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NeuroRhetoric(s) and NeuroComposition: Foundational Questions for Future Research

Robert Manfredi

NEURORHETORIC(S) AND NEUROCOMPOSITION: FOUNDATIONAL QUESTIONS FOR FUTURE RESEARCH

by

ROBERT WILLIAM MANFREDI

Under the Direction of George Pullman, PhD

ABSTRACT

This thesis aspires to give voice to Jordynn Jack and L. Greggory Appelbaum's call for more research in Neurorhetorics. The first chapter reviews the pertinent literature encompassing what is titled, "The Rhetoric of Science," noting appropriate concepts, arguments, and theories. The second chapter provides an introduction to fundamental ideas in Neuroscience and connects them to possible concepts and concerns within Rhetoric and Composition, raising questions for future consideration.

INDEX WORDS: Neurorhetorics, Neurocomposition, Neuroscience, Rhetoric, Composition

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ROBERT WILLIAM MANFREDI

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ROBERT WILLIAM MANFREDI

Committee Chair: George Pullman

Committee: Elizabeth Lopez

Michael Harker

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Dedication

I would like to thank all of the people who encouraged and guided me through all of the stages of this project. I dedicate this thesis to Silvia, my beautiful wife, for loving me, supporting me, and understanding why I must spend so much time in the library, and to my mom and dad, for believing in me and encouraging me to chase my dreams.

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I would like to thank Dr. Lopez for her wisdom and encouragement, Dr. Harker for opening my eyes to the intricacies of composition and revision. And last, but certainly not least, I want to thank Dr. Pullman for being my director, my mentor, my teacher, and my friend.

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Chapter One: Introduction and Literature Review

A study of very basic ideas in Neuroscience reveals fascinating questions and implications for Rhetoric and Composition. This thesis argues that scholars of Rhetoric and writing pedagogy should be highly interested in some of Neuroscience's claims about the functioning of the brain. It may seem strange for a humanist to claim that understanding Neuroscience is important for those who are interested in teaching people how to write and argue, but what is at stake in understanding the implications of this field is what it *means* to be conscious, what it means to be human. To be sure, findings from the field of neuroscience affect policy, major decisions, and public opinion, but more than anything, neuroscientific findings illustrate in greater detail the biological reality for rhetorical theory and precepts underlining composition studies.

Rhetoric and Composition needs to stake a claim in Neuroscience discourse for many reasons. Alan Gross, in *The Rhetoric of Science*, argues that scientific discourse *is* scientific argument i.e. the Rhetoric of Science, and it can be analyzed rhetorically (Gross 7). In other words, Gross believes that scientists use rhetorical methods to convince each other that certain theories and ideas are true. This leaves open the possibility that there are alternative ways of approaching research, alternative assumptions, questions, and methods, but that the dominant, historical, arguments silenced the possible alternatives.

The Rhetoric of Science

In discussions about the place of Rhetoric in Science, one controversial issue has been the idea of determinism: does Science, like an intrepid detective, follow a natural path set before it by an eternal and infallible truth, or does Science, in fact, follow unnatural paths, set by dominant, persuasive writers and speakers? Writing in the *Encyclopedia of Rhetoric,* Steve Fuller says that Rhetoric of Science scholars should aim to "demystify scientific jargon and introduce considerations that force scientists to address a wider audience than their discourse would otherwise allow" because "foundational and practical issues concerning science that most frequently enter public debate transcend any given scientist's expertise" (Sloane 704). This work of demystification is necessary because Science, left to its own devices, Fuller argues, sometimes functions in a way that is not best for those it seeks to serve:

> … science masks its sense of kairos with the mythos of presenting our most general claims to knowledge as physis, which upon demystification really turn out to be instances of nomos. In other words, what were previously thought to be universal laws of nature are revealed to be sustained acts of ventriloquism whereby a subset of our social conventions are imaginatively projected on the larger canvass of reality. However, these conventions, once demystified, may suggest that the pursuit of science does an injustice not only to rhetoric but perhaps even the creative capacity of homo sapiens. After all, the conventions governing science largely pertain to the manipulation of physical objects—including human beings regarded as masses whose motions are subject to constraints imposed by external forces…. (712)

This quote serves as his conclusion. He arrives here by describing the essential arguments that justify Rhetoric of Science scholarship.

Fuller argues that there was an official schism between rhetoric and science: William Whewell differentiates between a "'philosophy of science'" and a true science" (703). Fuller believes that this demarcation is flawed and that this flaw necessitates rhetorical analyses of scientific discourse (704). If Science, as popular belief has it, truly seeks to benefit all, then all should have the right be a part of the discourse community, and all should participate (703).

This tension between Philosophy and Science, according to Fuller, dates back to the debate between Socrates and the Sophists (704). The Sophists "refused to draw a sharp distinction between science and rhetoric," and they seem to be redeemed in Quine's "undetermination" and Thomas S. Kuhn's work concerning the structure of "revolutions" in science (705). As Fuller puts it,

> Those defining moments of scientific culture—the great paradigmatic showdowns originally identified by Kuhn (1962)—occur only because science does not always follow its own internal trajectory … eventually matters of dialectic get caught up with public action, the stuff of rhetoric…. (706)

Fuller's point is that Science works in a manner which makes it appear as that which it is not. The product of scientific discourse is an illusion. Scientific knowledge appears as if (and maybe its practitioners believe that) social and rhetorical processes have no bearing upon the choices that were made to arrive at the conclusions and the outcomes when they actually do.

Fuller complicates matters further by scrutinizing the scientific act itself (708). He argues that the original scientific knowledge-constructor composes a text for an audience that is, in many cases, "absent from a knowledge production site" (708). Furthermore, he suggests that the integrity of the event rests on assumptions: "similarities with anticipated audience" and ethos of the original communicator(s) (708). The essence of these claims is that *the scientific act of writing to make knowledge claims* is problematic because the original communicator assumes that the audience shares his or her assumptions, priorities, goals, and values (708). Beyond this, Fuller observes that "posterity" plays an essential role in scientific communication because the consensus experts must at some point determine whether the text is "foundational" or "obstacle" (708). Scientists use rhetorical strategies to bypass the problem of turning a universal audience into an "ideal unity," thereby allowing the processes of "posterity" to deem a text as knowledge per se (709). Finally, Fuller acknowledges that the Textualists add additional complications: "everyone (scientists) routinely misreads each other's texts," and "science would be better, if scientists were to adopt the textual practices of humanists" (708).

To review, Science affects all and claims to have the benefit of all as its goal, yet neither does it allow all to have a voice, nor does it even attempt to have representatives of the whole within its discourse communities. In addition, demystification of scientific discourse is necessary because Science uses rhetorical methods to make claims, and, because of rhetorical processes, these claims then appear as if they were natural, determined, when, in fact, they are actually constructed and subject to social and, perhaps, even political forces. Because of these arguments alone, Rhetoric and Composition scholars should be interested in Neuroscience; however, there are other reasons as well.

Jeanne Fahnestock, writing in *The Viability of the Rhetorical Tradition*, says, "Ultimately an understanding of the brain should lead to a better understanding of language, and that in turn should lead to a better explanation of effective language, of persuasion, and hence of the complex behaviors and historical processes mediated by language, that rhetoricians study"

(Fahnestock 161). In other words, Fahnestock believes that research about the brain will help scholars understand how writing functions and how rhetoric affects the brain. Furthermore, understanding these things can lead to greater understanding of very important, pressing concerns, for example: ideology.

In his book, *The Function of Theory in Composition Studies*, Raúl Sánchez argues that classical definitions of writing are not efficient because they are dependent upon theories that originate in outside fields. Furthermore, he argues that composition plays an essential role in ideological processes, and he has called for more original, theoretical work concerning the processes and function of writing (Sánchez 15). What does writing really do? How does it actually function? What roles do rhetoric and rhetorical activities play in the formation of identity as well as the construction of knowledge and reality? If writing, understood as a behavior, is involved in the formation of self and the construction of knowledge, then asking how writing can be represented as a function of processes within the brain and understanding these processes might further theoretical and practical discourse in the field, including discourse concerning pedagogical practices

It's safe to say that science will march on, boldly, with or without us. For instance, currently there is a massive, controversial project underway called the Human Brain Project; it seeks to "simulate the human brain" for the purpose of "understanding" in order to "gain profound insights into what makes us human, build revolutionary computing technologies and develop new treatments for brain disorders" (The Human Brain Project). Those involved in this project seek to build a robotic brain so that they can understand the human brain. They invoke "revolution" as they talk about technologies, and they are doing this with or without the insights and theories that Rhetoric and Composition might provide—insights that might complicate their findings and refine their methodologies. Another way of looking at this is that if Rhetoric and Composition continues to turn a blind eye to findings in Neuroscience, one might argue that it will be complicit in any of the possibly foreseeable problems that may arise in a future that does not value and respect rhetorical concerns. Along these lines, Jordynn Jack, Gregory Appelbaum, Chris Mays, and Julie Jung believe that Neuroscience is important for Rhetoric. They call for more research in Neurorhetorics, and they provide many important reasons for those interested in this work. I agree more research needs to be done, but I believe these authors overlook an essential concept: to join in Neuroscience discourse, a scholar needs a grasp of the elementary fundamentals of Neuroscience. Few scholars have provided this foundational knowledge, and this thesis seeks to do so, but first, let us look at the fundamental theories and rationales for the subfield of Neurorhetorics as it stands today.

Jack, Appelbaum, Mays, and Jung's Neurorhetorics

A number of writers have recently suggested that scholars and teachers of Rhetoric and Composition should be interested in Neuroscience research and writing. In their recent works, the authors have introduced methodologies and methods for this work. Their findings matter because they provide a strong, intellectual foundation for beginning this interdisciplinary work.

In "Priming Terministic Inquiry: Toward a Methodology of Neurorhetoric," Chris Mays and Julie Jung seek to introduce a methodology for approaching Neuroscience research that will not endanger the responsibilities of Rhetoric and Composition as a discipline concerned with upholding democratic ideals. They argue that scientific knowledge in Western history, tangled in the webs of positivism, has existed in a rigid place of authority, perhaps putting into place, or helping to put in place, the very structures that produce and reproduce difference, inequality, social injustice, and conflict (42). They believe that, if Rhetoric and Composition rushes headlong into acceptance of Neuroscience research findings without thorough analysis and reflection, it might actually aid in the creation or reification of unhelpful binaries (42). Basically, Mays and Jung agree with Fuller by saying that neuroscientific literature should be analyzed in a way that seeks to note and illustrate the rhetorical processes that are bringing about "objective truths," in order to illustrate that knowledge is not, in fact, a product of infallible and indisputable scientific method alone.

In Mays and Jung's view, though, Neurorhetoric research might endanger or cheapen Rhetoric and Composition by "overly generaliz[ing]" "complex, varied, and invisible processes," resulting in "disassembling the processes of persuasion and writing by providing empirical specimens that 'prove' how key concepts in our field really work," and resulting with "important processes los[ing] their rhetoricity and we the motivation to debate them" (45). They also suggest that neuroscientific ideas about agency, neuroplasticity, and mirror neurons should be approached with caution and sensibility, pointing towards "epistemological uncertainty" as an important anchor for this work (53). Moreover and most importantly, they suggest that "nonspecialists can so easily misread brain scans as representations of what 'really' exists or happens inside the brain," when in essence, they are, in the end, only inferences constructed from complex computer programs and mathematical equations (44).

Jordynn Jack agrees with Mays and Jung. In her article, "What Are Neurorhetorics?," she maintains that neurorhetoricians must immediately admit their impulsive nature and their undeniable urges to study the Neuroscience of Rhetoric (406). Basically, she is saying that it is very easy to get caught up in the exciting claims coming from Neuroscience discourse, and it is important to admit this from the start in order to gain control of these urges and approach these topics with caution and preciseness. In this vein, Jack collaborates with L. Gregory Appelbaum, a Post-Doctoral Associate in the Duke University Center for Cognitive Neuroscience, in "This is Your Brain on Rhetoric: Research Directions for Neurorhetorics." The two observe that the challenges facing Neurorhetorics[i] are foregrounded in its twofold definition: "the neuroscience of rhetoric," which considers "brain functions related to persuasion and argument," and "the rhetoric of neuroscience," which considers "how neuroscience research findings are framed rhetorically" (411). For the former, the neurorhetorician would describe the physiological processes behind rhetorical activities, observing and explaining the neural flow from one end of the process to the other. In the latter definition, the Rhetoric of Neuroscience, Neurorhetorics would be charged with the task of analyzing "the modes, effects, and implications of … discourse about the brain" (412).

Jack and Appelbaum claim that one must "understand how knowledge is established rhetorically and empirically in the fields of cognitive neuroscience" (413). In claiming this, they seem in line with Lawence Prelli who describes the *essential, rhetorical concepts* ingrained in the Scientific Method. In his book, *A Rhetoric of Science: Inventing Scientific Discourse,* he describes the methods, or topoi, which allow scientific knowledge to be epistemologically sound and acceptable, at least to the scientists and, arguably, to the majority of the public (Prelli x). Next, Jack and Appelbaum offer four imperatives for research in the field: first, understand that scientific knowledge is constructed via "complex methodological choices in cognitive science involving neuroscientific "topoi," including "accuracy," "efficiency," and "bias" (413). Second, make connections between Neuroscience and Rhetoric. Third, approach and analyze Neuroscience research as rhetorical texts (413). Last, be able to recognize the "common tropes used in popular accounts of neuroscience research findings," tropes which often function to mislead readers (413). These imperatives are important because they serve as a point of departure for research in this area.

Jack and Appelbaum also emphasize a major point: assumption, or inference, plays a significant role in neuroscientific discourse about brain imaging research. Neuroscience uses "three [particular] topoi to argue for methods that can usefully extend existing knowledge of the brain's structures and functions": accuracy, precision, and bias, and neuroscientists use these topoi to support one of two approaches that are "rhetorically negotiated through ongoing debates": "case studies of individuals with brain deficits to draw inferences about normal brain functions" or "careful statistical analysis of digitized data generated through imaging technologies," for example, fMRI, or Electroencephalography (EEG), using methods such as "graphic comparison, sequential analysis, numerical measure, and statistical summary" (413-14). fMRI uses "high-powered, rapidly oscillating magenetic-field gradients … to detect small changes in brain metabolism, particularly oxygen" (Breedlove, Watson, and Rosenzweig 53). EEG uses "electrodes" to measure the "gross electrical activity of the brain" (Breedlove, Watson, and Rosenzweig 420). The "primary objective" of these, and other, neuroimaging techniques is "to infer information about the brain activity that supports cognitive functions (such as perception, memory, emotion) from local changes in blood content" (414). Blood Oxygenation Level Dependent (BOLD) activities are "widely accepted as a close proxy for the synaptic activity assumed to underlie neuronal communication, brain function, and ultimately cognition" (414). These concepts matter because they summarize the major ideas and technologies involved in brain imaging studies, as well as the logic involved: inference.

In their discussions of Neurorhetorics, most will readily agree that Mays, Jung, Jack, and Appelbaum have provided a strong foundation for further inquiry into the Rhetoric of

Neuroscience and the Neuroscience of Rhetoric. Although I agree with the authors on most points, I must insist that a very important part is missing: we need a summary of the basics of Neuroscience as they are understood and taught to students today. Before we can read Neuroscience research to see what they are saying about processes of interest and before we can analyze, suggest, or design research which might answer our own specific questions, we must know *these basic ideas*: how neurons function and the physiology of reading, hearing, motor control, learning and memory, attention, and language. No matter how tedious reading about and studying (and memorizing) these topics might be for some readers, this work is essentially necessary to move forward.

Chapter 2: NeuroRhetoric(s) and NeuroComposition: Approaching the Present State of Neuroscience

This chapter is a case study of sorts. It, first, analyzes Jeanne Fahnestock's, "Rhetoric in the Age of Cognitive Science." This analysis is important because it highlights what is missing from current NeuroRhetoric(s) scholarship, which becomes the second part of this chapter, and what is at stake, which, along with questions for future neurorhetorical studies, serves as the conclusion of this thesis. Mays, Jung, Jack, and Appelbaum's work helps to form a foundation for research questions and empirical studies that might aid in answering questions about theories and practices for Rhetoric and Composition, but there are two things missing: they do not do highlight the urgency of Neurorhetoric(s), and they do not provide readers with a *basic understanding of Neuroscience as it is understood today.* If we turn to another example, we can see this lack clearly. In "Rhetoric in the Age of Cognitive Science," Jeanne Fahnestock's discusses the importance of Neuroscience research for Rhetoric and the importance of Rhetoric research for Neuroscience.

Fahnestock demonstrates the relevance of what I am calling NeuroRhetoric(s) by describing the "touch" or "overlap" between Neuroscience and Rhetoric and Composition:

> If cognivists and neuroscientists ever reach agreement on a model of the brain and mental processes, and particularly of how people produce and use language and images, that model should be compatible and even contiguous with the characterizations of human communication available in the rhetorical tradition. (160)

Ultimately, whether or not they find Neuroscience interesting to read, scholars of Rhetoric and Composition should be interested in the knowledge that Neuroscience is constructing.

In Fahnestock's view, Neuroscience and Rhetoric need to listen to each other (161). Rhetoric, by understanding what Neuroscience is saying, will be better equipped to function as the Academy traditionally envisions it, as being a viable field which is able to teach students how to write effectively, and Neuroscience, by understanding what Rhetoric is saying, will be better equipped to understand the physiology of language and learning when it realizes that Rhetoric has important things to add to Neuroscience's inherent definitions and assumptions (161-2). Specifically, Fahnestock believes that Neuroscience's current theory of language is lacking and thus, so, too, are its studies and findings (162). She suggests that Rhetoric can and must provide a more effective theory for Neuroscience to use (164).

Now, in her chapter, Fahnestock admits that she does not provide an "overview of cognitive science," but she does describe "findings in contemporary neuroscience that suggest the viability of rhetorical stylistics as it is embodied in the classical and early modern attention to language" (161). In doing so, she describes the physiology of vision:

> A visual stimulus is analyzed into separate components … Signals from nerve cells in the retina go to the thalamus and specifically to a group of neurons called the "lateral geniculate nucleus" (LGN) and from there to the V1 or primary visual area of the cortex. Studies in animal brains show the exquisite sensitivity of neurons in this primary visual cortex. Some are so specialized that they respond differentially (i.e. in their rate of firing) according to the orientation of an object in the visual field, some responding 45 degrees of rotation and others to 60 degrees, and so on, around the full 360 circle. (166)

She describes the physiology of hearing as well:

> "The primary auditory cortex registered noise, the right and left temporal gyrus were involved in the 'passive' recognition of a syllable. Broca's area in the left hemisphere, usually associated with speech production, became active when finer phonetic discriminations were made, showing that subjects had to 'access an articulatory representation' when noticing the similar endings on syllables such as 'big' and 'bag' … Finally, when subjects were asked to make pitch discriminations, other areas of the right hemisphere showed activity … The separation revealed in such imaging suggests not only the evolutionary layering of language perception but also, and most important for an assessment of rhetorical stylistics, the manipulable parameters of a language, the features that can remain the same when others change. (166)

She goes on to discuss the function of the right side of the brain, which interprets the emotional characteristics of the sounds of speech and notes the connection to "prosody," thereby implicating traditional rhetoric as connecting, or overlapping, with current Neuroscience findings (167). By focusing on the connections between classical methods and the brain, Fahnestock is demonstrating an important step in this work. However, any claims being constructed from work like this rest on a questionable assumption: do the readers, arguably Rhetoric and Composition scholars, have the fundamental knowledge they need to understand what Fahnestock is talking about? Though her descriptions of physiology are suitable for her purposes, and Mays, Jung, Jack, and Appelbaum have all covered very important ground as well, no one has attempted to place the fundamental ideas of Neuroscience within the basic contexts of Rhetoric and Composition. From how neurons communicate to the physics of the written or spoken text, to transduction, the place where the physical aspects transform to the physiological, on down the neural pathway, and, finally, deep into the brain, where the effects equate to learning and memory, which then translate back into conscious decision-making and communication, here and now, in the conclusion of my inquiry, these processes are described. The second part of this thesis does not aspire to explain every biological process of the mind. Instead, it seeks to explain the most relevant processes.

Neurons Communicate Rhetorically

By focusing on caveats, methodologies, methods, and claims about language, Fahnestock and the neurorhetoricians overlook the basics of Neuroscience: how neurons communicate. Understanding this matters because this is the process, happening at the cellular level, that brain imaging seeks to measure. To understand brain imaging and the inferences being made, such details should not be overlooked. Furthermore, describing how neurons function leads to a surprising, helpful connection between Neuroscience and Rhetoric, one that might bring the two fields closer.

Breedlove, Watson, and Rosenzweig are recognized authorities in Neuroscience, and all the Neuroscientific claims made by this thesis henceforth come from their textbook, *Biological Psychology*. These authors use a metaphor to describe basic neuronal function, a metaphor that, interestingly, is quite similar to how rhetoric is thought to work: neurons *communicate* or interact with one another within "synapses," and the message between neurons takes the form of a neurotransmittor (25). Thinking of neuron communication and Rhetoric in this way may help to bring Neuroscience and Rhetoric together on methodological levels.

The metaphor of "communication" works as an "overlap," as Fahnestock would say. One neuron sends its messages, or texts, to another neuron, and if that neuron is *receptive* to the messages, it can be said to be *persuaded* to activate and send its own messages along or to hold onto its messages. This process, then, explained in this way, could be called the Neuron Metaphor of Rhetoric. If Rhetoric scholars would take this metaphor and add those elements that Neuroscience's current theory of language lacks, elements that a strong, unified theory of language must have, perhaps interdisciplinary studies between Neuroscience and Rhetoric could enable ever more critical research and more stable ideas which both sides can work with.

Taking the metaphor a bit further, we find that, just as there are different types of people sending and receiving different types of messages, there are different types of neurons: some send information from the brain to various parts of the body while some send information to the brain; some reside in between these two, but, for the most part, they all seemingly act and interact in the same way (35). 150 billion neurons are all interacting, forming groups (sometimes understood as circuits) and affecting each other, working with each other, and, as plasticity indicates, changing each other (24).

Broken down in a very basic but detailed manner, the process of one neuron communicating with another seems to work in this way: at the synapse, the space between two neurons, there are "synaptic vesicles" that hold "neurotransmittors," the messages (33). The neuron sending information is doing so because it has "produced an action potential" (73). The firing of neurons, the sending of messages, involves "electrical" (within the neuron) and "chemical" (between neurons) processes (61). The "action potential" originates at the sending neuron's "axon hillock," and the signal moves quickly down/up the axon, and the neuron "communicates" its information i.e. releases chemicals (62-3). Once the receiving neuron is stimulated enough, when the "postsynaptic potential" is just right, it reaches its "threshold" and fires its own messages (63). It must be noted, though, that there are two types of changes occurring in this space, one that causes action potentials and one that suppresses them (70). The change depends on the neurotransmitter itself, and the ability of the receiving neuron to accept that information (71). The neuron receiving information measures the "electrical activity" and "fuses" with the sender, causing "molecules" to enter into the space, and there is further electrical activity (33).

"Receptors," found on the "dendritic spines" of the receiving neuron will "capture and react to molecules of the neurotransmitter" (33). This basic interaction causes "dendrites" and "dendritic spines" to "rapidly alter," the basis of neural plasticity (discussed in more detail later) (33). Large groupings of neurons are called a "circuit," a notable metaphor connecting the biology of the human to technological terminology (34). Finally, circuits flow just as basic logic might flow from a writer to an audience and vice versa, many neurons down to one or one leading to many (81). Finally, and quite importantly for the purposes of NeuroRhetoric(s) and NeuroComposition, when neurons are active, they generate "electrical activity" which can be measured (81). This activity is what brain imaging technologies seem to be measuring. Thus, when someone reads a persuasive text or hears a persuasive message, the neurons involved in these behaviors are assumed to be active, and we might ask what those processes look like so that we are more prepared to read and interpret claims being made about those activities and more prepared to ask our own questions and make our claims regarding those processes.

The Neuroscience of Reading and Hearing

Breedlove, Watson, and Rosenzweig explain that "experience" "sculpts [increases connections and the size of neurons] the brain," both during the formative years and during "adult neurogenesis," and reading and hearing are brain-sculpting experiences of the utmost interest to Rhetoric and Composition scholars and teachers (as well as researchers in the subfield of Disability Studies) (205). NeuroRhetoric(s) and NeuroComposition would seek to learn about brain activity during these processes. Rhetoric, for the sake of clarity, will be understood, here, as George Kennedy has defined it:

> "Rhetoric in the most general sense may perhaps be identified with the energy inherent in communication: the emotional energy that impels the speaker to speak, the physical energy expanded in the utterance, the energy level encoded in the message, and the energy experienced by the recipient in decoding the message. (americanrhetoric)

Of considerable interest to neurorhetoricians, then, given Kennedy's definition, is the systematic exploration of how the energy in the texts affect a reader and how those effects can be measured and plotted. Furthermore, of interest to the neurocompositionist is a systematic understanding of what processes are at work in the creation of utterances and messages, or texts.

In neuroscientific terms, the "text," in the case of reading, written words, becomes the stimuli (218). The eyes of the reader detect the stimuli, units of light, "bands of electromagnetic radiation" called "quanta" or "photons" (218). These units are measured by "wavelength" and "frequency," and they travel from the page, the computer screen, or the surface of the medium, to the eye (284). The stimulus is then converted into "change in electrical potential" in a "cell membrane," causing signals to be sent to "nearby neurons" (218). This is called "transduction" (219). As the signal moves on, a great amount of information is processed before the signal reaches parts of the brain that are further down the path, determining, for instance, whether the light is bright or dim or which stimuli should be ignored (221-3).

The neural pathway for reading is this: "neurons in the eye and brain select out certain important features and construct a visual experience" (282). "Photoreceptors" gather information about the light touching them and send information to "bipolar cells" which connect to the optical nerve (290). Some messages stay on the same side while others cross to the other side of the brain (292). Information travels to the lateral geniculate nucleus, which is "part of the visual thalamus," and, finally, to visual cortex," and it is there where mapping occurs (292-3).

Seeing (and, therefore, reading) plays an integral role in constructing experience: "one-third of cerebral cortex is devoted to visual analysis and perception" (281). The "nervous system" computes all of that data at "three times per second" and determines, for that person, what created/caused the stimuli (283). In terms of a text as a stimulus, "we [humans] have to learn to recognize words" (as with anything else), and the data "triggers responses determined by the consequences of our prior experiences" (283). Thus, what a person sees, dependent upon its qualities and the light reaching the eyes, is recognized as what it is based on what the subject has seen before.

Although these details may seem trivial, this process, the neuroscience of seeing and knowing, is fundamentally implicated in epistemological questions concerning the essence of writing itself. Because seeing is indeed the brain actually constructing the image, and knowing, theoretically, is comparing the image to previous experience, might understanding this help to confirm social constructionist theories and constitutive theories of language? This discussion of the neuroscience of seeing is also important because it is, essentially, the basis of reading, and, as Fahnestock notes, "language in use is the object of study for rhetoricians" (Fahnestock 160). These processes will have significant applications in asking more advanced questions, like how do these processes work towards learning and the creation of memory? We can think along these same lines as we explore the neuroscience of listening.

Breedlove, Watson, and Rosenzweig argue that "the sounds of speech form the basic elements of languages and therefore of social relations" (247). Thus, the neuroscience of listening, or as Kennedy might put it, "the energy experienced by the recipient in decoding the message," matters not only for its rhetorical implications but also for its socio-political implications. Here is the process, in detail: the ear "detects rapid changes of sound intensity," decibels, caused by vibration (248). In the case of speech, the "larynx," causes the vibrations, or "sound waves," which are measured by "loudness" and "pitch" (248-9). The listener/audience receives the waves via the ears, "specially evolved to receive waves between 2000 and 5000 hertz and allow the brain to know where the waves originated" (248). Via the canal, the waves reach the "ear drum," which moves specialized bones and muscles, connected to the "oval window" (249). This causes the movement of "fluids" in the "inner ear," and, within the "cochlea," transduction occurs, and the orator's creation becomes chemicals and electricity (251). From there, movement of tiny "hair cells" causes "rapid changes in ionic channels, and neurons fire (251). The message then travels to the "pons," to the "inferior colliculi," to the "medial geniculate," to auditory cortex (255).

My discussion of the Neuroscience of listening and seeing, by providing more details and context, will aid those interested in discovering "insights into and even affirmations of traditional rhetorical stylistics," as Fahnestock mentions (167). Having covered the basics of seeing and hearing, it is much easier to understand more complex claims of neuroscience. Furthermore, these processes (seeing and hearing) are significant because they are the cognitive, phenomenological building blocks of consciousness and being. By seeking to understand as much about these processes as possible, NeuroRhetoric(s) and NeuroComposition can seek to understand the rhetorical aspects of language better, and, as a result, rhetorical functions and affects. Having covered the Neuroscience of receiving messages, we will now look at the Neuroscience of composing messages.

The Neuroscience of Composition

According to Long and Flower, in "Cognitive Rhetoric," Cognitivists are interested in the "performative act" and, specifically, understanding the mental processes involved (108). To explain the act of composing as its base level, it is essential to understand what Breedlove, Watson, and Rosenzweig call an "act," a "complex sequential behavior," involving a "plan," (318). The process of the act can be traced as follows: the plan seems to originate in the cerebellum and project to basal ganglia, on to thalamus, to nonprimary cortex, and, then, primary cortex sends "commands" to brainstem which "integrates motor commands and transmits" to spinal cord which "controls the skeletal system," in the case of composing, allowing for those movements involving the pen, the keyboard, or the screen—the complexities of speaking can be understood more fully in the language discussion to come (320-1).

Interestingly, "mirror neurons" are found within premotor cortex, and they are active before movement, during movement, and after movement; however, they are also active when a subject is observing another making particular movements (335). Note that these neurons seem to be active as if they are actually performing the movement themselves, pointing to a very important question: might observing movements equate to reading and/or hearing about movements, and if so, would that not equate to the experience of those movements in some manner? The authors remind us that "it is possible that this function … is the basis for acting jointly with others to accomplish a task," yet, even if this is so, mirror neurons would be important to rhetoric in practice, so to speak, rhetoric that seeks to persuade the other to act with the rhetor.

The implications of mirror neurons aside, for now, and having covered the basics of seeing, writing, speaking, and listening (as they relate to Neuroscience), we can now turn to the concepts of learning and memory, attention, and language.

Understanding Learning, Memory, and Plasticity

This section about learning and memory is important for many reasons and for many people interested in Rhetoric and Composition. Many of us are tasked with teaching students how to communicate effectively, and understanding the neurological processes involved in learning and memory will help us with this task, even as Neuroscience continues to make claims about how the brain learns and forms memories. Furthermore, effective messages, crafted by skilled rhetoricians, will also serve to teach readers and form memories in their minds. Therefore, these are processes we should understand. Learning is defined by Breedlove, Watson, and Rosenzweig as "the process of acquiring new information," and memory is defined as "the ability to store and retrieve that information (511). Learning and memory take on different "forms" and involve different regions of the brain (512).

Along with short term and long term memory, there is "declarative" and "nondeclarative" memory: declarative being "a memory that can be stated or described," including "episodic memory," ("memory of a particular incident or a particular time and place") and "semantic memory," ("generalized memory, for instance, knowing the meaning of a word without knowing where or when you learned that word"); nondeclarative is "a memory that is shown by performance rather than by conscious recollection," including "skill learning," ("learning to perform a task that requires motor coordination"), "priming," ("the phenomenon by which exposure to a stimulus facilitates subsequent responses,") and conditioning, ("a form of learning in which an organism comes to associate two stimuli or a stimulus and a response") (513). Declarative memory is associated with medial temporal lobe, dorsomedial thalamus, "diencephalic structures," "mammillary bodies … contiguous with the hypothalamus," the mammillothalamic tract, medial temporal region, and the hippocampus, and the "mammillary bodies may serve as a processing system connecting medial temporal regions … to the thalamus via the mammillothalamic tract … to other cortical sites," for instance, left frontoparietal and right parieto-occipital, hippocampus, and parahippocampal cortex (515). Nondeclarative memory is associated with basal ganglia, motor cortex, cerebellum, bilateral occipitotemporal cortex, cerebellar circuits, hippocampus, ventral striatum, and regions of cerebral cortex" (526-7).

Although discussion of these processes might be tedious and technical, I contend that scholars working at the intersections of Cognitive Rhetoric, Neuroscience, and Writing Studies would benefit from developing research questions aimed toward determining what role rhetorical processes and texts play in the physiological processes of memory development. What types of memories do texts create? Where are these memories stored and for how long? What methods might writers use to create texts that are more memorable? In many ways, rhetoricians and philosophers—arguably back to Plato—have concerned themselves with similar questions. However, our current moment offers opportunities for drawing on the field of Neuroscience to answer perennial questions about communication and learning in compelling ways.

Along with the creation of memories, rhetorical acts are, of course, involved in learning processes, and many in our field are involved in different pedagogies. The basic learning definitions, most relevant to Rhetoric, are “nonassociative,” “presentation of a particular stimulus alters strength or probability of a response,” “habituation,” “organism becomes less responsive following repeated presentation of a stimulus,” “dishabituation,” “restoration of response,” “sensitization,” “organism becomes more responsive to stimulus after being exposed to unusually strong or painful stimulation,” and “associative learning,” “an association is formed between two stimuli or between a stimuli and a response” (516).

Short and long term memory are broken up into different classifications from shortest to longest: “iconic” is a very short “glimpse;” “short term” is a bit longer, recalling a phone number for example; “intermediate” “outlasts” short term yet is “not permanent”; and “long term” is just that (517). Literacy, then, involves “vast” long term memory, “at least 100,000 pieces of information,” and that is just language alone (517). The boundaries of long term memory are not known and may be nonexistent (519).

Long term memory involves a three-step process. The first step is called “encoding,” for images: right prefrontal cortex and parahippoccampal cortex (both sides); for words: left prefrontal cortex and left parahippocampal cortex. The second step, “consolidation” involves storing the information, usually “in the region of cortex where the information was first processed and held in short term memory”: parahippocampal cortex, prefrontal cortex, and hippocampus (520). Notably, and of interest to anyone interested in pedagogical implications, “emotion can powerfully enhance our memory” (521). The final step of long term memory, “retrieval,” involves mediation between “cortical sites and hippocampal sites,” and it is notable, here, that the act of retrieving, over and above “cramming,” also enhances learning (521).

As declarative learning is associated with the medial temporal lobe, spatial learning is associated with the hippocampus; there are “grid cells,” which map “longitude,” and “latitude,” and “border cells” which map borders; thus, the further a person travels in the world, the more the hippocampus is changed and enhanced (525). Nondeclarative learning, on the other hand, is broken up into three different classifications, “skill,” “repetition,” and “conditioning” and involves the following areas of the brain: in skill learning, basal ganglia, motor cortex, and cerebellum are involved (526). Repetition involves “reduced activity in bilateral occipitotemoral cortex” and “reduced activation of the left frontal cortex” (527). Conditioning involves cerebellar circuits, cerebellum, hippocampus, ventral striatum, and “regions of cerebral cortex” (527).

As pedagogy is a central concern to most scholars in Rhetoric and Composition scholars, despite their subfields, the terms used in this description need to be connected in clear ways to the outcomes strived for in most classrooms as well as to outcomes rhetorical actors strive for. Understanding the areas involved might help to better understand what it means to “teach,” what it means to “learn,” and what role rhetorical processes play in learning. In addition, understanding these ideas will help us to learn and say more about plasticity.

Plasticity falls under learning and memory: the brain is always changing itself, rewiring its connections, based on experiences (529). Plasticity, the idea that “memory storage requires neuronal remodeling” was first posited by Donald Hebb, (529). Plasticity is important because it equates to new memories, to learning, and it is detectable (531). Plasticity can be many different things: changes on either end of the neuron or both; more neurotransmitters being released; more receptors; increase/decrease in the amount of time it takes for a neuron to be ready to fire again; separate “neurons” somehow affecting polarization of another neuron; new synapses or less synapses; and "new pathways" being created, making cognitive processing and processes faster (531). Evidence of plasticity would take the form of cortex getting "heavier" and "thicker, "enhanced cholinerginic activity throughout cortex," "larger cortical synapses," "Hebbian changes," and "altered expression of a variety of genes … involved in memory processes" (532). NeuroRhetoric(s) and NeuroComposition scholars might analyze the current research noted as authoritative and foundational concerning plasticity and attempt to fuse the ideas to concerns in the field. They might also create experimental composition, rhetoric, and literature classrooms: dynamic, experimental environments where, hypothetically, evidence of plasticity, evidence of learning, could possibly be found. Experiments could compare classic pedagogies, online pedagogies, contemporary pedagogies, and hybrid pedagogies in an attempt to determine which methods, methodologies, and environments are most effective.

We obviously need more discussion and understanding of the processes of learning and memory. Here, I have provided the textbook claims. We need to make these claims even more accessible because these processes are essential to most of the major questions in our field. Furthermore, finding and plotting where and how rhetoric and composition affect learning and memory will further strengthen our field's foundations in the Academy. However, for now, we will move on to a discussion of attention and consciousness.

Understanding Attention and Higher Cognition

At the base of higher cognition is "attention" (549). Attention, a "state or condition of reflective awareness or perceptual receptivity, by which specific stimuli are selected for enhanced processing," is contrasted with "arousal," a "global, nonselective level of alertness"

(546). Attention, defined this way, seems as if it could be directly related to critical reading, or analysis, where the student must focus on the argument and key ideas of a text in order to decide either what to do with or about it. Although this relation may seem to be of small concern, it should in fact concern anyone who is interested in critical reading, teaching or otherwise, because *attention can be measured,* and, therefore, so too can critical, rhetorical reading processes involving a subject attending to a textual argument (aural, visual, etc., as well) (550). This raises the possibility that we no longer must depend on the test or the paper alone to measure what has changed in the student's mind. I argue that we can measure *actual* changes and pair them with our classic measurements.

There are two models that seek to demonstrate how attention seems to work, "early selection," and "late selection" (552). In early selection, the brain "exert[s] control early in the processing pathway, filtering out stimuli before even the preliminary perceptual analysis has occurred;" the second has the brain "exert[ing] control late in the processing pathway, filtering out stimuli only after substantial analysis" (552). Which of the two is correct is still debated today, but it is assumed that the brain works both ways or by a combination of both (552).

There are two types of attention: "exogenous," where the stimuli itself causes the subject to pay attention, and "endogenous," where the subject chooses to pay attention to a certain stimulus; these two usually work together to apply different types of searches: the "feature search," "looking for an object, in a sea of objects, which stands out," and the "conjunction search," looking for an object … based on one or more features" (554). These searches seem to combine to construct, in the brain, "multiple cognitive feature maps" of the direction of attention, and, somehow, the brain, using many different parts, is able to differentiate between different "attributes" that combine to be single objects (558). The problem for neuroscience is deciding whether the stimuli are already ordered, and the brain files through them, or whether the brain locates each stimuli and orders them afterwards (558).

EEG tests can show the first stage of attention, location of the object, the process of deciding to concentrate on that object, and the "higher order processing which occurs after, within "parietal cortex" (559). The major brain region involved is visual cortex, which locates the stimuli, choosing to focus on it, and activation actually moves within visual cortex, itself, if the stimuli is moving (564). If attention is divided between two stimuli, activation shows two areas active (564). This is what Fahnestock is describing when she talks about the "exquisite sensitivity of neurons in … primary visual cortex" (166). The superior culliculus drives the eye; the pulvinar is involved in "shifting attention" or paying attention to something that is not in the direct gaze; the parietal lobes "control [or are the] source of attention," "processing details and preparing for a shift of attention;" the intraparietal sulcus seems to be involved in "top-down control of attention," "encod[ing] a … priority map" of stimuli; the temporoparietal junction is invlolved in focusing on "unexpected "targets," and all of these regions, both cortical and subcortical, work together to construct "experience" and "reality" (567-8).

My discussion of attention might have significant applications for hypotheses of original, neurorhetorical research: when a subject decides to focus on a text, the process should involve the dorsal frontal parietal area, dorsolateral frontal and superior temporal, posterior cingulate, and medial frontal; "processing" should involve pre and postcentral gyrus, ventrolateral frontal, SMA cingulate, and visual cortex (568). All of these processes, within the fronto parietal network, equate to consciousness, or awareness (872). However, despite these claims concerning brain processes and consciousness, the authors note that there are lots of theories about consciousness but not much data (572).

Science has a hard time determining what unconsciousness is, in fact: is it sleep or is it being comatose (872)? In fact, patients in a coma can "signal" "yes" and "no" (572). The authors write that many "aspects" of consciousness are "cognitively impenetrable," aspects that are not controlled, aspects that "we" are not aware of, aspects "we" cannot comprehend; however, the authors do note that these aspects may be understood one day leading to the ability to "read minds" (574). Ultimately, what is at stake here is the definition of being, and it is in fact a crucial concern for our field, considering the implications. Do we truly desire to read minds? Will the ability to "read" minds shake the foundations of Rhetoric, Composition, and communication in general?

Neurophilosophy, a branch of philosophy linking ideas in philosophy to neuroscience research, is highly interested in consciousness, asking, "how does neural activity create subjective experience," what is free will, and what is agency (574)? This branch talks about the "Hard" and "Easy" problems of consciousness (574). The Easy Problem asks, "how does neural activity create a specific conscious experience" (574)? The Hard Problem asks, "how does neural activity create subjective experience," i.e. different experiences of the same object (574)? Neurorhetoric(s) and NeuroComposition should claim a stake in this conversation. They might seek out research or do their own experiments wherein researchers "conscious[ly} manipulate … intentions to act" in order to see what processes are at work; they could concentrate, specifically, on the rhetorical aspects of the text, how the text actually affects the brain and decisions, perhaps to confirm that "exercise in willful control of actions results in … activations of the presupplementary motor area, along with … inferior parietal sulcas and dorsal prefrontal cortex (575). Studying the processes in this way might teach scholars and teachers of Rhetoric what effective texts look like: mapping the process from text to brain might help in teaching process (from brain to text) more effectively.

Although I grant that, as a result of work like this, rhetoric might be broken down into very reductive, overly simplistic terms (e.g. "frontal cortex" is "active" in specific ways "when the subject has to make a decision that may provide a reward…") I maintain that our field will not be weakened or cheapened but, rather, strengthened (577). Furthermore, other fields are doing this work without us and will make claims that are, arguably, more persuasive than our own because they are embracing Neuroscience. For example, studies show that, in monkeys, frontal cortex is "active" when the animal has to make a decision that may provide a reward" (579). Orbitofrontal cortex "forms associations between hedonic experiences … and reward signals" (579). Studies like these spawned Neuroeconomics, a field that is already working on questions about decision-making. Neuroeconomics provides two basic models of decision-making: the "Valuation System," and the "Choice System" (580). In the first, frontal cortex works as a "network that ranks choices based on the perceived worth and potential reward" (580). Implicated within this model is ventromedial prefrontal cortex, anterior cingulate, and a "dopamine-based reward system for the basal forebrain" (580). The second model involves dorsolateral prefrontal cortex and parietal regions "sifting through the valuated alternatives and producing the conscious decision" (580). This research implicates prefrontal cortex as suppressing "impulsive decisions" and amygdala and prefrontal cortex as producing regret for bad decisions (580). All of this matters because NeuroRhetoric(s) could look at this discussion closely in order to determine whether Neuroeconomics' research might gain from different perspectives, different definitions, and a thorough study of the assumptions involved. And just as we might be needed in discourse about decision-making and consciousness, we, as a field most interested in language-use and its affects, are sorely needed in discourse about language, and I maintain that we can only gain from learning as much as we can concerning the intricacies of how the brain acquires and uses language.

The Neuroscience of Language

Cognitive Rhetoric scholars and elocutionists may find the following discussion of the relationship between Neuroscience and language acquisition interesting. Breedlove, Watson, and Rozenzweig, break language down into "basic elements," "composed of sounds," "symbols," and "elements arranged according to rules" (583). There are "phonemes," which are "sounds produced for language," and "morphemes," the "smallest grammatical units of a language; a word or a meaningful part of a word" (584). Then, there are "semantics," "meanings or interpretation of words and sentences," "syntax," "rules for constructing phrases and sentences," and "grammar," "rules for usage" (585). These are the assumptions, the building blocks, about language that Neuroscience students are learning.

Fahnestock argues that Rhetoric needs to persuade Neuroscience to add more elements to its theory of language" (Fahnestock 162). She argues that a "robust theory of language," taking into account ideas valued by the rhetorical tradition, but ignored by science up to this point, would

> … offer explanations connecting small-scale features to the attempted achievement of large-scale schemes. Such a theory must … also include some system of identification. We can call this system a "parser." Though that term has computer connotations, it also connects to the older notion of "parsing" a passage in Latin or Greek by identifying certain formal features. With a "parser"

> one can identify elements of a language. Any grammar—traditional, generative, construction—that identifies types of sentences, clauses, phrases and words is a kind of parser. No matter what elements are ultimately identified, a parser describes formal linguistic features irrespective of their content. A rhetorical parser would include higher level structures like the enthymeme and the topoi, and it would connect the features identified to their potential uses." (163)

My Neuron Metaphor of Rhetoric might be of value here. Upon constructing a more essential theory of language and Rhetoric and sowing its basic elements into the metaphor, it might serve as a place where the two sides can begin to relate to one another. Such tilling might produce healthy fruit: more essential studies and research. However, because Neuroscience currently defines language in a deficient manner, its claims about language remain questionable in the eyes of Rhetoric and Composition. Nevertheless, it still is helpful to know as much as we can, despite weaknesses in assumptions, about processes involving words.

The authors note that the most important time of language acquisition is childhood (dominated, in most cases by parental figures); a child understands basic language rules around seven months, and the home environment plays a critical role in this understanding (584). The authors cite Falk, 2004, Marcus et al., 1999, Curtiss, 1989, and K. H. Kim et al., 1997, specifically, in making this claim (584).

There are two major "language" areas in the brain: Broca's Area and Wernicke's Area. Broca's Area is the "region of frontal lobe … that is involved in the production of speech: the left inferior frontal region and left cerebral hemisphere; this area is also directly connected to writing, evidenced by studies of patients with "Aspasia" (590). Wernicke's area, close to Broca's, in the posterior temporal cortex, also plays a critical role, involved in "reading comprehension" and the "ability to understand or produce language" (592-4). The roles of these two parts of the brain are better understood by analyzing some basic experiments as described by Breedlove, Watson, and Rosenzweig.

The first experiment focuses on what occurs in the brain when subjects hear a word and repeat it back aloud. Wernicke's Area analyzes the "sound" and matches the word based on previous experiences, and Broca's Area "forms [a] motor plan to repeat the word and sends information to motor cortex" (595). The second experiment looks at what happens when a subject speaks a written word (this is arguably related to what is happening in your brain as you read this!): "visual cortex analyzes the image and transmits the information … to the angular gyrus"; "angular gyrus decodes the image … to recognize the word and associate this visual form in Wernicke's Area," (595). Wernicke's area sends the information to Broca's Area via the arcuate fasciculus where a plan is created to be sent to motor cortex" (595). The "Motor Theory of Language" postulates that "anterior left hemisphere programs the simple phonemic units of speech," and the "posterior systems are responsible for stringing speech sounds together into long sequences," while other areas outside of this area are also active (595).

The authors note that "reading and writing are relatively new developments, and we have not had enough time to evolve the same sort of innate mechanisms for these behaviors; however, subjects seem to be "focused on sounds of letters," "meanings of whole words," and these acts seem to be "shaped by training," or "brains appearing to mold themselves" (597). Studies show that Broca's Area has "distinct regional differences," including "anterior and ventral division" providing "meaning of words," while "posterior" provides "patterning of speech and sounds;" and the supramarginal gyrus" is associated with "semantic and phonological aspects" (601). In addition, studies (e.g. Posner and Raichle, 1994) indicate that reading is associated with the posterior area of left hemisphere," while hearing is associated with temporal lobes;" "repeating words" back involve both sides of motor cortex, a portion of the cerebellum and insular cortex," and "semantic association" is located within Brocas's Area (602-3).

Breedlove, Watson, and Rosezweig also describe research that seems to link certain brain areas to certain ideas connected to rhetorical concerns. They claim that "passive viewing," which seems as if it is related to reading, is connected to the "posterior area" of "left hemisphere" (602). "Passive hearing," seemingly related to listening, is linked to the temporal lobes (602). "Repeating words," also related to listenting, involves "both sides" of "motor cortex," a "portion of the cerebellum," and "insular cortex" (602), and they link "generation of semantic association," seemingly related to reasoning, to "left hemisphere," including Broca's Area (603).

As a final note, there also seems to be another connection to recognize—between elocution and Neuroscience. Breedlove, Watson, and Rosenzweig link sign language and speech together by noting that they use the same areas of the brain (584). This seems to imply that there is an evolutionary connection. Perhaps, language evolved from "facial expressions" and "hand movement" (584).

My discussion of the neuroscience of language, as well as the neuroscience of consciousness illuminates a few major concerns: first, there is more work to do here. We must link the ideas highlighted here to ideas in Cognitive Rhetoric and other subsets that may contain possible connections, like Elocution. Furthermore, we must begin constructing a Rhetorical Theory of Language, one that is potent, fluid, and comprehensive, especially with respect to the ways in which it engages with recent findings from the field of neuroscience.

Conclusion

Although I am still cautious, I believe this thesis has accomplished two major goals: I have provided an overview of the basic ideas in Neuroscience that Rhetoric and Composition should understand, and I have, at the very least, provided a language that might be used to "close the gap" between our field and Neuroscience. The goals of NeuroRhetoric(s) and NeuroComposition will have important consequences for all domains concerned with writing and reading. Work of this sort might lead to highly valuable questions like these:

- What is the difference between the "patterning," the flow of neural activity from the source to the behavior, of speech and the "patterning" of writing (3)?
- How might a basic conception of rhetoric be described in physiological terms?
- How do children learn to write, and how do college-level writers learn more advanced concepts?
- "What brain regions are particularly involved in language" (Breedlove et al. 3)?
- What brain regions are particularly involved in reading and writing?
- What mechanisms make writing possible, and what are the differences between active mechanisms in speech and writing, hearing, and reading?
- How can NeuroRhetoric(s) and NeuroComposition help to strengthen theory and pedagogy in Rhetoric and Composition?
- How might brain-imaging technology provide new types of evidence for researchers interested in defining, tracing, and understanding the cognitive effects of particular rhetorical appeals (ethos, pathos, logos)
- How might pedagogy in composition improve as it comes to know more about the brain?

By using fMRI or electroencephalography, Neurorhetoric(s) could seek to determine the brain areas active when a subject watches Dr. Martin Luther King Jr.'s "I Have a Dream" speech as the stimulus? It could explore the differences between brain processes when a visual/aural stimulus (e.g. M.L.K. Jr.'s speech) is replaced with a textual version. Similar research might show how the three classical appeals affect the brain, which appear to be more effective, and why. NeuroComposition, on the other hand, could seek to understand the physiological aspects of the writing process. Experiments of interest might provide specific cognitive tasks inherent in writing classrooms and activities, composing a text for example, while performing brain scans, in order to further recognize those functions involved in writing. It might seek to enter the conversations about neuroplasticity and neurogenesis: the goal of any classroom, it could be argued using neuroscientific terminology, is to increase the number and size of neurons and the number of connections between neurons. How might certain pedagogical methods/methodologies increase positive neuroplasticity in students? Which methods are more effective? How might lesson plans improve by truly understanding this process?

In seeking answers to these questions about the physiology of rhetorical processes, NeuroRhetoric(s) and NeuroComposition could help to supplement the foundation of Rhetoric and Composition in a time when the humanities are being devalued in general. Henry Giroux describes this devaluation, pointing to its causes:

> Shaping the neoliberal framing of public and higher education is a corporate-based ideology that embraces standardizing the curriculum, supporting top-down management, implementing more courses that promote business values, and reducing all levels of education to job training sites. (Giroux 2)

NeuroRhetoric(s) and NeuroComposition might help to counter this trend by providing empirical data to back up many of its claims, claims that often seek to subvert the forces Giroux mentions. NeuroRhetoric(s) and NeuroComposition can accomplish these things, perhaps, by adding to Composition Theory. Raúl Sánchez, in *The Function of Theory in Composition Studies*, writes:

> Writing happens, and composition researchers can watch it happen and make claims about it, or they can look at the artifacts it leaves behind and make claims about writing as a result. (Sánchez 9)

Brain imaging is a viable way to watch writing (and reading) happening, collect empirical data, and use that data to make claims about what writing is and what writing does; it might illuminate writing processes in different ways by showing how writing, itself, functions, both as a product shaped by the brain as well as an experience which shapes the brain. When a subject is shown an object versus when a subject merely imagines the object, or reads about the object, what is happening in the brain? What differences exist between reality and representations of reality as constructions of neurological processing? Sánchez writes, "This assumption of a space between discourse and experience (and by implication language and reality, word and thing) authorizes precisely the hermeneutics of suspicion" (Sánchez 48). Can Neuroscience help to answer classic, basic epistemological problems? Might it prove these problems to be, in fact, rhetorical problems? Sánchez argues,

> rather than take this hermeneutic approach to writing, composition theory should examine the acts of control, resistance, adaptation, and accommodation that composing subjects, who are both producers and products of discourse, carry out.

> More importantly, it might attend to and explore nonrepresentational functions of writing, functions that would situate writing more deeply in the matrix of cultural (re)production than current perspectives have been able to. That is, if one were to fuse composition theory's interest in understanding writing to cultural theory's concern with explaining how ideological formulations are rooted in uneven power relations, one would prepare the ground for empirical studies that might, in time, provide a more comprehensive account of writing *as*, rather than *in*, culture. (Sánchez 70-1)

Can brain imaging inform this argument in any way? Does the brain relate writing and the act of writing to knowing? If it can be proven that active brain processes do not differ much between representational stimuli and actual stimuli, then can ideology as a negative hold fast?

To begin to approach the answers to all of these questions, through primary or secondary research, the first step is a firm understanding of Neuroscience fundamentals. It is important to understand how neurons work, how seeing and hearing work, how attention works, how consciousness comes to be, and how language works because these processes are the catalysts of rhetoric and composition.

As a sort of culmination, I note that this thesis, in a way, helps to stake a place for Rhetoric and Composition in Neuroscience discourse by joining ongoing conversations while demonstrating that there is value in studying these ideas. We return to founding questions of rhetorical studies: what does it mean to think, write, read, and, to some extent, be? These have always been our innermost concerns, and these would be our motivations as we seek to analyze, as Fahnestock calls it, "one of science's last great frontiers" (159). Randy Harris demonstrates what is ultimately at stake here:

> … in labs all over the world there are subjects strapped into fMRI scanners right now by marketing people and political strategists. Lies are being tested. Cortical real estate is lighting up. We won't stop the testing by simply declaring all neuro-cognitive rhetoric is inherently bad or immoral. Luckily, I'm pretty sure the neuromarketing research is misguided and simplistic. No one even knows what it means for cortical real estate to flicker briefly. But, to the extent that these people do find tools of manipulation based on the structure of the mind and the wiring of the brain, we are the folks who should be able to understand, resist, and counter the strategies they develop. (Harris 10)

How much research is going on right now that is based on unethical intentions? How much research is based on unanalyzed or mistaken assumptions? NeuroRhetoric(s) and NeuroComposition might answer these questions. The ethical foundations of rhetorical studies and our unique connections to faculty psychology and cognitive rhetoric put us in the perfect position to carry out similar studies but for more ethical ends. Furthermore, NeuroRhetoric(s) and NeuroComposition might enhance many topics in Rhetoric and Composition, theoretical, practical, and pedagogical. These new lines of inquiry have the potential to be bold and the potential to back up the many beliefs, ideals, and instincts of our larger discourse community.

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[i] As a side note, although all four authors use the term, Neurorhetorics, I ask them to consider (and I will use henceforth) these slight changes in nomenclature: NeuroRhetoric(s) seems to allow for the dynamic potential of this line of inquiry and opens up possibilities for multifaceted characterizations of the work associated with it. Additionally, adding the term NeuroComposition to ongoing discussions related to Neuroscience might make possible inquiry that focuses on the physiology of composition activities and the concerns of Composition Studies.