The Challenge of Gender Research in Neuroscience

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THE CHALLENGE OF GENDER RESEARCH IN NEUROSCIENCE[1]

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Introduction

Historic presumptions that men and women differ in intellectual capacity, especially in math-intensive fields plunged the gender debate into neuroscience. Scientists have explored these suspected differences empirically, including studying sex/gender differences in various cognitive domains. One justification for continuing research on sex differences is a potential relevance for disease control and intervention (Cahill, 2006).[2] Given that society holds knowledge produced by neuroscientists in high esteem, various popular writers have been known to twist results obtained from brain research to support their biased beliefs about women and men being "wired" for different roles in society.[3] Weisberg and colleagues (2008) empirically demonstrated the power of neuroscience explanations by showing that even irrelevant neuroscience explanations alter rational judgment, independent of whether the persons involved are equipped with formal training in the subject. Neuroscience thus plays an important role in shaping perceptions in society, and hence there is a need to be wary because it is that knowledge that is employed in changing structures and shaping society. However, it is not only the biological sciences that have concerned themselves with the gender/sex question. During this past decade feminist perspectives have become prominent in the sex/gender debate. The first point of divergence in feminist compared to neuroscientific perspectives stems from the definition of the terms gender and sex, as these terms signify different ideas between the two academic communities. In turn this distinction informs the kind of research pursued by these fields. The second point of divergence involves, the "power position" from which these disciplines discuss "difference." Neuroscience speaks from a position of power, from the mainstream (the norm), and feminist perspectives speak from the periphery.

I start this chapter by outlining the background and progress of neuroscience research, followed by a discussion on the meaning of the term gender as it is understood from a gender studies perspective. A short background that explains how gender enters neuroscience research is provided, followed by a discussion of the challenges towards objective sex/gender research in neuroscience.

Neuroscience in perspective

The study of the nervous system, and here the brain, dates back to ancient times. Ancient Egyptians attempted to cure headaches and mental disorders by trephination, drilling through the skull, to relieve suspected increased pressure. Association between human intellect and the brain however came at a much later period in history. It began with the crude evaluation of cranial structure stemming from the belief that different races possessed different intellectual capacity. It was believed that this conclusion could be reached by simply measuring the size of the skull, i.e. craniology. This practice was followed by phrenology, another pseudoscience that propagated the idea that specific brain functions were localized on specific regions of the human skull. Phrenologists identified areas for language, friendship, philosophical thought, love, among other complex phenomena. The failure to produce consistent results through phrenology stimulated a desire to observe the brain directly. Variations in the cortex and its convolutions were immediately obvious. Brains of famous deceased scientists were donated to anatomists interested in linking intellectual capacity to cortical structure. After examining the human brain, anatomists observed that the complexity of the cerebral convolutions in humans was greater than that of apes. This observation loosely matched the complexity of thought processes and mental acuity that humans possessed.

A major breakthrough for neuroscience was Camillo Golgi's development of a silver chromate method for staining nerve tissue in 1873. Santiago Ramón y Cajal improved the Golgi technique and used it to study the intricate structures of individual neurons. He extensively described and categorized neurons throughout the brain. This research led to the formulation of the neuron doctrine: the functional unit of the brain is the neuron, as the atom is to matter in physics. In the mid-nineteenth-century, Hermann von Helmholtz among other scientists demonstrated that neurons were electrically excitable and that their activity predictably affected the electrical state of adjacent neurons. Advances in many fields, including electrophysiology, physics, molecular biology, and computational science have contributed importantly to the development of techniques that enable non-invasive exploration of complex brain processes. These techniques and other advances in neurobiology and psychology facilitated the emergence of neuroscience as a truly multidisciplinary field of inquiry. Its main objective is to establish the biological foundations of behavior (Farah, 2005). New technologies to image the nervous system pose novel ethical challenges. These problems arise, for example, from unexpected discoveries such as tumors that participants taking part in a study are found to have. Since the aim of the studies is usually not clinical, incidental discoveries pose an unprecedented challenge to the scientist who is often unprepared to deal with such information. Another challenge comes from cognitive-enhancing technology through pharmaceuticals, again illuminating traditional moral and philosophical problems such as nature, free will, and moral responsibility. A recent, and yet to be resolved dispute concerns the use of neuroscientific knowledge to provide evidence in legal contexts. "Can neurological evidence help courts assess criminal responsibility?" (Aharoni *et al*., 2008). There are reports of defendants attempting to reduce criminal responsibility through neuroscientific evidence, as in the case *United States v. Hinckley (1982)*. In this case, the defendant was tried for his attempt to assassinate President Ronald Reagan:

> The defense presented an insanity defense, which they based, in part, on CT scan evidence. The expert witness, a psychiatrist, argued for the defense and testified that the CT scan showed atrophy in the brain. The psychiatrist then argued that the atrophy is associated with schizophrenia. A radiologist was also consulted and testified that the scans showed brain abnormalities, but did not have any causal implications on the behavior or sanity of the defendant. Nevertheless, the jury found Hinckley not guilty by reason of insanity.
>
> (*Shafi* 2009: 32)

"Despite the skepticism on introducing neuroimaging to litigation, many courts are accepting brain scans as reliable evidence" (Shafi, 2009: 34). Some neuroscientists feel that neuroscience cannot contribute to law, specifically in deciding the intentionality of criminal acts. They feel that "there will never be a brain correlate to criminal responsibility" (Gazzaniga & Steven, 2005). There is nevertheless growing confidence that psychological profiling through functional magnetic resonance imaging (fMRI) will be useful in the future of lie detection (Illes, 2004; Shafi, 2009). Researchers are dedicating their time and energy to construct brain maps, i.e. "brain fingerprinting" (Farwell & Smith, 2001) and it is believed that future fMRI scans will be able "to detect concealed knowledge, despite efforts to conceal" (Illes, 2004). Leading scholar Judy Illes further points out that this phenomenal ability to intrude into the privacy of personal thoughts will raise another conundrum of ethical concerns. Furthermore, it is still not clear how accurate and reliable such technology will be.

A recent experiment introduced the question of free will to the host of unresolved emerging philosophical questions. Libet (2005) claimed to demonstrate that the brain reacts in response to stimuli, ahead of a conscious decision by an individual to act. The experiment was designed to determine the precise moment at which participants became conscious of their decision to flex their wrists or fingers. Electroencephalograms[4] placed on the scalp of the participants

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established the onset of activity in the supplementary motor area (SMA). The results indicate that neural activity in the motor strip commenced 350ms before the participants were conscious of making the decision to flex. These findings raised a host of philosophical questions regarding causality and determinism (Aharoni *et al.*, 2008). In the early 2000s, William Safire coined the term "neuroethics" to refer to the "field of philosophy that discusses the rights and wrongs of the treatment of, or enhancement of, the human brain" (Gazzaniga, 2006: 141). The field has certainly grown beyond enhancement, as neuroscientists formulate and raise ethical issues in various fields of practice. At the conception of the field of neuroethics, the study of gender in neuroscience was a relevant ethical issue. To date however, it has proved difficult to formulate the gender problem in mainstream neuroscience research without seeming redundant. In this chapter, I conceptualize the problem arising from neuroscience's understanding of gender difference and discuss why gender research in neuroscience continues to pose a challenge to objective research, and hence, is a matter of ethical concern. Gender/sex difference has long been a focus of feminist discourse. I argue that not enough has been done in conceptualizing gender/sex as an ethical concern, especially with a specific focus on neuroscience research.

What is gender?

Defining gender is not a simple task. Gender acquires new meanings depending on the context of who is asking, why they are asking, and what purpose their assumed definition will serve, as "social resources and contexts are consistently part of the production of knowledge; not only does science take place within specific social contexts, but these contexts form and shape the very style and content of science" (Chalfin, Murphy, & Karkazis, 2008: 2).

Sally Haslanger (2000) points out that gender is subject to a variety of interpretations. To some it might refer to sexuality and sexual orientation, to others it might highlight matters relating to identity, others see gender as a social category, for others it refers to social roles assigned to men and women, and finally, for some it alludes to a system of sexual symbolism. Gender is also often intertwined with images of masculinity and femininity, with hormones, and with body images. Gender is thus relevant to social life and political life, is an object of study in natural science and social science, and therefore has important religious, ethical, and philosophical implications. Gender, through its application in different ways by different communities represents a "boundary object." Boundary objects are plastic enough to adopt local constraints and needs, but robust enough to maintain a common identity across sites (Star & Griesemer, 1989). So as in the example of gender, different scientific communities can converse about gender and generally understand each other, but the symbols that they associate with the term can vary greatly among them: For example, when gender is discussed in the biological realm, the genitalia, the gonads, the hormones, and the brain's anatomy play important roles. Feminists refer to power, control, and regulation when they talk about gender (Butler, 1990).

According to Haslanger (2000: 45), women are those persons "who occupy a certain kind of social position, viz., one of sexually-marked" subordination. Because the female bodies have to operate within certain designated social spaces (of subordination), they encounter unique social experiences within the regulative structures of power that set their oppression in place, depending on whether they are white or black, poor or rich, educated or not. These aspects of difference in socio-economic status open them up to new and diverse layers of vulnerability that necessarily result in different social experiences and understandings of what it means to be a woman (Luna, 2009). Societies generally privilege persons with male bodies, as is exemplified by the famous case of Dr. Ben Barres, a female-to-male transgendered person who described how his work was differently evaluated after the sex change (Barres, 2006). He reported that he gained more respect from male faculty who went to the extent of claiming that his work was much better than that of his sister (they had not been aware of his sex change). He published this article to counter claims by Lawrence Summers, then president of Harvard University, who had suggested that discrepancies observed between women and men in mathematics and science performance might be rooted in biology. In addition to sexism, racism and homophobia, to name but a couple of examples, inform feminist perspectives.

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Dr. Barres's experiences bring out the strong relationship between gender and power. Gender is about control and regulation as Foucault (1998) illuminates from his historical review of sexuality in Victorian society. Sex/gender constitutes laws governing marriage and human intimacy (there are many countries today that still consider same-sex relations as a violation of law), it assigns the social place in which the sexed body is allowed to operate, and it assigns normalcy to some bodies and not to others. Gender is a tool of power and regulation as Judith Butler expounds in her book *Gender Trouble* (1990).

Regulation has relevance to the intersex[5] body, which possesses both male and female genital organs. True hermaphrodites possess one testes and one ovary, male pseudohermaphrodites have testes and some aspects of the female genitalia, and female pseudohermaphrodites have ovaries and some aspect of the male genitalia as discussed by Anne Fausto-Sterling (1993). In contrast to true hermaphrodites, "pseudohermaphrodites possess two gonads of the same kind along with the usual male (XY) or female (XX) chromosomal makeup" (Fausto-Sterling, 1993: 22). Myra Hird (2000) brings to light the fact that these bodies have been under tight regulation and control, and it is no surprise that the majority of the population is ignorant of their existence. Intersex bodies are considered an anomaly in society, and the medical profession tends to "correct" them. Those bodies that do not fit into the predetermined categories are hormonally and surgically assisted to "slip quietly into society as 'normal' heterosexual males or females" (Fausto-Sterling, 1993: 22). The need for a synthetic creation of physical boundaries that are written on the body through sex reassignment surgery exposes the artificiality of the sex/gender binary, and exposes the nature of this regulation. Hird (2000: 353) asks: "What incites the medical community to favor extremely intrusive surgery for anatomical conditions that doctors themselves admit present no functional or medical dangers?" That "correction" has now been perfected by advancements in surgical technology that enable intervention at birth, raising serious unaddressed ethical issues. Sexuality, sex and gender, and the cohort of the meanings associated with these concepts expose only the tip of the iceberg to the varied and deeply ingrained complexities that this challenge entails.

Challenges

Scientific knowledge consists of logical reasoning applied to observational and experimental data. This uncritical perception of science lasted until the 1960s. Thomas Kuhn (1996/1962) and Paul Feyerabend (2010/1975) challenged the claim that science was acquired by value-neutral and context-independent methods. They demonstrated that observation was theory-laden and never innocent. In the early 1980s, feminists began to observe the social nature of what had been understood to be objective evaluations of sex. Science studies provided feminist researchers with methodological tools to evaluate critically the practice of science in its study of sex difference. The critique in this section however does not discuss androcentrisim in science. In this section I introduce aspects related to terminology, hypothesis, and sometimes methodology that undermine neuroscientists' concerted efforts to evaluate gender difference objectively. I lay these challenges out in this section, and expound on each by drawing from some examples in the field.

Terminology and inclusion

It is often not clear what is meant by gender or sex in a neuroscience context. More often than not, these terms are used interchangeably (Kraus, 2000). Sex is the concept almost always indiscriminately chosen to discuss difference, and more so when chemical or biological aspects are discussed, e.g. Cahill (2006).[6] Some scholars will however make the effort to use the term "gender" when reporting behavioral performance. Moreover when the terms sex and gender are used, they refer to either male or female persons excluding intersex categories. The division between sex and gender originates from the second wave of feminism in the early 1970s.

This distinction came in order to highlight the social situation of women and the inequalities that held them in their place of oppression. It was argued for example that the scarce representation of women in science and politics ought to be considered as an effect of social stratification rather than an outcome of biology. Feminists revised the term "women" and replaced it with gender because the social space in which men were privileged and women emancipated was occupied by both females and males, highlighting the fact that woman's oppression was related to men's privilege. It was about this time that the distinction between gender and sex arose. The analytical evaluation of gender was taken up by anthropologists and social scientists; sex was left to the biological regime.

From the mid-1980s, feminist writers like Susan Leigh-Star, Ruth Bleier, and Anne Fausto-Sterling, among others, started to evaluate the objectivity of science in discussing sex difference. Following critiques formulated by historians of science concerning the social and cultural nature of science, feminist researchers re-examined the basis of the conclusions reached by biological sciences concerning the fixedness of sex difference. First, these scientists recognized that most of the claims about innate difference and hard-wiring were often used to affirm the social segregation in roles and labor between men and women. This was problematic because the social stratification that forced men and women to operate in different social spaces (i.e. the public vs. the private sphere) had already been theorized and categorized as a social construction. Additionally there were aspects of experimental design that were inherently androcentric. Anne Fausto-Sterling (2000) in Sexing the Body demonstrated that most animal studies utilized a cohort of male animals. Carol Gilligan (1993) also demonstrated that girls' performance in behavioral research was often measured against the "male norm." The exposure that sex difference research in science was not value-free, and that in fact this ideology shaped the appearance of biological sex differences and how they were understood prompted feminist empiricists to re-examine their position on the sex/gender boundary, i.e. re-examining the idea that the body (linked to the concept of sex) was separate from the social context it existed in. Feminists rejected the idea that there was a natural female body that was ahistorical and universal over cultures. The body is socially and culturally construed, and these perceptions are mediated through language, and language is utilized by science to fix norms (Oudshoorn, 2001). By the beginning of the twenty-first century, the new feminist position suggested that the body and the cultural were inseparable, and that in fact no separation between sex and gender should be theoretically maintained, hence the "sex/gender" concept.

The history of how sex difference research evolved in the scientific realm in the West is more ancient. Aristotle conceptualized sex differences and theorized their relevance in society. His opinion was that females did not contribute to the society intellectually; that they were passive and receptive, while males were active and productive, which justified females' exclusion from public life and the political scene. He based his argument on the premise that a female's childbearing experience brought her closer to nature and perhaps obviously (at least in his opinion) endowed her with the natural role of mother and wife. State and social organization, he argued, could ideally be maintained by labor division where the private sphere would be the meaningful female participation.

Modern conceptualization of gender difference in neuroscience came in the early nineteenth century. Cognitive neuroscience irrevocably changed after Paul Broca, a prominent physician, anatomist, and anthropologist published a series of articles between 1861 and 1866 that proved that cognitive function could be localized to distinct brain regions. His ideas were not original, and in fact built upon those of preceding researchers including Franz Joseph Gall, who pioneered in associating brain function to various anatomical regions of the brain. But Broca, by employing the clinico-pathological correlation technique to analyze a loss of speech (aphemia), demonstrated for the first time that direct brain damage affected cognitive behavior, and therefore function. Paul Broca in theorizing gender difference made the following statement: "On average, the brain mass is larger in men than in women, in clever men than in ordinary ones, and in superior races than in inferior ones … There is an obvious relationship between intelligence and brain volume" (Broca, 1861). Broca went on to carry out several experiments weighing the masses of male and female brains in order to empirically demonstrate his hypothesis. The relationship between brain mass and function has long been disapproved, but Broca's notions indicate the conceptualizations of gender/sex that confronted cognitive neuroscience at its inception. Theoretical considerations such as these were the basis upon which man and woman, sex and gender was understood and investigated at the turn of the twentieth century. As Catherine Vidal (2005) notes, ideology regarding sex difference has closely followed brain research since its establishment as a field of investigation. It is certainly difficult to find any value-free research on as politically charged an issue as gender/sex.

It is of political and ethical concern that the binary gender system excludes the representation of intersex and transgender people by defining a standard of norms that places them outside what is considered to be normal or acceptable. It is also interesting to note that these persons are rarely included in general clinical research.

Naturalization

Cognitive neuroscience aims at locating the biological foundations of behavior. Biological sciences presuppose that gender/sex is of a natural kind, i.e. resulting from biological processes that are inherent to the system under evaluation. This is not a naive position as research in cell biology demonstrates the significant role that X and Y chromosomes and sex hormones play in autoimmune conditions, pharmacology, and diagnostic interventions among others as documented in a report prepared by the Difference Committee on Understanding the Biology of Sex and Gender (2001), and approved by the National Research Council.

Biological sciences continue to reinforce immutability into socially instituted human relations and male/female socio-cultural practices, and this is problematic. The concept of the division of labor held women in the private sphere and allocated them the role of nurturing, whereas men were allowed to participate freely in the public sphere and in politics. Representing these socially instituted distinctions, as if they occurred without a history and without human intervention, i.e. as if they were a natural consequence of being male or female, results in the naturalization of a social category. Unifying the social and the biological results in a hybrid that melds biological and social explanations of gender/sex differences, i.e. gender/sex differences are interpreted as unchangeable facts and a simple consequence of nature. Here I will present two examples to expound on this point. In the first example, Wang *et al*. (2007: 228) demonstrated in their experiment that men and women responded differently to stress. The aim of the experiment was "to further explore the gender-specific neural circuitry of psychological stress in the male and female brain." They used perfusion-based fMRI to measure cerebral blood flow responses to mild to moderate stress in 32 healthy people (16 males and 16 females). Psychological stress was elicited using mental arithmetic tasks under varying levels of psychological pressure to perform. The results showed that men activated the left orbitofrontal cortex which is implicated to the "fight or flight" response, while women activated the ventral striatum, putamen, insula and cingulate cortex, which forms part of the limbic system. Deducting the meaning of these differences in activation, the researchers posit the following explanation:

> Evolutionarily, males have to confront a stressor such as a predator either by overcoming or fleeing it. Females respond to stress by nurturing offspring and affiliating with social groups that maximize the survival of the species in times of adversity. Whereas the physiological stress response typically involves activation of the sympathetic nervous system and the HPA axis in both genders, the female stress response may specifically build on attachment–caregiving processes (especially those mediated by oxytocin) that buffer the sympathetic and HPA arousal.
>
> (*Wang et al.,* 2007: 236)

While by no means is it my intent to undermine the findings of this research study, it is noteworthy that links are drawn from the task to the limbic system, to emotion, and finally to female reproduction that is linked to caregiving needs. This discussion follows the mainstream perception of sex/gender difference and has been published elsewhere (Taylor *et al*., 2000). Problematic is this expounding on women's nurturing ability and making it relevant to cognitive ability. It builds on the idea that the role of woman as caregiver and nurturer is obvious and natural, and that it is this characteristic that consequently affects how she relates with the world in significant ways. This philosophy is echoed in economic studies that suggest that men make better economic choices because they are rational,[7] while women, under similar conditions, engage in economic decisions with their emotion (Van Vugt, De Cremer, & Janssen, 2007). These elucidations demonstrate the modern reconstruction of difference that integrates social roles and females' and males' cultural experience into biological brain matter.

Another example of naturalization comes from Arnold (2004) who argues that all sexually dimorphic signals in birds and mammals ultimately configure the expression of differentiated sex roles related to mating, reproduction, and raising offspring:

> For optimal reproduction in a complex vertebrate, sex differences in the brain are required to coordinate the exchange of gametes (pair-bonding, courtship and copulation), and to engage in sex-specific territoriality, aggression, parental care, sociality and cognition.
>
> (*Arnold*, 2004: 3)

Ultimately, the problem of naturalization in gender/sex difference research stems from the fact that difference is boxed up in the concept of reproduction and reproductive capacity. One only needs to look at the templates implemented to describe difference within biological research to verify this. Difference is discussed along the terms of procreation and the mainstream asserts that biological facilities have evolved to make the organisms better suited for procreation and survival of the species. This is in fact the basis of the heteronormative binary gender system that taboos bodies and sex practices that do not reproduce. This position is highly criticized by new aspects of feminist research, for example queer theory,[8] which among other things disagrees that the function for sexual activity is procreation. Queer theory demonstrates that not all women desire to have children, and neither do they all possess the nurturing characteristics supposedly common to all women.

Extrapolation

What is criticized in this section is the one-to-one mapping of results from animal studies onto complex gendered human social relations. This is not a new critique as it has been voiced by Helen Longino and Ruth Doell (1996). I will take up a similar critique, but here I extend this view to relate to research in cognitive neuroscience. There is a strong belief in the immutability of gender/sex because animal studies confirm a direct link between biological processes and the expression of behavior in their species. In birds and mammals, for example, Arnold (2004) reports that the differences in development between the sexes arise from the differential actions of genes that are encoded on the sex chromosomes. What is problematic with animal reports is the assumption that similar principles apply for humans. Arnold (ibid.) does not make this claim obvious, because he juxtaposes reports from animal studies with concepts relating to human relations, e.g. *“Genes on the sex chromosomes probably determine the gender (sexually dimorphic phenotype) of the brain.”* The use of the term “gender” here suggests human relations. Xu, Burgoyne, and Arnold (2002) argue that biological sex differences in animals are not only expressed in the physical appearance of the species, but also in the anatomy of the brain through sex-specific differentiation in a number of brain regions. A clean link between sex chromosomes, behavior, and the brain is quickly drawn and implicitly attributed to human relations. It is these kinds of silenced associations that catalyze the belief that sex/gender differences in human behavior are fixed and essential to the organs. These associations become facts that are generally agreed upon but nowhere stated. Basing his arguments from mostly animal research, Larry Cahill (2006) argues that hard-wired biological facts express themselves differentially in men and women, and that these variations occur throughout the brain.

This claim does not of course undermine the important role of animal studies, but rather points out that human interaction is complicated and that animal social relations hardly match any cognitive experience between persons. Additionally, the brain’s plasticity describes how the social context and experience shapes the brain (Maguire *et al*., 2006) and how cognitive function is also shaped by training (Feng *et al*., 2007). The brain’s remarkable ability to respond to new demands is further demonstrated by studies that show that training in specific skills, such as piano playing, affects other unrelated cognitive functions, for example pianists had improved expertise in sequence learning against non-pianists (Landau & D’Esposito, 2006). Clearly when measuring the human brain, one is tapping into an integrated network that is shaped by and learns from its environment. It is impossible to assume a single-factor type of analysis that is likely used in animal studies. That said, I acknowledge the fact that animal studies undoubtedly provide important clues into human studies, but emphasize the need for caution when cognitive ability is discussed. What is questioned here is not the validity of animal research in knowledge production, neither do I question the scientist's competence, but rather, I take issue with the presentation and discussion of results obtained, especially in terms of their direct relevance to human cognition. These studies provide important clues, but they do not give sufficient indication about gender identities, sexualities, and cognitive behavior in humans.

Ideology and stereotyping

In this section we shall be looking at the links made between obscure results obtained in the lab, and the sophisticated social behaviors that men and women practice. One of the major challenges in discussing data stems from the fact that data in themselves have no meaning. In order to be appreciated, not only do the findings need to support present prevailing thoughts on the subject from other research groups, but they also have to make sense in real-world contexts. To make the points of data obtained in the laboratories intelligible, they are filled up with, and described in terms of observable generalizations, and especially if the results discuss male/female difference.

The problem with generalizations is the fact that women (and men for that matter), are not homogeneous categories; their characteristics cannot be unified by the simple fact that their bodies share a similar morphology. Research in gender studies indicates that different historical periods, diverse ethnic relations, and disproportionate economic backgrounds shape individual experience, hence there cannot be any uniform characteristic representing a collective experience. We also know that our brains are plastic and that they are shaped by these experiences, hence the variability in the representation of these experiences cognitively. Cordelia Fine in *Delusions of Gender* (2010) and Jordan-Young in *Brain Storm: The Flaws in the Science of Sex Differences* (2010) separate fiction from fact and present detailed reviews on the question of gender/sex difference based on empirical research. While Fine focuses on criticizing the popular writers and press for injecting irrelevant ideology into sex/gender concepts, Jordan-Young takes a fresh look at how the process of obtaining difference through biological sciences in itself may contribute to fueling prejudiced views. They mark (in different but relevant ways) the huge leaps in reasoning that have to be made in order for such conclusions to be reached. On the other hand I would like to point out that neuroscientists themselves could also be held accountable for the present links of lab results to ideology. I cite another remark by Arnold:

> In birds and mammals, differences in development between the sexes arise from the differential actions of genes that are encoded on the sex chromosomes. These genes are differentially represented in the cells of males and females, and have been selected for sex specific roles.
>
> (*Arnold*, 2004: 1)

The fact that this researcher can leap from genes and sex chromosomes to sexspecific sex roles is problematic. Chromosomes do not assign cultural and social roles selectively to either a male or female. Results obtained are fit into some form of pre-described notions of gender.

Ambiguity

In the last part of this chapter I would like to point out the challenges specific to studies measuring behavioral performance relating to cognitive capacity in sex/gender difference. Currently, a paradigm shift has occurred; brain images are preferred when establishing sex differences compared to behavioral studies in human research. There is a shift from the external to the internal, communicating a growing desire to confirm that difference emanates from internal characteristics that have a biological (read "unchangeable") basis. For decades, before imaging technology came to the forefront in neuroscience, behavioral performance was the platform from which researchers argued for/against sex/gender difference. Most behavioral experiments adopt the "reaction time"[9] paradigm. Computerized tasks are preferred because the experimenters can monitor the exact response time in milliseconds, i.e.

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the exact moment the individual taking the computerized experiment taps a button on the computer tab to give a response. Often in testing the influence of gender/sex in a test, researchers have to categorize participants in terms of their gender/sex. These gender/sex categories are recorded at the beginning of the experiment. These categories are useful when running statistical analysis to determine whether or not significant differences exist between female and male participants in the tasks assigned to them. It is interesting to note that gender/sex differences cannot be detected when the researchers do not make gender/sex a variable in the test. This is to say that a gender difference is not the result of a cognitive test, that is, it is not an obvious difference that will, on its own, affect the results significantly; it has to be looked for in order to be found! However, this is not the point that I would like to raise in this section.

I would like to highlight some contradictions resulting from what is observed behaviorally, compared to what is observed on the brain scans (this, by the way, is a point that has been raised by other neuroscientists in the field). A specific example to illustrate this point more clearly can be drawn from the utilization of the mental rotation task (MRT) in demonstrating sex/gender differences in spatial abilities. The mental rotation experiment was introduced into cognitive neuroscience by Shepard and Metzler in 1971. The experiment consisted of the presentation of a pair of three-dimensional cubes on a screen. The cubes were identical in shape and size, but were presented by the experimenter in different perspectives. One of the cubes was rotated by some angle, e.g. 50 degrees, away from the other cube. The two cubes were presented on a screen at the same time and the task of the participant was to determine whether or not they were identical in the shortest time possible. To accomplish this task, mental manipulation of these visually presented stimuli is necessary. People report that they mentally rotate one of the images so that it fits the orientation of the other image, then they compare the two objects, in order to make the judgment. What is measured in this experiment is the speed (measured from the reaction time) and accuracy (determined by whether the response given was correct or not) of the response given. The mental rotation experiment was modified to a task that measured sex/gender differences by Vandenberg and Kuse (1978), and has become a classic experiment in showing that sex/gender differences exist in spatial abilities (spatial abilities are part of what is considered to be mental/intellectual ability). It is in fact general consensus within the field that gender/sex differences in spatial abilities favoring males exist and are "well established" and persistent (Geary, Gilger, & Elliott-Miller, 1992; Casey *et al*., 1995; Voyer, Voyer, & Bryden, 1995; Kimura, 1999; Terlecki & Newcombe, 2005). McGee (1979) and others have argued that sex differences in certain forms of spatial cognition have biological origins that contribute to sex differences in specific mathematical areas.

With the advent of imaging techniques, brain images during mental rotation are being taken. Corballis and Sergent (1988) demonstrated from research with a brain lesioned patient that the right hemisphere is more relevant (than the left hemisphere) when mentally rotating objects. Jordan *et al*. (2002) report that it is men who significantly activate the right regions of the parietal lobe, and that females have greater bilateral activations when carrying out the mental rotation test. Jansen and Heil (2010) demonstrate that gender differences in mental rotation skills remain constant across age, but Jordan *et al*. (ibid.) report that even in the cases where both men and women perform the task with equal competence, there are genuine sex-differentiated cerebral activation patterns.

The challenge I would like to introduce here arises from the conflict resulting from a mismatch in behavioral results and imaging data, as such, even in the absence of a measurable behavioral trait, a sex/gender difference can be reported. In this sense, "difference" acquires a new significance and is no longer pegged on behavior; it is pegged on brain images. This shift locates our first instance of ambiguity: What does sex/difference mean (in this context)? What does the activation represent? It has been hypothesized that men and women use different strategies in completing the mental rotation task, and that it is this differentiation in strategy that might activate different brain regions (Heil & Jansen-Osmann, 2008). This statement suggests the malleability and plasticity of brain activity, and there is some evidence suggesting that hemispheric processing may be influenced by the strategies that participants use (Zacks *et al*., 1999), and some researchers argue that it might be the anatomical regions that drive the activation pattern. Rilea (2008), for example, suggests that the interaction of brain organization and type of spatial task might lead to sex differences in spatial abilities.

Studies that present anatomical references to cognitive behavior allude to biological origins for cognitive differences. In the case where men and women show differing brain activation patterns, neural networks are implicated in behavioural difference. The question that remains when testing sex/gender differences in higher cognitive functions is; what constitutes a sex/gender difference? In the MRT, for example, it has been demonstrated that environmental and social factors directly affect performance. So, for instance, in the face of stereotype threat,[10] e.g. when women are informed that "females are known to underperform in the MRT," females' performance is worse than that of males. In the face of self-affirmation, women perform as well as males (Martens *et al*., 2006). It is also a proven fact that stereotype threat can impair the cognitive performance of stigmatized individuals on a wide variety of tasks (Schmader, Johns, & Forbes, 2008). What is also known regarding spatial skills is the fact that training improves women's performance (Feng, Spence, & Pratt, 2007). These important influences of environmental and social contexts in shaping behavior cast doubt on the materiality of a sex-based gender/sex difference in spatial abilities. Is it possible that scientists, instead of measuring innate sex differences, are actually only tapping into the life-molding effects of culture, diversity, experience, and training on the social brain? What is in fact a sex/gender difference in higher cognitive function?

Challenges and opportunities

As a feminist empiricist doing neuroscience research, the greater challenge is to consider how feminist perspectives might be adopted and utilized in neuroscience research. A growing number of feminist researchers strongly feel that neuroscientific perspectives on gender theory seriously lag behind. But there are difficulties associated with this stance as well. It is difficult to directly apply feminist philosophies on the gender/sex concept in empirical lab work because current feminist reasoning would argue against clear-cut distinctions between gender and sex. I, for example, wonder whether gender and sex might be useful as separate analytical categories that could help neuroscientists distinguish between socially construed ideologies that masquerade as biologically determined natural things. Choudhury, Nagel, and Slaby (2009) suggest that a critical approach to neuroscience practice would necessitate interdisciplinary considerations coupled by a self-critical analysis by the scientist. Einstein (2011) is of the opinion that integrating methods from other disciplines (destabilizing the central position that positivism takes) would enable a situating of knowledge that could overcome some of the problems arising from overt generalizations and misconceptions, but I suggest that perhaps some intervention can arise from the field of neuroscience itself. A recent research report (Afraz, Pashkam, & Cavanagh, 2010) in the field of visual perception demonstrated that the perceived gender of a face was strongly biased toward male or female at different locations in the visual field, i.e. some faces were categorized as female (or male) faces more often when they appeared at certain regions of the visual field. In this experiment, the researchers asked eleven people of varied backgrounds to categorize a set of computer-generated faces as either male or female. These computer-generated faces had been stripped of all gender-identifying characteristics including hair and clothing. The faces were shown following a random sequence from a morphing[11] spectrum ranging along a spectrum of very male to very female faces. Participants were asked to classify the faces by gender. The results indicated that different individuals categorized the faces as male or female depending on where the faces appeared on the visual field. Facial gender varied dramatically across different locations and the pattern of recognition was unique for each individual. This result did not depend on the gender/sex of the participants. This research could be recognized, in the domain of sex/gender difference research, as a demonstration of the constructiveness of sex/gender as a category: that the cognitive capacity to determine the gender/sex of a person is not obvious. There is a variance of the perceptual appearance of gender and its bias is different for different people, indicating an effect of (individual) social/cultural or environmental experience. To be consistent across all subjects, certain standards would have had to be enforced as markers, e.g. type of dressing or specific social codes.

Conclusion

The implications of gender research and understandings of the concept are farreaching, and they have been used over time to establish systems of government, to order society, as well as to lock out and/or admit certain persons and bodies. This is indeed an ethical issue. Highlighting (sometimes irrelevant) biological information when explaining sex differences in performance with regard to intellectual activity is also an ethical concern because it implicitly inscribes fixed notions about gender abilities that are reproduced and established in academic discourses, genuinely threatening neutrality. Sex/gender difference research has found its way in the education system. In an example of an article published in the *New York Times* (Weil, 2008), separately educating boys and girls is advocated; teachers are encouraged to teach boys within blue walls, and girls within yellow rooms to boost their cognitive abilities. This is an understanding of difference that is exaggerated, yet from it we have a glimpse of the impact of some of this discussion.

As Claude Steele (1997) notes with concern, teachers, researchers, policymakers, and parents make assumptions about the abilities of boys and girls, unconsciously propagating stereotypes associated with their ability to perform cognitively. Honest critical science is able to admit and expose the influence that society, culture, and perhaps prejudice have in shaping the process of knowledge production. Neuroscientists have to be self-critical and revise their prejudices when establishing hypotheses, to be open to thinking beyond predefined norms, and to be wary especially when their statements occupy volatile political space.

Neuroscience research continues to play a significant role in explicating the role of neural networks, how they function in humans, and what meaningful purpose this knowledge might serve humans in the future. It is a fascinating area of research full of promise. As the ethical concerns continue to increase, the question of sex/gender difference in cognitive ability warrants further research and scholarly consideration.

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Notes

1 This chapter was first published as an article in Spanish by in the journal Perspectivas Bioéticas 2011, No. 30, pp. 62–84. www.flacso.org.ar
2 A detailed review of this question was published by a committee representing the board on health sciences policy (Pankevich *et al*., 2011).
3 Cordelia Fine (2010) presents an excellent review of various popular beliefs propagated by popular writers who cite neuroscientific evidence as proof. She discusses the *real* science behind the pseudoscience.
4 An electroencephalogram is an instrument that generates a record of the electrical activity of the brain by measuring electric signals using a set of electrodes attached to the scalp that act as transducers.
5 Standard medical literature uses the term *intersex* as a catch-all for three major subgroups with a mixture of male and female characteristics (Fausto-Sterling 1993: 21).
6 Dr. Larry Cahill is a neurobiologist who vehemently believes in the immutability of gender/sex biological differences in the brain. In his *Nature* article in 2006, he discusses why sex difference is valuable to neuroscience research and presents valuable evidence from animal and human studies to support sex/gender as a relevant category for analysis in cognitive functioning.
7 The prefrontal cortex which males activate during stress is closely associated with intellectual capacity, decision making, and reasoning abilities.

In Neuroscience and Political Theory, Ed. Vander Valk. 2012: 268-287, Routledge London
Dir: W:/TandF/RAPS/5746-Vander-Valk_11-0892/FPP/9780415782012_Vander.3d
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8 Queer theory is a field of critical theory that emerged in the early 1990s from the work of Eve Kosofsky Sedgwick (1985, 1990) and Judith Butler (1990). Its main focus of analysis concerns issues of sexual orientation and gender identity, and the field itself originated from gay and lesbian studies, and feminist studies.

9 Reaction time refers to the interval in time between the presentation of a stimulus and the initiation of the muscular response to that stimulus.

10 Stereotype threat (Steele, 1997; Steele & Aronson, 1995) describes the experience of anxiety or concern by individuals when they are exposed to a (negative) stereotype that says something about the social group that they belong to. The affected minority acts in a manner consistent with the stereotype, fulfilling its prophecy. Stereotype threat has been shown to reduce the cognitive performance of individuals who are exposed to the threat of confirming those stereotypes.

11 Morphing is a computer-generated special effect that allows one image to transform to another image through a seamless transition, so that you are not able to trace the place at which the actual change takes place.

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