Towards an Interdisciplinary Theory of Embodied Cognition

by

Terence McKall
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Supervisory Committee

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Dr. Arthur Kroker, (Department of Political Science)
Supervisor

Dr. Stephen A. Ross (Department of English)
Co-Supervisor

Dr. Daniel Bub (Department of Psychology)
Departmental Member

Abstract

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In this thesis, the author explores the connections between developments in the fields of neuroscience and neuropsychology and the theoretical study of embodiment in political and literary theory. Through examination of the development of neuroscience and its interactions with theoretical approaches to embodiment, the author argues that the current approach to interdisciplinary work in the area is limited by entrenched disciplinary boundaries. Examining how these disciplinary boundaries limit the scope of the study of cognition and embodiment presents the necessity of a new approach. Based in the work of Elizabeth A. Wilson and David Wills, the author presents a new approach, the embodied cognitive approach, as an alternative interdisciplinary approach.

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Chapter 1 – An Interdisciplinary History

Late twentieth century innovations in imaging technologies advanced our ability to study the brain. Rapid expansion and legitimacy of neuroscientific research met increased popular media attention. Political and literary theory have been less involved. Despite the limited interest of those fields traditionally concerned with proposing theories of subjectivity, a model of subjectivity based on empirical research in the neurosciences has emerged of its own accord. While this neuro-subject is rarely stated explicitly it is so accepted as to be assumed in the majority of neuroscientific and neuropsychological work being done today. Emerging from the cybernetic period of the mid-1940's and the explosion of artificial intelligence from the 1950's onward this subject reflects a computational understanding of thinking and a materialist understanding of cognition. This new model of subjectivity has met suspicion and opposition from the humanities.

Despite this history of opposition, I argue that the development of affective neuroscience represents an opportunity for interdisciplinary engagement with the idea of the subject. With due scepticism regarding empiricism and equal respect for its contributions, I outline a possible approach to studying subjectivity that attends to material embodiment and humanities-based theoretical advances in studying subjectivity.

The development of affective neuroscience has brought neuroscience and the humanities into such proximity that it has made a reconsideration of the relationship between the two disciplines unavoidable. This proximity occasions reimagining of interdisciplinary work in the relationship among the subject, the body and the world. Part of engaging with the proximity the empirical and theoretical approaches now find

themselves in is the recognition that this condition is not new, and not limited to the affective neurosciences. As William Connolly points out, "every theory of culture bears an implicit relation to biology and biological theory"; the reverse is also true.[1] Engaging with this convergence, then, draws attention to the work that is necessary to maintain these disciplinary boundaries, and the work that these boundaries, once established, continue to do. Examining the empirical and theoretical approaches to affect and emotion makes clear that these disciplinary divisions function to limit the scope and potential of work on all sides. Studying the specific ways in which each of these disciplines, on their own, fails to completely address their subject matter will show how revitalizing interdisciplinary work by removing disciplinary boundaries is not only inevitable but a desirable project.

Thinking at the intersection of theoretical engagement with the embodied subject and the developing affective sciences produces three related outcomes. First, it establishes the necessity of a new approach to interdisciplinary work with a focus on removing the limitations of disciplinary boundaries. Second, it provides the ground on which to develop the relationship between embodiment and cognition in a way that challenges existing theories of embodiment on all sides of the disciplinary divide. Third, and last, the effort of working through the relationship between embodiment and cognition within this framework allows proper attention to the contributions the material specificity of an empirical approach to affect, and reveals the full potential of this reimagined interdisciplinary approach. The theory of embodied cognition emerges from working through the connections between science and theory, affect and emotion, and embodiment and cognition.

Cognitive Neuropsychology – a History, from Animal Spirits to Cognition

The interdisciplinary nature of neuropsychology, and of the cognitive tradition within neuropsychology, creates problems when constructing the discipline's history. How far back should a history go in order to relate all the information relevant to the current state of the discipline? With neuropsychology there are a number of options. Some are as recent as the establishment of discipline separate from neuroscience in recent decades. Some begin slightly further back with the direct antecedents in the post World War II period, though there is no agreement on which of the numerous influences should be included. The beginning of modern scientific psychology would also be logical, though few histories take this route. A common choice is to focus on developments occurring around the same time in the then nascent fields of neurology and neuroscience. Histories often take a different tact, beginning with a story of the discipline's false start under Gall's pseudoscientific phrenology. The most common origin story begins more than a century earlier with Descartes formulating the problem of mind-body dualism. There is also an argument to look further back Andreas Vesalius' shift away from the Galenic tradition in anatomy, though this crucial juncture is generally ignored. Occasional reference is made to the Greek or Egyptian worldview's connection of the soul to the material body. While this list may seem long it is not exhaustive.

Neuropsychology's disciplinary history is complicated by the scarcity of historical research and the difficulty of locating what material does exist. Most available material comes from accounts of historical developments in various fields that neuropsychology draws from. For instance the Journal of the History of the Neurosciences, publishing since 1992, occasionally contains articles relating specifically to the development of neuropsychology but mainly to neuroscience. Events from the

above list have each figured as the starting point of at least one historical account of the development of neuropsychology. Which one an author chooses depends on what argument or objective the history is intended to introduce. The majority of these developments will be absent from most disciplinary histories even if the account begins from the more chronologically ancient event.

Most textbooks and brief introductions reduce this history to four or five of these events, which are then covered in as many paragraphs. The most popular narratives include the Greeks, Galen, Descartes, Gall, and the Broca and Wernicke period, usually offered in a series of stories that lead directly to the current state of the field.

More inclusive accounts have a different problem: simple chronological presentation becomes hopelessly complex around the mid-19th century. It is during this period that the disciplines now contributing to neuroscience begin to proliferate and diversify, yet they will often not directly interact in a way that affects the development of neuropsychology for nearly a century in some cases.

The Ancients

While Descartes is most commonly the figure associated with establishing a philosophical connection between soul and body in its modern form the idea that the spirit might reside somewhere in the physical body can be dated as far back as the ancient Egyptians. Though neither the Egyptians nor the Greeks had much interest in the brain, the legacy of their cardiocentric view can be seen as late as the fifteenth century in the form of the theory of vital and animal spirits as well as in the position in neurology that the nerves acted as conduits for a fluid or gas.[2] As authors of the first surviving written history of medicine, the Egyptians remain the first to locate the spirit or soul of the

human in a specific material location, for them the heart. The idea of vital fluids is also of lasting importance.

The Greeks adopted the theory of fluids and the cardiocentric view from the Egyptians, which remained dominant throughout the Greek era. However there were important developments during the Greek era. Two lasting anatomical theories of the brain originated in Greek thought. Herophilos, seen by many as the 'father of anatomy,' was keenly interested in the brain and proposed a connection between the psyche or soul and the ventricles of the brain.[3] This connection would serve as the basis of ventricle theory, an influential early theory of brain activity. In addition, Erasistratos developed fluid theory into a theory of pneuma in which the heart's left ventricle transformed inhaled air into 'vital pneuma' that, "together with blood, results in heat, energy, and life."[4] While vital pneuma was common to all living animals it's transformation of vital pneuma into psychic pneuma distinguished human life from animal life. While the cardiocentric view was initially more influential than the early Greek theories emphasizing the role of the brain, versions of both ventricle theory and the theory of pneuma would develop into influential theories central to Galenic and Medieval medicine and their influence would last into the renaissance period.

While these early formulations may seem to be merely the medically inaccurate relics of a long past era their influence has been extensive. As medical historians Tesak and Code note on the importance of Greek thinking: "without the theory of fluids the fundamental medical and early psychological thinking of the subsequent centuries is difficult to understand … the theory remained the basis of many model representations of human physiology and medical intervention until the eighteenth century."[5] While the

Greeks were also the first to challenge the strict cardiocentric view by proposing an important role for the brain, both the proposals of Erasistratos and Herophilos would become influential later on, the continued dominance of the cardiocentric view would continue with little attention paid to the brain throughout Europe for over 1500 years.[6]

Galen & The Middle Ages

The next major figure to disturb the Greek tradition was the Roman medical experimenter Galen. Galen stands as one of the most significant pre-Enlightenment medical experimenters and significantly developed the understanding of the brain beyond what had been proposed by the Greeks. Roman medicine was largely a continuation of the Greek tradition and is generally considered within that tradition.[7] Along with his pioneering work on the anatomy and physiology of the brain, Galen rejected the dominant cardiocentric view in favour of ventricle theory. Alternately known as cell theory, ventricle theory presented "a connection between the ventricles of the brain and human intellectual faculties."[8] The human spirit was located either in the *rete merabile* or in the ventricles. Galen's ventricle theory marks the first occasion following Plato's tripartite division of the soul to feature the brain as a prominent organ, thus initiating the first lasting era of craniology. Consistent with Greek thought the activity of the intellectual faculties was still not located in the material of the brain but theorized as being located in what were thought to be the empty spaces of the ventricles. Galen's contribution to our understanding of the human brain stands as uniquely influential in European medicine, his influence not waning until the seventeenth century.[9] Ventricle theory would persist as the dominant theory of brain activity through the Middle Ages although many of Galen's "anatomical insights were lost and the ventricles were

understood in the Middle Ages rather as theoretical concepts than anatomical quantities," with even the number of ventricle cells varying, usually between three and five, largely with the requirements of a given theory instead of any sort of anatomical development.[10]

Renaissance

The Renaissance is an interesting period in the history of our understanding of the brain and its connection to behaviour. While anatomist Andreas Vesalius began a period of considerable advances in the anatomical knowledge of the brain these anatomical advances did not immediately lead to a philosophical shift to finally overcome the cardiocentric perspective. This shift was eventually accepted and the brain was taken to be the seat of the intellectual faculties and the material base of the soul. While ventricle theory remained dominant throughout this period, the work of Vesalius and of English medical professor Thomas Willis during this time would lay the foundations for its eventual rejection.

Vesalius' publication of *De Humani Corporis Fabrica (On the Fabric of the Human Body)* was a notable breakthrough for the attention it paid to the brain. The entire seventh volume of *de Fabrica* is dedicated to the brain and dismissed many of the errors in Galenic anatomy that still persisted at the time. Some of the more major corrections involved disproving the existence of Galen's proposed *rete merabile,* a much more detailed description of the ventricles and, critically, a shift in the localization of memory from the ventricles to the cerebellum.[11] This is the beginning of the shift from locating mental functions in the ventricles to the material of the brain.

Thomas Willis furthered this shift, though he argued the cerebral gyri were responsible for memory, and even went further in rejecting ventricle theory in favour of a

cortical theory of mental activity.[12] While he rejected ventricle theory in favour of a cortical location of intellectual function, Willis maintained the existence of an immortal soul and imagined the brain as the meeting place between this rational soul, the brain's intellectual faculties, and the lower animal spirits coursing through the body via the blood. However, there is debate about whether or not this concession of the immaterial aspect of the soul was simply an attempt to appease religious authorities.[13] Willis' argument for the co-presence in the brain of impulsive animal spirits and the rational soul reflects the dominant religious doctrine at the time, in which undesirable impulses were attributed to the body and thought to only affect the rational soul so far as it was tied to the body and it was the soul's responsibility to control.[14]

René Descartes

The separation and opposition of the immaterial soul and the passionate body finds a more radical, and perhaps its most famous, expression in Rene Descartes' 1649 publication *The Passions of the Soul.*[15] Descartes is also famous for employing a mechanistic view of the body in which the physical bodies function as mechanical automatons, with human bodies distinguished from animal bodies by the presence of a divine soul animating the human body.[16] Descartes employed the pineal gland as the mechanism through which the immaterial soul could communicate with the physical body, a choice full of anatomical imprecisions and which immediately drew criticism from other anatomists at the time.[17] The radical division between soul and body, a position that has become known as Cartesian dualism, relies on the separation of *res extensa*, the body, from *res cogitans*, the soul.[18] Kurt Danziger argues that one important consequence of Descartes' radicalization of the separation between rational soul and

passionate body, and its banishment of the undesirable passions from the soul to the mechanistic body is that the passions are imbued with physical causes against which the soul must then intervene.[19] He argues, "Descartes' rigid mind-body dualism introduced a fundamental division between *voluntary* and *involuntary* action that was not like anything recognized in the classical literature" so that "in this respect, his work on the passions certainly marked the beginning of a new period."[20]

Franz Joseph Gall, Organology and Phrenology

Following the monumental impact of Descartes' proposed dualist division of mind and body the next major figure to emerge in the history of neuroscience and neuropsychology is Franz Joseph Gall. The relatively short period during which Gall's organology, often remembered by his student Spurzheim's preferred moniker phrenology, remained in favour with the scientific community has often seen it relegated to a footnote in histories of neuroscience.[21] Though organology has widely been dismissed as absurd, its influence on modern neuropsychology should not be denied.[22] Tesak and Code argue that, far from being merely a misstep, "Gall established the foundations of localization theory, the most influential theory that was to drive neuropsychology and cognitive neuroscience to the present day."[23] While there had been earlier attempts to localize different mental functions in parts of the brain, such as Descartes' focus on the pineal gland, Gall established cerebral localization as a serious theory focused on the neocortex and based on a wide and varied base of empirical data.[24] Elizabeth Wilson describes Gall's impact as twofold: both establishing localization as the focus of neuropsychological research to follow; and shifting attention to the physical material of the neocortex itself rather than viewing the brain merely as an organ to

translate Cartesian intellect.[25] While the unfortunate schema of localized character traits Gall chose to employ has often led to his role in the development of neuropsychology being downplayed his shifting of mental functions into the physical material of the brain has secured his place in history.

While part of the ridiculousness of organology can be attributed to its popularization as phrenology, another part of its fall from favour can be seen as the consequence of its association with the political atmosphere of the time, which is overtly expressed in its popularized form in contrast with Gall's more empirical writings.[26] Tesak and Code note that the rise of organology and the first efforts in classical localization from Bouillaud and Broca occur at the same time as colonial imperialism became the dominant political feature in Europe. They point out that instead of being dissociated from the political climate of the time, "scientific endeavours were also in progress to determine for example, and according to political orientation, the inferiority or equality of black people in comparison to white ones" and that the proponents of localization were not removed from this discourse.[27] The "increasingly bizarre" development of phrenology away from Gall's initial more anatomical focus, especially in relation to proposing connections between race, appearance, and criminality, have left much of this ascientific legacy solely with Gall.[28]

The Classic Language Localization Debates

Following Gall's introduction of a more systematic approach to localization, the question over whether or not the mind could be located in circumscribed areas of the brain was taken up primarily as a debate amongst neurologists regarding the localization of language functions in the brain. This classical era of localization, and especially the

work of Paul Broca and Carl Wernicke, is generally taken as the emergence of modern empirical neuroscience. This is partially due to a shift in focus as, "where the phrenologists had looked for avarice, quick-wittedness, and criminality, these neurologists searched for centers for writing, concept formation, mathematical calculation, reading, and orientation in space, and they attempted to locate these centers not on the skull but in the outermost layer of the brain, the cortex."[29]

The first versions of a theory of localized function resembling the model still accepted today appear in the work of Jean Baptiste Bouillaud in the 1820's.[30] While Bouillaud's work went largely unnoticed initially, 40 years later it would influence Paul Broca in developing his theory of hemispheric localization and specifically the localization of language functions in the area of the left hemisphere that is now known as Broca's area.[31] Broca's work was based on the comparison of patients' language impairments with damage to the brain revealed during the patients' autopsy.[32]

While substantial advances were made in line with the strict localization approach pioneered by Broca this so called 'golden age' of cerebral localization that would serve as the precursor to later information processing models was largely ignored in the period following World War I until the mid 1950's[33]. This falling out of favour has been attributed to a combination of the lasting impact of the discrediting of Gall's phrenology, a theoretical opposition posed by anti-localization approaches, and social and political influences. Specifically, the twin emergence of a gestalt approach to psychology and the rise of theories of distributed hierarchical functioning as put forward most notably by J. Hughlings-Jackson provided the intellectual counter force to localization.[34] This partially reflects a shift away from a continental influence on science toward an emerging

dominant role for American and English scientific communities.[35] The influence of the Kantian theory of innate knowledge that had previously informed the European scientific community, and especially those proposing a localization theory in neuropsychology, began to fade. With the rise of the American and English influence on science a Lockean understanding of behaviour took hold. Most relevant to the study of neuropsychology was Locke's argument that beliefs and ideas were not innate, as Kant thought, but derived from experience. The privileging of learning in Locke's conceptual scheme "provides little reason to look at the structure of the brain to understand behaviour."[36] In conjunction with this philosophical shift there was a growing aversion to German science after the First World War, specifically away from the Wernicke-Lichtheim model of aphasia.[37] The beneficiaries of this political shift of influence on science were the rising proponents of holist approaches to psychology. K.S. Lashley and Henrey Head stand as two of the more prominent proponents of this holist approach.[38] On the influence of these political events American neurologist Norman Geschwind has noted:

> Head had been shrewd enough to point out that much of the great German growth of neurology had been related to their victory in the Franco-Prussian war. He was not shrewd enough to apply this valuable historical lesson to his own time and to realize that perhaps the decline of the vigour and influence of German neurology was strongly related to the defeat of Germany in World War I and the shift of the center of gravity of intellectual life to the English-speaking world, rather than necessarily to any defects in the ideas of German scholars.[39]

This political shift toward England and America was strengthened by the rise of fascism in German in the 1920's, which saw many academics in Germany lose their university positions, with many fleeing or being forced out of the country.[40] Following this political shift, focus within psychology shifted away from innate brain structures as a possible explanatory tool for understanding behaviour.

The period following the Second World War witnessed a resurgence of localization and information processing approaches to understanding behaviour as a product of the confluence of a number of diverse developments.[41] First was a rediscovery of the work of the classic localization advocates, such as Broca and Wernicke, and replications of their findings.[42] Then, in 1949 Donald O. Hebb published *The Organization of Behavior: A Neuropsychological Theory*, explicating one of the first testable hypotheses for a specific neural basis of mental processes such as attention, memory, and learning.[43] At the same time, Russian 'father of neuropsychology' Alexander R. Luria was making remarkable progress in making connections between behavioural impairments and the anatomy of the brain based on analysis of traumatic brain injuries suffered by Russian soldiers of which, as this was in the years immediately following WWII, there was an unfortunate abundance.[44] The final development contributing to the re-emergence and solidification of the information processing model was the development of information theory and artificial intelligence research in America starting in the 1940's.[45] These advances combined to create sufficient theoretical complexity of information processing models and technical improvements in anatomical studies allowing information processing to again emerge as the dominant approach to the study of mind, brain and behaviour.

The influence of information theory and artificial intelligence (A.I.) on the resurgence of localization theories after WWII is not a simple return to the 'golden age' of Broca and Wernicke with greater detail. Developments in information theory and the then burgeoning field of cybernetics substantially change what is understood by localization, and what thinking is understood to be, when it emerges back onto the intellectual scene. Understanding differences between these apparently similar theories requires a return to the work of Alan Turing, Claude Shannon, and the Cybernetics of the Macy Conferences.

Alan Turing and the Materialization of Logic

While the understanding of how the brain worked was developing rapidly in the latter half of the 19th century and beginning of the 20th, it is the initially unrelated publication of Alan Turing's 1937 paper "On Computable Numbers" which Jean-Pierre Dupuy argues "announced the birth of a new science of mind." Given the developments already highlighted in understanding the brain, why does Dupuy place such significance on Turing's paper? The answer, in short, is that it would change our understanding of what it means to think. This change comes in two steps, only the first of which was present in the initial Turing thesis. Turing's aim was mathematical: to show that mathematical logic could be computed mechanically. That is, that logic propositions could be processed automatically by a machine given the appropriate instructions.[46] This was an innovation in itself, to connect the idea of effective computability with the automatic execution of a machine, and involved bridging the gap between the traditional metaphorical use of mechanical in mathematics with the more literal, and now familiar, sense of 'computable by a machine.'[47] The second step, which is just as important, is that this machine could be

embodied as a physical machine.[48] While these connections seem commonplace in today's computer-saturated context it was a striking proposition at the time, inspiring changes in a number of different research programs. How this continued on to redefine what could count as thought, and to connect the material world of the brain to the activity of the mind, is described by Dupuy:

> The symbols – the marks written on the tape of the [Turing] machine – enjoy a triple mode of existence: they are physical objects and therefore subject to the laws of physics; they have form, by virtue of which they are governed by syntactic rules (analogous to the rules of inference in a formal system in the logical sense); and, finally, they are meaningful, and therefore can be assigned a semantic value or interpretation. The gap that would appear to separate the physical world from the world of meaning is able to be bridged thanks to the intermediate level constituted by syntax, which is to say the world of mechanical processes – precisely the world in which the abstraction described by the Turing machine operates.[49]

Dupuy also argues that while the Turing machine and Turing hypothesis are now popularly associated with the field of Artificial Intelligence the initial appeal was less in the connection of mind and matter than with "what it implied about the relation between thought and machine."[50] It would not be long before Turing's work inspired McCulloch and Pitts to connect computation and matter via Cajal's neurons, but even that move would be dependent on Turing's connection of thought to machine.

Turing's 1937 paper was essential to the founding of cybernetics but his 1950 paper "Computing Machinery and Intelligence" has also been seminal to contemporary

cognitive science.[51] As laid out in that paper, the "Turing test has laid down the philosophical foundations for most cognitive research that has followed."[52] But far from being a simple straightforward test of intelligence the Turing test establishes a complicated relationship between cognition, embodiment, and gender that is retained by the cognitivist disciplines influenced by it.

In contrast to its significance and complex effects, the test initially appears rather benign. The Turing test is a game of imitation. The conditions for a thinking machine are met when its responses to a set of problems cannot be differentiated from those of a thinking man.[53] Initially, an interrogator is asked to correctly identify a man and a woman based on their written responses to certain questions. "The test proper comes into play by swapping the man with a machine. If the interrogator makes the same sort of judgments, deductions, and guesses after this swap as before, that is, if the interrogator is unable to distinguish the machine's answers from the answers of a man, then this particular machine is said to have passed the Turing test."[54]

The test is conducted by written information in order to eliminate bodily, visual, and aural contact between the participants. This is done in order to establish a sharp line between a man's physical capacities and his intellectual capacities so that the test is a measure of a purely intellectual exchange.[55] As Wilson points out, "this desire to draw a sharp line between mind and body, between sensation and intellectuality, lies at the heart of traditional Cartesian dualism."[56] But, contrary to the popular mythology that has evolved around the Turing test, Wilson points out that instead of a negation of the body in favour of a virtual space what Turing effects is not the expulsion, but the careful disavowal and deliberate restraint of the body.[57]

Instead of negating the body, Turing imagines a very specific restricted form of the body. “The body is never radically absent from Turing’s field of cognition; rather, it has been fabricated and naturalized as a benignly noncognitive entity.”[58] “Turing’s fantasy of a discrete cognitive domain and of pure intellectual communication between cognizing subjects is premised not on the eradication of the body but, rather, on an attentive constraint and management of corporeal effects.”[59]

This constraining of the body of cognition is important to how cognition will relate to embodiment in the cognitivist model inspired by Turing. Crucial to this relationship is the way it not only divides along the lines of cognition/body but along the lines of male/female as well. As Wilson demonstrates, this division is not a peripheral side effect of Turing’s cognition/body division but a central feature that makes it possible. In the initial formulation of the test the woman is already displaced as the test is a measure of comparison between the answers of the man and of the machine. Later on in Turing’s paper the woman is displaced further when she is replaced by a male respondent, with the test becoming a direct comparison by the interrogator between the man and the computer.

Far from benign Turing considers, once this change is in place, “the ground to have been cleared and we are ready to proceed to the debate on our question ‘Can machines think?’”[60] What exactly is it about the female body that has to be cleared out so that Turing feels it is safe to make a pure comparison of cognitive capacities? The presence of sexual difference, which initiates the Turing test in its first iteration, threatens to “breach the sharp line that Turing has drawn between the players’ intellectual and physical capacities,” undermining the purity of the intellectual comparison that is the goal

of the test by introducing the particularity of the female respondent.[61] With the female player excluded the man is left to stand as the universal standard for pure cognition against which the machine may be compared. That is, "for Turing, cognition is rendered identifiable and intelligible at the moment when the female participant becomes the receptacle for noncognitive corporeality and is excluded from the homo-computational pact of thinking beings."[62] The male subject is left to stand not only as the intellectual standard but also as the figure in which the complications of corporeality do not influence or contaminate the subject's cognitive processes. This is not a simple anticorporealism but, as Wilson identifies, a very restrictive definition of corporeality as subject to cognition. Hence, "it is the management of the body of the female respondent, rather than its radical exclusion, that allows the similitude between computer and man to be established."[63]

Given the widely acknowledged importance of Turing and his formulation of cognition to the cognitivist tradition that has followed him, it is important to remember that the corporeal body is never fully negated in his formulation of cognition and to remain attentive to the ways in which it is present. Rather than negation, "the contemporary logic of cognition has been established within a tightly constrained set of bodily corrections and identifications."[64] These constraints reflect a gendered definition of normal cognition and one that reflects a specific limited role for embodiment. It is important to remain attentive to the way these restraints are reflected in the models of cognition after Turing. It is also important to remember that this formulation of cognition develops out of his initial 1937 formulation of the Universal Turing Machine as a logical computer. Before his 1950 paper, it is this earlier proposal of a logical machine that has a

significant impact in the scientific community and especially on those who will come together under with the intention of forming a new discipline to be called cybernetics.

McCulloch & Pitts – Idealized Neural Networks

While cybernetics is widely regarded as starting with the Macy conferences, a number of the people involved were already doing ground-breaking work similar to what would become known as cybernetics within their own disciplines. Of these, the most significant to a history of the neurosciences are Claude Shannon, and Warren McCulloch and Walter Pitts. The latter's model of neural networks represents a crucial juncture bringing together a number of diverse developments in different disciplines in a way that anticipated and contributed to the inauguration of the cybernetic project, and has had a lasting legacy in the formation of cognitive science, neuroscience, artificial intelligence, and von Neumman's model of computation.[65] The McCulloch-Pitts model brought together late 19th century theories of cerebral localization and then-new understanding of neuronal activity with the new field of mathematical biophysics and logical mathematics. It also drew strong inspiration from Turing's recent work proposing a theoretical machine capable of processing logical equations.[66]

Part of the lasting legacy and widespread impact of the McCulloch-Pitts model is due to the innovative way in which it built on recent advances in neurology, combining them with the emerging field of mathematical biophysics. While his paper with Pitts was not published until 1943, as early as 1929 McCulloch had been looking for a physiological basis on which to ground the mathematical logic he had been building around the idea of a 'psychon,' or a minimal unit of psychic activity.[67] Through his collaboration with Pitts he realized that the recently accepted "all-or-nothing" model of

neuronal excitation could provide the physiological ground he was looking for.[68] While McCulloch was not the only one to adopt a mathematical biophysical approach based on the neuron the significance of his work with Pitts lies in the "observation that as propositions in propositional logic can be 'true' or 'false,' neurons can be 'on' or 'off" - they either fire or they do not."[69] The significance of this observation lay in the ability it opens to represent physical neuronal activity, McCulloch's base unit of psychic activity, in the language of mathematical logic. The formal equivalence observed by McCulloch and Pitts allowed them "to argue that the relations among propositions can correspond to the relation among neurons, and that neuronal activity can be represented as a proposition."[70] Significantly, Pitts and McCulloch drew inspiration for their idealized neuron from Turing's proposition of a logical machine.[71]

While McCulloch and Pitts drew inspiration from Turing they were aware that there were important differences between their networks of idealized neurons and the capacities of a Turing machine. For their networks to have the same computational capacities as a Turing machine they would have to be equipped with the two essential elements of every Turing machine: a mobile head capable of reading, writing, and erasing symbols; and, more important still, a potentially infinite tape or memory. "The brain being a physical – and therefore finite – organ, it clearly cannot compute everything that Tuning machines can."[72] This difference would often be forgotten during the period of the Macy Conferences, however, with McCulloch and Pitts along with the other cyberneticians both mistakenly presenting Turing's theorem as proven and, going further, arguing that "any behaviour that can be logically, precisely, completely, and

unambiguously described, in a finite number of symbols, is computable by a neural network."[73]

McCulloch and Pitts continued to collaborate to try and improve their initial neural network model throughout the period of the Macy Conferences in order to address problems and limitations that emerged. McCulloch remained focused on his goal of giving an account of the mind's capacity to form and to know universals. One of the more significant advances was the attempt to introduce randomness into the networks in order that the networks might function in the presence of errors as well as of the system noise to which early calculators and connections were prone.[74] While it would not be enough to save their idealized neural networks from falling out of favour, Pitts' presentation of his initial thinking about random networks at the October 1946 2nd Macy Conference has been shown to have a lasting impact, particularly on John von Neumann's efforts leading to his application of probabilistic logic to computation.[75]

Claude Shannon

At the same time that McCulloch and Pitts were developing their neural networks, Claude Shannon, independent of McCulloch and Pitts, was developing the basis for systems theory. Shannon demonstrated that symbolic logic could be applied to automatic electrical switching circuits in use by communications engineers so that "for each logical function … there is a *circuit* that is a *physical embodiment* of the corresponding process of logical addition, multiplication, negation, implication, and equivalence.[76] Dupuy summarizes the novelty of Shannon's approach in the context of a history of the cognitivist approach as follows:

> The novelty of [Shannon's 1938] paper was twofold. On the one hand, of course, such networks [of electrical circuits] had already been the object of various kinds of mathematical modeling, only these depended on a mathematics of quantities; Shannon's first innovation was his recourse to a logical tool, namely, the propositional calculus. On the other hand, there existed prior to Shannon's paper a long tradition of research aimed at resolving logical problems by means of mechanical, physical devices. …. Shannon's second innovation consisted in shedding an entirely new light on the relationship between machine and logic.[77]

Similar to McCulloch and Pitts, Shannon established a connection between a physical process and a logical process in which the operation of the physical process embodies the parallel mental process. The impact of Shannon's theory is hard to overstate. As neuropsychologist Chris Frith puts it, "the development of information theory … enabled us to see how a physical event, an electrical impulse, could become a mental event, a message."[78] Looking back from the present it is difficult to understand the significance of Shannon's innovation. Dupuy puts Shannon's work into perspective best, stating:

> The idea that Boolean algebra (that is, a logical calculus of propositions) can be materialized in the form of electric circuits and relay switches has come to seem altogether familiar to us, living as we do in a world of computers. It is hard for us today to imagine the intellectual shock that this discovery held for those who experienced it. …. No one today is surprised in the least that the brain, which we suppose to be the source of our logical faculties, should be compared to a digital computer.[79]

Dupuy distinguishes Shannon from the era that preceded him and rationalizes the extent to which Shannon, and similarly Turing, McCulloch and Pitts, have shaped the discipline of cognitive science since.

While the focus of Shannon's work did not initially lie in the application of information theory to the process of cognition, Frith demonstrates how Shannon's information theory was received by those interested in cognition as a physical process. Published in 2008, Frith's work also demonstrates the longevity of Shannon's impact on the field of neuropsychology. Shannon contributes to the shift in the understanding of cognition as a physical process of a very specific type, based on a development unrelated to research on the brain. Joining the physical and mental aspects of cognition changes the understanding of both, as Frith again states: the understanding of the physical event changes so that what occurs in the physical events "transmit not energy, but messages."[80] Shannon would continue to develop information theory both independently, and as an occasional participant in the Macy Conferences.

Macy Conferences

Following the work of Shannon, McCulloch and Pitts there was a massive moment of interdisciplinary exploration, remembered as cybernetics. Cybernetics brought together specialists from a variety of disciplines to propose a number of new connections and ideas. While many of these did not work, and a number of their failures remain what the era is remembered by, many of their projects solidified into new, often very closely related disciplines. Most of these disciplines have cut their ties with their cybernetic lineage as they have established their independence.[81] What remains is the legacy of interdisciplinarity. None of the offshoots can be said to be independent of the varied

histories of their composite disciplines. For cognitive neuroscience and neuropsychology, the legacy of Turing, Broca and Wernicke all remain strong influences on their current form as disciplines.

The first Macy conference, titled "Feedback Mechanisms and Circular Causal System in Biological and Social Systems," took place in March 1946 in New York with the subsequent meetings taking place every six months until the spring of 1948.[82] Following this first cycle there was a break in the schedule during which the September 1948 Caltech Hixon Fund Committee symposium took place before the second cycle of Macy Conferences resumed in the spring of 1949, taking place annually until 1953.[83] Much has been written about the short-lived discipline of cybernetics and the Macy conferences and, due to the impressively interdisciplinary and open nature of the work done during the conferences, accounts of the specific outcomes, character, and legacy of cybernetics often differ wildly. Certainly there were a number of strong personalities in the group, many of which were at the head of their respective fields, and many of whom continued on with great success, and in very different directions, after the conferences. This openness – presentations often took the form of posing a new problem rather than providing a specific solution - combined with the rapid pace of scientific change at the time is part of what made the conferences such a unique and remarkable event.[84]

In response to this openness, Dupuy's excellent history of the Macy conferences locates the efforts at unification not at the level of solutions but at the level of problems.[85] There were two main classes of problems that characterize the conferences: "The problems of communication, on the one hand, and the problems posed by the study of self-integrating mechanisms on the other."[86] These two problems were both oriented

around the common goal of a single objective that can be said to characterize the first generation of cybernetics, which was "obtaining for the sciences of the mind the same degree of objectivity enjoyed by physics."[87] Those in attendance at the conference also shared a common orientation to the problem of crating a science of the mind, which, inspired by the work of Shannon, Turing and McCulloch and Pitts, centered on explaining human mental activity as mechanized process: the functioning of a logical machine.[88]

John von Neumann

One of the more important figures to emerge out of the Macy conferences on cybernetics is John von Neumann. His contribution to the development of computer architecture, strongly influenced by McCulloch and Pitts model of idealized neurons, has had one of the most dramatic and lasting effects on the understanding of cognition in the latter half of the twentieth century.[89] Computation, as theorized by von Neumann, ends up as the resolution of the opening created by the work of Turing and Shannon. His model of computation remained dominant for much of the latter half of the twentieth century and, while alternative computational architectures have emerged to compliment it, remains so today.

The central feature distinguishing von Neumann type architecture is a separation of the hardware and software of the computer. As Dupuy puts it, von Neumann's contribution, which made it possible to lay the conceptual foundations for the second generation of computers, is the "idea that the logical conception of a calculating machine was *separable* from the design of its circuitry."[90] While separating the specific program from the machine used to execute that program, the hardware/software distinction, made

possible the linear computers we know today, it also had an important impact on the relationship between cognition and embodiment in the emerging cognitive sciences. Specifically, "cognitive models that rely on an analogy to von Neumann architecture have assumed that there is a distinction between a cognitive program (mind) and the machine (body-brain) on which it is run. Cognition is taken to be a universal process that always operates in the same way irrespective of its embodiment in a particular machine-brain."[91] What the hardware/software distinction allows is a disembodying effect that comes to define computational approaches to cognition in the latter half of the twentieth century. The specific ways in which von Neumann's separation of software and hardware becomes problematic when applied to cognition will be discussed in detail in chapter 4. For now it is enough to restate the impact that the shift, in the remarkably short time between its inauguration by Turing and Shannon, was to have on cognitive science:

> More specifically, the influence of information theory in cognitive science meant that 'it became possible to think of information apart from a particular transmission device: one could focus instead on the efficacy of *any* communication of messages via *any* mechanism, and one could consider cognitive processes apart from any particular embodiment.
>
> – Gardner (1987)

Cognitive Science as a Discipline

Much of the history presented so far predates the formalization of cognitive science and neuropsychology as distinct disciplines. Far from rendering this history irrelevant, it lays the theoretical foundations that make the emergence of these two closely connected disciplines possible at all. The beginnings of contemporary,

mainstream cognitive science are generally accepted as coinciding with the September 1956 Symposium on Information Theory held at MIT. The unity of purpose, if not perspective, which had defined the first phase of cybernetics had begun to fracture as more and more of the participants left or attended with much less frequency, due either to conflict with the group or simply a choice to focus instead on their own research interests. The 1956 symposium, then, comes to stand as the point where these fissures coalesce into a cohesive, though still diverse, and lasting research program, known as cognitive science. A number of landmark papers were delivered at the conference, including "Newell and Simon's presentation on the Logic Theory Machine, Chomsky's new grammar based on information theory, and George Miller's influential paper on the capacity of short-term memory."[92] While the emerging cognitive science represented a new discipline that functioned to replace, and effectively bury, the cybernetic research program, it was not a complete rupture from cybernetics but a refinement and narrowing of the cybernetic program. In fact, the symposium "was widely seen as having brought to fruition the promised new science that had been evident since the Lashley, von Neumann, and McCulloch papers at the Hixon Symposium at the California Institute of Technology in 1948."[93] It was at the Hixon Symposium, Dupuy notes, that many of the Macy participants had found their cybernetic program subjected to a level of criticism, both in tone and in specificity, which they had not yet encountered during the Macy proceedings.[94] As its own science, cognitive science continued the cybernetic tradition of interdisciplinarity. Cognitive science "brought together research from cybernetics, computer technology, information theory, formal logic, neurology, and linguistics to form an authoritative hybrid domain."[95] In the years following the MIT symposium, the

influence and authority of cognitive science has grown dramatically, and remains strong today.

Out of this cognitive revolution has emerged the field of cognitive psychology, and cognitive neuropsychology. The increasing importance of a cognitive paradigm in psychology has followed from the emergence of cognitive science as a discipline, but also owes to "the inevitable decline of behaviourism's theoretical and experimental authority, advances in computer technology, and the consequent development of an information-processing model of cognition."[96] Ulric Nisser's *Cognitive Psychology*, published in 1967, is usually seen as the foundation of cognitive psychology. Nisser is credited with "offering the first sustained argument (within psychology) for the modeling of psychology on computational processes, and differentiating such an approach from psychodynamic, behaviourist, and neurological accounts."[97] The extent of the influence of the cognitive paradigm in psychology is hard to overstate. Wilson argues that, "like behaviourism before it, cognitive psychology now dominates scientific psychology to the exclusion of any other approach. Psychology has become cognition."[98] Carried with the cognitive approach's rise to dominance are the theoretical grounds on which it is based, from Turing to McCulloch and von Neumann, though now the innovations they produced are naturalized as the basic assumptions on which the cognitive psychology is founded.

Engaging with a Discipline

From this point on, a historical account of the development of neuroscience and neuropsychology is no longer enough. This introduction has laid out the developments of the concepts that remain central to the current discipline of neuropsychology, and specifically to the cognitivist understanding of thinking around which this discipline has

been built. Moving forward, the chapters that follow will each deal with a significant aspect of cognition, or debate within the cognitive sciences.

Chapter two focuses on the role of imaging technologies in the development and current state of the neurosciences. Building off a historical account of the development of fMRI, PET, and other neuroimaging technologies, as well as the historical context of the role prior imaging technologies have played in the development of the empirical sciences, this chapter will examine what effect the introduction of neuroimaging has had on various disciplines that have made use of them. From its inception neuroimaging has functioned to confer a sense of legitimacy wherever it has been employed. Part of this legitimizing effect can be attributed to the weight of neuroimaging's ability to render visible the previously elusive activity of the living human brain. The *in vivo* access to neural functioning neuroimaging makes possible lends empirical weight to studies previously restricted to observing the various forms of external evidence of changes in neural states. Through a comparison to other current modes of technical representation, the Human Genome Project and the Visual Human Project, this chapter will demonstrate how the introduction of neuroimaging has impacted not only the development of numerous disciplines, but also contributed to shaping our understanding of what constitutes cognition.

Chapter three deals with the development of affective neuroscience, specifically as developed by Antonio Damasio. His approach to the place of emotion within a cognitivist concept of subjectivity is analyzed for what it contributes, and also for what such an approach excludes from consideration. Damasio's affective neuroscience approach is then contrasted with two theoretical approaches to the place of emotions in an

account of the subject, both of which are based in literary theory. Sarah Ahmed focuses on the aspects of affective economy that exceed the neuroscientific approach presented by Damasio. She builds her argument through attention to production of emotions through social and historical forces, and to the mechanisms that connect these broad emotional communities with the individual. She draws attention specifically to how these mechanisms affect the individual subject and constitute particular subjective positions. Building off Ahmed's critique of the absences and silences created in Damasio's affective neuroscience I will look at the work of Lisa Zunshine on connections between neuropsychology and the act of reading fiction to highlight how Zunshine's work facilitates reconnection of social and historical forces articulated by Ahmed with a biologically grounded account of cognition. By bringing theoretical and empirical approaches back into conversation with one another, Zunshine demonstrates one way social and historical relations of power can become embodied and the processes, social and neurological, through which that embodiment occurs. I will then apply Zunshine's approach to Jean Rhys' novel *Wide Sargasso Sea* to make clear otherwise understated political consequences of Zunshine's work. Bringing Ahmed and Zunshine into conversation through Rhys' novel reveals how everyday practices such as reading fiction not only contribute to learning affective cognition, but do so in a way that is far from politically neutral. It also highlights difficulties that arise when attempting to connect empirically grounded affective neuroscience with a theoretically grounded account of emotional subjectivity.

The aim of chapter four will be reconciling these difficulties in a way faithful to both empirical and theoretical approaches to understanding subjectivity. It examines two

attempts to bridge the void between critical theory, specifically Derridean theory of deconstruction and the feminist critique of science approach, and an empirical account of the subject based on a materialist understanding of mind. First, through William Connolly's *Neuropolitics*, the difficulties of interdisciplinary work bridging Derridean literary theory and neuropsychology are examined. Connolly's approach not only demonstrates the difficulty of such work within a standard interdisciplinary approach, in which there is an attempt at conversation between two independent disciplinary fields, but gives a strong warning about the ways in which the failure of such an approach has consequences that extend beyond simply the collapse of such a theoretical project. I will then look to Elizabeth A. Wilson's *Neural Geographies* for an alternative approach to both interdisciplinary work and to connecting empirical and theoretical approaches to cognition. Grounded in Derridean literary theory and a feminist critique of science approach Wilson argues first against restrictive disciplinary boundaries, with attention to specific ways maintenance of such boundaries foreclose productive interdisciplinary work. She then builds this critique into a proposal for an alternative approach to interdisciplinarity, applied to the project of creating an embodied approach to cognition, that builds on what is already present in empirical neuro-disciplines and in theoretical approaches by refusing disciplinary division and focusing on deep connections already present between these otherwise opposed approaches. Chapter four concludes by reconnecting Wilson's embodied cognition approach with Damasio's more detailed empirical work, and with David Wills' engagement with the relationship between body and technology, to create a framework for establishing a theory of embodied cognition.

The final chapter will clarify my framework for a theory of embodied cognition. Two examples demonstrate how this approach is either already explicitly being pursued, or open up the possibility of applying such an embodied approach to work already being done. First is neuroscientist V.S. Ramachandran and sociologist Laura Case's attempt to connect gender identification and neuroscience through a study of body identification in transsexuals. Their work presents the opportunity to expand our understanding of the connection between gender and embodiment in a way that is both attentive to material conditions of embodiment and to social forces influencing gender identification. This is followed by a critique of Andy Clark's extended mind thesis that focuses on how Clark fails to take into account how neural prostheses change the cognitive system they are incorporated into. David Wills will again be instructive, making clear how the accepted relationship between user and technology conceals the shaping effect on the user, especially in the case of cognitive extension. These two examples demonstrate that an embodied cognitive approach is not an oppositional stance requiring a radical departure from existing research projects, but a reengagement with work already being done through the embodied cognition framework.

Chapter 2 – fMR“I”: Neuroimaging and the Materialization of Mind

Introduction

Expanding the neurosciences to a point where the discipline feels comfortable studying the more ephemeral processes of mind has not come easily. Accepting the study of consciousness and emotions as legitimate scientific endeavours took many years. There is still no consensus on exactly which neural processes contribute to these phenomena. The development of neuroimaging technology has contributed significantly to the acceptance of these new areas of study. The ability to represent visually the neural activity of a living subject lent empirical weight to a subject matter that had been limited by a reliance on a subject's own account of his or her inner mental state and the external observation of a subject's behaviour.

The introduction of neuroimaging technologies rapidly conferred new levels of credibility on the neuro-disciplines utilizing them. They provided a new level of access to the living subject that was immediately useful to studying more accepted cognitive functions such as sensory processing. Neuroscience and neuropsychology have been changed by neuroimaging's provision of this new type of information about the brain's activity. The development of photography in the mid-19th century provides historical context for the introduction of new visual technologies into the scientific domain and helps to understand exactly how such technologies alter the disciplines that employ them. This chapter will move through the historical context into which the present neuroimaging techniques have emerged before looking specifically at their development and the current directions in which they are pushing the study of mind and brain.

Current developments in neuroimaging will be compared with other current 'Human' projects, including the Human Genome Project and the Visible Human Project. Comparing these different implementations of imaging technology in the study of the human subject to find shared practices between them will help understand what assumptions underlie the current practices making use of these technologies, as well as some remaining technical limitations on their use.

Historical Context for the Emergence of Neuroimaging in Neuropsychology

While there are a number of significant effects that neuroimaging has had on the fields of neuropsychology and neuroscience, some of these effects can be generalized across other disciplines in which a new imaging or visualization technology is introduced. Paramount among these trends is an increased privileging of direct visual knowledge and visual-spatial representation over other forms of knowledge. In neuropsychology this trend has emerged as a move away from research based solely on evidence of changes in externally observable behaviour. Research of this kind is now frequently integrated with imaging technology, or an attempt is made to qualify results through recourse at some point to the use of an imaging based method.

This shift reflects the most immediate and profound change that imaging technology has had on the neurosciences: the ability to represent visually brain activity in a living subject. The *in vivo* capability of techniques from x-ray CT to fMRI dramatically expanded the range of what could be observed and measured in the living human brain.[99] Neuroimaging relies on a variety of markers to represent changes in brain activity, from hemodynamic-metabolic measures such as regional blood flow and blood-oxygen levels to electric-magnetic measures of neural activity.[100] While this matter will be explored in

further detail later in this chapter, there remains significant debate over how these measurements correspond to the functional processes of mental activity.[101] I argue that this reflects a fundamental issue with the use of imaging technologies beyond a simple, or rather complicated as the case may be, technical question. Any digital visualization of brain activity must convert mental processes into something empirically quantifiable and visually representable according to a standardized method if it is to be medically or commercially useful. Put simply, any image of mental activity must be mediated by the method of imaging and conversion to binary code implemented by the imaging technology in order that it be presented visually.

The ability to visually represent brain activity of living patients immediately strengthened an already strong trend toward localization-centered theories of brain function, mainly the information-processing model presented in the cognitive neurosciences.[102] It is useful to present the historical context of imaging technologies before looking specifically at the development of neuroimaging.

The authority of neuroimaging to represent the activity of the mind rests on a much earlier shift in anatomical practice away from the Galenic tradition to the work of Andreas Vesalius. Vesalius' publication of *De Humani Corporis Fabrica* in 1543 inaugurated the modern period of human anatomy.[103] The status of the body in *De Fabrica* distinguished Vesalius from Galenic anatomy. Against Galen, Vesalius argued the body should be the active source of anatomical knowledge, not the anatomical text. Eugene Thacker argues: "the crucial move implied in Vesalius' critique of Galen was that, for anatomical science, the demonstrability of visible proof would take priority over the tradition of textual authority forging an intimate link between seeing and

knowing."[104] Shifting away from the authority of the text to describe the body to the authority of the body to speak for itself is a crucial shift in the source of knowledge about the human body. It provides the ground for acceptance of neuroimaging's promise to directly observe physical processes of the brain that lead to behaviour, instead of relying on the observer's theory of what those physical processes *should* be.

Replacing the text's authority with the body that speaks for itself is not Vesalius' only relevant innovation. *De Humani* employed a number of new strategies for representing the anatomical body that were technical advancements over Galen's texts. As we will see later with neuroimaging, the method and techniques employed by Vesalius and the placement of authority in the body over the text are not separate, are not neutral developments. Both shift the mode of representation of knowledge. In both neuroimaging and Vesalius' anatomy, this is toward visual representation of knowledge:

> Vesalius' rigorous engagement with contemporary modes of visual representation placed great emphasis on the visual (that is, the observable) as the anatomist's primary mode of investigation. The innovations which Vesalius developed for the *De Humani* …, including diagrams, tables and keying mechanisms, marks a move away from a purely linguistic-descriptive mode of anatomy (found in Hippocrates, Avicenna or Galen), and towards an informational, taxonomic and classificatory mode grafted upon a highly ornate and graphic sensibility.[105]

With the text no longer acting as a sufficient source of knowledge Vesalius gives voice to the body and develops new techniques through which the body is suitably able to speak.

Similarly, neuroimaging is not a neutral granting of access to the mind's physiological activity on the same grounds as prior neuroscience and neuropsychological theory. It is a set of techniques presenting a new type of information to the observer in novel formats, privileging information based presentation over theoretical description of what is taking place in the brain.

While Vesalius introduced new techniques for representing the anatomical body there was still a reliance on the observations of the anatomist, and with that reliance there remained the possibility of errors in observation. The accuracy of the scientist's observations was increasingly called into question in the centuries after Vesalius. By the end of the seventeenth century the "mere evidence" of the corporeal eyes alone was increasingly subjected to "the (rational) mind's eye" when establishing scientific knowledge. This privileging of reason over empirical observation grew in influence to the point where "most famously in the work of René Descartes, we find a doubting of any representations not securely grounded in reason."[106] Photography emerges just as the early nineteenth century formation of modern biological science was challenging the classical order of natural history.[107] As Steve Garlick notes in his history of photography in scientific practice, "photographic technology emerged out of a period in which the lucidity of human vision was challenged as never before … the act of seeing has become inextricably contaminated by the vicissitudes of subjectivity, and the corporeality of the observing subject weighed heavily upon all attempts to grasp the visual object with any certainty."[108]

Photography's technical innovation addressed two problems facing contemporary scientific practices: objective observation independent of the human observer, and visual

representation of biological processes. The first problem, as noted above, addressed the scientist's unreliability as observer. Photography, in the mechanical and automatic way it represented its subject matter, seemed to "purify vision and provide objectivity."[109] The second problem facing the emergent modern biological sciences was the shift from representing the static universe of anatomy, which was primarily concerned with capturing the ideal form, to the need to represent a subject matter that was increasingly defined by changes that took place over time. Photography was exemplary in this regard as, in the way a photograph captures what exists only momentarily and preserves it beyond its fleeting temporal existence, "the camera supplements the human eye, allowing it to grasp the passing of time and to thereby bestow some order upon it."[110]

How photography introduces a new temporal relation to the natural world, in its ability to remove biological processes from their temporal existence, is central to neuroimaging's success in the late twentieth century. The ability to capture and preserve the neural correlates of a cognitive process is central to the cognitive tradition. It is used to establish a concrete physical existence of a given cognitive function, which is incredibly important when attempting to lend the weight of empirical observation to affective processes such as emotion and consciousness.

One important distinction stands between nineteenth century photographic images and modern neuroimaging technique's digital representations. An excess of individuality and particularity that could not be edited out of the photographic image plagued the use of photography as a scientific technovisual device.[111] The inability to remove particular details in order to present its subject's ideal form limited its application in botany and anthropology, among other sciences.[112] This limitation is a consequence of the

mechanical method of representation in photography, its function as a literal recreation of what is observed. The digital nature of information captured by neuroimaging allows it to be generalized as scientific knowledge – instead of just particular knowledge, in a way that remained elusive from analogue photography, and indeed earlier photographic representations of the brain. Not only could it capture the brain *in vivo*, a rather significant advantage over previous technologies, the creation of a stereotaxic space through manipulation of the raw information captured by the new imaging technologies allowed for comparison between photographs of one person and between photographs of different people.[113] Especially when the relative lack of resolution in PET/fMRI were compared to photography, this comparative ability has to be seen as a crucial factor in the immediate acceptance and continued growth of neuroimaging technologies. *In vivo* was key, but this comparative ability also must be credited when accounting for why such a lack of precision (temporal) and resolution (spatial) has been tolerated for so long.

Neuroimaging techniques were to emerge into a specific historical context in neuroscience that would both shape and make possible their rapid development. The period following WWII witnessed a resurgence of localization and information processing approaches to understanding behaviour, as a product of a confluence of a number of diverse developments.[114] The first was a rediscovery of the work of the classic localization advocates, such as Broca and Wernicke, and replications of their findings.[115] Then, in 1949 Donald O. Hebb published *The Organization of Behavior: A Neuropsychological Theory*, explicating one of the first testable hypotheses for a specific neural basis of mental processes such as attention, memory, and learning.[116] As mentioned earlier, Alexander R. Luria was working at the same time in Russia on the

connection between the brain's anatomy and behavioural impairments. The final development contributing to the re-emergence and solidification of the information processing model was the development of information theory and artificial intelligence research in America in the late 1940's.[117] These advances combined to create sufficient theoretical complexity of information processing models and technical improvements in anatomical studies, allowing information processing to emerge as the dominant approach to the study of mind, brain and behaviour. It is into this context that the new technologies of neuroimaging emerged, and to which they contributed as they were developed.

How to See Your Brain: The Development of Neuroimaging

The emergence of modern neuroimaging techniques is marked by the advent of the x-ray Computed Tomography (x-ray CT, or CT) technique in 1972.[118] X-ray CT marks the juncture between classic imaging techniques and the modern era of neuroimaging, as it replaced the film based image of x-ray by using computational processes to produce digital images. Renowned neuroscientist Michael Posner sums the change up nicely, stating, "what was really unique in the development of x-ray CT was the employment of clever computing and mathematical techniques to process the vast amount of information necessary to create *actual images*."[119] While using x-rays image the brain was not new, coupling this technique with newly developed mathematical and computational capacity was.[120] Shifting from film to computer-based production of digital images represents a decisive shift in neuroimaging's history in which the brain is opened up through the logic of digital representation.

X-ray CT was followed within two years by Positron Emission Tomography's (PET) introduction between 1973 and 1974.[121] PET has its foundation in the film-based

technique of autoradiography, a technique fundamentally limited by the requirement that the organ targeted for study be *removed* before it could be imaged.[122] This obviously had limited applicability to studying humans, and especially to studying living humans with any interest in prolonging that life. While the ability to image living subjects immediately qualified PET as a useful complement to x-ray CT, it also significantly improved upon its predecessor. Marcus Raichle, who was himself deeply involved in the development of the technique, sums up this difference by stating that while x-ray CT "merely did considerably better what clinicians had been doing for years" with PET "we were suddenly handed a tool that could give us ... measurements in the brain [that] had never been a part of the clinical practice of medicine."[123] New measurements included "blood flow, blood volume, oxygen consumption, glucose utilization, tissue pH, and receptor pharmacology" from the outset, with additional measurements being added later.[124] With PET we can see how immediately after x-ray CT opened up the brain to digital representation, applying advanced computation to the study of brain activity vastly expanded the array of empirical measurements and data available to researchers.

PET was followed relatively quickly by yet another significant new technique: Magnetic Resonance Imaging (MRI). While MRI immediately created images of organ anatomy in far greater detail than those possible with x-ray CT, its later development into Functional Magnetic Resonance Imaging (fMRI) represents the technical capacity distinct from PET scanning. fMRI allowed researchers to look for temporal correlations between sensory inputs and cortical response, as by using a rapid temporal sequence of scans it allowed for the measurement of *change* in activity between states.[125]

These imaging techniques have historically been limited in their ability to provide information about the duration and sequence of activation of brain areas, although this is a limitation that is rapidly diminishing. To adapt to this limitation researchers have used PET and fMRI in combination with various measures of the electrical activity produced by the firing of neurons.[126] Animal studies use electrodes placed in the brain of the subject, human studies rely on Event Related Potential (ERP) and electroencephalography (EEG), a recording taken from the patients scalp. While these techniques lack the ability to describe the functional anatomy underlying the activity they measure in the same way PET and MRI can, their temporal accuracy makes them powerful tools in combination with the spatial representation given by PET, MRI and fMRI.[127]

An acknowledgement of the exponential rate of development in resolution, sensitivity and speed of imaging technology must qualify any statement of neuroimaging's limitations. This is to be expected in such a new field, and is likely to continue growing at a relatively rapid rate for some time. To put this statement in context, when Posner and Raichle published their overview of the state of neuroimaging in 1994 they estimated that a proper PET or MRI scan required approximately 40 seconds to gather enough data to produce an image of what areas of the brain were active during the testing period.[128] Given the speed at which thought occurs; this was a significant constraining factor in the applicability of PET to the localization of brain function. Though combining PET or fMRI with EEG still allowed incredible progress in mapping functional areas of the brain, the speed of imaging techniques relative to the speed of neural activity was obviously limiting. Since that review was published staggering gains

have been made toward improving these existing imaging technologies. Researchers can now produce fMRI images at rates approaching real time, though this is still far slower than the speed of neural activity.[129] The last decade has seen another expansion in available neuroimaging techniques. These include MRI based voxel-based-morphometry (VBM), deformation-tensor-morphometry (DTM), perfusion MRI, as well as magnetoencephalography, transcranial magnetic stimulation, and radionuclide based single-photon emission computed tomography (SPECT).[130]

Where To From Here? Two Current Developments in Neuroimaging

Neuroimaging techniques have had a significant impact on the development of disciplines using them since their emergence.[131] They have made possible the study of phenomena previously relegated to the 'unscientific' consideration of the humanities, such as consciousness, and the opening of the brain in incredible levels of detail allowing for far more accurate descriptions of the content and processes of thought, behaviour, and their underlying neural processes. The two examples presented below represent only a sample of divergent directions that neuroimaging is driving development in the neurosciences.

Development One: Mapping the Neural Correlates of Consciousness

Currently the study of consciousness in neuropsychology is a wildly diverse topic, due in part to the relative youth of this sub-field. It is only since the late 1980's that the possibility of a scientific study of consciousness has been taken seriously, and the last 10 to 15 years that theoretical approaches have been backed up by substantive and dedicated empirical research.[132]

While particular approaches to consciousness differ substantially, and a number of contrasting explanations exist, they are unified by two basic assumptions, which act as the prerequisite to any scientific approach to the problem of consciousness. The first is that consciousness is a distinct cognitive function that can be dissociated from the other cognitive functions of the brain. The second assumption is that, whatever form it may take, consciousness is the product of material processes of the brain. So while consciousness itself may not be a stable concept in neuropsychology, what has come to be accepted is the possibility of dissociating consciousness from other cognitive processes and its origin in the neural activity of the brain.

It is difficult to overstate the role neuroimaging has played in advancing consciousness as a serious subject matter. There are some methods of differentiating between conscious and non-conscious activity strictly through behavioural means, the phenomenon of blindsight stands out, but these are necessarily limited in what they can say about consciousness as a phenomenon.[133] Neuroimaging has made possible the visual representation of a differentiation between conscious and non-conscious activity, through the combination of a variety of techniques focusing alternately on task-based activation and on observing differences in brain activity at different levels of consciousness.

While it may seem controversial to argue that consciousness is reflected in any digital representation of neural activity the application of neuroimaging to the study of consciousness reflects the logical extension of the argument that consciousness arises from neural activity, and is therefore the proper subject of objective empirical analysis. If neural activity produces the effect of consciousness then the content of any particular conscious state must in some meaningful way correspond to the underlying neural

activity. And if neuroimaging is a measurement of neural activity then the digital representation of that activity produced by neuroimaging techniques must in some way reflect the content of consciousness at the time the image was taken. Within this logic the concern that the content of consciousness could never be completely decoded due to the relative complexity of any given conscious state does not contradict the argument that consciousness is reflected in the digital reproduction of a given brain state. While reassembling the content of consciousness may or may not be possible due to this complexity, the assertion of any neuroimaging study of consciousness is still that the resulting digital representation of the brain is not lacking anything necessary for such a reassembly. That is, consciousness does not indicate something in excess of what is observable in the brain.

One of the more influential neurological accounts arising from applying empirical analysis to studying consciousness has come from cognitive neuroscientist Joseph LeDoux. In *The Synaptic Self* he argues that the experience of self is strictly the product of neural activity, that we *are* our synapses.[134]

Like bioinformatics and genomics, LeDoux's reduction of the individual to the brain's synaptic activity allows for tremendous variance between individuals. The assertion is not that we are all identical down to the last synapse as such an assertion would be absurd in light of what is known about the anatomy of the brain and its plasticity and variability. It limits the possible forms of human action to those intelligible within the logic of neuronal activity. Like the Human Genome Project (HGP) creates a certain representation of the human according to the particular logic of digitization and the database, LeDoux sets out the project of neuroscience as creating a certain

representation of the human according to the logic of neural activity. LeDoux's human is displaced a step further, as the only way to know neural activity is through its visualization in neuroimaging technologies. Each of these technologies renders brain activity visible, and therefore intelligible according to its own computational processes of virtualization and digital representation.

For LeDoux then, and cognitive neuroscience in general, observable behaviour, what once stood as the only accessible reality, is but a poor and partial reflection of a subject's true being – its neural activity. That synaptic self, in the process of its technical opening to visual representation in order to render it intelligible, is also disturbed and displaced through its subjection to the techniques of neuroimaging and their specific logics of representation. The synaptic self stands in direct, though troubled relation to the visual representation produced by PET and fMRI, as the human stands in relation to the Visible Human. The classic subject stands doubly displaced. As itself a projection of the activity of the synaptic self, it is twice removed from the digital representation produced through imaging techniques.

At present it could be argued that this doubled self is also limited or distorted by the relative technical shortcomings of neuroimaging. I would argue that this is a matter of immaturity of technology as there are still consistent advances in the ability to represent in real time and three dimensions the activity of the brain. The question of a practical limit on the ability of those technologies to represent the full detail and speed of neural activity remains, but this matter is secondary to inherent problems with digitally representing brain activity, and the relation of brain activity to measures of blood oxygen levels that PET and fMRI are premised upon.

Development Two: Like a Book: Reading Mind

Studying how the brain interacts with its environment through the sensory systems is tied closely to the study of consciousness. Work in this area has largely focused on the visual system, as it is the easiest to approach empirically.[135] Implicit in the argument for the brain as information processing system is the logic that the activity of the brain could then be 'decoded' and read back through the utilization of imaging techniques documenting neural activity. While the idea of reading the visual content of minds, our dreams and mental representations, may seem like the realm of science fiction a recent study by K.N. Kay demonstrated a remarkable ability to do just that. In a technical jump from previous attempts at decoding the representation of relatively simple visual stimuli through imaging of the visual cortex, Kay focused on being able to identify novel, natural images that were presented to the subject. Using both natural and novel stimuli is significant as it requires that the decoder be able to recognize the complexity of natural images as opposed to simple stimuli, as well as identifying which image the subject had seen without prior knowledge of how the subject would respond neurologically to each image (as they would if they had prior imaging's of the patient's response to each visual stimulus). [136]

In the first stage of the experiment subjects were presented with a battery of images and the activity in the visual areas V1, V2 and V3 was recorded using fMRI. This data was then used in the second stage in which subjects were then presented with a set of 120 novel natural images. fMRI was again taken of the subject's response to each image and the data was analyzed to determine which image corresponded to which recorded response. Using this method researchers were able to predict with 92% and 72% accuracy for the two subjects when data was averaged across repeated trials. In repeated trials,

chance performance would be 0.8%. Predicting based on a single trial is much more difficult, yet the model was still able to predict with 51% accuracy for subject one and 32% accuracy for subject two, when chance was again 0.8%. In actual numbers, the model was able to correctly predict 110 out of 120 images presented to subject one when data was averaged across repeated trials and 834 of 1620 images when the images were identified from single trials.[137] Kay repeated these trials again two months and one year later and experienced only a slight decline in performance. This indicates "the stimulus-related information that can be decoded … remains largely stable over time."[138]

Kay concludes that the surprising results "suggest that it may soon be possible to reconstruct a picture of a person's visual experience from measurements of brain activity alone," and goes on to hypothesize that such a 'general visual decoder' may even allow access to "the visual content of purely mental phenomena such as dreams and imagery."[139] While Kay remains optimistic about the "great scientific and practical" value of such a general decoder, the availability of the technology to 'read' even the visual content of an individual's thought strictly through imaging neural activity immediately brings to mind far less utopian applications.[140] Among the unsettling applications the potential extension of such a capacity to the legal justice system is the most concerning, as it invokes the potential for predictive or pre-emptive law enforcement in which guilt is derived from intention rather than action.[141] One version of such an application is explored in Steven Spielberg's 2003 film *Minority Report*, an adaptation of the Philip K. Dick short story of the same title.

Leaving those concerns aside for the time being, the study demonstrates the extent to which the mind can not only be visually mapped and divided according to specific

brain functions, such as the processing of visual data, but the extent to which neural activity in these areas can be meaningfully converted into information in order to discriminate the *content* of that activity, and with a level of success that is surprising given the early stage of such an effort.

Questioning the Reflection in the Mirror: Problems in Digital Eden[142]

At this point it is useful to return to the techniques used in developing and substantiating the above theories of functional localization of brain processes. Information processing models of the brain advocating localization of brain function are now intimately dependent on techniques of neuroimaging to provide empirical data to support and substantiate their theories. But what exactly does a PET or fMRI measure when it reports brain activity?

PET and fMRI rely on different ways of measuring effects of changes in blood-oxygen levels in specific brain areas. While it is clear that these neurophysiological changes do correlate in some manner with changes in levels of brain activity there is not as of yet any clear understanding of what kind of activity causes this change, and what exactly the relation between changes in blood-oxygen levels and brain activity are.[143] As Kosslyn states:

> It's not simply that we don't know whether the activity reflects net inhibition or excitation at the synaptic level, it's that we don't know what the area is doing (is it activating stored information? Releasing some other area from inhibition? Selectively activating a process implemented elsewhere? Transforming input into a different kind of output? ect.) and we don't know how the area is carrying out this computation.[144]

This lack of knowledge of the function of neural activation, not just of functional areas of the brain, becomes all the more significant in the context of the primary method for analyzing neuroimaging data. As outlined by Raichle, the subtraction method remains predominant in the analysis of neuroimaging. In the subtraction method changes in brain activation are determined by taking a baseline measure of brain activity and subtracting this from an image of brain activity during task performance over a number of trials.[145] An added problem with this model is that it does not always measure whether the change in activity represents an increase or decrease in activity from the baseline data.[146]

Raichle notes the problem posed by the ambiguity regarding how exactly neuroimaging results correspond with actual neural activity is compounded by what he describes as the 'sanitizing effect' of a growing dependence in the neuroscience community on computer programs used to determine statistical significance, called statistical parameter maps (SPM). [147] This issue of neuroimaging's technical complexity has come to attention again recently in two public cases. The more recent of the two addresses the failure of authors to properly correct for the effect of inherent machine noise in studies utilizing fMRI data.[148] Although presented in a humorous manner (the study demonstrates how failure to account for noise produces a significant result for a fMRI study the author performed measuring the response of a frozen salmon to human social situations), Bennett et. al's study complements Raichle's concerns regarding potential impacts that a lack of familiarity with the technicalities of data processing can have on results of purportedly empirical analyses of brain activity. It should be noted that at the time of writing Bennett et. al. have encountered difficulty with publishing their report. While their article has failed to attract the interest of journal editors because the

statistical methods they address are fairly standard (to the point where they are included in most current SPM's and are the default setting in at least one major SPM) they argue that examples they provide of failures to correctly employ such basic techniques makes their article all the more pressing.[149]

The second and more troubling article addressing methodological errors in the statistical analysis of data in fMRI studies is an examination by Vul et. al originally released in December of 2008, and subsequently published early in 2009. Vul et al demonstrate how the 'non-independence error' in assessing statistical significance of imaging data produced inflated, potentially spurious correlations between measures of social cognition and measures of brain activity.[150] What is most interesting about the Vul et al paper is that it finds examples of this methodological error in papers published in the discipline's more prominent journals, including *Science, Nature,* and *Nature Neuroscience.*[151] The authors point out that while their study focuses on the prevalence of this methodological error in the area of social neuroscience there is no evidence that the problem does not apply more generally to fMRI studies in other areas of neuroscience and neuropsychology.[152] Again, this provides evidence in very recent fMRI studies of exactly the lack of technical knowledge that concerns Raichle.

Kosslyn and Raichle identify problems with the current lack of knowledge about what neuroimaging is measuring and how this information is processed. These two problems bring the project of information processing models to visually represent a functional atlas of the brain into close proximity with another recent effort to develop an information understanding of the human: The Human Genome Project. In *The Global Genome,* Eugene Thacker explores the role of the database and of the informational

approach to genomics that provide the foundation for bioinformatics in order to bring political operations of the HGP to the surface.[153]

There are two relevant aspects of applying informatics and computational organization to the HGP that have similar effects in the application of neuroimaging techniques to an information processing model of mind. First is the conversion of biological or neurological data into digital information and its organization according to the logic of the database.[154] While this process is currently much more advanced in the HGP, the same logic of organization and standardization of data applies to developing a functional anatomy of the brain. Second is the homogenization of media into binary code[155] that can clearly be observed in neurosciences. This is evident in neuropsychology to a greater extent than in the HGP as computational logic and organization stands as the foundation of the information processing theory of mind.

Thacker points out that one property characterizing a database is that it "is not just a randomly generated grouping of information, but a collection of logically related elements grouped into a single structure for a specific reason."[156] Databases set grounds on which something may exist, or have meaning. Through this same process they define by elimination and a silencing move what cannot exist, what is unintelligible to the logic of the database's organization. In both bioinformatics and neuroimaging this is referred to as noise. In neuroimaging the averaging of images over multiple trials in order to determine statistical significance is employed as a technique to defend against the incursion of noise into meaningful data sets. As Raichle points out, this process is largely being left to the computational logic of algorithmic programs, SPM's, which impose their own specific logic of intelligibility onto the data produced by the original scan.

Neuroimaging is presented with a second problem of intelligibility when converting from scanner data to meaningful data set and digital image. As Kosslyn argues, we don't actually have full knowledge of the functional correlation between blood-oxygen levels measured by scanners and neural function. This presents the immediate problem of excluding potentially meaningful areas and patterns of activity purely on the basis of neuroimaging technologies inability to either initially register, or assign meaning to activity (or functional inactivity) based on the constraints of the code converting initial stimuli to the binary code necessary for its computational processing. This problem of meaningfully converting data received by the initial scan into binary code intelligible to the programs analyzing it for value, and so that it may be then visually represented, is what Thacker referred to above as the second political function of databases: the homogenization of all meaning according to the requirements of binary code.

From Visible Subjects to Visible Subjectivity: Neuroimaging and the VHP

There is another 'Human' project that the current drive in neuroimaging bears a striking resemblance to in terms of its desire to fully expose to the medical gaze the operations of mind and brain: the Visible Human Project. The history and implications of the digital anatomical drive of the VHP have been eloquently argued by Catherine Waldby, and so it is to her description of the VHP that I now turn to find out more about the neuroimaging of mind.

In comparing the VHP to the HGP Waldby asserts that both projects develop and exploit the "relation of the body's delineation to its susceptibility to the logic of archive."[157] As she states: "Both archives stage human species-being through the most

thoroughgoing instrumentalization of the human as itself a system of technics, an array of visual or genetic data."[158] It is not difficult to imagine how neuroimaging expands this project to include subjective aspects of the human: the materialization, normalization and instrumentalization of processes of mind as neural processes. But whereas for the VHP "morphology can only be produced through the spatial logics and inscriptive imperatives specific to anatomical atlas," and in this context the atlas is now digitized, neuropsychology faces a different problem.

In order to conform to the form of an atlas, neuropsychology must first correlate observable morphologies of behaviour with their underlying neuroanatomical functions so that morphology may be visually, and therefore more properly empirically measured. For neuropsychology morphology is initially both behavioural and biological. This requires a double shift in order to essentialize behaviour as a product of its neural substrates. Both in its normalized and deviant forms, behaviour must first be produced and delineated for it to be normalized. Second, neuropsychology may then produce the neuroanatomical atlas of these functions and relations. For neuroimaging this requires the production of a standardized stereotaxic space, to which results of different studies on different patients can be normalized.[159] Raichle described this as one of the primary tasks undertaken during the development of PET, as well as one of the innovations that led to the technique's massive success.[160]

Doubling and Displacement: When the Man in the Mirror Talks Back

Waldby describes the VHP's most disruptive effects as destabilizing the distinction between virtual and real, between double and original. In her words:

> The VHP figures bear witness, first of all, to the instability of the distinction between actual and virtual space. This is perhaps their most dramatic achievement, demonstrating as they do that once living bodies and social entities can be reconfigured *in silico* and strangely reanimated on the far side of the computer screen.[161]

This doubling stands as a challenge to the authority of the material, to its primacy and particular uniqueness:

> This new power of virtual technologies to 'copy' a body does not simply work as a benign reflection, a symmetrical moment in which the human form finds its confirming virtual analog. Rather, like all doubles, the figures displace what they seem to mirror, and like all apparitions they return the familiar in unfamiliar form – the human reproduced and destabilized by the Visible Human.[162]

For neuroscience the relation to the machine/screen is equally disturbing, as it promises to fully represent virtually that which, more than anything targeted by the other Human projects, makes us human: the unique properties, capabilities and contents of our minds. Our virtual double not only threatens us with its physical appearance, as in the VHP, but now also by speaking to us from the far side of the screen. Like the figure in *The Ring* who transgresses this virtual/material barrier rather violently, the specter of virtual representation of mind threatens to reach across the screen and tear us open so that it may betray us in the most intimate details of our private privileged inner space, revealing that unconscious material which we are unable to access our selves, now for all to see. Self-awareness no longer stands as the final word, the most authoritative account of self. Our double knows us more intimately than we can ever hope to know our selves.

Waldby anticipates this encounter in her description of Don Dillilo's novel *White Noise*. The anxiety of its machinic vision, the "abolition of the bodily interior as private, or sacred, space" anticipates the subsequent materialization and destruction of mental space.[163] The "humanist commitment to the unknowable interior is necessarily destabilized by any attempt to treat the interior as itself surface."[164] The VHP and HGP take the first steps, and they are substantial steps, toward destabilizing the humanist subject. Yet Waldby again seems to anticipate neuroimaging in setting this subject up for the promise of its final destruction: "this claim to interiority has nevertheless relied upon an equation between psychic and literal interior, that which exists beneath the superficiality of the body's social and organic surface."[165] The ultimate fantasy of cognitive neuroscience, of the information processing model of mind, is to render the self, the subject, the mind material through its reduction to brain activity. The "atopia" of interiority of psychic space first troubled by the VHP stands faced with its complete and utter annihilation through its final exposure, its rendering transparent to the medical gaze so that it may be spread out visually to be read.[166] This exposure is the premise and the promise of neuroimaging.

On this ground the continued development of neuroimaging can be understood as an extension of both the VHP and bioinformatics, a rendering visible through the logic of the database and binary code of the depths of interiority, of all aspects of self. In the end, "all interior spaces are equally superficial."[167] For neuropsychology this requires the further step of delineating the surface for neural/mental activity. It is not only the exposition and display of interior materiality but also a rendering of the elusive activity of

mind as material. The wings of thought are clipped so that the mind may be mounted on screen, like a digital butterfly on a pin for all to see.

This stands in sharp contrast to the celebration of the human spirit in J.D. Bauby's account of locked-in syndrome in *The Diving Bell and the Butterfly.*[168] There is a certain pornographic air to the cognitive neuroscience's voyeuristic vision, its exposition of soul: "what can be seen, what is superficial and hence visible, is all there is … no subjective depth is attributed" to the processes depicted through neuroimaging.[169]

Targeting Consciousness

It would seem appropriate now to introduce Jordan Crandall's concept of armed vision, in which he examines the targeting function of vision technology's tendency to render visual according to a specific logic.[170] This logic is inherently one making it possible to mark and target difference. In this sense the viewing technology both targets the difference that it delineates and produces that difference through the technologies implementation.

This problematically reduces its subject to that which can be seen or measured according to the logic of that imaging technology. With virtual bodies, and minds, and materiality – this logic is of its conversion to information, to binary code, the logic of its storage, and of its reproduction and representation on screen. What does not fit according to this logic becomes excess – noise, junk DNA, invasive morphology, or deviance depending on context.

Materialization of the visual double proceeds along lines of utility, of what can be said to be useful to the cognitive processes being targeted.[171] Enframing of the individual as productive, reduced to a source of value, has as its second consequence the exclusion

or prohibition of that which the technologies fail to make visible, or intelligible in the case of noise. What is missed, or rejected, is crucial to maintaining a political openness for the materiality of body, and of processes of mind. It is what exceeds, or rejects the logic of visualization that opens a space for political engagement with the project of neuropsychology. This is a potential place for poetics of being to stand against scientific reduction of being to the logics of modern sciences various viewing technologies. The objective of the subsequent chapters is to explore this space beyond the field of view of fMRI and PET scanners, to define what exactly they miss and to make explicit the consequences of the myopic vision resulting from reliance on imaging technology.

Two important clarifications of this position must be made. First is that this is not a matter of immaturity of present technical ability or understanding of the scientific community. The argument is that something fundamental is missed as a consequence of the logic of imaging. While the techniques of neuroimaging are not yet near their technical limits, it is of vital urgency that they be engaged actively and politically before they fully establish dominion over claims to objectively reduce and represent subjectivity as functional brain areas. Second is to distinguish this argument from one seeking to argue against current scientific trends *on their own grounds*. While that type of argument is important, and does have a place within this position, it does not exhaust the argument presented here. It is critical to challenge the specific accuracy of a given study, but also the ground on which it assumes it may lay sole claim to observe and truthfully describe a given phenomenon.

Chapter 3 - Thinking and Feeling: Neural Subjectivity Meets the Emotional Self

While once the quest to study emotion was considered the proper domain of the humanities, or at least it was not considered a proper subject for the natural sciences, recent developments in neuroscience have begun to change this accepted division of expertise.[172] Neuroscientists have been describing the neural substrate and cognitive organization of emotions in increasing detail and confidence over the last two decades. Internationally acclaimed neuroscientist Antonio Damasio is one of the most prominent figures of the sciences extension into the humanities. His books, from *Descartes' Error* to the more recent *Self Comes to Mind* are recognized by popular and scientific audiences as landmarks of the neuroscientific account of emotion.[173] *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* and *Self Comes to Mind: Constructing the Conscious Brain* most clearly and completely state his account of emotions. As such *The Feeling of What Happens* is the most appropriate source to turn to for full understanding of what constitutes the neurobiological self and what is excluded and silenced in Damasio's account of the self.

Against this neurobiological account I argue that emotions and subjectivity cannot be understood in the absence of their social context. Damasio effects crucial silences and exclusions by limiting the influence of the social dimension to the particular content of feelings and the autobiographical self. I will show the consequences resulting from exclusions effected by Damasio's account of the self. While some of these exclusions can be understood through and with neuroscience some of them stand in opposition to such an account. Sara Ahmed presents an argument for emotions as the product of social and

historical forces that exceed what can be viewed through the lens of scientific empiricism.

Ahmed's argument about social and historical sources of emotional community are supported by Lisa Zunshine, who shows that while it may be problematic, the framework given by neuroscience can still be used productively to reveal the social operation of emotion, especially as emotion participates in producing identity. Extending Zunshine's analysis into the political realm shows how identities and social norms we learn from reading fiction are not politically neutral norms, but reflect deeply unequal relations of power. The political operation and framing of emotion becomes glaringly apparent when Zunshine's use of Theory of Mind (ToM) is applied to Jean Rhys's novel *Wide Sargasso Sea*. Rhys makes explicit the history of emotion that operated as the foundation of British imperialism, and the devastating consequences for those tied up in that network of power. Together what all these authors make unavoidable is not only the root of emotion in social and historical relations but also the consequences of excluding these experiences from the study of emotion by subjecting emotion to the occasionally sterile gaze of scientific empiricism.

Neuroscience and Categorization: A Precautionary Tale From the Garden

While researching the empirical approach to the study of emotion in the journal *Cognitive Neuropsychology* two articles having seemingly little to do with emotion caught my attention. Both articles discuss the selective impairment of the semantic knowledge of fruits and vegetables. The context for such an argument is the established theory of "category specificity" in semantic processing, which presents the dissociation of semantic processing of living and nonliving objects.[174] What establishing the existence

of this category specific dissociation asserts is that the brain stores and processes various forms of knowledge about living and nonliving objects separately. Evidence of the brain's separate processing of living and nonliving objects can be found in selective impairments of knowledge of living or nonliving objects. After suffering an injury a patient may not be able to identify a wolf as a wolf but will have no difficulty identifying the year, make and model of a particular car. This patient would be described as having a deficit for the processing of living objects in the presence of preserved nonliving object processing. The authors of both articles seek to prove through the example of impaired fruit and vegetable processing that this broad distinction between living and nonliving objects can be further subjected to much finer categorical divisions.

While I was aware of the more general distinction between the semantic processing of living and nonliving things the specificity of the deficit these two articles were reporting was surprising and, I must admit, captured my imagination. The division between living and nonliving objects had never seemed particularly problematic to me before. Specifying "fine-grain" categories within these broader categories began to raise my suspicions.[175] Fruits and vegetables are presented as one such fine-grain category that subdivides the larger category of living things. Animals are presented as the alternative to fruits and vegetables within the category of living things, with both articles making only passing mention of flowers as a potential complicating distinction.[176]

One of the more obvious problems that Crutch and Warrington take up in their analysis is that the division between living and nonliving tends to become blurred by our species habit of eating things that were once living, but no longer are. "After all," they observe, "fruits and vegetables are not only living things but also foods."[177] While they

eventually argue that food is its own category within nonliving things they make the curious move to distinguish between living foods and nonliving foods. In their words: "nonliving foods (e.g., bread, spaghetti, bacon) are also an interesting category in that the ratio of the living component to the man-made component is greatly varied."[178] There are a host of problems that follow from this statement. Why is bacon a nonliving food when fruits and vegetables are presented as a living food when they later claim that lamb is a confounding example due to its dual identification as a living animal and as a food?[179] They attempt to close off this categorical blurring by stating "there is no evidence that a selective impairment of fruits and vegetables leads to particular difficulties with their relative derivatives."[180] This deferral of categorical identification to mode of food preparation is particularly unconvincing considering their prior statement that it was precisely "the ratio of the living component to the man-made component" which made the example "particularly interesting."[181]

The contortions that both articles are forced into as they try to map the mind's processes onto the world that the mind is processing immediately call to mind Jorge Luis Borges' description of the absurdity and ambiguities of the categorical division of animals in the Chinese encyclopaedia *Celestial Emporium of Benevolent Knowledge*.[182] As Michel Foucault observes in his discussion of Borges in the preface to *The Order of Things,* it is the impossible juxtapositions and the possibility of simultaneously inhabiting multiple locations that positions Borges' Chinese encyclopaedia as a challenge to the very possibility of classification by revealing the arbitrary foundations of any system of classification.[183] "Order is," Foucault argues "at one and the same time, that which is given in things as their inner law, the hidden network that determines the way they

confront one another, and also *that which has no existence except in the grid created by a glance, an examination, a language*."[184] What the cognitive scientist's effort to make the mind's processing of semantic knowledge intelligible to the scientific gaze reveals is the difficulty of imposing conformity and normality onto a processes that does not necessarily conform to the order 'discovered' by scientists in the external world. One of the main sites of disjunction is that the mind does not work on a single register, and in a single context as science has the luxury of doing. The mind must make the world intelligible to both scientific and technical discourses of the workplace as well as to individual's social practices, which often involve the same 'material' objects. Fruits and vegetables are a fantastic example of this confusion of scientific and cultural discourses as their biological taxonomy is relatively basic and generally known, yet they participate in the cultural register as they are prepared daily in our meals.

The necessity of being able to approach similar or identical objects and experiences on a multiplicity of discursive registers applies well to attempts to understand the organization of semantic knowledge in the brain, but it is absolutely unavoidable in the attempt to subject emotion to an empirical categorization. What Borges writes about - the impossibility of capturing the world in language - applies equally well to the language of scientific empiricism, especially as it attempts to pin down the fluid and social movements of our emotional states: "man knows that there are in the soul tints more bewildering, more numberless, and more nameless than the colours of an autumn forest; Yet he seriously believes that these things can every one of them … be accurately represented by an arbitrary system of grunts and squeals."[185]

The larger problem to which Crutch and Warrington's difficulty with fixing the identity of food gestures is that their system of classification has already drifted hopelessly astray from natural order into the complex network of errors that comprises human thought. This departure from the strict order of scientific classification is not a problem in itself. It becomes problematic when you try to assert, as Crutch and Warrington do, that the root of such a domain specific deficit is evolutionary in origin.[186] Their model is already forced to defer to method of food preparation in order to make the distinction between tomatoes and tomato sauce. It is hard to imagine how they could provide an evolutionary account of the place of tomatoes if they decided to further divide semantic knowledge in order to separate fruits from vegetables without admitting the social influence on neural organization.

While I have focused on the problems of their theory I remain in awe that despite all these difficulties neuroscience has still repeatedly demonstrated in practice, at least provisionally, the differentiated impairment of fruit and vegetable knowledge in the presence of preserved food and animal knowledge. They are at once able to demonstrate the specificity with which fruit and vegetable knowledge can be impaired while at the same time remaining unable to provide a rationally acceptable justification for the origin of such a categorical dissociation. While the acuity of their observation in the absence of a sufficient explanation is not immediately threatening when the subject is the details of our semantic knowledge of tomatoes and carrots, the stakes are raised considerably when the subject is human emotion. The authors of the articles discussed above describe fine-grain semantic categorization with different theories, but also present their own theories as counter arguments to a number of other theories claiming to describe the same

phenomenon. Claims that influence *x* is significant to semantic knowledge while stimulus *y* is irrelevant or insignificant are far more problematic outside of the scientific community, especially in social and political realms when *x* and *y* designate social influences from race to gender to social class and not whether a tomato is whole or diced. As our attention turns to the structure of emotion and subjectivity given by Damasio in *The Feeling of What Happens* it is crucial to remain aware of how his account privileges certain stimuli and excludes or silences others.

From the Garden in the Mind to Minds that Gardens (and enjoys doing so)

This appetizing introduction to Damasio's empirical account of emotion is intended to show the difficulty of establishing clear conceptual distinctions between what initially appear to be intuitively acceptable and clearly distinct categories. The extent of these difficulties revealed in the relatively simple example of the semantic processing of the contents of your dinner (versus the plate the meal was served on) is intended to serve as a warning against the uncritical acceptance of the categories derived and described by Damasio to describe the far more complex phenomena of emotion, self and consciousness. The natural sciences have been able to describe with relative ease and endless detail the distinction between fruits, vegetables, animals and inanimate objects. The difficulty cognitive neuropsychology and neuroscience in general continues to have with making the same distinction should make any reader wary of the discipline's ability to describe with any degree of certainty the essential character of emotions and subjectivity, which have remained elusive in the humanities for thousands of years. In the argument that follows I hope to show that such an assertion reflects more than just a sense of indignation and frustration in the humanities similar to what one might feel after

struggling with a puzzle for hours only to have a friend walk up and point out the obvious solution.

While my intention is to question the sufficiency of Damasio's account of emotion and subjectivity I do not want to reject outright the possibility that the study of emotion in the humanities can gain considerably from attention to developments in the neurosciences. Such an interdisciplinary awareness is in fact essential to developing a more accurate and complete understanding of the place and function of emotions in society. I do not argue, then, that the difficulties faced in developing a classification system for the emotions such as the one put forward by Damasio remove any value from such a project. The point of introducing Damasio's account of emotion with the example of the semantic processing of fruits and vegetables is to show that such a project will always be imperfect. Any such project demands careful attention to the silences, omissions and exclusions of its categories. This is especially true of any classification of emotion, where the subject matter so deeply and personally affects those it addresses as its object of knowledge.

Of course if anyone should have not only the "astonishing boldness" but the rare ability to corral the wilderness of our emotional landscape into a nicely organized set of brain states and chemical changes it is most definitely Antonio Damasio.[187] He is internationally renowned for his work on the neurological substrate of consciousness and emotions and his books stand as widely influential landmarks of the study of emotion in both the scientific community and popular culture.[188] *Nature* has credited him with providing, in *The Feeling of What Happens* "the first truly compelling neurobiological account of the self."[189] Using *The Feeling of What Happens* provides not only a single

point of entry into the study of emotion in neuroscience, but access to one of the landmark texts which has had a significant impact in shaping the direction and content of the study of the emotions in neuroscience since.

Damasio's neurobiological account of emotion centers around two sets of distinctions and how connections form between these two areas. He creates a hierarchy of emotion, feeling and pain as separate neurological phenomena. This first hierarchy roughly parallels a second: his division of subjectivity into the organism and the autobiographical self. Damasio's vision of the place of emotion in society is revealed in how connections within and across the two hierarchies are established or refused.

The first hierarchy distinguishes separate neural systems supporting emotion, feelings, and pain. Emotions are innate, biologically given products of a long evolutionary process. As such they are outside and above the influence of social organization and individual experience.[190] I do not wish to reject such a claim outright, but to argue for the need for more conversation between the grand narrative of evolutionary history and the shorter narratives of social order and individual experience.

directed toward the species' survival then feelings are the set of learned *associations* to emotions that are particular to each individual's experience and society.[191] As learned associations feelings are written onto, or in relation to the scripted patterns of emotional response bestowed by evolution. They do not actually change our emotional systems in any way. They can only affect how the individual relates these patterned responses to his or her own personal, historically and culturally specific experience.

The classification of feelings and emotions on the basis of their social versus evolutionary origin parallels, imperfectly, the structure of Damasio's account of subjectivity. The basic distinction is between self, mind, and organism. This division is complicated by its relation to conscious and nonconscious cognitive processes and the phenomenon of consciousness in general. As with emotions, both organism and mind are biologically given. While a distinction can be made between organism, as the totality of the flesh and mental activity of the subject, and mind, the totality of all cognitive and neural functions of the brain, pursuing such a distinction does little to further the argument being presented here. The distinction between mind and self is, in Damasio, the same as that between organism and self. In both instances the self is a part within the larger structure. The self, then, is what is open to the influence of individual experience and social factors. Damasio labels this sense of self, or experience of being a self the "autobiographical self."[192]

The universal biological versus the particular social influence is, as the criteria for distinguishing between both emotions and feelings, and between mind and self, consistent across both of Damasio's hierarchical schemas. Yet the two systems do not parallel each other perfectly. They are closely connected but emotions and feelings are different neural systems. While feelings only exist in relation to emotions they remain neurally and cognitively distinct. In contrast, the autobiographical self exists *within* the mind, which is the totality of all cognitive and neural functions.[193] The self does not define itself in relation to operations of mind, as much as it (we) would like to think so. Instead the self is itself one of those operations. In this sense, self bears more of a

resemblance to emotion and feeling than to mind, as emotion; feeling and self are all part of the larger structure of mind.

At this point it is critical to note that for both feeling and self the neural architecture that makes each possible is biologically given. What is open to social influence in each is the particular content. Feelings stand as the connections developed between the autobiographical self and emotions. The self is the history (memory) of the experience of core consciousness, or the core self. This organization is given, while the content of these connections is specific to the individual.

The distinction between emotion and feeling is, if somewhat uncomfortable, not immediately problematic on its own. The idea that habitual physiological responses might, to a greater or lesser degree than Damasio argues, be passed between generations is not altogether unreasonable. The distinction becomes problematic when you assert that emotions are deterministic, as Damasio does, and assert beyond that that emotions are part of human reason to the extent that they are geared toward the species' survival, as Damasio also does.[194] What is entailed in the assertion that *emotions* are innately part of our capacity to reason is that *feelings*, as learned and cultural ways of relating to emotion and stimulating emotional response, do not innately carry such a connection. While they may improve our innate reasoning processes' ability to navigate a learned social environment, the implication is that feelings may also produce negative effects. Such an assertion becomes troublesome when you look at what Damasio considers to be emotions. Beyond basic emotions he includes as secondary and background emotions: embarrassment, jealousy, guilt, pride, wellbeing, malaise, calm and tension.[195] To assert that these are all biologically determined processes drastically reduces the extent to which

Damasio allows a meaningful place for social and cultural impact on the processes of mind. To understand the implications and consequences of this exclusion of the social from our emotional constitution I would like to turn to Sara Ahmed and her account of the social and historical production of emotion.

An Alternate View of Emotions: Sara Ahmed

Damasio's work marks both the popular and scientific acceptance of neurosciences' foray into the domain of the humanities, granting the science of emotions and consciousness a new sense of legitimacy. While he stands as one of the more visible thinkers operating on emotion as an unfamiliar subject the humanities have been in no way content to concede this ground entirely to the sciences. Among the many recent reconsiderations of the connection between emotion and social order Sara Ahmed's *The Cultural Politics of Emotions* stands as one of the most productive engagements.

In presenting a neurobiological explanation for emotions, what might otherwise be presumed to be the result of a social process, Damasio presents one way of arguing for a material account of emotions. Ahmed also seeks to materialize the operation of emotions in social relations, but takes an opposing approach to Damasio. Instead of the brain developing around an innate emotional register as in Damasio, Ahmed argues that the interpersonal operation of emotion is what enables and produces the materialization of bodies as intelligible subjects.[196] The concept of contact, and histories of contact, as a productive moment that results in the formation of identity, as a history of relating to another body in a particular way, is central to Ahmed's thesis that emotions are the product of historical and social processes. Through these moments of contact identity is formed through its definition of itself in relation to that with which it comes in contact.

The content of this relation is given in the way the self relates emotionally to the contact, and the way the self then relates to the 'other' of the contact emotionally.[197]

The two formative dimensions through which emotional contacts and events produce subjectivity are histories of emotion and the social structures of emotion. The historical dimension of emotion involves how individuals relate to, and are produced through their emotional encounters with legacies of inequality and discrimination. "Repression always leaves its trace in the present" so that our "associations between signs, figures and objects … is bound up with the 'absent presence' of historicity" left over in the wake of past structures of inequality.[198]

The historical dimension of the emotional body is both complemented and complicated by the development of the self through those instances of contact with other bodies through which the self is materialized. To say that the body is materialized by moments of contact is intended as a statement that "undermines the distinction between the subject and the object," the body and the identity attached to that body.[199] What Ahmed is arguing for in suggesting that the self is the culmination of its 'bodily memories' is "that 'no thing' or 'no body' has positive characteristics, which exist *before contact with others* … subjects as well as objects are shaped by contact."[200] As such, subjects do not give meaning to others, or assign value to an event or moment of contact, but are *formed* by that moment of contact in ways that exceed subjective control.[201] These two registers, social and historical, combine so that "the subject materialises as an effect of contact with others and has already materialised given such histories of contact."[202] The body is not a set of innate neural processes to which cultural meaning is attached, but instead is constituted by its interactions and contacts. In this process emotion is the

register on which the self, as an identity comprised of relations to others, becomes intelligible as a self.

Taken at face value Ahmed's account is not necessarily at odds with the neurobiological account of emotion. Damasio would likely respond that what Ahmed discusses is not emotions proper, but the social and historical processes that influence the individual's feelings – the associations each individual develops with the emotional systems. For Damasio it is not problematic to admit that the development of feelings and the content of the autobiographical self might be influenced in one way or another by larger social and historical forces. He is not particularly concerned with this prospect so long as Ahmed is willing to admit that all she's addressing is the relation between society and emotion (i.e. feelings) and not actually changes or structuring of the emotions themselves. Disturbing this cordial allowance, however, is exactly what Ahmed's work makes possible, even if she does not address neuroscience directly.

The challenge Ahmed poses to neuroscience is most clear in her chapter on emotion and the politics of hate. In the operation of hate the emotional constitution of our perceptual systems as a political process is most apparent. The connection between perception, emotion (hate), and the constitution of self in moments of contact that result from the connection of perception to emotion can be seen clearly in Ahmed's reading of Audre Lorde's story of one of her first encounters with race. In this story a small black child is taking the subway and sits next to a well-dressed white woman. The white woman is appalled by the child's audacity and proximity. As Lorde describes: "Her mouth twitches as she stares and then her gaze drops down, pulling mine with it ... She jerks her coat closer to her. I look. I do not see whatever terrible thing she is seeing on the

seat between us – probably a roach. But she has communicated her horror to me."[203] At this point in the story the child is unaware of the history of racism that is being enacted through the white woman, but she is aware of the perceptual activity and visceral reactions of the woman. Without knowledge of the racial politics to which the child is being introduced she is learning that there is a connection between the various responses of the white woman. The story continues: "When I look up the woman is still staring at me, her nose holes and eyes huge. And Suddenly I realise there is nothing crawling up the seat between us; it is me she doesn't want her coat to touch."[204] The sense of shared identification with the woman, their common response to an imagined roach on the seat, is now established as a relationship not between the two of them and the roach but between the white woman and the child. The child is still unaware of the context of this relationship but is beginning to identify with the event, to learn who she is through the contact. "I don't know what I've done … Something's going on here I do not understand, but I will never forget it. Her eyes. The flared nostrils. The hate."[205] While the child has been affected by this contact in such a lasting way that Lorde retains the memory into her adult life to write about it, the historical social organization of racism is not yet intelligible to the child. This will be attached later, but what Ahmed makes obvious through the example is that such a history of inequality does not need to be conscious or obvious in order for it to shape the contact between individuals in a way that racially constitutes the child's subjectivity. The story of the girl on the bus relates how existing structures of racial hierarchy and prejudice are re-enacted and passed on between generations through emotions, as interpersonal relations. The story describes how we

come to learn the stories we occupy as subjects: the girl learns that *she* is the source of the woman's disgust.

This part of Ahmed describes how individuals come to inhabit pre-existing social positions, such as 'black female.' Ahmed also describes emotions as having a social aspect. They are not static positions, but the products of active re-enactment and participation of people. Part of this is the capacity not only to occupy your own subject position but also to attribute to another the characteristics associated with their subject position. One of the principal assumptions of racism is that white and non-white people are somehow *different*. The operation of racism, then, involved engaging with other people on the basis of your assumptions about how they will act, about how they think, and how they will behave. To better understand this process it is necessary to return to the grounds of cognitive neuroscience.

Theory of Mind and the Politics of Emotion: Expanding Neuroscience

Ahmed begins her chapter on the affective politics of fear with a story from Frantz Fanon about a black man being surrounded by a white crowd in Paris in the winter. The principle characters in the story are the black man and a small white child who becomes afraid of the man. While Ahmed focuses on the affective economy between the man and the boy, I would like to draw attention to the process by which the white boy misinterprets the state of mind of the black man. In Fanon's story the black man's shivering from the cold is misinterpreted by the child: "the handsome little boy is trembling because he thinks that the nigger is quivering with rage, the little white boy throws himself into his mother's arms: Mama, the nigger's going to eat me up."[206] The immediate consequence of this misattribution of mind is the reconstitution of Fanon's

black man as a racialized body. As Fanon recounts: "My body was given back to me sprawled out, distorted, recolored."[207] The racial stereotyping that causes the child to fear the black man not only affects the white child but subjugates the man to the child's perception in a way that reconstitutes his body, his sense of self. He is not only identified as different, as a 'nigger,' but as predisposed to *acting* and *thinking* differently than the white dominated crowd. This is reflected in the child's fear of Fanon.

The mechanism through which the boy is able to project a state of mind onto the black body, one which has no correspondence with the black man's actual state of mind, is termed in cognitive psychology as 'Theory of Mind' (ToM) or 'mind reading.' ToM is another area where neuroscience is having an impact on how the humanities approach the operation of emotions. The application of ToM to the analysis of literature is one example of a new sub-discipline of literary analysis termed cognitive literary theory.

Lisa Zunshine takes up the connection between ToM and the practice of reading in her book *Why We Read Fiction*. One of the central ideas of the book is that we are capable of reading fiction because of our capacity for "the attribution of mental states to literary characters … and our tendency to keep track of *who* thought, wanted, and felt what and *when."*[208] We assume that the actions the author has the characters perform are intentional behaviours that reflect the presence of a thinking subject. The second idea in *Why We Read Fiction* that is relevant to the current discussion of the social production of emotion is that one of the reasons why we read fiction is as practice – to develop our ability to properly understand the complexity of the social world by going through the controlled environs of the fictional narrative.[209]

I have used the example of Fanon's experience of racism in Paris to introduce Zunshine's engagement with ToM because it exposes one of the limitations of her otherwise excellent account of what cognitive science can contribute to the study of literature. The example that Zunshine returns to throughout the book to demonstrate the operation of ToM, and the way it makes both reading and normal social functioning possible is one particular scene from Virginia Woolf's *Mrs. Dalloway*. In this scene a trembling Peter Walsh unexpectedly visits his past lover Clarissa Dalloway.[210] The key element of this scene that indicates the operation of ToM in the reader is Walsh's excited trembling.[211] But before getting into the limitations of Zunshine's reading of *Mrs. Dalloway* a bit more should be said about what exactly ToM is.

ToM allows us to effortlessly move through complex social situations by limiting the range of reasonable alternatives.[212] The brain's ability to reliably and automatically produce a manageable range of alternatives appropriate to the social situation is one of the things impaired in autism.[213] While Zunshine focuses on how our capacity for ToM enables complex social activity on a normal day to day basis she pays little attention to the content of the assumptions that are normalized in this process. Zunshine provides a range of normal, possible, and absurd causes for Walsh's trembling at Clarissa's door.[214] What is never suggested is that this man who shows up unannounced after years of separation might be trembling with animal rage and aggression. Yet that assumption is exactly what causes the child to cry in fear when Fanon lies on the ground shivering in Paris. The difference between Walsh and Fanon, even when Walsh is in a potentially much more threatening position in relation to the other characters, is reduced to their race. What Fanon's story adds to Zunshine's application of ToM to literary theory is how

the operation of ToM, including its learning through the reading of fiction, materializes and normalizes bodies in a way that is far from ideologically neutral. Fanon's story demonstrates both the materialization of the man's body as a black body through social contact, and the presence of a history of racism allowing the child to falsely attribute aggressive intentions to the black man in a way that exceeds the child's personal experience yet conforms to a history of racism.

Theory of Mind and Post-Colonial Writing: *Wide Sargasso Sea*

One of the most striking examples where the operation of ToM reflects the rationalization of emotional prejudice through the racialization of emotion is Jean Rhys's *Wide Sargasso Sea.* The novel reveals the normalization of political structures that must be embedded in a reader's ToM for the character Bertha in Charlotte Bronte's *Jane Eyre* to be unproblematically intelligible to the reader.[215] For *Jane Eyre* to make sense, for it to perform its aim of situating Jane as a feminine heroine, it must separate the colonial history of Bertha's character from the manifestation of the emotional trauma of this past.[216] Without such a separation and erasure of the past from the present emotional state of Bertha it is impossible for her character to stand as the mad woman in the attic. In *Wide Sargasso Sea* this denial of the woman in the attic's subjectivity and past is reflected in Rochester's violent renaming of his first wife, Antoinette/Bertha. Her identity, history, and any meaningful sense of her subjectivity as Antoinette are erased by Rochester's refusal to acknowledge that identity, and replacing it with the one dimensional ahistorical name Bertha. Antoinette is the product of a history of the emotional trauma of her colonial past, the legacy of the abuse of Creole women in

Jamaica.[217] In contrast, Bertha is a mad woman, a "paper tiger," who exists only to further the plot of *Jane Eyre* through her supposedly inexplicable madness.[218]

ToM, while it may be what makes it possible to read fiction like *Jane Eyre* and *Mrs. Dalloway*, refuses to stay within the pages of the books we read. Zunshine is explicit that reading fiction is, in part, a way of learning how to navigate the complexities of the social environment.[219] The political organization of race and emotion that makes reading *Jane Eyre* possible is carried over into how we navigate our social environment. The racialization of ToM manifests in real world racial prejudice, and the consequences of this manifestation mimic those Rhys recounts in *Wide Sargasso Sea.* The voicing of Antoinette/Bertha's narrative in *Wide Sargasso Sea* is one way of engaging with the normalization of problematic social practices. The films *The Street* and *Squeegee Punks In Traffic (S.P.I.T.)* by Daniel Cross are another.[220] They present the stories and histories of their subjects as a counter narrative to the dehumanization of the homeless and street involved people.

Giving voice to these otherwise silenced people through documentary helps to challenge the practices, ToM included, which materialize bodies as damaged or violent, bodies to be feared and controlled. By allowing them to speak for themselves Cross enables a counter-narrative that "shatters the windshield between Us and Them."[221] What both of these films make clear, however, is that this materialization of the homeless body or the street kid does not just affect those who are forced to interact with them – police, drivers approached by squeegee kids, or anyone else downtown. The effect that the making of the film has on its subjects is a testament to Ahmed's argument that the moments of contact constitutes *both* parties involved. Several of Cross's subjects are

empowered by Cross's movie to pull themselves out of the socially imposed silence and begin to change their lives in ways that do not reject their position, as homeless or squeegee punks, but which do not conform to the subjective position imposed on them by the actions of police and other people downtown.

Emotional Bodies: Beyond Emotion in the Brain

What is clear in each of the examples presented above is that social and historical influences constitute the bodies and subjectivities of the individuals involved in a way that exceeds the limited vision of the neuroscientific gaze. From Lorde's story of the black girl's encounter with the white woman, to Daniel Cross's contact with his subjects in *The Streets* and *S.P.I.T.*, bodies materialize in ways that cannot be captured by an evolutionary account of emotion. The connections between Antoinette's descent into madness and her experience of British imperialism in *Wide Sargasso Sea* strikes far deeper into the core of her subjectivity than any theory of emotion, without factoring in the social origin of her emotional trauma, can possibly hope to account for. For Damasio such an example must necessarily revert to the exclusion of Antoinette's past in a way that mimics the same exclusion in *Jayne Eyre*, so that she is defined by the appearance of madness and subsequently reduced to her madness. Such trauma cannot be addressed solely by treating it as an ahistorical condition. This simply normalizes the social practices responsible for the production of the emotional trauma in the first place, erasing the fact that Antoinette was not always Bertha, but must become her through the erasure of Antoinette. Rhys closes Rochester's narrative in *Wide Sargasso Sea* by making explicit the effect of this process of silencing and the way it erases the subjectivity of the traumatized and victimized: "very soon she'll join all the others who know the secret and

will not tell it. Or cannot. Or try and fail because they do not know enough ... others are waiting to take their places, it's a long, long line. She's one of them. I, too, can wait – for the day when she is only a memory to be avoided, locked away, and like all memories a legend. Or a lie."[222] What in Rhys is the loss of history through a return to England is in the present context a return to the sterile and austere language of scientific empiricism with which neuroscience promises to dissect and present the emotions. For neuroscience the emotional subject must be erased of any complications of the social historical traces that constitute that subject. Social and historical forces cannot provide foundations for the sterilized categorization and universal application of a scientific theory of emotion. They must be jettisoned to make the neurobiological self intelligible to the scientific gaze. Ahmed, Rhys, and Zunshine have shown that this cleansing move comes with disastrous consequences for the individual. Those who are the victims of racial, imperial or civilizational, and class hierarchies are then doubly victimized as the sources of their emotional and psychological trauma are unintentionally denied by the very professions who state as their aim the treatment of such pain.

The focus to this point has been to establish the insufficiency of the exclusively neural based account of emotion presented by cognitive neuropsychology, even when the traditional cognitive approach is expanded to consider the role that affect plays in mind. My intention is not to discredit the influence of Damasio's expansion of neuroscience into the affective realm, but, instead, to argue that this important step is not the final one. It opens the door to a potentially productive joining of the humanities and the sciences in the study of emotion, but on its own it falls short in the very important ways I have highlighted in this chapter. Having firmly established the range of erasures and silences

effected in Damasio's approach, I will turn in the next chapter toward establishing a framework which can not only accommodate both materialist considerations of the neural underpinnings of mind as well as social factors that exceed that model, but which productively bridges these two approaches.

Chapter 4 - Neuropsychology and Subjectivity: Materialism, Embodiment, Critique

Up to this point the scientific and social discourses have been presented primarily as oppositional forces in the debate over how to define subjectivity with either side insisting on the centrality of a concept that the other cannot account for, be it social factors or neuroanatomical structures. Even in Zunshine's account of ToM, the neuropsychological and the social remain independent. Where they are not in direct disagreement, they are never actually engaged in meaningful conversation with one another. Instead, ToM is presented as an updated account of the scientific givens; a new tool that *tells* us about how we read, and how this changes how we can analyze fiction.

While all of these approaches (scientific discourse; social critique, whether of science or without reference to science; and Zunshine's limited cross-conversation between the two) are interesting and necessary in their own right, none of these is sufficient on its own. Examining Damasio's neural account of emotion demonstrates the necessity of social inputs in excess of strict scientific objectivity. However, theoretical critiques of scientific discourse have proved as reductive as the accounts they take on.

William Connolly, in *Neuropolitics*, provides one model for engaging political theory with contemporary developments in neuroscience. He brings Derrida's literary theory, film studies, cosmopolitan political theory and neuroscience into conversation. However, like Zunshine, in maintaining the independence of each discipline he fails to engage with how the elements of each discipline he analyzes reverberate back into all of the others. More than in Zunshine, the consequences of maintaining this disciplinary closure are glaringly present in *Neuropolitics*.

Elizabeth Ann Wilson provides a critique of reductively antibiological theoretical positions and of the limited form interdisciplinary engagement typified by Connolly. She also provides an alternative model for the development of a productive discourse combining the materialism of neuropsychology and the discursive analysis of feminist theory, achieved through the refusal of disciplinary distinctions. She makes the argument "to think the conjunction criticism-science is … never simply a matter of adding two discrete and independent domains. It is always an unraveling of the interdependent structure of debts and disavowals that constitutes these domains."[223] It is in this spirit that she presents a new approach to thinking cognition based in aspects of embodied feminism, cognitive neuropsychology, Derridean deconstruction, and connectionism.

The model Wilson develops around what she terms the microstructures of cognition provides an excellent foundation from which to move forward in developing a model of subjectivity based in a merger of neuropsychology and contemporary critical theory. Wilson also provides opportunity for a more positive return to Damasio who, in return, provides a more nuanced approach to Wilson's attempts to articulate a model of embodied connectionist networks.

Neuropolitics: William Connolly's creative dimension of thinking

With the goal of expanding the scientific discourse of cognitive neuroscience and neuropsychology to include social elements that the previous chapter's analysis of Damasio demonstrated were lacking, William Connolly's book *Neuropolitics*: *Thinking Culture Speed* would seem like a useful place to start. In *Neuropolitics,* Connolly draws from neuroscience, film studies, and literary theory in addition to his own well-established work in political theory. His project is similar to Elizabeth Wilson's, whose

work will be explored later in this chapter, as both insist on the unavoidable connection of biology to theory and culture, whether or not that connection is acknowledged. Both authors insist on a strong material dimension to thinking in connection with consideration of the cultural context of those material processes. Wilson focuses on the promise of connectionist networks to reimagine cognition, while Connolly's focus is on what he terms the compositional dimension of thought. Finally, both also employ the Derridean notion of 'play' in systems of signification, though in very different ways.

The two part ways, however, as Connolly abandons the concepts developed through a close association with biology in the first part of his book in order to reaffirm his pre-existing ideological framework. The biological foundation is retained only as empirical confirmation for a previously established model of the modern liberal humanist subject consistent with Connolly's cosmopolitan pluralism. While I will explore the consequences of Connolly's turn away from biology, examining the reliance on this modern understanding of the subject in *Neuropolitics* presents an opportunity to consider how this model of the subject is assumed (and subsequently 'found' or 'confirmed') in the empirical and social sciences alike. Working through *Neuropolitics* will also provide a foundation for considering whether the liberal humanist understanding of subjectivity is the most accurate or appropriate given what the development of the neurosciences can tell us about the material processes through which thought occurs.

Connolly opens *Neuropolitics* by introducing what he sees as a shift within the neurosciences from deterministic materialism into a more open discipline, a shift indicated the developing appreciation of the "layered character of thinking" and the need to consider the "compositional dimension of body-brain-culture relays."[224] He argues this

shift "alerts us to the critical significance of *technique* in thinking, ethics, and politics."[225] Connolly engages with this shift as the foundation for what he terms *neuropolitics:* "the politics through which cultural life mixes into the composition of body/brain processes ... and vice versa."[226]

Thinking at the intersection of neuroscience and cultural life, Connolly argues, enables a new vision of political life. For Connolly, what is opened up is a new vision of cosmopolitan pluralism capable of "coming to terms thoughtfully with contemporary issues unsusceptible to resolution by one country, one faith, or one philosophy."[227] Cosmopolitan pluralism joins together "an irreducible plurality of regulative ideals" no longer able to claim access to an absolute source of knowledge.[228] The mechanisms enabling this unification are an ethic of agnostic respect and the cultivation of self-modesty. While at first this political vision seems far removed from the particularities of neural activity, it is precisely through recourse to the authority of neuroscience that Connolly grounds his pluralist ethic as independent and apolitical.

Before Connolly can present his vision of cosmopolitan pluralism he must first create the need for such a supra-national authority. This requires demonstrating the insufficiency of current theist and secular claims to essentialist sources of knowledge and ethics. The first half of *Neuropolitics* is devoted to establishing the impossibility of a transcendent or universal source of knowledge. This impossibility is demonstrated through the argument for a dynamic and constantly changing natural order. There are two elements to Connolly's account of this dynamic order: the materiality of thinking; and the indeterminacy of natural systems. The materiality of thinking focuses on the way the affective quality of thought, techniques and tactics of thought, and the role of perception

and memory in thinking are developed in relation to neuroscience. The work of Ilya Prigogine grounds Connolly's discussion of the indeterminacy of natural systems. Connolly grounds his argument that knowledge is immanent in the individual neural register and in the general structural level.

Connolly moves from this dynamic imagining of nature to the political sphere. The connection occurs through an argument for techniques of thought as the foundation of an ethic of deep pluralism and agnostic respect. Connolly labels this tactical element of thought the micropolitics of cognition. Against transcendental visions of ethics Connolly argues for an immanent ethical plane, susceptible to modification through tactical practices of techniques of thought. The ethical dimension of micropolitics provides the first entry into the overall political project of cosmopolitan pluralism Connolly develops in the second half of the book.

Connolly's insistence on the immanence of all sources of ethics leads him to argue for the necessity of a deep pluralistic approach to politics. The impossibility of grounding one's own ethical claims in an absolute source forces an ethos of pluralist respect for the claims of other ethical systems. For Connolly this pluralist order necessarily exceeds the claims of state sovereignty and ascends to the possibility of a pluralist cosmopolitanism.

The ethical foundation of cosmopolitan pluralism is made possible by a second foundational requirement of such a vision of politics: the modern subject. Connolly does not provide a detailed review of the model of subjectivity his argument relies on. Instead, it must be pieced together from glimpses and appearances throughout the book. Connolly presents a neurologically inspired account of individual subjectivity that reflects the

central requirements of citizenship in a cosmopolitan political community, including wilful, autonomous and ethical action. Through the selective practice of techniques of thinking Connolly's neural subject is able to direct his patterns of thought toward the ethical ideal of modesty and respect central to the diversity of cosmopolitan pluralism.

The model of subjectivity that emerges to support Connolly's argument for cosmopolitan pluralism calls into question the radical gap Connolly argues exists between his image of nature and the causal universal models of nature he opposes. Connolly claims that his vision of politics is inspired by a fundamental departure from the conception of nature found in classic empirical science and a theistic image of divine natural order. The models of subjectivity and authority that are found in his cosmopolitanism do not end up departing significantly from the established relationship between science, authority and progress detailed by Shiv Visvanathan in "From the Annals of the Laboratory State." The consequence of Connolly's ethical injunction to self improvement and refusal of any claim to essentialist forms of identity emerge when *Neuropolitics* is read through Visvanathan's work. The idea of *triage* Visvanathan develops is not limited to a vision of politics founded in reductive materialist models of science. Refusing to extend his critique of essentialist forms of knowledge to his own model of subjectivity limits Connolly's argument for cosmopolitan pluralism in *Neuropolitics.*

Setting the Stage: Connolly and Nature

Neuropolitics, as an argument presenting a new foundation for democratic pluralism and ultimately revitalizing cosmopolitanism, begins farthest from the recognizable grounds of political theory as possible. The first chapter introduces readers

to current approaches to neuroscience, and brings in film as a technique for reconceptualizing political thought.

From the outset, Connolly's interest in neuroscience is qualified and cautious. Cautious because he is aware that he is by no means a neuroscientist.[229] The qualification is that his interest in neuroscience is limited to what it can say about the relationship between thinking and politics. Qualifying Connolly's interest in neuroscience does not diminish its place in his theory or imply that it is dishonest. As he points out, "every theory of culture bears an implicit relation to biology and biological theory."[230] With the intention already on the table that he will eventually tie neuroscience, as a biological theory, to his own brand of cultural theory we can now turn to the details of his vision of neuroscience. He defines contemporary neuroscience against three existing reductive approaches joining science to cultural theory. The first two are the "classical conceptions of nature."[231] The "theo-teleological tradition" on the one hand and on the other a "law like model of science" that has defined itself against the first tradition.[232] The third approach emerges as a response to the first two. Echoing Wilson's problematization of feminist critiques of science, Connolly describes a "disembodied conception of cultural life" which emerges when, in an "attempt to ward off one type of reductionism …[cultural theorists] lapse into a reductionism that ignores how biology is mixed into thinking and culture and how other aspects of nature are folded into both."[233]

For Connolly it is their reductive stance, not their particular content, that limits these three approaches. Neuroscience, in combination with an attention to the social context of political thinking, opens an alternative non-reductive approach to biology. Neuroscience denies the possibility of reductive biology on two levels. First, in

recognizing the layered character of thinking and, second, in developing the *compositional dimension of thinking.* The compositional dimension of thinking refers to "the way in which thinking helps to shape and consolidate brain connections, corporeal dispositions, habits, and sensibilities."[234] The compositional dimension of thinking refers to the material instantiation of thought that lends our perceptual and cognitive habits their persistent character. As Connolly quotes Gerald Edelman and Giulio Tonino, "neurons that fire together wire together."[235] The material foundation of thought provides empirical justification for the possibility of corrective improvement as it provides a foundation for thought that is physically present in neural patterns of thought, unlike innate states of mind that exceed immanent correction.

The layered and compositional dimensions of thought combine to make possible the *creative* dimension of thought. This is the central concept of Connolly's theory. The creative dimension of thinking is central to Connolly's argument in *Neuropolitics* as he uses it to bring the modern individual back into his image of nature. For the purpose of an engagement with Connolly the most important characteristic of the 'modern individual' is a capacity for wilful or intentional action; the modern individual implies the possibility of a certain degree of autonomy of thought. This individual enjoys a certain degree of separation from the surrounding environment and the will to engage in that environment in his or her own, self-defined interest.[236]Above all, and as the condition that makes the freedom and autonomy of the individual possible, is the unity of the individual. This unity *as* a subject is tied closely to its autonomy from the surrounding environment. It is also what makes it possible to discuss the behaviour and intentions of the individual as attributes or evidence of an *individual actor*.

Connolly's introduction of the creative dimension of thought is at once his insertion of culture into the findings of neuroscience and his insertion of his own conception of culture into those same findings. Connolly's vision of nature is later grounded in Ilya Prigogine's model of a non-causal natural order. Neither of these models on their own, however, can support the idea of a creative dimension of thinking. Connolly inserts the idea of intention. The difference is between identifying the accidental, random and unpredictable element to thinking and saying that this indeterminate element acts as a pathway for creative forces attributable to a human actor. The former values randomness, the latter an ability to direct unpredictability towards achieving pre-existing objectives.

The creative dimension of thinking acts like a filter throughout the remainder of *Neuropolitics*. Every theorist and concept Connolly introduces becomes coloured by the possibility of an intentional, creative element of thought. The idea that the subject can direct the development of his thought *according to his own interests* makes possible Connolly's argument for micropolitics, pluralism, immanent ethics and eventually cosmopolitan pluralism.

The first instance when the intentional character of the creative dimension of thought influences Connolly's reading is in his introduction of techniques of thought. The book's most in-depth engagement with current neuroscience ends with a note on V.S. Ramachandran's famous 'mirror-box' solution to phantom limb syndrome. Simply put, Ramachandran was able in some instances to relieve a patient's painful experience of a phantom limb by enabling the experience of having regained use of the limb through an arrangement of mirrors. [237] Ramachandran's experiments with phantom limb syndrome

"suggest that in domains where direct intellectual reconfiguration is insufficient … an ensemble of techniques or tactics applied to regions below direct intellectual control can sometimes reorganize predispositions to perception, feeling, and judgment."[238]

Connolly bridges the gap between clinical practices targeting the physical experience of pain and his interest in the politics of neural organization by introducing film theory to the discussion. Through the manipulation of perceptual experience possible in film the neural plasticity that allows the physical "re-composition of brain connections" can be repurposed as a tool for the "arts of self-cultivation."[239] Joining film and neuroscience creates the context for a "return to forgotten questions about how cultural ritual, discipline and arts of self-cultivation infiltrate patterns of thinking, identity, and ethical sensibility."[240] "Relational techniques of the self," or techniques of thinking refer to attempts to change the way we experience and relate to the world on both the conscious and non-conscious, affective registers of thinking.[241] Connolly focuses on visceral or affective layers of thinking that "pass below intellectual attention while still influencing emotions, judgments and actions."[242] The affective layer of thought will later be central to Connolly's argument for the immanent ethical register. His intentions for potential use of techniques of thought are already explicitly clear. Neural plasticity carries over from neuroscience to film as the promise of self-improvement. As an intentional challenge to normalized perceptual habits, film carries the potential to "inspire creativity in your own thinking or to cultivate some noble potentiality in your sensibility."[243] As noted earlier the connection between technique, creativity, and intention opens space for the entrance of a 'noble potentiality,' as the randomness of non-deterministic change quietly exits stage left.

Nobility is not the only unexpected guest Connolly picks up traversing through film from neuroscience to political theory. This cinematic diversion also allows a shift in terminology. The medical discourse of rewiring by "tactical means" that is appropriate to the intention to target and eliminate pain is shifted to the softer term "techniques of thought."[244] While Connolly's interest in the affective layer of thinking helped him to avoid the militaristic inflection that would come with framing film as a 'tactical media,' the connotation of elimination and normalization of thought processes carries over to his discussion of techniques of thought. Eliminative implications of advocating technical work on thought remains fairly quiet, however, until Connolly ties this creative element of thought to his model of cosmopolitan pluralism.

From Technique to Politics: Ethics and Pluralism

Techniques of thought and the creative dimension of thinking may operate at the intimately individual level but Connolly's argument in *Neuropolitics* is that they are also the foundation for a new cosmopolitan vision. This requires that he move from corrective measures targeting individuals to the grand scale of political organization. Connolly's route is through ethics to pluralism, and from ethical pluralism to cosmopolitan pluralism.

In moving from the personal register to the interpersonal considerations of the ethical register Connolly's neural indeterminacy comes face to face, once again, with reductive claims to knowledge he opposes. Having found his way out of classical neuroscience's reductive materialism though neural plasticity and tactical neural re-organization he runs up against two claims to absolute sources of ethics: the divine source of theist ethical systems and the transcendent ethical imperative of a rational order that Connolly takes up primarily in Kant.[245]

Connolly is not concerned with particular content or specific ethical demands of any of the systems he approaches, be they theist or secular. They are reduced to a single characteristic in that they present either an essentialist position incompatible with a pluralist system or they recognize the contestability of their own claims in a manner conducive to pluralist engagement with other ethical systems.[246] While Connolly's own position is immanent naturalism he positions that approach as "one among several contestable existential faiths from which a positive ethos of engagement might be negotiated between interdependent partisans in a pluralist culture."[247] The source of faith and ethics is Connolly's target in advancing a non-deterministic natural order. In challenging essentialist ethics, content of a particular ethical system is secondary to assumptions about the nature of that system's source.

Connolly turns to Ilya Prigogine's work on the character of science and dissipative structures to generalize the non-deterministic approach he finds developing in the neurosciences. While systems may exist in equilibrium, far from equilibrium these 'dissipative structures' are "marked by an element of internal unpredictability, by capacities of self-development, by periods of significant openness to outside forces, and by a trajectory of irreversible change that endows them with a historical dimension."[248] What makes Prigogine's model especially attractive to Connolly is the aspect of retrospective intelligibility that emerges when, after a period of unpredictability "sets new possibilities into motion," a "new state of order" can be observed.[249] Prigoginian order, then, "lies somewhere between the two alienating images of a deterministic world and an arbitrary world of pure chance."[250] The possibility of knowing the world is constantly suspended between what is observable, and the possibility that it could at any point

change that casts the future as "a contestable expectation."[251] As a foundation for social organization this natural order insists on contingency of the natural world against any claims to immutable or divine organization of nature.

Connolly employs Prigogine's insistence on the indeterminacy of the natural world to deny transcendental ethical claims their absolute foundation. Ethical systems are at most an immanent order, subject to change, revision and always deeply contestable. To this end Connolly replaces the Kantian transcendental ethical plane with an immanent ethical plane.[252] The two operate identically, directing thought prior to the intellectual layer of thinking.[253] The difference is that in refusing a transcendental ground for the ethical plane, Connolly's immanent plane "retains some susceptibility to cultural inscription and technical intervention."[254]

Once the immanence of ethical claims is admitted, and a Prigoginian view of nature insists that it must be, Connolly argues moving to a deeply pluralist order is obvious, if not inevitable. If no one system can claim to have discovered an absolute source of knowledge or ethics, how can anyone assert authority over any other system on the basis of the veracity of his or her ethical vision? The contingency of knowledge shifts the approach to ethics away from a debate contesting the essential value of the particular content of opposing ethical visions. The important question becomes how ethics are practiced and cultivated.[255] Changing the debate's focus to how ethics can be cultivated, however, assumes acceptance of Connolly's insistence on the ethical register's susceptibility to tactical work. Accepting ethic's openness to tactical work is already to admit that the particular content of the ethical framework is not of divine or transcendent origin. For Connolly, recognition of transcendent ethics impossibility necessarily entails

a pluralist order founded on "agnostic respect" for other ethical systems and "self-modesty" in one's own identity and ethical sensibility.[256]

Connolly follows William James in arguing "an ethos of deep pluralism is the most promising way to extend freedom in a state already inhabited by proponents of multiple faiths," where "faiths" applies equally to religious and secular orders.[257] Connolly builds off James' work in developing how techniques of thought can foster a non-conscious and affective foundation for an ethos of pluralism. Ethics ties into deep pluralism as the tactic through which an openness to pluralism can be developed. "Ethical artistry, in its highest forms, is work applied by the self to itself to render its relational proclivities more congruent with principles it professes, to put the self in the position of responding more generously to newly emerging identities that call into question the self's implicit sense to embody in its mode of being the dictates of the universal."[258] In the context of the impossibility of claims to essentialism and the proliferation of new identities, pluralism stands for Connolly as the method of organizing society through which each of these emergent identities has the freedom to develop as it wishes without dooming the entire system to the nihilism of cultural relativism. [259]

Connolly does not stop at arguing for the merits of deep pluralism within the limits of a given state. He repeats throughout the book that his target is as much secular sources of ethical authority as it is theist sources. Insisting on the absolute nature of its own authority deems the sovereign state unsuitable to pluralism as a mode of governance. In addition to its assertion of absolute sovereignty Connolly argues that the state is not compatible with the accelerated and differentiated pace of modern society. It is suited for the slow deliberation of democratic politics at best, rendering it unable to deal with the

multiple accelerated tempos of modern politics.[260] The only possible political form that Connolly thinks can deal with both "an intensification of intraterritorial pluralisation" and the pace of modern life is cosmopolitanism.[261] Far from accepting Kant's apodictic recognition of morality as the foundation of cosmopolitanism Connolly argues the diverse form of cosmopolitanism "involves the difficult task of coming to terms receptively and reciprocally with the multiple and contending final sources of morality."[262] A "new matrix of cosmopolitanism, then, to the extent that its citizens "cultivate such self-modesty in their respective existential faiths… becomes populated by more citizens coming to terms thoughtfully with the contemporary issues unsusceptible to resolution by one country, one faith, or one philosophy."[263]

Re-examining the Cosmopolitan Citizen

One might argue that pluralism based on the principle of agonistic respect is not all that challenging of a concept. It is also not all that useful. In itself it provides no mechanism to settle disputes between distinct ethical systems. This critical point is never explicitly addressed by Connolly in *Neuropolitics*. The logic of authority that his cosmopolitan pluralism entails can be drawn out of his discussion of the relationship between ethics and pluralism.

Two key concepts reveal the logic of authority and exclusion inherent in Connolly's *Neuropolitics*. The first is the rejection of essentialist sources of ethics and identity. The second is the possibility of self-improvement through techniques of thinking. The second becomes an ethical injunction when combined with the first. Ethical pluralism requires that the individual, in recognizing the impossibility of proving his own ethical source, work on his own perceptual habits so that he may be more open to

recognizing the claims of others. Connolly is quite clear in his rejection of essentialist forms of identity: "the *base* treat themselves as if they were born to be what chance and power have made them." At the opposite end of the spectrum the noble are those who "cultivate a grace and ease of conduct," and "enter into affirmative relations with other types of nobility" with the sensibility that "its projection is apt to be profoundly contestable in the eyes of others."[264] As soon as his cosmopolitan ideal has been set up it immediately functions to exclude those not willing to recognize the "legitimate contestability" of the source of their subjective identity.[265]

Despite Connolly's often stated objection to essentialist and reductive science he ends up reproducing the relationship between science and sovereign authority he turned to science to escape. Connolly's cosmopolitan authority still requires that all citizens acknowledge cosmopolitan order as a higher authority than their individual ethical sources as a condition of their inclusion in society. Modern science falls back into its legitimizing function in *Neuropolitics*, as the ethical imperative to practice artful improvement of self directly contradicts any essentialist claims to identity. Those who refuse to change are labeled as 'base,' and unable to keep up with Connolly's self-improving nobility. Shiv Visvanathan argues that what this relationship between sovereignty, science, and the imperative of progress results in is "the idea of triage: the combination of the concept of rational experiment, the concept of obsolescence and vivisection – whereby a society, a subculture or a species is declared obsolete and condemned to death because 'rational' judgment deems it incurable."[266] While Connolly works hard to downplay the role of deterministic reason in his theory, determinism is not necessarily a requirement for the idea of triage to find its way into his work. His

connection between his use of neuroscience and his ethical imperative to social improvement is glaringly obvious at times, perhaps most when he refers to his call to pluralism as "the great experiment."[267] Even when not stated so bluntly, the logic behind "self-experimentation" with the techniques of thought and self that underlie the possibility of ethics, pluralism and cosmopolitan order belie the logic of triage.

Operation of the idea of triage can be seen most obviously in the confrontation between capitalist societies of Connolly's nobles and societies whose identity, and very existence are tied to place. Visvanathan presents the example of Mega Dams in developing nations, which each require the forced relocation of tens of thousands to hundreds of thousands of people.[268] The refusal of any essentialist source of identity refuses to acknowledge "that to a traditional people land is not real estate or a space over which people are moved like objects. Land is memory, a map of one's world, a way of life for which people are willing to die."[269] He argues that the term "displacement" is used in a way that covers up this process of development "as slow genocide" for the young and healthy, and "the moment of death" for the old, few of which can make the transition from their society to the foreign society of the refugee camp.[270] Though Connolly denies such a position, what this type of confrontation reveals is the implicit logic of development and progress contained in his cosmopolitan pluralism's imperative to self-improvement. Indigenous peoples "must either acculturate or disappear" as the laboratory sovereign "must break the rituals of tribalism and traditional farming" in which an attachment to place is an essential source and requirement of identity.[271]

Connolly takes great pains to distinguish his theory in *Neuropolitics* from progress-oriented models of linear history.[272] Introducing neuroscience served to distance

his image of nature from that of the reductive classical sciences. Those classical sciences were pushed even further away through his reading of Prigogine's dissipative systems. How, after all this effort, does Connolly find himself stuck back in the same science-society order he set out against?

Two concepts tie Connolly to the vision of science-society he disavows in letter but cannot let go of in spirit. The first is the possibility of ethics. While it was shown above that he has minimal interest in regulating the content of other's ethical claims, the entire objective of his order of cosmopolitan pluralism exists to insure that the *possibility* of ethical action persists.[273] Almost as soon as he declares his debt to Prigogine his allegiance to Prigogine's insistence on the indeterminacy of chance falters. Connolly's insistence on an ethical potential imposes a concept that transcends the play of the Prigoginian natural order.

Connolly's insistence on the modern subject's persistence is the second concept betraying him to Prigogine. Inventive and compositional dimensions of thinking are framed as "essential to freedom of the self," and serve as the constitutive possibility for the individual's employment of techniques of thought to self-correct his perceptual engagement with the world. Connolly is explicit about the distinction between a passive mode of subjectivity and his insistence on a subject capable of engaging with the world and with his own patterns of thought, as well as driven to do so. The distinction between passive subject and the active, "artistic" subject is the ground on which Connolly asserts his vision of nobility and the noble actor described earlier.[274]

The logic of triage and the imperative to development that Visvanathan makes undeniable at the macro level does not disappear when Connolly retreats to the neural

level. It becomes more explicit in Connolly's command to practice techniques of thinking as "ethical artistry."[275] 'Ethical artistry' joins together two problematic assumptions in *Neuropolitics*: ethics and the modern subject. The possibility of ethics, as discussed above, returns a transcendental ideal to Connolly's indeterminate order. The modern subject creates distance from that transcendental ideal that allows it to work toward the achievement of that ideal, even if it may never attain perfection. Existence of the subject in time, its immanence, separates it from the fixity of the transcendent and the divine. The virtue of existing in time is that in the indeterminacy of the subject's existence it can be improved, and it can improve itself in a way that aims toward better alignment with the transcendental ideal. We can, to an extent, correct our thinking with a mind to purifying it as much as possible, if never completely.

This corrective practice takes place though implementation of techniques of thought outlined in Connolly's discussion of modern neuroscience. In effect, these tactics of the self subject the individual to the gaze of science-societal authority by providing technical means and the ethical imperative to self-artistry. *The individual is now the target of science*, and of progress. Indeterminacy of thought does not relieve the individual of the obligation to improve patterns of thought. Quite the opposite. This indeterminacy contains the very possibility of such a process of self improvement. The consequence of this shift in scientific gaze to the level of the individual is that now the idea of triage outlined in Visvanathan applies to the practices of individuals and not just larger communities and societies of individuals.

However, if Connolly were willing to extend his criticism of transcendent and theist ethical systems to the model of the individual he refuses to let go of he would be

able to fully develop the critical potential of the compositional layer of thinking he develops throughout the book. While the compositional dimension of thinking represents a critical step to reconceptualizing the interplay of social and biological factors that comprise political activity, Connolly's analysis remains limited by his attachment of the capacity for creative thought almost exclusively to a concept of the subject that receives little to no critical consideration. Elizabeth Wilson, in focusing on ways in which to reconceptualize the ontological status of cognition itself, and precisely in doing so as a challenge to existing models of subjectivity, begins her analysis at the point where Connolly's begins to falter.

Elizabeth Wilson: Connectionism, Feminism, Materialism

In *Neural Geographies: Feminism and the Microstructures of Cognition*, Elizabeth Wilson, like Connolly, takes on the project of creating a common ground between scientific discourse and theoretical consideration of the subject. Unlike Connolly, who uses this connection to furnish the pre-existing theoretical construct he brings to the project, Wilson's objective is to establish the possibility of a different type of relation between scientific and critical theoretical discourses. Her intention is to do away with the mutually self-imposed disciplinary separation that allows both sides to continue producing reductive accounts of subjectivity.

Wilson's work opposes feminist theories of embodiment arguing for embodiment in the absence of material biological considerations of the body. She argues the anti-biological position they develop is equally reductive as the positions of the cognitive neuropsychologists they oppose. Working through the problems she identifies with both of these restrictive discursive positions, Wilson proposes an embodied theory of

cognition based in a merger of the connectionist theory developed in the 1980's by McClelland, Rumelhardt et al and Derridean notions of play and pure difference.

While Wilson's initial critique of both feminist anti-essentialism and cognitivist neuropsychology is useful in its attention to material considerations, the closing chapter of her book, like Connolly's, wanders back into the more abstract space of linguistic theory and away from its biological instantiation in processes of cognition. Unlike Connolly, however, Wilson still provides an excellent framework going forward. First, she effectively disrupts discursive separations preventing meaningful communication between embodied feminism and neuropsychology's empiricism. Second, Wilson's use of the distinction between connectionist model's focus on cognitive architecture in place of cognitivist concern with 'software' of cognition lends itself to a renewed theory of cognition, even if she chooses to return to linguistic theory instead. Proper attention to the possible ways connectionist models of cognition could be materially instantiated may force Wilson to soften her strong anti-localization stance, but it does provides an opening to reimagine cognition as the foundation of a new model of subjectivity.

Wilson begins her project to bring together the empirical study of mind with the feminist critique of subjectivity not by repeating the familiar accusations that the neurosciences have become reductive and essentialist, but by questioning the way feminism's own critical procedures are "deeply implicated in routinized antiessentialism" that is just as limiting as any empirical essentialism.[276] She is concerned that in the context of an "increasingly fashionable" use of 'the body' as a theoretical gesture, there remains "a persistent distaste for biological detail."[277] "The body in question is pursued in its socially, culturally, experientially, or psychically constituted forms, but rarely in its

physiologically, biochemically, or microbiologically constituted form, the idea of *biological* construction having been rendered either unintelligible or naïve."[278] While disinterest in the body is regrettable, it is the oppositional stance with regard to biological detail that Wilson finds to be most problematic for the relevance of any feminist critique, as it severely limits the possibility of critique by foreclosing the option of focusing on biological detail. It is not just a choice of a different focus, but also the assertion of the abiological body in "its social, cultural, experiential, or psychical construction having been posited *against* or *beyond* any putative biological claims."[279]

In the context of neurobiology, Wilson argues that this oppositional stance presents two important obstacles to any successful engagement with the intersection of feminism and science. She argues that the "gesture to a nonneurological culture or environment" implicit in feminism's naturalized antineurologism "misrepresents the complex relation between neurology and its outside" by reinforcing the assumption that the two fields are distinct and separate, and must remain so.[280] Second, and as the immediate consequence of the first, in asserting this separation of cultural and biological environments any antibiolgical feminist critique, "by locating malleability, politics, and difference only in the domain of culture or environment, abandons neurology to the very biologism it claims to be contesting."[281] Feminist theories of the body rejecting substantial engagement with the biological reproduce and affirm the space of scientific objectivity as an apolitical space independent of effects following from their critique. As Wilson points out, this severely limits the political purchase of that critique.[282]

Beyond insistence on greater attention to the biological, the argument in *Neural Geographies* is for a new strategy for engaging the common ground of science and

critique: "How to think the conjunction criticism-science is … never simply a matter of adding two discrete and independent domains. It is always an unraveling of the interdependent structure of debts and disavowals that constitutes these domains."[283] This shift in approach separates Wilson from Connolly, and is central to the usefulness of her engagement with neuropsychology. What is proposed is a repositioning of the embodied feminist stance from an 'outside' critique *of* neuropsychology to an engagement with what the relationship is between empiricism and critique, so that neuropsychology and feminism are seen to be cohabiting the same site.[284]

In order to get from the opposition of feminism and science to the sense of mutual indebtedness denoted by the conjunction criticism-science Wilson adopts Derrida's approach from *Of Grammatology*, in which he insists on the impossibility of the epistemological separation of empiricism and theory, of data and interpretation.[285] The point of showing how the epistemological distinctions are constructed is not necessarily to replace those constructions with a new, better construction but, in recognizing that those constructions already inhabit a shared space, to examine the effect of those constructions. Wilson argues that the objective is not necessarily a matter of resolving "the tension between empirical projects as they traditionally operate in psychology … and the critical projects that emerge from postmodern, poststructuralist, and deconstructive theories," but to work in that space of tension in order to "exploit its productivities."[286] The effect is that both neuropsychological *and* feminist constructions of the subject are re-situated in the ruptured epistemological grounding that once rendered their production invisible, and naturalized, and called back into question.

Wilson turns to cognitive psychology not just with an eye to whether or not it might be reductive, but to how that reductive move functions and to what effect. In the context of a deconstructionist approach to cognition, Wilson is most opposed to cognitive neuropsychology's argument for functional localization. The theory of localization is problematic in its reliance on the self-presence of a cognitive 'trace.' Reliance on a trace being reinstates a center, a presence within cognitive structures which arrests movement and malleability of the biological by reinstating it as a fixed and originary ground from which reduction then draws its discursive strength.[287] This not only arrests movement, but acts as the ground on which reductive neuropsychology reinstates a disciplinary separation between biology and culture. While Wilson does differentiate between the initial broad localization before the mid-twentieth century and more recent 'distributed' form of localization, she argues the principle remains the same: "in the first instance, they presume a self-present neurological trace, center, or pathway to which certain psychological capacities can be ascribed."[288]

In turning to cognitive psychology with an eye to how reduction operates through localization Wilson argues "reductionism functions in contemporary scientific psychology to ground the complexity and intangibility of psychological phenomena in the apparent surety of biological matter."[289] The effect is "to transpose the psychically internal and unobservable into a discrete, empirically verifiable presence."[290] Malleable cultural parts of subjectivity are separated from the claimed objectively observable, and therefore apolitically 'real' biological composition of subjectivity.

Instead of turning away from neuropsychology entirely, Wilson looks to 'second order' connectionism's mid-1980s emergence for a model of cognition attentive to

biological factors and yet still containing an acceptable degree of environmental openness. The crucial distinction Wilson draws between linear processing of traditional cognitive approaches and parallel distributed processing of connectionist models is the ontological shift from storage based models of cognition that rely on a disembodying distinction between hardware and software to the implicit and architecturally determined operation of connectionist networks.[291] This shift from linear to parallel processing allows a rejection of the self-present, locatable psychic trace that is so problematic in theories of localization and a continued fidelity to the project of an embodied theory of cognition. Where in the computational logic underlying traditional cognitive models "there is a distinction between a cognitive program (mind) and the machine (body-brain) on which it is run," allowing cognition to be understood as "a universal process that always operates in the same way irrespective of its embodiment in a particular machine-brain," in connectionist models this distinction between hardware and software is rejected.[292] Instead, "the structure and wiring of a network instantiates the functional ability of that network," relying on rules implicit in a network's structure rather than on stored linear rules.[293] In contrast to the disembodying effect of a cognitive approach indebted to the logic of linear computational processing, in connectionist networks "embodiment is irreducible: there is no universal connectionist machine."[294]

While this shift to the architecture of a system as the source of cognitive rules allows Wilson to make her subsequent argument against the localized psychic trace, she does not explore the particularity of the cognitive network further. Instead she stays focused on establishing her model of the implicit, distributed connectionist trace. Connectionist architecture allows that "unlike a traditional cognitive system, the

individual units have no representational status as such; it is the overall pattern of activity across the network in total that determines a particular 'cognitive' output."[295] Instead of continuing to examine the ways in which architecture is materially embodied, she remains focused on disproving the self-present identity of the traditional cognitive trace by establishing the principle that meaning (knowledge) is only given through the relation of differences between units and connections. Her focus for the remainder of the book remains on establishing the theoretical particularities of this nonpresent trace. The consequence of this narrowed focus is that the shaping effect network architecture has on cognition becomes a guiding principal which enables her theory of the nonlocalized trace, but which remains unexamined in its particularity. Embodiment's biological particularities fade behind her model of Saussurean topography, and are erased entirely by the end of *Neural Geographies* in her effort to dispel the reintroduction of a fragmented, yet still self-present localized trace into the connectionist model of cognitive functioning.[296]

Regrettably, while her exploration of connectionism establishes theoretical grounds to replace theories of localized function, her choice to elucidate the material particularities beyond what is already present in McCulloch's work is Freud's theory of neuronal activity as presented in his *Project for a Scientific Psychology.*[297] The contact-barrier hypothesis Freud develops is interesting as it is the foundation of Derrida's theory of psychic 'breaching' as *différance.* Specifically, the uncanny way Freud hypothesizes how differences in neural excitation produce meaning instead of the excitation of any one neuron or connection predicts the connectionist model of neural activity despite being developed much earlier.[298] Part of Wilson's attraction to the *Projects* neurology is how it

meshes with connectionism by privileging neuronal placement over differences in 'biological essence' between neurons.[299] The functional differences between the three classes of neurons presented in Freud's contact-barrier theory are an attribute of anatomical placement and subsequent differentiation in the origin of their excitation, not of the neurons themselves.[300] Since in this model function shifts with any shift in location, the neuron no longer has any biological essence and is therefore "unable to carry the origin of the psyche."[301] While this theoretical neuronal modeling is useful for imagining an alternative to neuropsychological localization, Wilson admits it is not supported by histological evidence. The use of Freud's neuronal theory is productive for the way it reconnects Derrida's application of *différance* in cognition back to neurology, and for the way this creates a bridge between Derrida and connectionism that makes visible the full philosophical implications of connectionism's application to cognition. Missing from *Neural Geographies* is the reciprocal acknowledgement of what connectionism, in being grounded in the century of neuroanatomical research subsequent to Freud's *Projects*, can add to Derrida's conceptualization of cognition.

Some of what connectionism brings to a reconsideration of Derridean cognition is already present in Derrida's writing, and initially in Wilson's reading of Derrida. But this nuance is lost in Wilson's drive to eradicate the last vestiges of localization from connectionism. Wilson's problem with connectionism lies in the concession that while "physical entities (e.g., memories, knowledge) are distributed and thus not localized … distributed models do not necessarily contradict models of localized function in the brain."[302] That is, "a system that uses distributed representations still requires many different modules for representing completely different kinds of thing at the same time"

so that while knowledge is distributed, "the distributed representations occur *within* these localized modules."[303] The consequence is that "the distributed connectionist trace becomes less a radical displacement of traditional locationist topography than simply the fragmentation and dispersal of such a topography as prototraces or subsymbolic entities."[304] The radical dispersal Wilson draws from Saussurean topography, and which she sees implied in McClelland et al.'s connectionist system, is "reduced to a system of empirical, graspable differences between self-present fragments."[305] Instead of engaging with how localization of function might be conceptualized other than as a reductive return to a "system of empirical, graspable differences between self-present fragments" Wilson retreats to the insistence that "to exploit fully the implications of Saussure's system, pure difference must remain mobile, and must not be recuperated under a single or simple dispersal;" it must "imply an irreducible dynamism in an otherwise inert dyadic sign."[306] This fidelity to a poststructuralist system of pure difference would be productive if only it remained attentive to the particularities of its embodiment in a system of cognition, instead of functioning primarily to rule out the localization model of cognition.

Forms of Embodiment – Pragmatics of Embodiment

Luckily, reconnecting the connectionism-deconstruction conjunction to its material embodiment is not that difficult. The beginning of such a juncture is, as mentioned above, already present in Wilson's work. With regard to the tension between Derridean play and a reductive model of localization, Wilson states:

> As the playing movement of a nonpresent, nonoriginary nature, *différance* thwarts the reductionist's desire to reveal, in biology, the final and

> incontestable foundation of the psyche. Or at least, any origin so 'revealed' will be non-innocent and historically contingent.[307]

This can be taken as the oppositional formulation *différance*-reduction, which is where Wilson ends up. Or it can be taken as opening a space between *différance's* permanent radical openness and reduction's permanent radical closure. The latter remains faithful to her injunction against essentialism in neuropsychology *and* in feminist critique.

This space between the two closures expresses the kind of pragmatic resolution required by material processes, and particularly by embodied cognitive processes. This type of pragmatic resolution is familiar to neuropsychology, as detailed by Connolly in his description of the cumulative dimension of thinking. It is also present in Wilson's description of how a connectionist network learns through altering connection weights, though any implications of how this affects the mobility of cognition within an embodied network are jettisoned as she reverts to the ideal of the Saussurean system. Both Connolly's cumulative dimension of thinking and McClelland et. al's original connectionism emerge from the biological, and find their openness to the cognitive mobility Wilson aspires to already present in the materiality of cognition. As such, their version of the infinite mobility that Wilson insists on is already tempered by the material context in which they observe cognition. This awareness that cognition occurs in the biological context produces something akin to a paced mobility, the reintroduction of temporality into the cognitive process, as established connections and weights must be altered or overcome in the process of creating new connections. Pragmatic closure, then, means that while a cognitive system may be non-innocent and historically contingent, cognitive mobility isn't entirely abstract. It takes place in the context of material

networks in which the effect of such cognitive movements are cumulative, producing a slow, if minimal, non-permanent closure of thought. This process is not negative, but essential to the functioning of the cognitive system. Defined other than immobility, the meaning created through the change in connection weights in a connectionist system, and the resultant resistance to redefining those connection weights, is the process of learning.

Beyond the simple recognition that cognition occurs through a material process, the main constraint on the mobility of cognition is the architecture of the network. Wilson acknowledges how important this is to understanding a network, but this acknowledgement is not reflected in her embodied theory of cognition. While she is ready to admit to specific constraining features in Saussurean signification (syntax, semantics), she is less willing to relinquish cognitive mobility to any specific architectural constraint within connectionism.[308] Building an understanding of the effect of a system's architecture results in important changes to her theory of embodied cognition. Two examples will show different ways the architecture of a cognitive network can constrain how we understand cognition in that system. The first example, from David Wills' *Dorsality: Thinking Back Through Technology and Politics* appeals to Wilson's suggestion that cognition needs to be thought of as exceeding the brain/body boundary. But how Wills conceives of the temporality of the biology-technology relation also serves to disrupt Wilson's embodied cognition by fully theorizing how the relationship between architecture and cognition affects how we understand cognition within that system. The second example, from Antonio Damasio, returns us to more expected grounds to examine more detailed aspects of architecture within the brain, and how they serve alternately to constrain and facilitate cognition.

In *Neural Geographies,* Wilson suggests any theorizing of cognition should not be restricted exclusively to what takes place within the brain.[309] Following through on how this expansion of the place of cognition changes the process as a whole produces some interesting results, especially when considered in concert with the role of architecture in shaping cognition. In *Dorsality*, David Wills explores at the most basic level how the body participates in, or shapes cognition. Beginning by reconsidering the foundational articulation of the limb, not as natural but as a (bio)technical turn, Wills forces critical attention on aspects of embodiment so central to our identification as human that the ways they allow us to participate in the world are rarely given full consideration. What comes from this analysis is his theory of orientation, dorsality, which describes what these aspects of our bodies make possible but also, in describing each of these features as a deviation from neutral posture, how bodily orientation changes our relation to what is obfuscated by this deviation, that is, what is turned away from. Our upright posture and forward gaze not only orients us to what is in front of us, but also changes our relation to what is behind, or approaches from behind.

Wills returns to these most basic features, those which make us human, not so much to explore the historical role evolution has played in changing the human brain, but in order to demonstrate the active constitutive role these basic features continue to play. Dorsality, the turn toward the back, plays a central role for Wills for the way, in its use of the spinal column to describe our way of relating to the unseen, it blurs the line between interior and exterior, between natural and technical. Rethinking the body in this way means "turning to see the technology of the human itself, inside itself, if you wish, in any case inaccessible or indivisible from the perspective of an integral human gathered within

its neatly prescribed limits or borders and gazing ahead into a controlled exteriority of the artefact."[310] Dorsality not only draws attention to orientation, but also to the extent what we take for granted directs us from behind without our knowing its influence. The (bio)technical functions not as technical intervention into otherwise normal functioning, but as that which we conceive of *as* normal functioning. Its facilitation is at once enabling and restricting. Reconsidered as architecture, dorsality draws attention to how human embodiment, considered as cognitive architecture, shapes or orients cognition by establishing the prior conditions out of which cognition emerges, and which enable cognition. These interventions are not imposed *on* cognition but are *prior to* cognition. These orientations range from the forward orientation of upright posture and its effect on sensory orientation, to the vertebral column, to the functional freedom of upper limbs.

Wills' formulation of bio *as* technical in his concept of dorsality provides specifics for how cognition is shaped by the bodily architecture in which it takes place, but also establishes a novel way of relating to that shaping function. Whereas for Wilson architecture is necessary to understanding how a cognitive network may operate, the architecture-cognition relation is only notable for the way it forces consideration of embodiment. Wills goes further, in figuring this as a technical relation, to reveal how, if embodiment effects cognition, and embodiment is prior to cognition, the relationship between cognition and embodiment in which cognitive control is exerted over the body must be reconsidered. Specifically, in figuring the body as (bio)technical, Wills introduces an element of mechanicity or automatism seemingly in excess of subjective control. For Wills, this creates a requirement for a new ethical formulation:

> How could we begin to conceive of an ethics of the mechanical? Ethical behaviour, political 'choice,' free will, agency, indeed, the human itself are for us, by definition, representative of what breaks with mechanicity, automatism, or programmation. Yet, according to my argument, the human breaks, or turns at the same time, into mechanicity, into automatism and programmation.[311]

In relation to Wilson's politicization of cognition, reification of human agency and subjectivity are the most relevant. How does introducing the architectural component of cognition as an automatism or mechanicity change our understanding of cognition? How does it affect the formulation of neural subjectivity?

Applying an understanding of the architectural as technical to biological specificities within the brain more commonly associated with cognition complicates this question. Being open to neural architecture as (bio)technical creates a problem for Wilson's unrestricted mobility of cognition. I argue, though, that rethinking biological specificities of neural architecture facilitating cognition, when thought of as orientation instead of an imposed inviolable or essentialized nature, is more faithful to the conjunction connectionism-neuroscience-deconstruction Wilson initially opened than the Saussurean topography of unrestricted mobility she concludes with. The concept of orientation enables an acknowledgement that embodied human cognition does not take place within a uniform space, but is differentiated according to place within the brain and type of neuron.

This space created between Wilson's rethinking of cognition and Wills' enactive way of relating to the material body is useful for reevaluating neuroanatomy's role in

Damasio's theory of cognition, and of neural subjectivity in *Self Comes to Mind.* While Damasio's cognitive model of functional localization and Wilson's strong opposition to any such a restriction on cognitive mobility are strongly opposed, Wills exposes common ground already existing between the two stances. In particular, attention to the role that architectural location, patterns of connections, and differences in types of neurons play in Damasio's model of neurosubjectivity makes possible an understanding of the specific ways in which a cognitive network is embodied constrains, or orients, the possible activities of that network. While she would not agree with the ontological status of the cognitive trace in Damasio's work, attention to biological specificity is exactly what Wilson's model of cognition demands. She states this attention to embodiment is what separates connectionism from traditional cognitive models built on the assumption of von Neumann computational architecture in which hardware and software are separate considerations: "This distinction between hardware and software is rejected in connectionist models. The structure and wiring of a network instantiates the functional ability of that network. Embodiment is irreducible: There is no universal connectionist machine."[312] In Damasio we find careful attention to the structure and wiring of human cognition as well as the role this architecture plays in forming human subjectivity.

Damasio's description of the multiple areas involved in creating the basic elements of mind, which, for him, refers to the basic feeling of having a body, provides one example of this attention to how biological detail relates to cognitive function. For instance, he argues the importance of two brain-stem nuclei not traditionally considered part of the production of feeling, the nucleus tractus solitarius and the parabrachial nucleus, in "generating basic aspects of mind, namely, the feeling generated by ongoing

life events."[313] As evidence, he details the connections between these two nuclei, the body, and cortical nuclei involved in the processing of feeling. On the one side, both nuclei receive a "full complement of signals describing the state of the internal milieu in the entire body" via the spinal cord, trigeminial nucleus, as well as input from the bloodstream via connection the nearby area postrema.[314] These two nuclei are also extensively connected to the insular cortex, an area with an accepted role in processing feelings, via the thalamus.[315] As described earlier, in the Freudian neurology Wilson uses, a neuron's function is dictated by its location within the brain.[316] In contrast to Freud's blunt tripartite division and broad sense of physical location, Damasio presents a more detailed account of the architectural location of different nuclei based on the specific type of connection and strength of connections between areas. It is these connections Damasio argues proves their role in facilitating specific cognitive capacities.[317]

In addition to the connection weight and structure, Damasio argues a specific brain area's anatomical structure can give it a unique capacity to facilitate a specific cognitive function. He gives the example of the superior colliculus, and the way its layered structure presents a unique anatomical superposition of a variety of sensory inputs.[318] The way maps produced in each layer correspond to one another provides a level of integration Damasio argues is unique in the brain.[319] While his argument for the superior colliculus' function is partially grounded in its connections to sensory inputs and motor areas of the brain, the specific anatomical structure of connections within the superior colliculus are most interesting. He sees the layered organization of the different inputs as key to what cognitive functions that area is capable of performing.[320]

Conclusion: Working Toward Openness

What does it mean to supplement the undifferentiated cognitive space Wilson presents with the embodied specificity Damasio presents? The effect of such attention to detail begins to be understood when Wills is brought back into the conversation. Replacing the logic of a constraining imposition on cognition with Wills' reconfigured relation to technology, including the (bio)technology within the body, rearticulates the place of cognitive architecture not as a place where cognitive control is lost but a place where there never was complete cognitive control, at least as has been traditionally thought. It is these constraining elements which make cognition possible at all, and which make human cognition human, but do so with the possibilities of its expression already limited by how it comes into being. But, as Wills makes clear, recognizing this means recognizing the introduction of an element of automation, mechanicity, and programmation into the model of cognition. These elements are also introduced into what appears to be free, wilful action. This is not a simple subversion of free will, or assertion that free will is impossible.[321] None of the authors reviewed here would agree with that statement. Wills' addresses the significance best when he argues that it means a new relation to ethics, to technology, and to our understanding of the subject. Rather than providing a final answer or account of the subject, what this reading of Wilson, Wills, Connolly and Damasio presents is a different way of approaching the question, one that resists closure to insist on subjective openness, as well as disciplinary openness. How the model of cognition and subjectivity given by each author both contradicts and complements the others serves as reminder of Wilson's starting point in her analysis of disciplinarity in connectionism and deconstruction: "The idea of a line or a demarcation is unable to sustain the complexity of the relation between science and its others. Indeed,

now we can see more clearly how *drawing a line between science and interpretation is always a reductive and conventionalizing gesture."*[322] The consequence of enforcing disciplinary separation is clear: "any critical or political analysis that is not open to this constitutive movement in its location, any analysis that is able to accommodate its objects and methods only when they are sequestered and contained, is an analysis that will inevitably falter and become ossified."[323]

Liberal individualism's central tenet has always been the rational individual actor, and the corollary that instinctual or automatic response represents the individual's failure to employ rational consideration of one's own best interest, or self interest, before deciding on and following a course of action. The development of various neuro-disciplines demonstrates, in a way that should be seen as a challenge on the scale of Freud's early twentieth century introduction of the unconscious, that this model of subjectivity must be reconsidered. Connolly takes microstructures of cognition as an extension of the individual subject's free and unlimited ability to make rational choices. The consequences of this approach have been exposed. Recognition must be developed that even processes appearing to be entirely within the realm of conscious action are more complicated than this reductive model of rational choice can accommodate.

Each author considered in this chapter has established a connection between biology and theory that acts as one point of departure from the subject of liberal humanism. It has been my objective to establish not only the necessity, but also the desirability of a renewed approach to studying subjectivity. Building on the outline of an approach established by Elizabeth Wilson, each of these departures offers an opportunity to expand and sharpen our understanding of what it means to be a subject.

Chapter 5 - Embodied Cognition: Beginnings, Continuations, Redirections

Developing embodied cognition as an approach to working within Wilson's identified conjunction criticism-science allows for a productive reengagement with the various disciplines whose work has increasingly focused on the intersection of theory and neuropsychology over the latter half of the twentieth century, especially around the development of affective neuroscience. By disrupting the discursive separation of disciplines that limits interdisciplinary conversation to oppositional approaches, embodied cognition is a step away from the routinized anti-essentialism of theoretical critique of the sciences, as well as from the reductive empiricism of strict materialist cognitive science. In place of discarding the history of materialist cognitivism identified in chapter one and the subsequent rich body of work, an embodied cognitive approach seeks to respectfully engage with it in a way that challenges and disrupts both the strict cognitivist approach and the antibiologism of feminist engagements with the body. The previous examination of the development and impact of neuroimaging technologies on the one hand, and the shortcomings of Damasio's affective neuroscience on the other, have established the necessity of a renewed engagement with the empirical sciences.

The critique of Connolly's *Neuropolitics* emphasized that this interdisciplinary engagement must not be superficial, but must be a deep engagement that challenges all approaches participating in the conversation. The critique of Connolly's additive approach to interdisciplinarity in *Neuropolitics* also highlighted the need for great care and attention in doing work at this intersection, and the consequences of failing to take the conjunction criticism-science seriously. It is in Wilson's *Neural Geographies* that the

foundation for an appropriately interdisciplinary approach to embodied cognition begins to come together. It is worth repeating her articulation of this approach: "How to think the conjunction criticism-science is … never simply a matter of adding two discrete and independent domains. It is always an unraveling of the interdependent structure of debts and disavowals that constitutes these domains."[324]

Once Wilson has established the conjunction criticism-science as a productive space to engage in multiple disciplinary approaches to a subject, the specifics of her engagement with embodiment and cognition become the focus of *Neural Geographie*s. While this starts off well with a focus on the use of neural architecture to understand cognition Wilson runs up against her own approach's limits. Instead of engaging these limits she turns away from a productive engagement with cognition's biological architecture in favour of an analysis based in literary theory and Freudian neurology.

The framework for embodied cognition emerges from an engagement with Wilson's work prior to her turn away to literary theory. A critique of the limitations of Wilson's approach based in the work of David Wills and the reintroduction of Antonio Damasio revitalizes Wilson's conjunction criticism-science to establish the embodied cognitive framework. This involves a renewed commitment to taking the biological and architectural aspects of cognition seriously in place of Wilson's exclusion of the biological for the literary theoretical.

Following Wills, this framework of embodied cognition requires a reorientation of cognition in relation to the body. It involves taking Wilson's insistence on the importance of architecture to cognition seriously, and pursuing the consequences of this connection fully. Through Wills' work in *Dorsality,* the relationship between architecture

and cognition is reinvigorated in a way that challenges the assumption of cognitive control over a passive body it has subjugated. Wills' reinterpretation of the role of architecture in orientation is especially relevant as it applies both within the confines of the brain, to neural architecture, as well as extending what is considered part of cognitive architecture to the non-neurological body. As we will soon see in relation to the work of Andy Clark, even this bodily limit to a cognitive system is more porous than previously imagined. Beyond a sense of dialogue or shared control, Wills' restructuring of the relationship between material bodily architecture and the processes of cognition requires attention to the processes of continual co-constitution between architecture and cognition. This exceeds the type of top-down intentional self-improvement Connolly argues for. As examples presented in this chapter will show, the expanded importance of embodiment forces changes what is understood as cognition. Faithful to Wilson's 'conjunction' approach, these changes have effects on both sides of the prior disciplinary divisions.

Key to applying Wills' theory of dorsality to cognition is his interrogation of the body as (bio)technical which, when applied to cognition, acts as the material technical context within which cognition occurs. Wills allows an engagement with embodiment that reveals how embodiment acts as an orientation, and how that orientation changes how we relate to our surroundings. In this understanding embodiment is enabling, allowing us to engage with the world, but enabling in a way that shapes experience as well, as it also changes how we relate to what is turned away from in the process of orientation. By conceiving of the (bio)technical function as that which enables engagement with the world, Wills is able to show how the (bio)technical functions not as technical intervention into otherwise normal functioning, but as that which we conceive

of as normal functioning. What reading Wills next to Wilson reveals is how his reading of embodiment coincides with Wilson's emphasis on the importance of architecture to cognition. Orientation of the (bio)technical turn in Wills and embodied architecture in Wilson are the productive grounds on which cognition occurs. The importance of turning to Wills' theory of dorsality, the orienting function of the (bio)technical turn, places more emphasis on how embodiment does not neutrally or passively enable cognition but actively orients that process. A theory of embodied cognition, then, is focused on identifying this shaping effect embodiment has on cognition and understanding the consequences, the obfuscations, and the positive possibilities of a given specific form of embodiment. Wills also makes explicit the shift away from the accepted temporal relationship between cognition and embodiment that assumes cognitive control over the passive material body. Reconsidered as architecture, dorsality draws attention to how the architectural orientation of embodied human cognition shapes cognition in ways that are not interventions imposed on cognition but are prior to cognition.

Combining Wilson's insistence on embodiment with Wills' problematization of the relationship between cognition and bio-technical architecture creates the necessity to redefine what is understood as cognition in relation to the subject, and to the tradition of liberal individualism. This will be the project of embodied cognition going forward. Embodied cognition emphasizes the deep connection between cognition and material architecture, and then challenges the usual hierarchical order by shifting and tempering, if not toppling, the traditional understanding of cognitive control over the passive body.

Applying the Embodied Cognitive Approach

There are two projects currently underway that have the potential to fit into the embodied cognitive approach. Each of these will be briefly described, along with an analysis of the unique potential opening or opportunity they present in the context of the interdisciplinary approach to subjectivity detailed in the preceding chapter. The first is the work of V.S. Ramachandran and Laura K. Case exploring an aspect of gender and sexuality they term brain-sex. The second is Andy Clark's proposal of neural prosthesis, and a complication of the opening created by his reading of cognitive extension. The intention in presenting these examples is to demonstrate that an interdisciplinary approach to embodied cognition does not require a breach or a new beginning, but that there is already work taking place that can productively contribute to such an embodied research project. As such, the descriptions are intended less as critiques of the work being done than as examples of how an embodied cognitive approach can, and already is, being applied in relatively diverse research programs.

Ramachandran and the 'Phantom Penis'

In contrast to the reductive approaches that the term 'brain-sex' and the rather sensationalist titling of a phenomenon a 'phantom penis' immediately call to mind, Ramachandran has been able to approach the subject of gender through neuroscience with a sense of awareness and openness that creates the possibility for exactly the type of engagement with the concept of gender that Wilson calls for in *Neural Geographies*. It is reassuringly bold of Ramachandran to engage with the politically charged world of gender politics, especially through a study of body identification in transsexuals. While the initial study proposing the research program after an initial research phase, coauthored with Paul D. McGeoch, was occasionally awkward and largely confined to

the familiar ground of neuroscience, it already contained a sense of approaching something differently which would likely not fit within the categories currently available.[325] The article expanded on the phantom limb phenomenon, for which Ramachandran has become known both within the scientific community and in the realm of popular science, and sought to see how it could apply to cases in which an individual's gender identification was at odds with his or her body's physical form. Their hypothesis, which found initial support, was that some transsexuals would have the sensation of the genitalia that they identified with before they had the surgery that would confer on them the physical presence of that genitalia, and that reassignment surgery would resolve this disparity between their 'hard-wired' body image and their physical body. [326]

Ramachandran has continued to pursue this research program, and expanded it to include bigender individuals who experience involuntary alternations between male and female states.[327] Now working with sociologist Laura K. Case, the language and complexity with which the article treats gender is significantly improved even from the opening sentence: "between the two extreme ends of human sexuality - male and female – lie a poorly understood and poorly studied spectrum of ambiguously defined sexual identities that are very much a part of the human condition but defy rigid classification."[328] While this article is still quite early in the research phase of the project, the hypothesis has expanded in complexity without losing its connection to the biological expression of the phenomena it is studying. The focus remains on gender incongruity, understood as a disparity between the body-image expressed neurally ("brain-based body sex") and the body's physical form ("morphological sex"), and understanding the impact and interaction of "nature and nurture."[329] Already this focus on the embodied aspects of

gender has produced an attentiveness to the expanded understanding of gender beyond the transsexual population. In their conclusion, Ramachandran and Case suggest that the study of bigendered individuals "could provide significant insight into determinants of brain-sex and malleability of gender."[330] While they recognize that the extreme forms of AGI (alternating gender incongruity) creates a range of potential problems for the individual, they also question in what ways "whatever its mechanism may be, AGI opens up a question of the extent to which each of us is a multiplicity of genders, or even persons, co-existing in harmony."[331] Attention to a variety of embodied elements of gender and sex, as well as elsewhere in the article to the malleability of these elements, represents exactly the type of inclusion of both material biological considerations and social aspects of gender and sexuality that Wilson argues is necessary for a revitalization of feminist theorizations of gender. While it is too early for their work to produce specific conclusions beyond hypotheses, Ramachandran and Case's work appears on track to take up Wilson's challenge.

Andy Clark: Extended Mind Reconsidered

Originally developed with David Chalmers, Andy Clark's extended mind thesis appears relatively straightforward: it takes the intuitive recognition that the objects in the world around us, as simple as the pen and paper used to write, help us to think and argues that the process is actually much more intimate. Extended mind theory argues that these objects do not just help our internal process of cognition; we actually externalize part of our cognitive process via these objects.[332] In this sense, they serve as cognitive extensions, or neural prostheses. He argues that it is only our "bioprejudices" that prevent us from seeing external objects as part of an extended cognitive machine, "quite literally

extending the machinery of mind into the world" in a process of building extended cognitive circuits "that are themselves the minimal material bases for important aspects of human thought and reason."[333] And this is exactly what Clark has in mind when he conceptualizes neural prosthesis as 'extensions' of the mind: that they become servile, facilitating the will of the individual.

What is clear from Clark's analysis is that he views cognitive control as continuing to reside within the individual, who then makes use of the cognitive extensions as needed. It is true that the individual, according to the thesis, finds these extensions necessary to the point of not being able to perform the cognitive task that they make possible in the absence of the extension. But this does not in any way approach the integrity or authority of the biological elements of the cognitive system. The prosthesis can always be removed, and the prosthesis is never in control. But this one way extension is exactly what David Will's conceptualization of a prosthesis in *Dorsality* problematizes. As in Chapter 4, even within the confines of the biological body the physical shape of the cognitive network already functions as a technical intervention into the cognitive potential of the system in a way that exceeds, and, further, precedes cognitive control. While Clark's cognitive extensions may be temporally subsequent to the biological cognitive systems, his expectation of one way extension is a fantasy.

If these cognitive extensions are such an essential and lasting part of the cognitive system they will, in the manner that Wills argues all prosthetics do, contribute to the possibilities of cognition in the system as a whole. That is, the extension goes both ways. The 'tools' we employ cease to be simply tools, as Clark would agree, but in becoming part of the system there is an extent to which they reorganize the system

according to the material requirements of their use. The process of incorporating the prosthetic object to be a functioning part of the cognitive system involves biological elements of the cognitive system adapting to the prosthetic's requirements and demands as much as the prosthetic bends to the will of the biological system. Depending on the object, the inverse proves true. Confronted with the immalleability of the physical object the comparatively flexible neural elements of the cognitive system must adapt.

With most contemporary prosthetic objects being interactive, whether laptops or smartphones, the incorporation process is assuredly not unidirectional in either direction. The process of incorporating a prosthetic object into a cognitive system must then be seen as a process of negotiation, mutual learning and adaptation. Or a process of mutual alteration, depending on the object, might be more appropriate. While this complication of Clark's extended mind thesis, on its own, presents an opportunity to expand what is understood as a subject, there is something more about contemporary objects that makes this relationship more complicated still. While this will be true to an extent no matter what the prosthetic object, in the case of smartphones, computers, and other highly interactive consumer prosthetics it becomes immediately obvious that extending the cognitive faculties of the individual purchasing the object is not the only interest with a stake in the transaction. The design of, say, an iPhone or Blackberry device reflects the interests not only of the consumer, but of a certain type of functionality and use expected by the designers and producers of the objects. If the level of integration of the prosthetic object is consistent with what Clark describes, then there is a very real sense in which the expected or desired directing of cognitive patterns by the designer of the prosthetic are incorporated into the cognitive system as a whole. Regardless of whether the designer

represents the interests of a corporation or some other entity, the incorporation of those interests in a very material way by the cognitive system complicates further the already troubled theory of the autonomous, rational and authoritative individual. Wills and Wilson have already complicated this, as demonstrated in chapter 4. The multiplication of interests that Clark's cognitive extension incorporates into a cognitive system is one example of how taking the materialization of mind seriously disrupts our understanding of the subject.

As applied to Ramachandran and Case's work on AGI and Clark's proposed model of cognitive extension, embodied cognition enables an engagement with current research programs in a way that focuses attention on how the specific details of embodiment change what is understood as cognition in that context, and what the potential cognitive range is in that context. Further, approaching these examples through the lens of embodied cognition draws attention to the consequences this shaping effect of embodiment carries with it. Such attention allows embodied cognition to act as more than a neutral detailing of specific attributes of a given embodied cognitive system so that it can, at the same time, help us to understand how specificities of embodiment shape us as subjects, shape the world around us, and shape our engagement with that world.

Endnotes

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[141] See Melissa Littlefield "Constructing the Organ of Deceit: The Rhetoric of fMRI and Brain Fingerprinting in Post-9/11 America" *Science Technology Human Values* Vol. 34, No 3 (May 2009): 365-392.

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