space (or spacings) of these micro-topologies that the curious "resolutions" to the relationship between physical and psychical states were truly negotiated, a relationship that the doctrines of localization were only managing and plotting. Reflex was the key to the vertical architecture since it named the fact that nervous matter was more than just a physical thing, but that neurophysiology had incorporated extra-material attributes from the outset. In this sense, the vertical neurological body had by the mid-nineteenth century enveloped extra-materiality attributes into the very dimensionality of nervous matter. Nineteenth-century neuroscience, therefore, can be characterized according to two simultaneous trajectories: 1) the reification of cerebral space in the form of localization discourses that came to achieve centrality and popularity, particularly by the mid-twentieth century when theories of cognitive information processing were confirmed in the localizational experiments of the visual cortex; but also 2) the incorporation of a radical spatiality, or spacing into the material dimensions of the nervous system and brain.

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[137] John Dewey, "The Reflex Arc Concept in Psychology," *The Psychological Review* 3, no. 4 (July 1896): 357-370.
[138] Ibid., 363.
[139] Sir Charles Sherrington, *The Integrative Action of the Nervous System,* 7th edition (New Haven: Yale University Press, 1947), 237.
[140] Ibid., 316.
[141] For writings on the history of holistic neurology, see Harrington "A Feeling for the 'Whole'" as well as *Reenchanted Science: Holism in German Culture From Wilhelm II to Hitler* (Princeton: Princeton University Press, 1996). Examples of holistic neurology and biology include Kurt Goldstein, *The Organism: A Holistic Approach to Biology Derived from Pathological Data in Man* (New York: Zone, 2000) and Jacob von Uexküll, *Theoretical Biology,* trans. D.L. Mackinnon (London: Kegan Paul, 1926).

Epilogue

DISLOCATIONS AND THE ONTOLOGY OF THE BRAIN

Topology and Neurological Matter

The development of the brain as a modern object and concept of physiology, psychology, philosophy corresponded to an underlying transformation in the ontology of neurobiological matter by the end of the nineteenth century. I have attempted to define the terms of that transformation, which I argued must be understood only by considering the brain and nervous system in the most abstract topological terms. The histories of cerebral topology I have presented tell the story of the neuro-material embodiments of topological conceptions of physical space, embodiments which themselves blurred the boundaries of the materiality of the brain, but which produced new theoretical frameworks of the brain and nervous system.

In Descartes' early modern philosophical physiology, the topology or material *spacing* of the brain was anomalous in relation to a Cartesian theory of matter, but not entirely antithetical to Descartes' larger systematic concerns. By the mid-eighteenth century, the cerebral topology of organizational unity translated into the brain's material protraction, which, while something of a theoretical aporia, nevertheless instantiated new conceptual developments in relation to the brain's decentralization as a proliferation of centralities throughout, and as, the nervous body. But by the mid-to-late nineteenth century, the materiality of the nervous system was in part defined according to the interstitial micro-topologies holding together the conceptual architecture of a neuronal hierarchy. Nervous matter in the conceptual space between the abstract organizational levels of the nervous system fully embodied non-material traits, as physical abstractions that were at once psychical emergences. Yet because these micro-topologies were located outside of cerebral space properly understood, the brain was free to be the beneficiary and orchestrator of organization complexities and emergences that were originally transpiring "prior" to the brain.

In this sense, the brain's material instabilities translated into new developments of neuroscientific concepts and frameworks. In other words, the science of the brain came to depend on, or implicitly assume, a problematic conception of materiality — problematic because neurological matter was not entirely material. But the transformation that arose as a consequence of neurobiological physicality taking on more topological characteristics had productive empirical consequences, bypassing older problems, even as it instantiated radically new ones. This transformation underlay in part the theoretical viability of a concept such as the emergence of psychical properties from physical processes. But this transformation was also connected to the strange ontology of the holistically defined organism that was being theorized by the end of the nineteenth and start of the twentieth century.

For example, in his 1908 *The Science and Philosophy of the Organism,* the German biologist, Hans Driesch argued for an original potentiality immanent within all organisms that determined their development and continued vitality.[1] Driesch wrote that "[t]here is something in the organism's behavior … which shows that the living organism is more than a sum or an aggregate of its parts" and that "this something we call an entelechy."[2] The concept of entelechy,

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[1] Brian McLaughlin, "Vitalism and Emergence," in *The Cambridge History of Philosophy, 1870-1945,* ed. Thomas Baldwin (Cambridge: Cambridge University Press, 2003), 631-633.

[2] Hans Driesch, *The Science and Philosophy of the Organism,* Vol. 2, Aberdeen University Studies No. 37 (Aberdeen: Printed for the University, 1908), 338.

borrowed from Aristotle, was what underlay the origin of any organic body, which was itself a "combination of singularities" describable in physical and chemical terms.[3] Although the entelechy was what built up the organic body, as "the faculty of achieving a 'forma essentialis'" where "being and becoming are united here in a most remarkable manner,"[4] the entelechy was itself defined according to its non-spatiality in relation to the organism. As Driesch writes, the "entelechy is affected by and acts upon spatial causality as if it came out of an ultra-spatial dimension; *it does not act in space, it acts into space;* it is not in space, it only has points of manifestation in space."[5] The organism was for Driesch an ontologically rich physical and metaphysical entity, insofar as the organic body was comprised of a complex topological arrangement of physical-spatial and non- or "ultra-spatial" components. The developments in the philosophy and ontology of life, including new organismic philosophies, vitalistic and holistic theories biology, and conceptions of psychical emergence can be seen as related to the topological materiality of the brain articulated by the end of the nineteenth century.

Cerebral Prostheses and New Neuro-Ethical Dimensions

Throughout the previous chapters, I have argued that in one way or another, the brain has been, in itself, external to itself. In other words, the brain has always ontologically exceeded the space defined according to the material-physical limits of its dimensionality, and has instead embodied a variety of complex topologically defined spaces. The episodes that I have examined within the history of the science of the brain have demonstrated that the brain's various and complex spatial formations came to be more and more commensurate with conceptions of neurological matter. By ultimately embodying radical topological formulations, even in the subtlest ways, neurological materiality eventually came to index the abstract spatial complexity of the brain and nervous system. This development can be seen as much to be the resolution of some long-standing philosophical and scientific quandaries concerning the relation of mind and body, as much as it is the production of an entirely new set of questions about the ontological status of the brain.

Given the extent to which the human subject has been identified psycho-biologically, philosophically and even socially as thoroughly cerebral, an ontological reconsideration of the brain will have considerable consequences on how a neural subject can possibly be imagined. In order to begin the project of re-imagining the neural subject, I return to the paradigm of neuroprosthesis with which I initially began, and to the formulation which first introduced the idea of the brain as a formal problem of space: I am situated in and by my brain by which I inhabit other spaces. It is possible through this formulation of the relationship between the subject and the brain to imagine the subject as cerebrally substantiated, without being forced to concede that the subject is entirely circumscribed by the brain. The ramifications of such a proposal are broad, but one implication with which I choose to end concerns the recent field of neuroethics.

The discourse of neuroethics that has recently linked neuroscientific research directly to questions of ethics, morality, and the law is itself divided into two general methodological approaches. The first examines the bioethics of neuroscientific practice while the second investigates the extent to which the brain can naturalize a biological ethics or morality. It is the second approach towards the cerebral naturalization of ethics or morality which concerns us here. Advocates of this position, such as Patricia Smith Churchland, suggest that the question of morality must be entirely recalibrated in order to be recognized as a natural knowledge, so to

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[3] Ibid., 137.
[4] Ibid., 149.
[5] Ibid., 235, emphasis in original.

speak. Morality must, in other words, be understood as a product of "how [brains] are configured," as well as how they are changed and influenced.[6] Churchland asserts a claim that has become something of an assumption in neuroethical research, and which has itself been an underlying premise since the physiologically grounded psycho-pathologies of the early nineteenth century, in their relation to sociological, ethnological, and criminological discourses: "[M]oral standards, practices, and policies reside in our neurobiology."[7] The brain, Churchland suggests, makes room for a moral order, gives space to normatively defined structures of right and wrong, and may indeed be the first basis by which a universal ethics might be produced.[8] And it does this, as the current popularization of the mirror neuron suggests, in a purely assimilatory and docile way, able to do little more than *verify* operative juridical, moral, and political categories.[9]

But this conception of neuroethics is not the only essential way of thinking the ethical dimensionality of the brain. By describing the brain as ontologically in excess of its own physicality — an excess that can only be topologically expressed — the brain is in itself paradigmatically neuroprosthetic, predicated in other words on its own externalization. And it is precisely in this sense that the brain is and has been the condition of the subject's dis/location. If the brain is both the where and the whence of the subject, then it is the brain that says "I" so long as it also says otherwise — that is, only if it also speaks or stages the alterity of the subject as well. The ethical future of the brain is not defined by the natural space provided to the order of normative moral values in accordance to their juridical applicability, but by a different kind of space, defined by the topological complexities whereby the brain encapsulates the relationship between the subject or self and its own alterity, the space within and through which the subject's transformation to and from itself is staged.

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[6] Patricia Smith Churchland, "Moral Decision-Making and the Brain," in *Neuroethics: Defining the Issues in Theory, Practice, and Policy,* ed. Judith Illes (Oxford: Oxford University Press, 2006), 3.
[7] Ibid.
[8] This is Michael S. Gazzaniga's point in *The Ethical Brain: The Science of Our Moral Dilemmas* (New York: Harper Perennial, 2005). He writes, "The new brain imaging results are highly suggestive that our brains are responding to the great underling moral dilemmas" (171).
[9] Giocomo Rizzolatti and Corrado Sinigaglia, *Mirrors in the Brain: How Our Minds Share Actions and Emotions,* trans. Frances Anderson (Oxford: Oxford University Press, 2008). Stephen J. Morse describes how the neurosciences remain powerless to challenge key legal concepts, like that of personhood. "Moral and Legal Responsibility and the New Neurosciences," in *Neuroethics,* ibid., 33-50.

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