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How Good Brain Science Gets That Way

Reclaiming the Scientific Study of Sexed and Gendered Brains

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In "How Bad Science Stays That Way," Celeste Condit (1996) argues that brain sex research relies on "commonsense understandings of the nature of the dispute about male and female sex and gender" (p. 88), leading to "bad science"—science that produces accounts that are "insufficiently rich to account for the material phenomenon under investigation" (p. 87). Since then, the growth of neuroscience as a discipline has led to more and more accounts that reproduce the tendencies Condit noted, relying on topoi about men's superior map-reading skills or women's interest in shopping. Other researchers in rhetoric have also pointed out these tendencies in brain research. Jeanne Fahnestock (1999), for example, shows how neuroimaging research produces antithetical visual and verbal arguments by exaggerating differences between men and women, using the rhetorical figure of antithesis. In Anne Fausto-Sterling's (2000) terms, this type of research mistakes sex/gender differences for sex *dimorphism*, rhetorically pushing men and women apart by exaggerating what are, in fact, small *average* differences between men and women. More recently, Christa Teston (2016) has shown how brain sex research relies on null hypothesis significance testing, a statistical method that, in Teston's terms, "disciplines scientists to see in certain ways" (p. 49), particularly by rendering as "significant" group differences that may in fact be rather minor (50).

With relation to neuroscience research, in particular, many scholars have thoroughly analyzed and questioned results that purport to identify measurable anatomical or connective differences in male and female brains. Cordelia

Fine's *Delusions of Gender* (2010) and Rebecca Jordan-Young's *Brain Storm* (2010) are both excellent resources for those seeking to understand that research. To date, then, the predominant position among feminist scholars has been to critique brain research, to point out its flawed reasoning, and to lambaste its tendency to uphold antiquated gender stereotypes.

This fallback position, though, poses problems for feminist rhetorical science studies because it begins from a standpoint of critique rather than engagement. Karen Barad (2007), for instance, argues that feminist researchers should avoid the traditional position in science studies, which has been to "position oneself at some remove, to reflect on the nature of scientific practice as a spectator" (p. 247), and, usually, to launch a critique of those practices. Indeed, research in the field of feminist science studies has, since the late 1970s, criticized the masculinist assumptions that have shaped scientific practice—its institutions, language, methods, theories, and norms.

However, scholars have also sought to engage with scientific practice by articulating new forms, including standpoint epistemology (Harding, 2001), situated knowledges (Haraway, 2001), and agential realism (Barad, 2007). While they differ in the particulars, these theories all call attention to how rhetoric constitutes scientific knowledge, the social and cultural are entangled with the material, and feminist researchers should not critique from the sidelines but begin to engage in scientific practice itself. Donna Haraway (2001) writes, for instance, that science "is rhetoric, the persuasion of the relevant social actors that one's manufactured knowledge is a route to a desired form of very objective power" (p. 170); for Haraway, in short, science is a deeply rhetorical endeavor. The goal of feminist science, then, is to use those persuasive tools to offer a

> richer, better account of a world, in order to live in it well and in critical, reflexive relation to our own as well as others' practices of domination and the unequal parts of privilege and oppression that make up all positions. (p. 172)

Barad (2011), similarly, argues for researchers to engage "in practices we call 'science studies' together with practices we call 'science'" (p. 446). As a precursor to this kind of engagement with the neurosciences, I will argue, feminist rhetorical science studies scholars need to reposition themselves, starting not from a place of critique but from an openness to engagement with the brain sciences that does not entail simply embracing or rejecting neuroscience wholesale. This may seem difficult given the tendencies Condit (1996) and Fahnestock (1999) outline. Here, I demonstrate how at least some neuroscience

researchers are moving toward a kind of approach more amenable to engagement with humanities researchers. By questioning gender stereotypes and how they emerge in brain research, these scientists open up possibilities for entanglement. In order to identify how alternative kinds of research can be possible, we must turn our attention to the experiment as the unit of analysis. Only by understanding how scientific knowledge is produced through specific experimental entanglements can we begin to identify new possibilities that better capture the interaction of the sociocultural and neurobiological networks through which brain sex/gender differences may (or may not) emerge.

In this chapter, I begin with two psychological studies in order to develop a framework: "Influences of Gender Role and Anxiety on Sex Differences in Temporal Summation of Pain" (Robinson, Wise, Gagnon, Fillingim, & Price, 2004) and "Gender Differences, Motivation, and Empathic Accuracy" (Klein & Hodge, 2001). Next, I show how this framework can be applied to neuroscientific imaging studies, showing in particular how some recent neuroscience research actually supports the viewpoints of feminist researchers who understand the sociocultural and neurobiological to be intertwined. These experiments help to illustrate how sex and gender are not merely preexisting differences that may be revealed through experiments but that sex/gender itself emerges through experiments, appearing differently depending on the experimental apparatus used.

On Neurorhetorics

This essay develops out of the area of study referred to as "neurorhetorics," or the study of "how discourses about the brain construct neurological difference, how to operationalize rhetorical inquiry into neuroscience in meaningful ways, and what those constructions imply for contemporary public discourse" (Jack, 2010, p. 406). Within this area of study, scholars might explore both the rhetoric of neuroscience, or how neuroscientific knowledge circulates through discourse, and the neuroscience of rhetoric, or how insights from neuroscience might inform rhetorical theory. Ideally, as I have argued elsewhere with L. Gregory Appelbaum, these types of study should be intertwined (Jack & Appelbaum, 2010). In other words, in order to understand how neuroscience concepts can contribute to rhetorical theory, I maintain that one should understand how those concepts are themselves established rhetorically. Methodologically, this means paying careful attention to scientific knowledge in the genre in which it circulates, the scientific article; examining the methods, tools, and concepts used in those articles; and remaining cautious when extending the implications of that research outward to rhetoric.

This research participates in the broader call for humanistic and social scientific approaches to neuroscience put forward by scholars such as Suparna Choudhury, Saskia Kathi Nagel, and Jan Slaby (2009); Des Fitzgerald and Felicity Callard (2015); and others. Among those scholars, I find Fitzgerald and Callard's (2015) call for a return to the experiment particularly useful. They have argued that "*experimental labour itself*" is worth "sustained attention from social scientists and humanists" (p. 5), since it offers a way not only to better understand how neuroscience knowledge is produced but also to engage with neuroscience and even participate in it (and here they draw inspiration from Barad's [2007] call for an "entanglement" with the natural sciences [p. 20]).

Before moving on, it is important to recognize how neuroscience functions rhetorically. To date, much of the scholarship on the rhetoric of neuroscience has focused on public discourse. Scholars have examined how neuroscience involving neuroimaging tools such as functional magnetic resonance imaging (fMRI) plays out in the popular sphere. As Joseph Dumit (2004) has explained, these imaging tools are constituted rhetorically as scientifically valid measurement tools, but they also "make claims on us" (in Dumit's words), establishing different types of people in public rhetorics about the "depressed brain" or the "creative brain," for instance (p. 5). Neuroscientists have themselves called attention to the problem of popularization, suggesting that neuroscience explanations hold a "seductive allure" that belies the tentativeness of current research findings (Weisberg, Keil, Goodstein, Rawson, & Gray, 2008).

My focus here, though, is on the rhetoric of scientific research articles and of experiments themselves in neuroscience. One important point to mention is that neuroscience is itself an interdiscipline, one that draws on insights from fields such as psychology, biology, computing, physics, engineering, and linguistics. In the area of cognitive neuroscience, in particular, much of the rhetorical work required involves bridging psychology and neurobiology, or linking psychology concepts such as memory, attention, and reward to neurological locations or substrates. This rhetorical work begins long before an experimental result is published; indeed, the research questions asked, the experimental protocols designed, and the apparatus used (including everything from psychometric questionnaires to measurement tools such as fMRI) involve rhetorical decisions. As Barad (2007) puts it,

> every measurement involves a particular choice of apparatus, providing the conditions necessary to give meaning to a particular set of variables, at

the exclusion of other essential variables, thereby placing a particular embodied cut delineating the object from the agencies of observation. (p. 115)

In neuroscience research on sex/gender differences, one choice is to assume such variances exist a priori (outside of scientific observation) and to then devise an experiment that demonstrates the extent of those differences. A different approach, however, is to assume that such variances are constituted in and through experiments, and to therefore design an apparatus that manipulates those differences themselves. In the latter, sex/gender take on other meanings depending on the apparatus.

Gender-Aware Methodologies

Researchers interested in sex/gender differences in neuroscience often begin from an antithetical commonplace about men and women (such as the idea that men are more interested in sports than women are) that is taken as objective and real, and then seek to explain it by blending psychological and neuroscientific methods. For instance, researchers might have measured spatial ability in male and female participants using an object rotation task while they were in an fMRI machine; the researchers would then determine, on average, how well men and women performed the task and identify which brain regions men and women used while doing it using null hypothesis significance testing, as Teston has outlined. The starting assumption they made—that men and women have different spatial reasoning abilities—shapes the materials of the experiment itself, including the questionnaire used, the brain regions examined in the fMRI machine, the use of the machine itself, and so on. This approach parallels the assumptions Barad (2007) outlines as the classical epistemological and ontological assumptions underlying Newtonian physics, which assumes, first, "that the world is composed of individual objects with individually determinate boundaries and properties whose well-defined values can be represented by abstract universal concepts that have determinate meanings independent of the specifics of the experimental practice" and, second, that it is possible to measure those objects neutrally, as separate from "the agencies of observation" (p. 107). In the case of neuroscience, then, researchers operating under this set of assumptions believe that sex and gender are clearly delineated objects that exist "out there" in the world: this includes "men" and "women" as well as "male" and "female" brains. It is this type of research that Condit critiqued in her 2008 study for its oversimplistic tendency to reify the very objects it sought to investigate.

However, researchers who make a different rhetorical decision might design a study another way. A feminist perspective, for instance, would require researchers, in Condit's (2008) words, to "ask questions such as 'under what conditions do people manifest particular behavioral patterns out of their available repertoires?' rather than simply asserting that males and females have fixed behavioral patterns" (p. 493). Here, I consider two studies to illustrate how starting from a different assumption leads researchers to pay attention to different aspects of the experiment and to recognize the entanglement of societal gender norms and priming effects with experimental apparatus and results. These studies demonstrate, in Barad's (2007) terms, how "measurement practices are an ineliminable part of the results obtained" (p. 121). By selecting different ways of measuring pain and empathy, in these instances, researchers allow sex/gender differences to materialize in various ways.

Typically, studies of pain call on participants to rank their pain levels on a scale; most studies have shown that men have higher pain tolerances than women. These studies assume that men and women exist outside of the experimental apparatus, as do pain tolerances; experiments, then, must simply measure those differences. However, in Robinson et al.'s (2004) study, "Influences of Gender Role and Anxiety on Sex Differences in Temporal Summation of Pain," researchers demonstrated how those differences in fact are produced by experimental apparatuses, including different scales of measurement, and how they are deployed within an experimental setting. In this study, participants first completed a set of questionnaires dealing with how they experienced pain, including one called the "Gender Role Expectations of Pain Questionnaire." This questionnaire asks subjects to report how the typical man and woman responds to pain, and then asks participants to rate themselves. One question asks how willing the typical man or woman is to report pain. In other words, this question asks participants whether they have absorbed the common social belief that men are less likely to admit to feeling pain than women are. Next, participants completed several types of tests in which they were exposed to physical pain via heat pulses.

Robinson et al. found that, while women reported greater levels of pain during these experiments, those differences corresponded to the participants' responses on the questionnaires. In particular, participants who believed themselves (and their gender) more willing to report pain experienced more pain. The authors concluded that pain is "a hypothetical psychologic construct" (p. 80), not simply a physical reality. To put this another way, we might say that these results provide an example of Barad's theory of entanglement—the material, embodied pain response is entangled with cultural expectations.[1]

This experiment further illustrates, in Barad's (2007) terms, how theoretical concepts, such as pain as well as sex/gender, "are not ideational in character but rather *specific physical arrangements*" (p. 139). Here, the physical arrangements include study participants, the questionnaires they complete, the researchers themselves, and the specific way pain was measured (via heat pulses) as well as the ways sex/gender were defined, including in the recruitment of subject participants assumed to be unproblematically male or female prior to the study itself. By setting up their apparatus differently—simply by using a different measurement scale than was used in other studies—researchers materialized pain and sex/gender differently from other researchers who assumed both objects existed independently from and prior to the study itself.

In the next example, Klein and Hodges's (2001) study "Gender Differences, Motivation, and Empathic Accuracy," researchers found that material elements of the study produced a significant (but not intentional) experimental effect: making gender differences appear or disappear in the study of empathy. Klein and Hodges sought to investigate an intriguing problem in the study of "empathic accuracy," or the ability of participants to infer accurately the thoughts and feelings of others. To judge empathic accuracy, one common method has been to have participants view videos of an individual discussing an event or problem. The participants must judge how the individual felt at key moments in the video (as determined by the individuals in the video, who noted their emotions or thoughts after watching their videos). A striking issue has emerged from studies using this method. Namely, researchers found no gender differences in empathic accuracy in the first seven studies. However, when they changed the written form on which participants recorded their findings, a gender difference began to emerge, with women performing better than men. On the new form, participants were asked to indicate how accurately they thought they had judged emotional states for each key moment in the video. In other words, the new forms made participants conscious of empathic ability—a trait commonly linked to women—and, in so doing, may have motivated women to do better at the task.

To test this hypothesis, Klein and Hodges performed two different experiments, using male and female college students as participants. In the first experiment, participants watched a video of a female student relating an academic problem. Half of the participants then completed a questionnaire reporting how sympathetic they felt, and then completed the empathic accuracy task. For the other half of the participants, the order was reversed. Presumably, the sympathy questionnaire would evoke gendered stereotypes, priming women to perform better on the test of empathic accuracy. The experimenters

also manipulated the instructions accompanying the empathy test. For one third of the participants, the task was introduced as a test of cognitive ability; in the second third, it was described as a test of empathy; and in the final third, no mental ability was invoked.

Klein and Hodges found that women performed better on the empathic accuracy test when they first completed the sympathy test. They also performed better than men on the empathic accuracy test when the instructions invoked the concept of empathy, but not in the control condition or when the test evoked cognitive ability.

In the second experiment, Klein and Hodges used the same protocol, only this time the test subjects were paid for each correct answer on the empathic accuracy test. (In the control condition, no payment was received; a third group received feedback on their performance but no money.) When paid for the accuracy of their responses, men and women scored equally well on the empathic accuracy test. The authors concluded that

> if a woman is aware that the task she is completing is assessing her empathic capabilities, it may be important for her to perform well. She therefore may be more successful than a man completing the same objective measurement of empathy because of her increased level of motivation. (p. 721)

In short, Klein and Hodges determined that a minor shift in the experimental apparatus could significantly influence results, in effect erasing gender differences that had been widely upheld in other scientific studies and that had become a cliché in contemporary discourse about gender differences.

Klein and Hodges were thus able to identify elements in the material-discursive entanglement of experimental apparatus and gender norms. For one, the form used in a study could prime a gendered concept in participants (the idea that women are more empathetic than men), leading to results that seem to uphold a gender binary. Alternatively, introducing a different material-discursive element into the study (money) could produce a different outcome, in effect erasing gender differences by motivating men to perform better on the test.

Studies such as the two I have examined here have been taken up by other researchers seeking to understand the social and rhetorical contexts that produce gender differences. Moreover, researchers are questioning the concepts themselves that tend to be associated with such research—pain and empathy are two of the concepts most commonly linked to gender. The Robinson et al. (2004) study has been cited in a number of review articles and meta-analyses

that now suggest a consensus: namely, that gender roles shape the experience of pain, with those who identify as more masculine reporting lower sensitivity to pain. Rather than taking this as evidence of some innate connection between masculinity and inherent pain tolerance, researchers concluded that "learned masculinity encourages stoicism" as well as "displays of withstanding pain." (Alabas, Tashani, Tabasam, & Johnson, 2012). Similarly, psychologist Andrea Lobb (2013) argues that the concept of empathy is "laden with dubious assumptions about sexual difference" (p. 427). More specifically, Lobb claims that the concept of empathy allows "regressive sex stereotypes" to be worked back into psychology research via the "moral cover" of empathy (p. 427). Klein and Hodges's (2001) study forms part of the centerpiece of Lobb's argument, namely, that the female advantage in empathy is not itself scientifically proven. From there, Lobb (2013) goes on to question the moral and ethical implications of assigning as important a value as empathy to just one sex. In other words, at least some researchers are beginning to recognize the entanglement of sociocultural and neurobiological factors that shape pain or empathy. However, these studies still seem to have swapped the idea of sex/gender differences for that of stereotypes; in other words, while they now question that sex/gender differences exist neatly outside of the experiments that purport to measure them, they still assume that gender stereotypes are obvious, preexistent concepts.

Together, the studies I have considered so far suggest two ways that neuroscience experiments can constitute or challenge sex/gender difference. First, sociocultural expectations may prefigure experiments, insofar as participants implicitly evoke their own beliefs (such as their belief that women are less tolerant of pain) within an experimental setting. Second, material elements of the experimental situation itself may shape responses; even small items like a form used as part of an experimental protocol may prime gendered responses. Other elements, such as rewards given for participation, may also shape results. As feminist scholars of rhetoric and science, we should be careful not to overlook these elements when interpreting an experimental study or drawing from its results. Not only can these small differences influence results, but they can also do so in ways that either force apart sex/gender distinctions or bring them closer together. As experts in rhetoric, we can be effective research partners in neuroscientific studies, to the extent that we are trained to identify the possible means of persuasion, even within a scientific experiment.

In the next section, I consider whether and how neuroimaging experiments investigating sex/gender differences might draw on these perspectives to demonstrate the entanglement of rhetorical and cultural gender expectations with the materiality of the brain.

Neuroimaging Sex and Gender

Despite the promising frameworks generated by the previously discussed studies, neuroscience research often starts from the assumption that sex/gender differences exist and seeks to identify those variances, rather than asking the question of whether observable sex/gender differences are in fact artifacts of cultural beliefs and rhetorical contexts of the experiment itself. To determine the extent to which the former approach dominates, I pulled all abstracts in which *sex* or *gender* appeared from a database of neuroimaging studies that appeared between 2004 and 2010 in five neuroscience journals.[2] Working with my research assistant, Jennifer Stockwell, we then eliminated abstracts referring to studies that did not explicitly examine sex/gender differences; these included forty abstracts that simply listed the gender of the participants and those that used terms such as *engender*. This left a list of forty-nine studies.

Jennifer and I then coded those studies, separately, identifying the hypotheses and study designs as either demonstrating sex/gender differences (D); studying phenomena specifically in either men's or women's brains (G); or questioning sex/gender differences themselves (Q). (Agreement between the research assistant and I neared 95 percent). Overall, thirty-one studies fell into the (D) category, fourteen into the (G) study, and only four into the (Q) category. These results suggest that opportunities for engagement with the neurosciences are plentiful. Heeding Fitzgerald and Callard's (2015) call for humanities and social science researchers to work alongside neuroscientists, rather than retreating to the more comfortable position of armchair critique, could allow us to enrich those studies that continue to start from the assumption of difference rather than questioning whether, why, and in what conditions it exists.

First, let's consider the studies that seek to identify sex/gender differences in the brain, or the (D) studies. While a thorough review of these studies is beyond the scope of this chapter, in general, we find that the frameworks Fausto-Sterling (2000), Condit (1996), and Fahnestock (1999) problematized persist in neuroscience research. These kinds of studies often *start* with an antithesis, posing a stereotype as common knowledge readily observable in day-to-day life, and then asking whether it has a neurological basis.

Often, these antitheses and generalizations appear in the first paragraph of the research article. Consider the following examples:

- "Behavioral studies suggest that females often perform better in emotional tasks than males." (Schulte-Rüther, Markowitsch, Shah, Fink, & Piefke, 2008, p. 393)
- "In the past few decades, scientists and the public alike have debated the existence of gender differences in mathematical skills." (Keller & Menon, 2009, p. 342)
- "Men and women . . . differ markedly in aspects of sexual behavior, such as the reportedly greater male interest in and response to sexually arousing visual stimuli." (Hamann, Herman, Nolan, & Wallen, 2004, p. 411)
- "Men outperform women on several spatial ability measures." (Seurinck, Vingerhoets, de Lange, & Achten, 2004, p. 1440)
- Disorders such as depression and post-traumatic stress disorder "have a substantially greater prevalence (1.5–3 times) in females than males." (Williams et al., 2005, p. 618)

We might summarize the arguments in these first lines as follows:

- Women are more empathetic than men.
- Men are better at math than women.
- Men like porn.
- Women can't read maps.
- Women are more emotional than men.

While some of these studies couch those stereotypes in results from behavioral or psychometric research, they nonetheless take a stereotype or a generalization at face value and then seek to identify its neural correlates, rather than seeking to identify where it comes from or whether it reflects rhetorical and cultural entanglements like the ones outlined in the previous section. These studies, then, assume that gender stereotypes are somehow outside of scientific practices, ignoring how "the social and the scientific are co-constituted" (Barad, 2007, p. 168). In fact, these studies do not reflect an existing reality about sex/gender and the brain but in fact contribute to the production of sex/gender differences both within the scientific experiment itself and in the discourses surrounding them; the prominence of these types of experiments in popular sciences news headlines offers one example of this.

The (G) studies also seem to reflect gendered stereotypes. These studies use gender stereotypes or norms as the basis for selecting participants, since they typically choose to study individuals of only one sex. In many cases, no rationale is given for deciding to study only one group; the reader is left

to fill in the assumptions underlying the choice. For instance, one study of pedophiles used only male participants who were attracted to female children but did not explain this choice (Schiffer et al., 2008). This pick of study subject and study design assumes the common belief that pedophiles are men who prey on young girls. In others, a weak rationale was given for confining a study to only one sex, as was the case in a study of responses to sexual stimuli that used only men viewing pornographic images of women; the authors assumed that men were naturally more responsive to such images than women (Borg, Lieberman, & Kiehl, 2008, p. 1531). Finally, some of the studies used only men or women because they were studying sexual responses unique to male or female anatomy. Here, the reasoning seems to be that men and women have unique neuroanatomy due to their different anatomical structures, so men and women are best studied separately. These studies are also typically confined to either heterosexual or homosexual participants. One study of sexual response, for instance, involved heterosexual males and their female partners, who participated by stimulating their boyfriends (Georgiadis et al., 2010). All these approaches, then, take sex/gender differences as preexisting and natural, with the study merely revealing those differences. Nonetheless, we can see even from these schematic descriptions that each study materializes sex/gender/sexuality differently through its choices. By focusing on men's responses to visual stimuli, for instance, Jana Schaich Borg, Debra Lieberman, and Kent A. Kiehl (2008) constitute men as sexually responsive to pornography and seek to produce such responses in the brain.

Next, let's examine the four studies (Q) that sought to question sex/gender stereotypes. Two of these studies (Mitchell, Ames, Jenkins, & Banaji, 2009; Quadflieg et al., 2009) were framed as research into the phenomenon of social stereotyping, with gender offering a case study with which to explore that phenomenon. In other words, these studies are not framed explicitly as inquiries into whether gender stereotypes have some neurological basis; instead, they seek to understand how those stereotypes work in the first place.

Jason Mitchell et al.'s "Neural Correlates of Stereotype Application" (2009) begins by outlining the broad phenomenon by which people mentalize about others by activating stereotypes. The researchers explain that stereotypes guide people's judgments about others' psychological characteristics and behaviors (p. 594). For example, the researchers showed participants a picture of a man or woman and then asked them to judge whether or not a statement would apply to that person, such as "likes scented candles" or "enjoys watching football" (p. 595). In rhetorical terms, the researchers prompted people with commonplaces or topoi about what men and women are supposed to like.

The authors suggest that we may draw on the right prefrontal cortex, an area of the brain associated with categorization, when making stereotyped judgments. Those participants who scored higher on measures of gendered attitudes (those who had been exposed to more gendered topoi and persuaded by them), in fact, showed greater activations in that region of the brain. The authors concluded that when applying gendered stereotypes to individuals, we draw on a more fundamental cognitive process of categorization. In Burkean terms, we might term this a sense of "what properly goes with what," or a piety that develops over time through repeated exposure to gendered topoi (1984, p. 74). This research, then, points to a potential example of what Fausto-Sterling (2000) and Barad (2007) term "dynamic systems" or "entanglements," respectively, or the mutual imbrication of neurological functions with social and rhetorical constructs of sex/gender. At the same time, however, it is important not to overlook how invoking gender stereotypes in this study itself materializes and cements those stereotypes, contributing to the very phenomenon it hopes to explain.

We see similar support for a neurological basis for gender stereotypes in a study by Susanne Quadflieg et al., "Exploring the Neural Correlates of Social Stereotyping" (2009). In this study, participants were asked to indicate whether certain kinds of activities, such as mowing the lawn, watching talk shows, or taking photographs, corresponded more with men or women (or neither). As they were doing this task, researchers monitored participants' blood oxygenation activation in an fMRI machine. The researchers correlated those activation responses with participants' results on two questionnaires, the "Implicit Association Test" and the "Attitudes toward Women Scale." They found patterns of activation in regions of the brain associated with activity knowledge and with evaluative or emotional processing (the amygdala). An interesting conclusion from this study is that gender stereotyping is fundamentally evaluative (p. 1567), but that it also depends on learned associations. In fact, those who scored highest on the scales used to test gendered beliefs had the greatest activation in the right amygdala, a region of the brain associated with "stimuli that have acquired emotional significance through learning rather than based on some innate propensity" (p. 1567). The authors concluded that while stereotyping is a nearly universal human capacity, "activity in the neural circuitry supporting these responses is sensitive to the strength with which gender-based beliefs are endorsed in everyday life" (p. 1567). This is a provocative finding. It suggests that rather than viewing sex/gender differences as hardwired or innate (as many seem to do), scientists might now consider those differences to be based on a fundamental cognitive capacity to

make judgments, coupled with a learned capacity to make those judgments based on previous exposure to gendered topoi. This study contends that the neurobiological and sociocultural are clearly entangled, with repeated exposure to such stereotypes producing material differences in the brain. Yet Barad would remind us not to view this study (or any other experimental study) as simply reflecting a reality about gender stereotypes; as with the studies of pain and empathy earlier, we must recognize the experimental apparatus itself as constitutive of this understanding of the phenomenon of gender stereotypes. In other words, this study constitutes gender stereotypes as binaries (male/female, masculine/feminine) that we can associate with specific tasks such as mowing the lawn; individuals differ only by the extent to which they put stock in those stereotypes.

Two other studies take the very act of ascribing sex/gender to individuals as the object of study. In the first example, Dutch researchers investigated how individuals make judgments about an unknown or invisible speaker's age, sex, and social background by interpreting their voice. To examine this phenomenon, the researchers recorded sentences pronounced by male or female speakers, children or adults, and, in the final condition, speakers with an accent associated with either an upper-class or lower-class accent (in Dutch). Some of these sentences conveyed information that would be expected of the speaker, and others did not. For instance, the incongruent utterances included a male speaker saying, "My favorite colors are *pink* and lime green" or a child saying, "Every evening I drink a glass of *wine* before going to bed" (Tesink et al., 2009, p. 2086). These sentences violated common social stereotypes.

While the authors do not speculate about what their findings mean with respect to gender stereotyping (or other forms of stereotyping) in particular, they did find activations in the brain when incongruent sentences were uttered that suggested "increased and more prolonged efforts to search and retrieve semantic knowledge about the likelihood of events occurring in the real world" (p. 2097). These activations occurred in the left inferior frontal cortex, an area of the brain associated with language comprehension. The authors further suggest that the process of "unification" also entails other kinds of information—not just words, but gestures and other extralinguistic vectors of information. Thus, this unifying process involves a variety of inputs, linguistic and otherwise, where individuals try to square incongruent information with their existing assumptions about sex and gender.

A final study in our sample examined a similar process of gender identification, but this time in relation to human motion—specifically gait. The study asked how it is that we ascribe gender to an individual's walk. To answer

this question, the researchers attached lights to the major joints of an actor's body. The actor then portrayed male, female, or gender-ambiguous walks, and participants viewing only those lights were asked to identify the gender of the walker. Importantly, the researchers found that this discrimination of gender is contextual. That is, after viewing a "female" walk, viewers tended to identify the next stimulus as a "male" walk, and vice versa. The authors concluded that "gender identification of human walkers is rapidly malleable and subject to adaptation" (Jordan, Fallah, & Stoner, 2006, p. 739). This study, then, perhaps goes the furthest of the ones reviewed here in recognizing gender as itself constituted through the experiment rather than existing a priori in the form of gendered bodies or stereotypes.

Together, this group of studies suggests that researchers who seek to understand how it is that we ascribe gender differences to others can help depolarize male and female brains by refusing the antithetical reasoning foundational to so many other studies. They also begin to resist the polarization between sociocultural and neurobiological elements, showing how they are also entwined. While by no means the most common approach among the studies we surveyed, this last group does indicate that feminist scholars in the rhetoric of science need not eschew brain research completely, and can even find moments of possibility within the experimental sites given here. Nonetheless, feminist scholars might push these researchers further to recognize gender-in-the-making within experiments themselves. For example, the voice study used voices that were presumably easily identified as male or female; while the authors do not describe how they chose such voices, we can assume that the "male" voices were deeper and the "female" voices higher. This marks an assumption that gendered voices match straightforwardly with gendered bodies. This study, then constitutes gender as something we can determine from the tone and timber of one's voice. In other words, vestiges of what Barad refers to as "representationalism" (the assumption, in this case, that "men" and "women" and "male voice" or "female voice" exist "out there" somewhere) continue to shape these studies, even when they seek to explain how sex and gender function neurologically rather than taking them as givens.

Conclusion

Good brain science can emerge when researchers recognize that psychological concepts, experimental protocols, and apparatus materialize sex/gender, rather than simply reflecting or explaining it. The articles reviewed here take us some of the way toward that goal. The psychology studies I've highlighted have helped to shift the conversation within psychology that takes men's greater

tolerance for pain, or women's greater empathic accuracy, as natural, as givens. Further, the neuroscience studies help to suggest how the very act of ascribing gender to another person depends on neurological operations as well as social and cultural inputs. My point here, though, is not simply to suggest that the specific results of these research articles necessarily improve on what feminist rhetoricians already know about sex and gender. Instead, I hope this analysis demonstrates how and why feminist rhetoricians should pay close attention to the rhetoricity of science at the level of the research article or experiment so that we may better understand how the decisions scientists make may or may not lead toward a feminist biology.

While I find the articles included here promising in that regard, they do have limitations. For one, the studies examined drew from relatively dated feminist theories. While these studies help to investigate the extent to which gender differences are socially and rhetorically produced, both within a culture and within an experimental setting, few studies take up a perspective of gender as polymorphic or diverse. Most studies assumed participants were naturally male or female, masculine or feminine. The study designs did not allow for a more complex model that would include gender diversity—that is, a wider range of sexed and gendered identities, including transgendered, genderqueer, or agender. That perspective might allow us the possibility to make even richer identity arguments.

In addition, the studies examined did not take an intersectional approach, which would consider gender alongside the dynamics of race, gender, class, sexuality, nationality, and disability. Most of the studies reviewed recruited participants mainly from undergraduate psychology courses—a common practice in psychological research that nonetheless risks generalizing heavily from a specific group of students and ignores the potential differences between individual brains across time, place, and culture. For instance, the types of stereotypes questioned in these studies might reflect mainstream white, middle-class stereotypes (that men don't like shopping, for example, or that women like scented candles, are more empathetic than men, and so on). These kinds of assumptions do not necessarily persist across different cultures, or even across time within a given culture.

Nevertheless, the examples given here suggest that feminist researchers in the rhetoric of science need not dismiss all brain research as sexist. In fact, because they demonstrate how sex-stereotyped behaviors can be constituted differently through minute changes (such as the type of form given), the scientific studies in this chapter offer useful thought experiments for thinking through sex/gender as a phenomenon more broadly—how material

and discursive interactions make and remake gender continually and how science contributes to those makings. After all, as Barad (2007) writes, "there isn't one set of material practices that makes science, and another disjunct set that makes social relations; one kind of matter on the inside, and another on the outside. The social and the scientific are co-constituted" (p. 168). This less deterministic view of gendered and sexed brains answers Condit's (2008) call for feminists to "grapple with a more complex account of biology," which she describes "as treating biological organisms as belonging to non-homogenous sets that change through time and whose characteristics are a product of the variable environments (or 'cultures') through which they move" (p. 493). I have argued that, for rhetoricians, this project requires a renewed impetus not only to analyze and disrupt stereotypical portrayals of men and women in scientific research but also a willingness to engage with brain science at the level of the experiment and research article.

Notes

1. For a more in-depth analysis of how pain, in particular, materializes in scientific experiments and discourses, consult S. Scott Graham's (2015) *The Politics of Pain Medicine: A Rhetorical-Ontological Inquiry.*

2. For study methodology, see "Mapping the Semantic Structure of Cognitive Neuroscience" (Beam, Applebaum, Jack, Moody, & Huettel, 2014).

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