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"Dura Mater" as the "Tough Mother":

Gendered Language in Neuroscience Textbooks

A Thesis in Women's and Gender Studies

by

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Dedication

To all feminist scholars who strive for a more inclusive science and to my professors, family and friends who helped me get here.

Abstract

Throughout the years, several feminist scholars have analyzed different aspects of science. Although their critiques have different perspectives, most feminist scholars agree that science, as human constructed knowledge, is influenced by social values around race and gender. Following similar feminist analysis of gynecology and molecular biology writing, this intersectional feminist analysis focuses on how the language used in neuroscience textbooks perpetuates ideas about race and gender. Textbooks are authoritative sources that are not often questioned but that are greatly influenced by the authors who write them. Specific images and text were selected from two undergraduate neuroscience textbooks, *Brain and Behavior* and *Neuroscience.* The analysis of the images showed comparisons of people of color to animals, which positions people of color as inferior and erotic. The images also portrayed white men more often than people of color establishing white men as the universal human being of science. The analysis of the texts revealed explicit references to ideas about motherhood, womanhood and femininity, which reestablishes these ideas without challenging their construction and (re)production. This analysis also explored the influence that the authors' identities have on the scientific writing itself. Their identities create a narrow perspective of science, which influence the language we use and the knowledge that is (re)produced. It is essential that feminist scholars and new neuroscience students continue to question science textbooks and become skeptical about the scientific knowledge that is taken for granted.

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Preface

When I decided to major in neuroscience, I knew that there were not many women in science. Thus, my decision was based on personal interests as well as on a personal resolution to go against the norms by excelling in science as a woman of color. Throughout my neuroscience classes, despite being surrounded by mostly female classmates, I kept hearing about these famous male scientists and their contributions to the field. Although 48.2 percent of all doctoral degrees in science were awarded to women in 2014 (National Science Foundation, 2016), I wondered about who and where these women were.

It was not until after I took Introduction to Women's and Gender Studies that I learned more about the ways in which gender organizes life beyond the construction of a division of labor. Gender intersects every aspect of our lives from the clothes we wear to how we act and what we say to the fields and professions we choose. Despite the fact that almost half of the doctoral degrees in science go to women, this statistic does not reflect the factors that still affect women in the workplace such as unequal wages, sexism, harassment, lack of paid maternity leave, and lack of childcare.

However, my interest in understanding how gender influences science did not mainly originate from these observations or from scholarly thought. Although I was familiar with some feminist critiques of science such as Emily Martin's "The Egg and the Sperm: How Science Has Constructed a Romance Based on Stereotypical Male-Female Roles," my own experiences as a queer woman of color and neuroscience student influenced my decision to examine gender, race and science.

The influence of gender is so deeply embedded in science itself that it has become invisible, at least to neuroscientists and neuroscience students. Throughout the process of examining neuroscience textbooks, I realized that I had become blind to the ways in which gender interacts with the neuroscience as examined by other feminist scholars. When reading Meg Upchurch and Simona Fojtová's analysis of the language used to describe glial cells, I realized how much knowledge about the brain I had taken for granted, without stopping to think about the context in which it was "discovered."

The idea for my original analysis stemmed from an example that genders the meninges, the layers between the brain and the skull, by assigning them motherly roles. However, through my search for similar examples, I found that ideas about race also influenced the neuroscientific dissemination of knowledge through textbooks. Some examples, such as those that attempt to find a biological explanation for "good" mothers using rats or that compare women of color to animals, were easier to understand and examine. Yet, others were more difficult to point out. My own experience in learning a particular, narrow "truth" about the brain had prevented me from seeing other perspectives. I had encountered the same information several times that I learned to not question them, because I assumed that science was what it claimed to be: objective and value-free.

Even when I had found enough examples from the textbooks, I struggled in negotiating my own practices as a science student and the requirements of a feminist analysis of science. Although I assert that the identities of those who do science and of those who construct feminist critiques matter, my own practices as a science student were contradicting those claims.

For example, this paper is cited in APA style. However, this citation style perpetuates the same scientific assumptions. According to Robert Madigan, Susan Johnson and Patricia Linton (1995) the goal of APA is to "encapsulate the core values and epistemology of the discipline" and is a "model of thinking…that serves as a socialization experience" (p. 428). In other words, APA style, similarly to other citation styles, captures the values of the discipline shared among those who form part of it. Yet, because APA focuses on the presentation of new information, the authors who conduct those studies become invisible, as Ruthellen Josselson and Amia Lieblich (1996) argue. Although I used APA as reference and citation style, I took the names of all scholars outside of the parenthesis and included their first name as well as some information about their perspective on the topic. However, it was not until later that I realized that, in using APA style to cite feminist scholars, I was perpetuating the same "anonymity of the researcher" against which I was arguing.

I have three main goals in writing this thesis. The first is more personal. In examining how gender influences science, I hoped to find people in science with similar experiences to mine. My second goal is to add to the feminist scholarship on gendered science by illustrating an aspect of gender, race and science that is often invisible. The last is to provide a new perspective for neuroscience students that allows them see science differently and challenge its main assumptions. In making these critiques of science, I do not claim that all science is "bad." However, I do hope that this thesis will illustrate some of the problems within science as a first step towards improving it.

Introduction

Feminist theory is a tool through which one can analyze concepts and ideas while incorporating the social values that shape the perception of those ideas. It considers gender, race, class, and other socially constructed ideologies as intervening factors that influence society's point of view and response to an event, concept or phenomenon. Although unified under the broad category of feminist critique, feminist scholars examine a wide range of theories, practices and concepts from varied points of view. As a result, their critiques of science focus on different aspects of the field but have certain arguments in common.

With respect to science, feminist scholars do not agree with its typical definitions as "objective, dispassionate, impartial, rational knowledge-seeking" (Harding, 1986, p. 16). They consider science to be socially constructed knowledge influenced by the scientists own values, perspectives and identities. In this case, as Kathryn Pyne Addelson (1983) argues, scientists become authorities who present the correct explanation for world phenomena. However, because of the narrow range of scientific methodologies and explanations, as well as the limits placed on who has access to science (mostly white men), feminist scholars question scientific findings and strive to find cultural and social explanations. Feminist scholars argue for the consideration of social values within science in order to improve its foundational ideology and current methods and practices (Harding, 1986).

According to feminist scholar and philosopher of science, Sandra Harding, the different perspectives of feminist critiques of science depend on the level of analysis and focus (1986). For instance, some feminist scholars include arguments related to "racism, colonialism, capitalism, and homophobia," introduced by other movements prior to the feminist critiques of science (p. 16). Others focus on scientific assumptions, the perpetuation of gender ideologies in science, and the role that scientists have on the (re)production of such ideologies. Still, other feminist scholars challenge the current scientific practices influenced by the gendered division of labor and the exclusion of women as scientists and participants (Harding, 1986).

Feminist scholars have varied definitions of gender, but most agree that is it is a socially constructed performance. Gender influences science at many levels, although what we mean by gender has been, and remains, contested, outside of and within feminist scholarship. Margaret Mead first put forward the definition of gender as a social construction in the 1930s when she studied social norms in three different primitive societies. She observed that gender roles are not static but rather change according to the environment and are thus not rooted in biology (1963). Although sex is thought to be only biological, it is also socially constructed as the biological criteria that determine sex have to be agreed upon and are influenced by social values and constructions. West and Zimmerman (1987) state, "sex is a determination made through the application of socially agreed upon biological criteria for classifying persons as females or males" (p. 127).

Moreover, the distinction between sex and gender is not as clear as it appears to be. Feminist scholars such as Simone de Beauvoir, Judith Butler and Monique Wittig argue for a more inclusive definition of gender, as the current definitions are limited and problematic. De Beauvoir (1949) describes gender as an endless process of becoming that is separate from sex. She states “one is not born, but rather becomes, a woman” (p. 267). Thus, gender is not innate, but is rather a continued process of becoming. Butler (1999) defines gender as a social construction that does not stem from sex. Gender is not a fixed constant but exists as a fluid identity. On the other hand, Wittig (1981) does not distinguish between sex and gender. She instead argues that sex and gender are both socially constructed, refusing to accept the premise that while gender is socially constructed, sex is not.

According to Harding, gender is a socially constructed performance that influences science and distorts its assumed neutrality (1986). Gender is not an innate characteristic but a performance, continually (re)produced by society through three main processes. First, gender is reproduced through “assigning dualistic gender metaphors to various perceived dichotomies that rarely have to do anything with sex differences” (1986, p. 17). In other words, society often uses opposing metaphors to define and separate men and women but these have no basis on biological sex differences but are rather perpetuations of social ideals. For instance, in the active/passive dichotomy, women are passive and men are active despite multiple examples of evidence to the contrary (Hyde, 2005). Second, the activities performed by men and women are usually separated by gender and thus create a gendered division of labor, rather than a "natural" gendered division of labor that reflects a difference in the "real" skills and abilities of women and men. This division of labor is based on assumed differences that make women and men differently suited for the workplace. Third and last, gender is posited as an individual identity, correlated to assumed sex differences (Harding, 1986, p. 18).

A particular area of focus, which challenges one of science's basic assumptions, is that of objectivity. Science historian, Donna Haraway, explains the debates among feminist scholars about what exactly objectivity is and how it applies to critiques of science (1988, p. 575). Broadly defined, objectivity "expresses the idea that the claims, methods and results of science are not, and should not be influenced by particular perspectives, value commitments, community bias or personal interests" (Stanford Encyclopedia of Philosophy, 2014). It can be defined as a "value that comes in degrees" (SEP, 2014). In other words, some concepts and ideas are more objective than others, because they are based on facts derived from scientific experimentation.

However, most feminist critiques of science argue that science is not objective, but rather, is subjective, as it is influenced by who the scientists are as well as its location in time and space. Despite the differences in meaning and application, most feminist scholars agree that science is not objective because it is impossible to achieve complete "value-neutrality" (Harding, 1986, p. 137). In fact, feminist scholars argue that science, like all other fields, is value-laden because of scientists "metaphysical commitments" (Addelson, 1983). Social values regarding gender, race, class, and other social ideologies influence all components of science, including scientific ideology, methodology and practice, despite assertions of objectivity and neutrality. These arguments are not separate, but rather, influence each other and form part of a larger debate about a more inclusive science.

Moreover, the continued association of masculinity and power, and their combined influence, impact the goals and process of science, and then necessarily exclude women in order to maintain that association (Keller,1982; Tiles, 1987). Associating masculinity, objectivity and autonomy with power and domination creates a particular perspective of science that includes only men as producers of knowledge and systematically excludes women, because it perpetuates the gender dichotomy that differentiates men as active and rational and women as passive and emotional members of society. Simultaneously, this association further creates a gendered division of labor where women and men are apparently differently suited for the workplace and continues to perpetuate the same gender binary on which this division is established. As Harding states, “The division of labor by gender in the larger society and the gender symbolism in which science participates are equally responsible for the small number of women in science and for the fact that girls usually do not want to develop the skills and behaviors considered necessary for success in science” (1986, p. 53).

Other feminist critiques focus on scientific practices and the processes through which science students learn them. According to social constructionist theory, groups of individuals share constructions of the world that help form assumptions about reality, which are then passed down through language (Haraway, 1988). In this case, scientists, through specific ideology and practices, construct a seemingly objective and universal truth about the world. This construction is based on established methodology and commonly agreed upon theories supported by existing, albeit arguably incomplete and problematic, scientific evidence. Social constructionism helps explain the static and structured (re)production of scientific methodology as teachers pass down unquestionable knowledge to new science students. The sharing of this knowledge constructs a specific and narrow view of the world that continues to establish science as objective without questioning the social factors that influence it.

The complex and technical scientific view of the world is limited to those studying science; those individuals continue to implement the same methodology, which contributes to the same scientific view of the world, without challenging the assumptions of what claims to be an objective and value-free science. Science students thus continue to practice and perpetuate the same methodological flaws of the field. In such narrow perspective, the social factors that contribute to world phenomena are ignored. The scientific explanation of world phenomena that is passed down from teacher to student is part of a socially constructed perspective on knowledge influenced by the individuals' values, rather than a passing down of objective truth, as scientists often claim. This constructed knowledge influences how scientists observe and study the world and therefore what constitutes knowledge.

The gendered construction of science matters because one of science's basic goals is to provide an explanation behind different world phenomena. Science assumes that there is only one absolute, universal truth or explanation behind natural events and that there are differences between males and females. Scientific experiments attempt to find evidence for those differences, rather than focusing on whether those differences actually exist. Yet, only scientists have access to this alleged truth because of their extensive training and assumed objectivity, which allows them to produce and reproduce new knowledge by conducting novel experiments and interpreting the results. This access allows scientists to develop a cognitive authority or the power to define what "true" is over other individuals and society (Addelson, 1983).

Although a gendered version of the truth is problematic, it is also important as it situates knowledge within a specific context. A gendered science perpetuates the same notions about gender without challenging the current stereotypes about who and what men and women should be. For instance, it continues to establish the gender binary and division of labor without questioning their construction. Yet, simultaneously, a gendered truth acknowledges the partiality of its own perspective in which context is taken into consideration (Haraway, 1988). Acknowledging the existence of a gendered science allows it to become situated in time and place. In this manner, situated knowledge does not attempt to generalize, but rather explains world phenomena within a specific context, considering its own limits and constraints.

Despite the scholarship on sex and gender as socially constructed identities, scientists continue to equate sex and gender and to differentiate male/men and female/woman based on chromosomes, hormone levels, and primary and secondary sex characteristics exclusively (Jordan-Young and Rumiati, 2012). Their rationale for doing so relies, first, on the assumption that sex is real, and that sex differences are real, and that those differences are meaningful and important. As "evidence" for that assumption, they rely on the claims of other scientists that brain differences between men and women are established during fetal development as hormones affect the development of the brain and body, which determine a person's sex. If brain differences are established prenatally and lead to hardwired, fixed and "natural" differences, then looking at chromosomes and sex characteristics is a reliable method for differentiating between males and females, because these methods are based on biology which is taken to be fixed and infallible.

Yet, in using biology to define sex, scientists do not recognize that sex is also a social construct that does not fit neatly into one or two categories. According to Addelson (1983), because scientists have a higher authority than “regular” individuals do, they agree on the biological criteria that distinguishes males from females, although whether sex is only biological continues to be debated. Furthermore, their current criteria for sex differentiation is narrow and simplistic and does not allow variability to be made visible. The biological characteristics that make up sex such as chromosomes, hormone levels and sex characteristics exist on a spectrum and vary greatly even among males and females. There are also cases that suggest that sex does not exist as a binary but as multiples. For instance, there are other chromosomal pairings besides XX and XY. In some cases, the chromosomal sex and the gonadal sex, or the gonadal sex and secondary sex characteristics, do not match. In addition, both men and women produce male and female hormones at different levels, and even sex characteristics vary, as there are women with a lot of hair and men with wider hips (Dworkin, 1974).

The differences in biology are not limited to sex and sex characteristics. Other characteristics such as height, weight and strength have been constructed as binaries when in reality they also exist on a spectrum. Ruth Hubbard (1990) analyzes these height differences between men and women and emphasizes the actual variability that exists. She states, “When we say that men are taller than women, what we really mean is that the abstraction average height is a few inches greater for men than women. Overall, women and men are about the same height, with many women as tall as, or taller than, lots of men" (p. 121). However, our perception that men are taller than women is constructed through social pairings. Most heterosexual couples choose partners based on this assumption, thus reinforcing the generalization. Individuals' preferences conform to these ideals, which make the pairings appear to reflect natural differences, and not socially constructed ones (Hubbard, 1990). Because differences within groups and social values are not considered, using differences in genitalia and other biological markers for sex as analogy for presumed differences is misleading and creates oversimplification (Jordan-Young and Rumiati, 2012)

Assuming that there are biological differences that absolutely distinguish and separate males and females leads to the assumption that those differences are also found in the brain. The research on sex differences is controversial among feminist scholars as they question the methodology behind and the application of such findings. Most scientists who study sex differences in the brain with human participants are limited to brain imaging techniques. Although the advanced imaging technology allows researchers to measure brain activity at the exact moment that it is occurring, there are several drawbacks to these techniques (Raichle & Mintun, 2006). For instance, brain imaging does not allow scientists to understand brain activity at the cellular level. Most of the techniques use the changing levels of particular substances that reflect cellular metabolism, which is only, at best, an indirect measure of brain activity. Additionally, because most brain activity for a particular task is not limited to one specific area of the brain, but rather involves many areas working together, there is great variability among individuals. With these results, it is very difficult to draw the conclusion that men and women are different since there is also great intragroup variability.

Furthermore, using a biological only explanation for difference is problematic for several reasons. First, biological determinism does not acknowledge the role of society in influencing biology. Some feminist scholars such as Ruth Hubbard and Sue V. Rosser reject the nature/nurture dichotomy. Rosser states, “Genetic, hormonal, and structural effects of the brain on behavior cannot be separated from the effects of learning and socialization in the environment on behavior. Indeed, the two are so interrelated that the environment can actually affect the prenatal structure of the brain which can then affect learning abilities” (1990, p. 26). Additionally, Hubbard emphasizes the role of epigenetics stating, “Many scientists have stressed that phenotypes are generated by an ongoing, complex, and mutual interplay between genotypes and environment” (1990; p. 72). However, in ignoring the effect of the environment on biology, scientists run the risk of “justifying sex role specialization and the division of labor” by establishing natural differences between groups of people (Rosser, 1990, p. 28). When scientific findings are applied to justify unjust treatment, such as sexism, based on assumed biological differences, and then it is important to acknowledge the ways in which these differences were constructed.

Neuroscience is a newer, interdisciplinary field that integrates biology, psychology and other branches of science and focuses on the practice and theory of the study of the brain and nervous system (Kolb & Whishaw, 2014). It entails a broad range of questions about the function and structure of the nervous system from multidisciplinary approaches and correlates those findings to behavior. However, it is similar to other scientific fields in its use of common methodologies and implementation of the scientific method.

The goal of neuroscience, like other branches of science, is to improve people's lives (Kolb & Whishaw, 2014). It can help us determine how we think by examining the role of the brain in performing particular cognitive functions. It also helps shape education by providing scientific knowledge about the brain, establishing critical periods of development necessary for learning and determining which methods of teaching are more effective for long-term learning. Neuroscience also has clinical applications by developing treatments for people who have brain-related disorders, diseases or injuries such as traumatic brain injuries, depression, and neurodegenerative diseases, among others (Kolb & Whishaw, 2014).

Yet, neuroscience is and should be subject to feminist critiques with the goal of making it a more inclusive science. Much of the critique of neuroscience from feminist scholars target the research that has found gender/sex differences in the brain in terms of structure or function. Yet, an important aspect to understanding gender/sex differences in the brain, if indeed those exist, and whether they have any behavioral or practical differences in function, is clarifying the definition, choice, and use of those terms in neuroscience specifically.

In addition, as with every line of scientific research, it is important to understand the role that social values play on science. Our own social values influence scientific findings. Neuroscientists "know" that men and women are different, because they believe in absolute biological difference, even if they do not recognize that this difference is socially constructed, and so they assume that their brains must be different. If they find brain differences, they then attribute them to hardwired mechanisms in the brain and use the findings to justify the differences in their behavior. However, feminist scholars would argue that neuroscientists do not realize that they constructed that difference in the first place or that society can change the biological.

Therefore, feminist scholars analyze the research on sex differences by questioning our assumptions about sex and gender and about our own definition of difference. In the research on sex differences, we assume that men and women are different from each other. The findings imply similar interpretations where women are different from men and such differences establish men as the universal norm. However, feminist scholar and neuroscientist, Deboleena Roy, calls for a shift in the definition of difference. She states that a shift from “different to” to “pure difference, difference in itself, difference with no identity” would shift the search for brain differences as a binary to differences as multiple (2016, pp. 540-541). In other words, women would no longer only be different from men, but they would also be different from other women and men would also differ from each other. This definition would account for within group variabilities and transform difference to a spectrum and not a binary.

More specifically, other feminist scholars focus on the methods through which gender is (re)produced in science. One such method is language. Language is complex and reflects the gender ideology of society, which becomes embedded in the content it conveys. Gendered language is problematic not only because it perpetuates common notions about gender, but also assigns gender to neutral objects. Such gendering is particularly evident through the use of metaphors. In neuroscience, metaphors are helpful in describing and illustrating the complex processes that occur inside our brains as they are usually invisible to the naked eye (Upchurch & Fojtová, 2009). Most students learn to use the commonly used metaphors without questioning their meaning. These metaphors, in turn, become the normal and accepted language in neuroscience.

One specific example of gendered metaphorical language is illustrated in discussions of glial cells. Meg Upchurch and Simona Fojtová, (2009) examined the scientific language used in scientific articles when describing glial cells. There are two main types of cells in the brain: neurons and glial cells. There are several subtypes of neurons and glial cells that differ in structure and function. However, the main difference between neurons and glial cells is electrical conductance. Neurons send electrical signals to each other as their form of communication. Glial cells provide nutrients and remove waste from neurons, and respond in case of injury (Upchurch & Fojtová, 2009; Kolb and Whishaw, 2012).

Previously, research had shown that glial cells were only support cells and were not directly involved in brain communication, and feminine and passive language had been used to describe their roles. Upchurch and Fojtová (2009) argue that the metaphors used to describe glial cells reinforce a “misleading notion of a patriarchal and hierarchical system of cell interaction within the nervous system” (p. 4). In their article, the authors quote several neuroscientists and their description of astrocytes, which are a specific type of glial cells. For instance, some scientists refer to astrocytes as performing "'housekeeping duties,' 'mopping up' the chemicals that neurons spill into the synapse" (Young, 1994 as cited by Upchurch & Fojtová, 2009, p. 5). Other refer to astrocytes as the brain's "other" cells (Travis, 1994 as cited by Upchurch & Fojtová, 2009, p.5). Yet, other scientists go even further to suggest an intimate relationship between neurons and astrocytes using phrases such as "astrocytes are 'elegant,' but 'seem obsessed with neurons, occupying the spaces between them, touching them with their long processes and surrounding their synapses'" (Young, 1994 cited by Upchurch & Fojtová, 2009, p.6). Upchurch and Fojtová (2009) conclude, "The metaphors of intimacy, perhaps even of foreplay, again suggest that these cells are gendered. Astrocytes may be motherly one instant and wifely the next, but they seem reliably female" (p. 6).

Recently, new research has shown that glial cells provide more than just support for neurons. A shift to more active roles has shifted the language used to more masculine words and metaphors. For instance, "'glial cells once had a reputation as the support staff of neurons, the real movers and shakers of the nervous system. In recent years, however, researchers have gleaned hints that glia . . . do more than just maintenance work. . . . Glia may even run the show'" (Miller, 2003 as cited by Upchurch and Fojtová, 2009, p. 7). Other similar metaphors reflect a shift in the perception of glial cells. Yet, the metaphors of neurons as passive continue to exist in neuroscientific writing. In this manner, the language used to describe brain cells illustrates a particular image of these cells and reproduces specific gendered norms.

Although this analysis primarily focuses on gender and science, it is important to acknowledge the intersectionality between the race and gender as part of the human experience and the influence they have on science. Considering both factors would prevent the erasure of women of color whose experiences are shaped by both race and gender. As Harding (1986) states “In racist societies, ‘womanliness’ and ‘manliness,’ ‘femininity’ and ‘masculinity,’ are always racial as well as gender categories.” Race and gender are linked categories, influenced by the construction of the other. Simultaneously, Harding argues that because of Africans and women’s similar positions as inferiors to white men, Africans and women “are attributed a concept of the self as dependent on others, as defined through relationships to others” (1986).

The relationship between race and gender is also seen in science. The analogy between race and gender goes back to the nineteenth century when “it was claimed that women’s low brain weights and deficient brain structures were analogous to those of lower races, and their inferior intellectualities explained on this basis” (Stepan, 1986). These analogies, however, were products of cultural metaphors that were perpetuated by science in an attempt to study human difference. Despite many changes, these problematic metaphors continue to be reinforced in science through the language used to (re)produce scientific knowledge.

Yet, the influences of race and gender are masked behind claims of an objective science that considers women and people of color as not fit to be scientists and does not consider white men as socially constructed individuals who share specific values and morals and thus influence scientific processes. All of this is based on the assumption that scientists employ value-free methodology, thus creating the illusion of science as objective. However, the view of science as objective is narrow and does not consider the actual social values that influence science and prevent us from seeing the flaws in the argument for an objective science. In neuroscience, language plays a strong role in the reproduction of gender ideology. Although neuroscientific research provides valuable information about the brain and nervous system, it also, through the language used within the discipline, perpetuates norms about race and gender.

Methods

Although there is no single methodology employed when constructing a feminist analysis, several factors distinguish feminist methodologies from other methods. Unlike scientific analyses, which focus on the methodological flaws and whether the supporting evidence leads to the conclusions reached, feminist analyses focus on the surrounding context. For instance, some feminist scholars examine the goals of scientific advancement and whether it has an equal impact for women and children. Others focus on the elimination of constraints based on sex, race, class, sexual orientation in the practice and access to science. They identify the bias in language, paradigms and concepts that allow for such constraints to exist in the first place. Feminist lens can also be applied to empirical analysis which allows for the identification of such bias. Yet, other analyses attempt to find alternative social explanations for those explanations rooted in scientific evidence. These analyses take into account culture and human variability (Harding, 1987; Spanier, 1995).

However, an important aspect of feminist analyses considers the relationship between the author and subject matter. Academic scholars are influenced by social values that affect their perspective on the subject matter. These analyses examine how their place in society and their own biases affect their own understanding and critique (Harding, 1987; Spanier, 1995). It is particularly important to apply a feminist lens in our consideration of science. In this analysis of neuroscience textbooks, the goal is to illustrate how gender ideology affects the construction of neuroscientific knowledge as examined through the language and images used in neuroscience textbooks, and to identify the ways in which the production and reproduction of gendered language and images perpetuates gender bias.

The decision to analyze neuroscience textbooks was influenced by Bonnie Spanier's analysis of molecular biology. In her book, *Im/partial Science,* Spanier (1995) examines papers published in two scientific journals, *Science* and *Cell*. Similar to Upchurch and Fojtová's (2009) analysis of the language used to describe glial cells, Spanier found that gender also influences the reproduction of scientific knowledge within molecular biology. Spanier focuses on cells, molecules and DNA, and demonstrates how gender interacts with and distorts scientific knowledge.

One particular example of hers focuses on assigning sex to bacterial cells. *E.coli* cells are assigned a sex based on the presence or absence of a plasmid;-the male cells contain the plasmid while the female cells do not. There are several problems with such assignment. First, with the plasmid as the signifier of sex, it establishes "male" cells as the norm. In this case, the plasmid becomes the phallus that gives power to those cells who have it. Second, it establishes "female" cells as lacking and, thus, abnormal or incomplete when compared to the male cells. Third, the assignment perpetuates heterosexist ideologies where the transfer of plasmid, or sex, should only happen from a male to a female cell, or from a male to a female human. In the process, it constructs all other transfers, pairings or relationships as "unnatural" (1995).

Yet, the influence of gendered language in science is present not only in scholarly journals or academic articles but also in textbooks. Gendered language is used when describing cells, molecules, brain anatomy and behavior. Textbooks are essential tools which enable the passing down of knowledge from experts to new learners. In this manner, the reproduced knowledge creates for new scientists a particular structure and context in which science is practiced.

Moreover, textbooks also play a unique role in producing and reproducing the same gender norms that influence scientific writing. In constructing the world through a shared reality, as social constructionist theory explains, scientists and new students use language to pass down established methodology and theory (Haraway, 1988). Textbooks, in this case, are the shared language through which scientific knowledge is established along with scientific methods for further study. The act of publishing scientific knowledge in the form of a textbook reconstructs the content as stable, authoritative and unquestionable. However, it is important to question textbooks because, as any other form of scientific writing, they are influenced by the authors' social values and the values of the discipline.

An important aspect of textbooks is that "as bearers of the discipline's status quo, textbooks are often slow to present students with information published in research articles that contradicts dominant assumptions" (Metoyer & Rust, 2011, p. 181). Although most textbooks have updated editions every few years, they do not contain the most updated information about a particular topic at a particular moment in time. They only present established information, sometimes without any mention of competing theories or the drawbacks of the experiments that led to those conclusions.

Additionally, as with other types of scientific writing, textbooks lead to the distortion of scientific knowledge in an attempt to become more accessible to nonscientists. As Metoyer and Rust (2011) state when describing gynecology textbooks, “Textbooks produce and disseminate ‘medical knowledge’ by selecting findings from research articles, and simplifying, reproducing, condensing, and often modifying them (MacDonald, 2002 as cited by Metoyer & Rust, 2011, p. 180). In the process, the authors’ own values and opinions become embedded in the language used to describe scientific processes. Additionally, textbooks act as selectivity filters (Spanier, 1995). The authors of such textbooks decide what knowledge to include and how to describe it. In this manner, scientific knowledge is not only influenced by the researchers who conduct the experiments, but also by the authors who write about it.

Following Emily Martin’s (1991) article about the stereotypical construction about eggs and sperm, Metoyer and Rust (2011) examined whether gender constructions about reproduction are perpetuated in gynecology textbooks. They focused on the contraception chapters of ten gynecology textbooks sampled from more than a hundred medical schools in the United States. Although scientific data has shed light about the active role of the egg, even twenty years after the publishing of Martin’s article, Metoyer and Rust (2011) still found that the sperm was framed in an active manner while the egg was described as passive in about two thirds of the instances in which they were mentioned. According to Metoyer and Rust (2011), sperm are busy; they “‘reach,’ ‘go into,’ ‘fertilize,’ ‘retain their fertilizing ability,’ ‘feed,’ ‘enter,’ are ‘motile,’ ‘survive in the genital tract’ and, most commonly, ‘penetrate’” (p. 186). Yet, egg lay passively waiting to be fertilized or penetrated (p. 186), not unlike the sleeping princess in the fairy tale awaiting her far more agentic prince.

Similarly to Metoyer and Rust's analysis (2011), I examined the images and text in *Neuroscience* (Purves et al., 2012) and *Brain and Behavior* (Kolb & Whishaw, 2014) undergraduate neuroscience textbooks, as well as the authors who published these books. I selected the textbooks based on availability, date of publication and content. I focused on general content books that are recently published and that are actively used in neuroscience classes. I selected the images and text that made explicit and implicit references to femininity/masculinity, womanhood, motherhood and race in order to analyze the ways in which neuroscience textbooks perpetuate norms about race and gender. I also conducted a general qualitative analysis of images that portrayed people in order to assess whether men and women were portrayed differently. For comparison between men and women, I only selected images that portrayed a person from the waist up in order to assess the portrayal of their activity. I included images that appeared more than once and those that included more than one person in the image. I excluded children, infants and human silhouettes. There were a few images that portrayed gender ambiguous people, which I included in the total number of images but did not classify into a category. For the comparison between races, I also included images that showed people's heads only, as I focused on whether the images portrayed only headshots or images of their entire body. However, the same exclusion criteria were applied. I also only counted once those images that appeared more than once. For the analysis of the authors, I conducted internet searches of their names, in order to find a picture of the authors of *Neuroscience*. For *Brain and Behavior*, a picture of the authors was provided in the textbook.

Analysis

Images

Images are important in illustrating how scientific findings apply to people, as one of the goals of neuroscience is to determine how the brain and nervous system control behavior.

However, the perpetuation of social norms through textbooks is not limited to text but also extends to such images. Through images and illustrations, we can examine the ways in which social norms and beliefs about gender are transmitted visually as well as linguistically.

There are differences in the textbooks I chose for analysis. For instance, *Brain and Behavior* (Wishaw & Kolb, 2014) is an introductory textbook. It contains more colorful images and simpler text than text geared toward more advanced students. It also focuses on main ideas and relies on real life examples and images. In addition, introductory texts serve to present established assumptions about the discipline. On the other hand, *Neuroscience* (Purves et al., 2012) is geared toward upper level classes. Although accessible, the language is more advanced and detailed, and assumes a pre-existing knowledge about the basics of the discipline.

Despite the differences in level, there are similar trends in the depiction of men and women in these textbooks. In *Brain and Behavior*, there were 176 images of people. Of those images, 69% (n=121) depicted men and 31% (n=55) depicted women. Similarly, in *Neuroscience*, of the total 31 images of people,81% (n=25) depicted men and only 19% (n=6) depicted women. These categories are further broken down into active and passive depictions by gender (see Table 1).

Table 1. Breakdown of textbook images into active and passive depictions by gender.

TEXTBOOK	*Brain and Behavior* (n = 176)	*Neuroscience* (n = 31)
Active Men	49.4% (n=87)	48.4% (n=15)
Passive Men	19.3% (n=34)	32.2% (n=10)
Active Women	17.0% (n=30)	12.9% (n=4)
Passive Women	14.2% (n=25)	6.5% (n=2)

In both texts, the differences in gendered images were qualitative as well as quantitative, in that the ways in which the people in the images were depicted also varied by gender. Not only did the textbooks mostly portray men, but those depictions also varied by level of activity. For instance, there were more images of active men than of passive men and active women. Also, the level of activity that the people in the images engaged in also varied by gender. Men were portrayed as more active demonstrated by the inclusion of men engaging in extreme sports. In *Brain and Behavior,* we see the most active man and woman engaging in air surfing and running, respectively. Similarly, in *Neuroscience*, we find images of men playing football while the most active depictions of women consist of a woman smoking marihuana and another woman performing a card-sorting task.

The traditionally gendered depiction of men and women in science textbooks serves to further perpetuate the active/passive dichotomy between men and women and continues to create differences. First, including more images of men positions men as the universal human and connotes that women are different from men and, thus, the same scientific findings do not apply. Second, the unequal number of images of men and women gives the illusion that differences between men and women are real and natural because the disparity is found in science textbooks, which are assumed to be authoritative sources of knowledge. At the same time, the higher number of images of men in textbooks perpetuates the "maleness" of science and serves to (re)produce the link between masculinity and science, which positions men as rational and powerful, in such subtle ways that it is difficult to notice, question, or challenge.

These findings are consistent with other literature on gendered images of men and women in science textbooks. In their analysis of gynecology textbooks, Metoyer and Rush (2011) made similar observations. They state, "Since their earliest editions, medical and science textbooks have displayed cultural assumptions about men's superiority, particularly the notion that women are passive and less capable than men. For instance, anatomy textbooks, which are presumed to contain objective descriptions of the human body, have consistently portrayed the male body as more active and developed than the female body" (p. 176). Although the focus of the science textbooks has shifted from general anatomy to brain structure and function, these textbooks also reproduce the same normative ideas about gender.

Moreover, some of the images in these textbooks portray diverse individuals indicating these images are not just gendered, but also raced, in equally if not more problematic ways. These categories are broken down by gender and whether the image consisted of a headshot or full body image (at least from the waist up). The new criteria include headshots but multiple appearances of the same image were only counted once. Most of the images of people of color are towards the beginning of the textbooks perhaps at first glance masking the lack of diversity in the textbooks. Yet, despite what is likely the authors' attempt at racial inclusion, some of the depictions of people of color actually replicate the racist stereotypes often portrayed in American culture.

Table 2. Distribution of people by race and image type.

TEXTBOOK	Brain and Behavior (n=170)		Neuroscience (n=39)	
	Headshot	Full body	Headshot	Full body
Men of color	7.0% (n=12)	5.8% (n=10)	12.8% (n=5)	7.7% (n=3)
Women of color	8.8% (n=15)	3.5% (n=6)	15.4% (n=6)	2.6% (n=1)
White men	15.2% (n=26)	29.4% (n=50)	10.2% (n=4)	33.3%(n=13)
White women	7.0% (n=12)	22.9% (n=39)	10.2% (n=4)	7.7% (n=3)

At first glance, *Brain and Behavior* appears to be more racially inclusive. However, the percentage distribution of white people and people of color in the textbook reveals discrepancies. Of the 170 total images, only 25.3% (n=43) show people of color while the remaining 74.7% (n=127) portrayed white people. Of the 127 images of white people, 76 images are of men. There is a similar trend in *Neuroscience* where of the 39 total pictures, only 8 pictures show men of color compared to 17 of white men. The distribution of images emphasizes that not all men are taken to be the universal human beings of science, but rather it is only white men. Full body images emphasize the bodies that are important in reproducing the knowledge that needs to be learned. By including more full body images of white men than of men of color and women, the textbook asserts the superiority of white men and emphasizes the association of science with a particular type of masculinity. These images accentuate the differences between white men and men of color and position this difference as natural by including them in science textbooks, which are not supposed to be influenced by social factors.

Furthermore, some of the comparisons between animals and people of color are problematic. For instance, in the chapter that describes the evolution of the brain in *Brain and Behavior*, there are comparisons of women to animals in relation to their intelligence and brain development. Although the image attempts to show the similarities in brain structure between different species, the image arrangement implies that women of color are similar to exotic birds and frogs, and, thus, exotic inferiors to men. These comparisons are consistent with the eroticization and sexualization of women of color for men’s viewing. It positions women of color as compelling and animalistic, but still unintelligent, irrational, and insignificant, just like the animals in the illustration. Simultaneously, this arrangement evokes the next image in the panel: a white man. This further perpetuates the notion that women of color are inferior to white men because they are similar to animals.

Throughout *Brain and Behavior,* there are other comparisons of people of color to animals. For instance, there are 16 chapters in the textbook. Each chapter starts with a background image of a person's face along with several smaller images and text that allude to the content of that chapter. There are 10 people of color shown in these images. Although at first glance these images might represent the authors' well-intentioned attempt to include racially diverse images, the comparisons to animals undermines their attempts. On six images of people of color, there are images of animals. Yet, in the background images, when white people are compared to animals, it is a woman or child. The only comparison of a white man to an animal is to a cat. However, there are also examples of background images of white men without being compared to animals. These images, although perhaps neglected at first as they do not provide essential information, further perpetuate racist stereotypes where people of color are associated with animals and positioned as inferior to white men.

The most egregious example of such comparisons is of a woman of color to an ape. The illustration depicts a woman of color *(Homo sapiens*) and the famous *Australopithecus*, "Lucy." The caption states that the brain size of this human ancestor is similar to brains of modern apes or about one-third the size a modern human brain. Yet, the illustration positions the woman as more similar than different to the ape because of her body stance and skin color. The similarities imply that the woman and Lucy share more than just physical characteristics and that even their brain sizes might be the same.

In addition, it is important to examine the textbook depiction of Lucy and question the origin of these assumed similarities. The image is a drawn illustration and not a picture. This plays an important role in the representation and comparison of these two figures. The woman represents a generic looking woman. Her illustration does not consider the diversity and difference among women of color in terms of physical traits. However, because it is a drawn illustration, the artists and textbook authors are able to change the color of her skin to make it even more similar to Lucy’s skin color. Similarly, Lucy represents a biased depiction of human ancestor where she is given more human-like qualities. We do not know anything about the physical appearance of human ancestors. All of our knowledge about them comes from fossils and partial skeletons, where anthropologists can at best only estimate their appearance. This representation of Lucy as well as the ones we see in museums and other science textbooks are human constructions. They are also subject to human biases and influenced by social values and morals. In this image, Lucy is created to resemble the woman of color. As a result, their similarities allow for a comparison to take place.

Comparing people of color to apes is part of a long history of racism in the United States and the rest of the world. Wulf Hund and Charles Mills (2016) explore the development of this racist comparison, which goes as far as Plato. In the 1500s, French philosopher Jean Bodin attributed the sexual intercourse between humans and apes to sub-Saharan Africa. Later, other narratives such as the one Antonio de Torquemada put forward focused on rape stories where women exiled from European countries to Africa were raped by apes and forced to have their babies. As Hund and Mills (2016) argue, such narratives contributed to the demonization of Africans and racialization of demons leading to the association of Africans as evil and ape-like. In addition, scientific theories such as Darwin's theory of evolution did not discredit scientific racism. On the contrary, people had opposite interpretations as Hund and Mills (2016) state "If it now had to be conceded that we were all related to the apes, it could nonetheless be insisted that blacks' consanguinity was much closer – perhaps a straightforward identity." Furthermore, sociocultural events such as the release of *King Kong* in the US at the same time as a rape trial was taking place where Black teenage boys were accused of raping a white girl also contributed to the continuation of this stereotype. Currently, the actual population of great apes which can only be found in Africa, the history of slavery that "stamped [Black people] as permanent sub-persons," and the reputation of Africa as a "contagious continent incubating pestilences" continues to reproduce this stereotype without challenging its racist assumptions (Hund & Mills, 2016). The depictions of these images in neuroscience textbooks only further perpetuate this stereotype under the disguise of offering it as scientific "knowledge."

Text

The perpetuation of gender ideologies is reproduced in the text itself through the descriptions of the brain and nervous system. In the description of the function and structure of the meninges, which are layers of connective tissue between the brain and the skull, we see how gender influences science writing. For instance, the authors write "the way to start our functional overview is to 'open the hood' by observing the brain snug in its home" (Kolb & Whishaw, 2014, p. 37). This sentence serves to establish the context surrounding the brain: inside a home. This analogy of a "home" for the brain is problematic in several ways. First, it creates a gendered environment for the brain, which is a supposedly non-gendered part of the human body. By making such comparison, the same notions about gender are reproduced and not challenged. Second, this analogy invokes the image of the traditional nuclear family with no room for any other version of a family such as same-sex couple or single parent home. Although there is no description of the actual "home," the textbook does not provide any clues as to an alternative composition. Thus, home refers to the conventional family, which includes mother, father and child who live in a nice suburban neighborhood in a spacious house surrounded by a white picket fence. The representation of the brain inside a home perpetuates heteronormative roles without challenging their exclusion or construction.

The analogy of a home implies that inside the home there is a mother. However, not just any type of mother. The authors continue,

> The first thing you encounter is not the brain but rather a tough, triple-layered, protective covering, the meninges. The outer dura mater (from Latin, meaning "hard mother") is a tough fibrous tissue…In the middle is the arachnoid (from Greek, meaning "like a spider's web") layer, a very thin sheet of delicate connective tissue…the inner layer, or pia mater (from Latin, meaning "soft mother") is a moderately tough membrane of connective tissue fibers that cling to the brain's surface (Kolb & Whishaw, 2014, p. 37).

The other textbook, *Neuroscience,* provides a similar description of the meninges, adding that the middle layer is not simply a layer but the "arachnoid mater" perhaps alluding to tasks traditionally done by women such as knitting or sewing (Purves et al., 2012, p. 742). This description of the meninges as mothers reinforces the placement of the brain within a heteronormative home with the skull as the father. However, it goes even further to establish the roles of a "good" mother. It implies that a good mother should be tough yet tender, whose sole purpose is to "cling" to the brain in order to protect it. At the same time, it should be feminine, as it is also "delicate" and engage in womanly tasks such as knitting or weaving, implied by the reference to the spider's web. Thus, the meninges should do anything to protect their child: the brain.

While the description of the meninges establishes the roles of good mothers, it also implies that there are bad mothers and neglects the role of the father in the protection of the child. Bad mothers, in this case, care more about themselves and do not protect their child, as they should. There is no emphasis on the role of the skull in the protection of the brain suggesting that when there is damage to the brain, it is due to a failure of the meninges to play their assigned roles. This characterization mirrors the public discourse of blaming the mother when the child engages in transgressive or unacceptable behavior, while disregarding the role of the father in child rearing.

The good versus bad mother dichotomy is reinforced in other parts of the textbooks. In the chapter that focuses on sex and sexuality in *Neuroscience*, there is a special box that emphasizes the roles of good and bad mothers. The description starts with a reference to Hollywood's portrayal of motherhood. The authors state, "In Hollywood movies, fairy tales, and myths, mothers have been portrayed as both saintly (who can forget Stella Dallas?) and evil (remember Medea?). While these stories rarely address the source of maternal warmth and feeling (or lack thereof), recent observations suggest strongly that good mothers are made, not born" (Purves et al., 2012, p. 683).

Similar to the motherhood reference in the description of the meninges, good mothers are warm and put their children first, to the extent of sacrificing themselves if necessary. The authors extend the good mothering behavior to rats.

> The mothers in question are female rats, whose repertoire of motherly behaviors does not extend to either sacrificing her life for her children (as did Stella Dallas) or to sacrificing her children (Medea). Instead, the sign of a good rat mother is the amount of time she spends licking and grooming her pups when she enters the nest for nursing, and her posture during nursing itself. The good rat mother arches her back distinctively, presumably allowing for better access for the pups without extreme spatial confinement. "Bad" rat mothers lick groom much less frequently and do not arch their backs when nursing (Purves et al., 2012, p. 683)

Although the authors conclude that good mothers are not born, but made, the link between human mothers and rat mothers, and the inclusion of the meninges in previous paragraphs, establishes motherhood as biological and further animalizes women and mothers. If the rat mothers, and even the meninges, have a biological instinct to protect their children, then motherhood is a natural role all women should play, and distinct from fatherhood, reinforcing gender dichotomies in parenting.

Beyond defining good motherhood as being protective and nurturing, this connection further narrows down motherhood to two behaviors: grooming and nursing. Although not explicitly stated, it is implied that good mothering as defined by particular behaviors is also expected of human mothers. In this case, good human mothers should clean their children and breast feed (as opposed to bottle feed), as demonstrated and supported by the behavior seen in good rat mothers. Equating good motherhood to two behaviors simplifies the complex social factors that construct it and does not consider the evolving socioeconomic factors that affect motherhood such as women’s need and desire to work outside the home.

Assuming that the authors' conclusions that motherhood is not biologically innate but a developed trait are true, such generalization still places the responsibility for good mothering on mothers. They state, "Thus, good mothering, perhaps as much or even more than genetic predisposition (at least in rats), makes for much better adjusted offspring and insures good mothering for the next generation. Good maternal behavior apparently is essential for the health and well-being of offspring" (Purves et al., 2012, p. 683). Good mothering involves teaching young future mothers how to become good mothers also. These mothers are also made responsible for the survival of their offspring. Similar to the argument for breast-feeding, children's well-being can be used against working mother who have young children as they can be blamed for the children's adjustment.

In focusing on the role of the good mother, whether rat or human, the authors never acknowledge the role of fathers, and whether good fathering is biological or social. This is just one example of how the socially constructed identity of scientists influences science. The scientists' partial perspective influenced by their identity as white men only provides a narrow evidence for phenomena that is then considered as a general explanation. Their research interests and available funding influence which topics are worth studying. In this case, good mothering is worth researching while good fathering is not.

Some of the counter-claims to the arguments about the gendering of the meninges focus on the history of the neuroanatomy. Neuroscientists and other scholars argue that including the Latin and Greek names is not the fault of contemporary neuroscientists as the Latin and Greek names were assigned long ago. However, I argue that while they did not assign those names, they did actively choose to include them in the textbook. The inclusion of the Latin/Greek translation does not add to the understanding of the role of the meninges. However, it does perpetuate social norms about motherhood and continues to create differences between men and women.

Authors

Although it is important to discuss the content of the textbooks and explore the ways in which the images and text perpetuate ideas about gender and race, it is also important to identify who writes these textbooks. Harding (1986) argues that science as socially constructed knowledge is influenced by the values and morals of those who do science and, in this case, those who write about it. The authors of both textbooks are white men. *Neuroscience* has 10 contributors in total, all of whom are white men. Their own shared identity and values influence their approach to science and scientific writing and construct a particular narrow version of science that is passed down with new students through the textbooks they author.

That the authors of the text are white men reinforces the associations between science, masculinity, and power that continues to reproduce the gendered division of labor. This is not to say that there are no women or people of color in science. However, their lack of inclusion as textbook authors constructs a particular image of science and associates it only with those who write about it, in this case white men. When the authors of texts are solely white men, it perpetuates the construction of science as a masculine domain where objective truths are disseminated and eliminates the possibility of an alternative identity for scientists and textbook authors as people of color. Simultaneously, their shared identity as white men acts as a filter through which they see the world and construct science, and affects their own contributions to science as researchers and textbook authors.

Conclusion

Feminist critiques of science greatly vary depending on the focus, level of analysis and perspective. However, most feminist scholars agree that science is not an objective truth. It is socially constructed knowledge influenced by the scientists' identities, values and morals as well as the associations between masculinity and power, the construction of scientists as cognitive authorities and the gendered division of labor, among other factors. These social ideas are reproduced in textbooks as they form part of the language of the discipline that helps construct a particular reality of the world. Through images, text and the authors themselves, norms about gender and race are perpetuated instead of being challenged.

This particular analysis focuses on two undergraduate neuroscience textbooks. The examination revealed that ideas about womanhood, femininity, motherhood, race, and the gendered division of labor are embedded in the images, text and assumed identity of the textbooks authors. The recognition of such ideas sheds light into the problems within science and acts as the first step towards finding a solution.

It is important to recognize the extent to which the identities of the textbook authors influence the language used in the textbooks and, in turn, scientific knowledge. Their identities as white men limit our current science metaphors. However, including more scientists that are diverse would expand our metaphors and change what we know. Until Emily Martin's analysis was published, the current scientific knowledge about reproduction was that the sperm penetrates the egg. After she started to question the identity of the scientists and the language they used to describe fertilization, there was a shift in language that gave the egg a more active role. It became possible for the egg to attract and envelop the sperm, changing the knowledge about this process.

Some scientists remain skeptical about my analysis and claim that without presenting the gendered and racial texts and images, the scientific knowledge would not be accurate. To that, my counter-argument would be that if gendered and raced images are necessary for scientific accuracy, then scientists cannot claim that science is objective and value-free.

There are several limitations with this analysis. First, the number of textbooks analyzed was small. It is possible that the selected textbooks and examples do not reflect all the different ways in which ideas about race and gender are reproduced in neuroscience. Second, and perhaps more important, is that my own categorization of images and authors into gender binaries perpetuate the same gender norms, despite my own assertions that the construction of gender as a binary is problematic. My own analysis positions race and gender as fixed and identifiable characteristics and does not consider gender and race as fluid and flexible identities.

Despite these limitations, this analysis adds to the growing feminist scholarship on gender and science. Although this analysis focuses on gendered and racial language in neuroscience textbooks, it is imperative that other intersectional feminist analyses continue to explore the ways in which science textbooks reproduce social norms about other forms of identity such as sexual orientation, class, age and ability in an attempt to challenge current scientific theories and practices.

My analysis of neuroscience textbooks started as a personal goal. Now that it is complete I move forward into the next part of my life as a more skeptical feminist who will examine all forms of scientific knowledge before taking them for granted, and who will share this perspective with new science students and feminist scholars.

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Preface

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Appendix A

Textbooks

Kolb, B., & Whishaw, I. Q. (2014) *An introduction to brain and behavior.* New York, NY: Worth Publishers.

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Appendix B – Examples

Images

Figure 1A. Most active depictions of men and women in *Brain and Behavior* (Kolb & Whishaw, 2014, p. 188, 194)

Figure 1B. Depictions of active men and women in *Neuroscience* (Purves et al., 2014, pp. 137, 571, 600)

Figure 2. Examples of headshot and full body images of white men (Kolb & Whishaw, 2014, pp. 59, 173)

Figure 3. Example of headshot and full body images of men of color (Kolb & Whishaw, 2014, pp. 55, 285)

Figure 4. Comparison of women of color to exotic and inferior animals in an attempt to compare brain sizes between species (Kolb & Whishaw, 2014, p.18)

Figure 5A. Examples of background images comparing people of color, a white woman and a child to animals (Kolb & Whishaw, 2014, pp. 1, 211, 245, 353)

Figure 5B. Background images comparing men of color to animals (Kolb & Whishaw, 2014, pp. 33, 139, 397,443)

Figure 6. Comparing a woman of color to an ape (Kolb & Whishaw, 2014, p. 20)

Figure 7A. The authors of *Brain and Behavior* (p.v)

Figure 7B. Contributors of *Neuroscience*: George J. Augustine, David Fitzpatrick, Anthony-Samuel LaMantia, James O. McNamara, Richard D. Mooney, Michael L. Platt, Dale Purves, Sidney A. Simon, Leonard E. White (left to right, top to bottom). William C. Hall is not included. Images taken as a result of a Google Image search.

Text

Neuroscience – Purves et al., (2012, p. 683)

The Good Mother

In Hollywood movies, fairy tales, and myths, mothers have been portrayed as both saintly (who can forget Stella Dallas?) and evil (remember Medea?). While these stories rarely address the source of maternal warmth and feeling (or lack thereof), recent observations suggest strongly that good mothers are made, not born.

The mothers in question are female rats, whose repertoire of motherly behaviors does not extend to either sacrificing her life for her children (as did Stella Dallas) or to sacrificing her children (Medea). Instead, the sign of a good rat mother is the amount of time she spends licking and grooming her pups when she enters the nest for nursing, and her posture during nursing itself. The good rat mother arches her back distinctively (see figure), presumably allowing for better access for the pups without extreme spatial confinement. "Bad" rat mothers lick groom much less frequently and do not arch their backs when nursing. Offspring reared by high licking grooming/ arched back nursing ("LG/ ABN") mothers grow up *to* have much greater adaptive response to stress and more modulated responses *to* fearful stimuli. When pups from low LG/ABN mice are transferred to high LG/ABN mothers, they acquire stress responses consistent with the maternal qualities of their new mother. Thus, good mothering, perhaps as much or even more than genetic predisposition (at least in rats), makes for much better adjusted offspring and insures good mothering for the next generation. Good maternal behavior apparently is essential for the health and well-being of offspring. Thus, the acquisition of motherly skills becomes key in understanding the transmission of adaptive stress responses from generation to generation. Michael Meaney and his colleagues at McGill University asked whether good mother rats-high LG/ABN females-were determined genetically or acquired their maternal behaviors based on their early experiences. By cross-fostering offspring of established low LG/ABN mothers with high LG/ABN mothers and vice versa, they demonstrated that, regardless of genetic identity, maternal skills depended on the skills of the mother that reared the pups. High LG/ABN mothers had foster daughters who were also high LG/ABN mothers---even if their birth mothers were low LG/ABN. Similarly, female offspring of high LG/ ABN mothers displayed low LG/ABN maternal skills when reared by a low LG/ABN foster mother. These observations suggest strongly that good mothers are made, not born, and that the foundation for maternal skills is established early in life---in part by the maternal behaviors to which female pups are exposed.

Subsequent work from Meaney's laboratory as well as others has shown that one of the key biological targets of the effects of early maternal behavior on offspring is the expression of glucocorticoid receptors in the hippocampus. These steroid-thyroid family receptors (see Figure 30.4) are key regulators of the stress response throughout the organism. Offspring of high LG/ ABN mothers have high levels of glucocorticoid receptor expression in the hippocampus, and thus are presumably are better equipped to deal with the deleterious effects of stress. But the maternal behaviors that establish these differences are apparently not strictly encoded by the genome (they are not heritable, and can be acquired based upon experience), so how are differing levels of gene expression established in the offspring of high versus low LG/ABN mothers?

The tentative answer is that high LG/ ABN behavior elicits altered levels of serotonergic signaling in the offspring. This signaling, via a specific serotonin receptor and subsequent signaling cascade, establishes differential expression of the glucocorticoid receptor via genomic imprinting-local modification of DNA and chromatin that leads to long-lasting changes in gene expression. The details of this intriguing epigenetic mechanism for establishing essential differences in behavior remain to be determined. It appears that the glucocorticoid receptor gene has several regulatory regions that enable transcription of this gene in different cell types. The signals initiated by maternal care alter the DNA methylation pattern and chromatin structure of a regulatory region that binds brain specific transcription factors, including one called NGFl-A. Those rat pups that do not get adequate licking and grooming have methylated DNA in that region of the *GR* gene that would normally bind NGFl-A, which cannot bind to the methylated DNA and therefore does not activate transcription of the *GR* gene in the brain. As a result, the glucocorticoid receptor protein is not present to negatively regulate the stress response.

Whatever the details of the molecular mechanism may be, early experience can profoundly and irreversibly alter an entire lifetime of essential behaviors. Unfortunately, these studies also suggest that the happy endings enjoyed by certain fictional offspring who were fostered by wicked stepmothers---characters like Snow White, Cinderella, and Hansel and Gretel-may need to be rewritten to project a far more grim ever-after than previously imagined.

Neuroscience – Purves et al., (2012, p. 742)

The Meninges

The cranial cavity is conventionally divided into three regions called the anterior, middle, and posterior cranial fossae. Surrounding and supporting the brain within this cavity are three protective tissue layers, which also extend down the brainstem and the spinal cord. Together these layers are called the meninges. The outermost layer of the meninges is called the dura mater ("hard mother," referring to its thick and tough qualities). The middle layer is called the arachnoid mater because of spiderlike processes called arachnoid trabeculae, which extend from it toward the third layer, the pia mater ("tender mother"), a delicate layer of cells that envelopes subarachnoid vessels and opposes the basement membrane on the outer glial surface of the brain (p. 742).

Brain and Behavior – Kolb & Whishaw (2014)

Cerebral Security

The way to start our functional overview is to “open the hood” by observing the brain snug in its home within the skull. The first thing you encounter is not the brain but rather a tough, triple-layered, protective covering, the meninges. The outer dura mater (from Latin, meaning “hard mother”) is a tough double layer of fibrous tissue that encloses the brain and spinal cord in a kind of loose sack. In the middle is the arachnoid (from Greek, meaning “like a spider’s web”) layer, a very thin sheet of delicate connective tissue that follows the brain’s contours. The inner layer, or pia mater (from Latin, meaning “soft mother”), is a moderately tough membrane of connective tissue fibers that cling to the brain’s surface (p. 37).