It's Only Natural: Analyzing the Role of Biased Knowledge in Science and Democracy

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Abstract

This paper examines the use of science in democratic society to guide moral and philosophical principles, and the resulting distribution of rights and resources. It explores the use of alleged natural differences to justify the denial of rights and resources on the basis of gender and race from early democracy to the twentieth century. To illustrate this trend, it draws on case studies including the historical examinations of anatomical and neurological differences between the races and sexes, and the laws and policies that both reflected and shaped these theories. This paper then evaluates activist efforts to counteract these biases and work towards equality. Finally, it explores the modern debate surrounding sex differences in the brain, and the ethical stakes it presents in light of these historical differences. On the basis of these examinations, it hypothesizes that in separating scientific theory acceptance from moral and political implications, and engaging in ethical debate around these implications, scientists, theorists, and politicians alike can promote equality while continuing to pursue scientific knowledge.

Introduction

> *"It was the erection and institution of an Order or Society, which we call Salomon's House; the noblest foundation (as we think) that ever was upon the earth, and the lanthorn of this kingdom…the end of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible"* – Francis Bacon, *The New Atlantis* (1627)

In his utopian treatise, *The New Atlantis,* Francis Bacon imagines an ideal world in which science provides a "true account" of the natural realm to be applied for the "use and benefit of mankind." (Bacon, 1627) To Bacon, science is a "lanthorn" – a guiding light for society that illuminates the path towards progress and "enlightenment." Scientists, in obtaining and interpreting truths about nature, are granted unparalleled authority to arbitrate political and moral issues. In *The New Atlantis,* this authority extends even to making decisions about what knowledge will be accessible to society; scientists decide "which of the inventions and experiences [they] have discovered shall be published, and which not" as they see "fit." (Bacon, 1627)

Bacon predicted that elevating science to a supreme moral authority would lead to a utopia; I propose that it has had devastating consequences for social and political equality in democracies throughout history. If, as Bacon believed, scientific knowledge was truly objective, then granting it moral authority would be beneficial. In reality, however, science is not always a completely "true account" of the natural realm; it often reflects the biases of the scientist and the social context in which it is performed.

Despite this reality, theorists and activists alike tend to equate what science deems "natural" with what society should deem morally "right." This tendency has led to the use of inherently biased science to create institutions and laws that reinforce these very biases, ultimately perpetuating a dangerous cycle of inequality that can be traced throughout the history of the United States. In attempting to undermine these systems, activists have rooted claims for equality in scientific knowledge, reinforcing a framework in which science is given the ultimate power to arbitrate moral issues. Relying solely on what is "natural" to shape morality is, however, insufficient; analyzing areas of scientific debate regarding issues such as the controversy surrounding sex differences in the brain shows that not only is our concept of nature shaped by biases, but it can also leave us with unsatisfactory and counterintuitive moral judgments.

None of this is meant to say that science should be ignored, dismissed, or constrained. Scientists should still strive for truth and objectivity in the pursuit of knowledge and progress. We must, however, recognize that striving towards these ideals is not the same as achieving them, and accepting biased science as the objective basis for moral judgments can have serious social consequences. Not only that, but if biological sameness continues to be conflated with political equality and

what is "natural" is equated with what is morally "right," scientists will be limited in their pursuit of truth. Lines of inquiry and theories that appear to show difference, or prove a morally unacceptable act has a "natural" basis, will be blocked and rejected by those whose values prevent them from accepting the social consequences of this knowledge.

It is only natural that we look to nature for guidance in moral issues, yet the tendency to equate biological difference with inequality has limited both social and scientific change. Nature is not and cannot be translated objectively; in the process, scientists project their own social and political conceptions onto the natural world and operate within the bounds of social acceptability. Nor does nature always provide the ethical support we seek; relying on what is perceived as natural limits work towards equality. Realizing that breaking out of social cycles of inequality requires moving beyond our reliance on nature to ground morality, we need to separate the processes of theory acceptance and social changes and focus on the distribution of rights and resources. As I will argue, the history of discrimination justified on science shows just how important it is to critically examine scientific knowledge in a way that surfaces social context. We need to replace Bacon's framework with one that takes into account both ethical and scientific principles rather than letting nature drive our concepts of morality.

Conflating the "Natural" with the "Moral"

> *"Great nature spoke; observant man obey'd; cities were built, societies were made."*
> – Alexander Pope, "An Essay on Man: Epistle III" (1733)

The modern reliance on science to dictate moral principles began in the late eighteenth century as a result of the rising reliance on liberal democratic theory and governance. Political theorists including Emmanuel Kant and John Locke set "social convention on a natural basis by identifying the natural order underlying the well-ordered polis," establishing certain rights, according to historian Londa Schiebinger, as "immutable, given either by God or inherent in the material universe" and therefore entitled to all men (Schiebinger, 1989, p. 215). The portrayal of rights as natural and therefore immutable – with the resulting shift in power from the divine rights granted to kings to the ability to reason present in all men – created a justification to overthrow monarchies and establish democratic systems in which rights were distributed based on natural laws. American revolutionaries declared their independence on the basis that "all men are created equal" and "endowed by their Creator with certain unalienable Rights." (US 1776) The French "Declaration of the Rights of Man" called upon similar arguments, claiming the "preservation of the natural and imprescriptible rights of man" as not only the rationale for overthrowing monarchies, but the "aim of all political association" moving forward (France 1789). These statements succeeded by facilitating the creation of democratic societies; however, as sexologist Anne Fausto-

Sterling contends, they "threatened to undermine the logic behind fundamental social and economic institutions such as marriage, slavery, or the limiting of the right to vote to white men with property." (Fausto-Sterling, 2000, p. 39)

Because theorists had based equality in nature, the only way to justify the continued subordination of certain groups was to prove their natural inequality. The Marquis de Condorcet, writing in 1790, outlined this need clearly: "If women are to be excluded from the *polis*, one must demonstrate a 'natural difference' between men and women in order to legitimate that exclusion." (de Condorcet, cited in Schiebinger, 1989, p. 215) Science, accepted as the accurate and objective representation of nature, became the method of choice for seeking these differences. In democratic societies, biology became destiny and nature the new moral authority. As eighteenth century poet Alexander Pope wrote, in the new social order "one truth is clear: whatever is, is right." (Pope, 1733, X l. 286)

The role of nature in democracy has traditionally been to serve as a "universal and abstract…governing principle." (Daston, 2004, p. 358) In order to be effectively applied, however, nature must be translated—a process which facilitates the "rise of powerful local interpreters," or scientists (Daston, 2004, p. 359). With "their privileged knowledge of nature, scientists became consecrated priests of the new secular order, intermediaries between the laws of nature and of states." (Schiebinger, 2004, p. 9) As historian Lorraine Daston argues, in the process of translation, nature becomes "an abstract entity and the main agent of the [scientist's] self-fulfilling prophecies." (Daston, 2004, p. 357)

The popular view of science, however, views it as a systematic, critical, and most importantly, objective effort to understand the natural and social world.[1] To be objective "is to aspire to knowledge that bears no trace of the knower—knowledge unmarked by prejudice or skill, fantasy or judgment, wishing or striving" (Daston, 2004, p. 17). According to Daston, scientific facts are those "conveyed without the mediation of the scientist." By their very categorization as scientific, theories are taken to be truthful representations of nature. Yet in acting as nature's translators, scientists engage in a "technique of self-formation, of centering" by projecting their own beliefs onto nature and portraying them as unbiased truth (Daston, 2004, p. 358). Those who claim the mantle of objectivity, however, obscure the reality of this process in a way that can reinforce pre-existing biases and inequalities.

In the eighteenth and nineteenth centuries, this process manifested in the dominant scientific approach of analyzing the world through a lens of difference. Driven by the political need to justify structures of inequality and strong unconscious biases, scientists subscribed to the view that

[1] In line with the English tradition, "science" will refer solely to natural sciences, including disciplines such as biology, anatomy, physics, and medicine but excluding the social sciences.

"species were immutable entities arrayed along a fixed and vertical hierarchy stretching from God above down to the lowliest sentient being." (Schiebinger, 2004, p. 145) Under this framework, the role of scientists was to determine where each individual was located on this "great chain of being." (Schiebinger, 2004) To them, inequality was not socially constructed, but natural; as eighteenth-century naturalist William Smellie put it, "independently of all political institutions, nature herself has formed the human species into castes and ranks" (Smellie, 1790, p. 307). This belief was so deeply ingrained in the scientific community that its effects reached down to the study of bugs: the nineteenth century naturalist Patrick Geddes boldly claimed that "throughout the class of insects there are numerous illustrations of the excellence of the males over the females" (Geddes and Thompson, 1889, p. 18)

In claiming that inequality was naturally rather than socially constructed, scientists cemented their role as moral arbitrators of society, as their findings provided the foundation for ethical decisions. Questions "of ethics (particularly those concerning equality) were taken to stand or fall on the findings of anatomists" (Schiebinger, 2004, p. 173). As French doctor Pierre Roussel argued in 1775, the "task of medicine [was] to provide a certain ground for ethics, for philosophy could not determine the moral powers of human beings without taking into account the influence of bodily organization." (Roussel, 1775, cited in Schiebinger, 1989, p. 222) In a continuation of this trend, physician Charles Meigs contended in 1848 that women and Africans' lots' were "cast for them; men did not make it; God made it" (Meigs, 1848, p. 364). The role of science, therefore, was to translate nature into law.

If, as scientists claimed, inequality was natural and conclusions about difference had been reached objectively, then social hierarchies were inevitable. Asserting that a "social convention…or a political arrangement (the disenfranchisement of slaves and women, for instance)" is dictated by nature means that this social convention or arrangement is "therefore irrevocable or optimal or both." (Daston, 2004, p. 2) Scientists themselves drew this conclusion from their work. In his text on female diseases, Dr. Charles Meigs argued that the "by the very nature of [women's] moral and physical constitution, they are bound to the horns of the family altar." (Meigs, 1848, p. 364) As a consequence, they "[could] not…and probably never [would], participate in the affairs of nations or municipalities." (Meigs, 1848, p. 364) Similarly, British anthropologist James McGrigor Allan argued against any type of equality for women:

> Thousands of years have amply demonstrated the mental supremacy of man, and any attempt to revolutionize the education and *status* of woman on the assumption of an imaginary sexual equality, would be at variance with the normal order of things, and as Dr. Broca says, induce 'a protuberance in the evolution of races...out upon this selfish whimpering of masculine women and feminine men, who, in ignorance or willful blindness, ascribe the obvious results of physical distinctions, the eternal fiat of Nature, to the tyranny of man! (Allan, 1869, p. ccxiii)

The natural state of the world, according to scientists, was inequality—and in a society structured around nature, inequality based in science was both permanent and optimal.

The exclusion of diverse viewpoints from scientific institutions further exacerbated the inequality perpetuated by scientific knowledge. White, European men dominated academic science, and "increasingly tightened the reins on what was recognized as legitimate knowledge and who could produce that knowledge." (Schiebinger, 2004, p. 142) In 1763, France passed an ordinance preventing any man with African origins (slave or free) from practicing medicine, and woman were similarly bared from scientific institutions (Schiebinger, 2004, p. 142). As Anne Fausto-Sterling, Helen Longino, and Londa Schiebinger have argued, the identity of the scientist can shape the knowledge they create, from influencing what kinds of questions they ask to how they interpret the data they generate. Despite being "objects of intense study" by scientists, women and Africans were "excluded from scientific institutions…[and] could say little about their own nature." (Fausto-Sterling, 2000, p. 200) Without the ability to participate in scientific or political discourse, minorities had little recourse to correct the destructive stereotypes and knowledge used to exclude them from the sciences and politics.

Using science to support the unequal distribution of rights in society while denying the influence of values and limiting diversity in the field facilitated a dangerous cycle of oppression: social biases shaped scientific knowledge, which was then used to reinforce and strengthen those very biases. The effects of this cycle can be traced from the founding of democracy, in the studies of skeletons and brains, to the arguments surrounding female reproduction and education, to the current debates about sex differences in the brain.

The Anatomy of Difference

In the late eighteenth and early nineteenth centuries, the overarching scientific principle of nature as a hierarchy and the political need to discover a natural basis for inequality led scientists to increasingly focus their studies on anatomical sex and race differences. While theories about natural differences had existed and been used to justify discrimination long before this time, the rise of democracy presented a new political "challenge" of justifying subordination that resulted in the furthered "intense scrutiny of human bodies." Unconscious biases worked in tandem with this drive for difference, resulting in "radical misreadings" of anatomy that scholars have now recognize as "scientific racism and sexism." (Schiebinger, 2004, p. 144) At the time, however, the dominant philosophical view of science and the exclusion of diverse viewpoints from scientific institutions led to this knowledge being accepted as objective. Since this knowledge was accepted as objective, it was used to justify the unequal distribution of rights.

As historian Londa Schiebinger shows in *The Mind Has No Sex*, the inherent assumption in research on biological difference was that the European male represented a "standard of excellence." Despite this value-laden assumption, scientists claimed that their work was "free from bias, reflecting only the 'cold-blooded' findings of science." (Schiebinger, 1989, p. 213) Prominent anatomist Samuel Thomas von Soemmerring expressed this view, arguing that scientists did not have to take a moral view because sexual and racial differences were "certain, definitive, and distinctive." (Soemmerring, cited in Schiebinger, 2004, p. 213) Yet the flawed depictions of African and female skeletons that he and others produced were far from objective; the same social biases that inspired this research influenced its outcome. At the time, however, the faith in objectivity and desire to maintain social hierarchies prevailed: flawed anatomical portrayals were not only widely accepted, but also used to justify disenfranchisement and oppression based on race and sex.

The most frequent subject of sexual and racial anatomical difference in this period was the skeleton. Scientists believed that finding "differences…in the bones of the body" would show that differences "permeated the entire body of the organism." (Schiebinger, 2004, p. 141) Unexpectedly, the most "sexist" and most widely accepted portrayal of a female skeleton came from a woman, French aristocrat Marie-Genevieve-Charlotte Thiroux d'Arconville. Her aristocratic status allowed her to pursue scientific interests, albeit in a limited fashion; d'Arconville's drawings were published without her name and attributed to Jean-J. Sue, a male scientist. Despite her gender, d'Arconville strongly believed that women in general were unsuited for intellectual thought (Schiebinger, 1989, p. 250). Her research in skeletons reflected this belief: she "exaggerated—almost to the point of caricature—those parts of the body emerging as sites of political debate: the skull as a mark of intelligence and the pelvis as a measure of womanliness." (Schiebinger, 1989, p. 197) This representation by a female scientist shows how pervasive stereotypes of gender inequality were; even a woman did not question their accuracy.

In 1796, Samuel von Soemmerring produced a skeleton with more accurate proportions than d'Arconville's. These proportions, however, were still not true to life, in large part because Soemmerring's ideals of masculinity and femininity influenced his methods. Despite his desire to "approach nature as nearly as possible," Soemmerring described his choice in model as follows:

> Above all I was anxious to provide for myself the body of a woman that was suitable not only because of her youth and aptitude for procreation, but also because of the harmony of her limbs, beauty, and elegance, of the kind that the ancients used to ascribe to Venus. (Soemmerring, cited in Schiebinger, 2000, p. 38)

Soemmerring explicitly selected a model based on pre-existing gender norms and used it to draw a skeleton that he claimed was "definitive proof" of female inferiority (Schiebinger, 1989, p. 223). Anatomists,

however, so strongly believed in the existence of sex differences that they widely criticized his version and rejected it in favor of d'Arconville's. Ultimately, values and gender stereotypes dictated social acceptance of scientific theory, which itself was shaped by these very ideas.

The same process occurred for skeletons of different races. As Nancy Tuana writes in *The Less Noble Sex*, "Since the European races were viewed as the most evolutionarily advanced, much scientific energy was devoted to documenting the superiority of the male in these races." (Tuana, 1993, p. 40) Again, this energy was directed primarily towards the skeleton. In line with the racial hierarchies of the time, Petrus Camper suggested that "skull measurements could illuminate the natural relationships among apes, Negroes, and Europeans." (Camper, 1794, p. 50) Anatomists measured the degree of the forward jutting of the jaw as 42-50 for apes, 70 for "Negros" and "Mongolians", and 80 for "European males" (Camper, 1794, p. 42). Since European males were the standard of excellence, anatomists reasoned that a greater angle must signify superiority. This led to the creation of a "hierarchy of skulls passing progressively from lowliest ape and Negro to the loftiest Greek." (Schiebinger, 2004, p. 150) Some anatomists went so far as to claim, as Soemmerring did, that the Negro was "nearer to the ape" than the white man (Schiebinger, 1989, p. 213). Social biases not only shaped the observation of data, but also resulted in perceived differences being used to justify inequality.

This scientific "proof" of difference was used to justify the continued subordination of certain groups in democracies. The "body—seemingly stable, ahistorical, and sexed—became the epistemic foundation for prescriptive claims about social divisions of labor, power, and privilege." (Daston, 2004, p. 357) Theorists "accepted [scientific] beliefs as axioms" upon which they constructed structures of inequality, from limiting white women's activities to the private sphere to disenfranchising and enslaving black men and women (Tuana, 1993, p. 162). In 1789, the newly formed French government denied women political rights, arguing that they did not possess "the moral and physical strength required for the exercise of…the rights [of citizenship]." (France, 1789 cited in Levy, 1979, p. 215) This proclamation rested on the basis of scientific evidence, as demonstrated by the clear parallels between political documents and anatomical studies:

> The male body expresses positive strength…sharpening male understanding and independence, and equipping men for life in government, in the arts and sciences. The female body expresses womanly softness and feeling…The roomy pelvis determines women for motherhood…The weak, soft limbs and delicate skin are witnesses of woman's narrower sphere of activity, of home-boniness, and peaceful family life. (Sachs, 1830, cited in Schiebinger, 1989, p. 214)

Similar rhetoric was used to justify the institution of slavery. Both the Dutch and French "refused political rights to any person with the slightest trace of black blood," believing they were incapable of the thought and

reasoning required in democracy (Schiebinger, 2004, p. 174). This argument manifested in American politics as well. Presenting to the Literary and Philosophical Society of South Carolina, French lawyer J.H. Guenebault drew on Dr. Julien-Joseph Virey's *History of Mankind* to convince attendees that the "character [of Negroes] being more indolent than active, they seem to be more fitted *to be ruled, than to govern…*they *were rather born for submission, than domination* [emphasis added]." (Guenebault, 1837, p. 39) Theorists and scientists alike dismissed calls for full equality by casting the use of the "name of liberty…and equality [to] levelling" as a "sad mistake of the natural order of things." In the natural world and the social order they constructed, women would remain "subjected to man, the slave to his master." (Guenebault, 1837, p. V)

Measuring the Mind: Sex Differences in the Brain

Having proven that difference permeated the bones of organisms, scientists honed their focus to another particularly politically compelling site of study: the brain. Differences in the brain, hailed as the site of human reasoning and intellect, would not only validate this exclusion from citizenship but also justify the continuation of white male control over women and Africans through institutions like slavery and coverture. In studying the brain, scientists moved beyond the simple methods of observation they had used to study skeletons and began experimenting along with hypothesizing using the scientific process. These new methodologies, despite being hailed as objective, were "not sufficient to exclude values from [scientific] inquiry." (Longino, 1990, p. 216) Instead, "contextual values and ideology [were] incorporated" into science through "background assumptions" that influenced not only which questions scientists asked, but also the ways in which they designed experimental procedures, interpreted data, and formed theories (Longino, 1990, p. 86).

Buying into the age-old notion that bigger is better, scientists hypothesized that white male brains were larger than female and Negro brains. This assumption influenced their selection of methods, experimental design, and interpretation of data, ultimately resulting in racist and sexist scientific theories. Bias regarding the inferiority of women was so strong that in studying brain size, scientists only used methods which would produce the desired results—any criteria for evaluation that "gave an advantage to women in terms of intellectual ability" was rejected as "erroneous" (Tuana, 1993, p. 73). As a result, calculating brain size as a proportion of body weight to brain weight, which gave women a comparative advantage, was deemed an invalid measurement. According to one doctor, this invalidity was a "relief" for which "the male sex owed its thanks." (Sutherland, 1900, p. 802-810)

Gender biases influenced not only the choice of methodology, but also the experimental procedure and results. Contemporary studies show an 8% difference in absolute size between male and female brains; early nineteenth century studies recorded differences of 12-14% (Tuana, 1993,

p. 68). This difference was in large part due to experimental manipulation. A central component of the scientific method is the practice of selecting what data to keep and what to discard as outliers; human error and experimental malfunction makes this necessary to generate reliable data and theories. However, determining what data to keep requires making value judgments based on background assumptions (Longino, 1990, p. 86). For many nineteenth century scientists, these background assumptions included a strong belief in female inferiority that resulted in inaccurate brain weight data.

During an experiment, if a scientist measured an "unusually large female brain," he would put it back in preservation fluid and repeat the measurement. This fluid, however, caused brain shrinkage; the longer a specimen was stored, the lighter it became. Despite being aware of this phenomenon, scientists "corrected" the original, heavier calculation with the new data. The expectation of difference was so strong that it led scientists to discard seemingly contradictory data and produce results that fit their assumptions (Tuana, 1993, p. 70).

The dominant belief in female inferiority also dictated how these results were interpreted; the smaller size of the female brain was taken as proof of the limited intellectual capacity of women. Writings by Gustave Le Bon, the founder of social psychology, demonstrate this reasoning clearly:

> The lesser size of the female skull, principally in the superior races, is accompanied by a corresponding intellectual inferiority...This inferiority is too evident to be debated for a moment, and one can hardly even dispute the degree of this inferiority. All the psychologists who have studied the intelligence of women…recognize that they represent the most inferior forms of human evolution and are much closer to children and savages than to civilized adult males. (Le Bon, 1879, cited in Tuana, 1993, p. 42)

Similar biases were incorporated into racial studies of the brain. The presumption of black inferiority led to various theories about the smaller size of "Negro" brains, many of which drew on comparisons between blacks and animals. Analogical reasoning, like data selection, is a key component of the scientific method. Practical limits prevent scientists from observing every aspect of the world, so they draw on known features to make inferences about similar unknowns ("Analogy and Analogical Reasoning," 2013). Much of modern scientific experimentation relies on analogical reasoning; for example, pharmacological studies are performed on lab rats before humans on the basis that their anatomy and behavior is similar enough to provide an accurate measure of a drug's safety and effectiveness. This process, while practically useful and often empirically adequate, relies on human judgment and therefore has the potential to incorporate biases. In drawing comparisons, scientists rely on background assumptions about what similarities and differences exist, which are important, and whether the data is sufficient to serve as evidence.

To reach conclusions about racial differences in the brain, scientists developed analogic comparisons between blacks and animals. Driven by pre-existing prejudices about the inferiority of other races, and the increasing political need to justify slavery in the face of criticism, these comparisons drew on presumed similarities in behavior, intellect, and appearance to support biased conclusions about the brain structure and intellect of black men. The anatomical studies of eighteenth-century scientists provided the foundation for this work, establishing flawed beliefs about black skeletons including that their bones were harder and their skulls narrower due to the decreased angle of the jaw (Camper, 1794, p. 42). Nineteenth century scientists reasoned that these differences lowered the "internal capacity" of the black skull, preventing the "perfect development of the brain" and resulting in a "poor intellect, congenial to that of brutes." (Guenebault, 1837, p. 25) This analogy permeated much scientific literature of the time, as displayed in Guenebault's description of the Hottentot:

> No human being can be more stupid, brutal, and dull than [the Hottentot] is. If we compare him with the most perfect monkeys, the distance between them will appear comparatively trifling, and he is next to them in his organization; witness the grinning projecting mouth of the Hottentot, the small size of the internal volume of brain…and the flat position of his soles of his feet as in monkeys. The Hottentot feels a difficulty in speaking; his voice is like the clacking of a turkey, and presents an evident affinity to the Orang-Outang, which has a kind of hollow clacking. (Guenebault, 1837, p. 101)

By drawing parallels between blacks and monkeys, scientists cast the "Negro" as the "reverse of the European," closer to the monkey than the man (Guenebault, 1837, p. 3). They used this comparison to "infer by analogy," generating flawed theories about the inferior intellectual capacity of the "Negro" based on the intellectual capacity of animals (Soemmerring, selections, cited in Guenebault, 1837, p. 70).

Just as scientific beliefs about skeletons were applied to exclude minorities from participating in democracies, beliefs about brains and intellect were used to maintain systems of inequality. Theorists and scientists alike argued that woman's inferior intellectual capability "precluded her ability to govern herself or society wisely," and as a result, "a woman must always be under a man's control." (Tuana, 1993, p. xi) This belief manifested itself in the law; through the late-nineteenth century, coverture doctrines in the U.S. and England denied married women rights, including owning property, controlling earnings, and entering into contracts; instead, legal control was granted to their husbands. It also reinforced the exclusion of women from civil rights by supporting arguments like the one sociologist Herbert Spencer made in an 1873 edition of *Popular Science Monthly*: that women were incapable of the "power of abstract reasoning and that most abstract of the emotions, the sentiment of justice." (Spencer, 1873)

Similar arguments were made for the continuation of slavery based on scientific evidence of difference. Throughout his treatise on the natural

history of Negroes, American theorist J.H. Guenebualt argues that the natural intellectual inferiority of Negroes justifies slavery on moral grounds:

> It is that from [the Negro's] infancy up to his manhood, his intellectual faculties, being not strong enough, or matured by experience, it would be imprudent, immoral, I may say, to abandon to himself, without any control or restraint, a being incapable of governing his passions. Who sees there an injustice? (Guenebault, 1837, p. 39)

By extending the study of difference from the body to the brain, nineteenth century scientific knowledge served to both justify the continued exclusion of minorities from civil rights and maintain systems of subjugation including coverture and slavery. This knowledge, however, was shaped by the social biases that drove these inequalities to begin with, and both perpetuated and reinforced systems of oppression.

The Consequences of Knowledge: Education and Reproduction

The mid-nineteenth century was marked by the rise of first wave feminism in the United States. Women (mostly white and upper class) organized to fight against their exclusion from the public realm, pushing for suffrage, equal access to education, and legal independence. This movement was formalized at the Seneca Falls Convention of 1848. In their Declaration of Sentiments, attendees attempted to fight science with science and reclaim the natural rights argument that white men had denied them:

> We hold these truths to be self-evident; that all men and women are created equal; that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness; that to secure these rights governments are instituted, deriving their just powers from the consent of the governed. (Seneca Falls Convention, 1848)

According to these first wave feminists, the "divinely implanted principles of human nature" were proof of female equality rather than inferiority (Seneca Falls Convention, 1848). Powerful arguments for equality strengthened the feminist movement in the late nineteenth century, including examples of women succeeding in academic pursuits and emerging scientific evidence that anatomical sex differences had been exaggerated. In threatening to undermine the established social order, however, this movement faced significant backlash. As the social context surrounding the debate changed, and the stakes attached to it increased, the scientific community adapted. Scientists shifted their attention to studies of the reproductive system, generating essentialist theories of biological difference that emphasized women's maternal capabilities at the cost of their intellect. This type of argument is demonstrated in the late nineteenth century writings of Austrian theorist Otto Weiniger:

> To put it bluntly, woman does not possess sexual organs; her sexual organs possess woman. [Woman is] completely occupied and content with sexual matters… [man is]

> interested in much else, in war and sport, in social affairs and feasting, in philosophy and science, in religion and art. (Weininger, 1903, p. 92)

In appealing to nature and emphasizing unchangeable biological differences, these Weiniger's and similar theories acted as powerful arguments against feminist demands of social equality—particularly those regarding equal access to education.

In the late nineteenth century, the dominant metaphysical view of the human body was as a closed system with finite energy. Based on Hermann von Helmholtz's theory of conservation of thermodynamic energy and developed by Herbert Spencer, this theory proposed that for the body to function, each organ (like components of a thermodynamic system) required the "expenditure of energy. Any undue demand placed upon one organ [would] inevitably deplete some other." (Weininger, 1903, p. 89) Based on this theory, physician J. McGrigor Allan reasoned that "great physical and mental exertion cannot go on at the same time in the same organism" (Allan, 1869, p. cc). According to Allan and other predominant scientists of the time, women were especially susceptible to this phenomenon because of their complex reproductive systems. Educating women (i.e. developing the female brain at the expense of the reproductive organs) was perceived to be the source of widespread infertility and illness.

During the height of the demand for women's admission into universities, Harvard requested a study by medical school faculty member Edward Clarke to use in deciding whether to annex the women's college Radcliffe. The resulting work, *Sex in Education, or a Fair Chance for the Girls*, provides insight into the shift in scientific focus and theory as influenced by social context. Clarke argued against coeducation for women on the basis that higher education would result in permanent damage to a women's reproductive organs and character. While influenced by the same bias and values as the preceding anatomical works, this conclusion was justified using fundamentally different arguments and claims.

Clarke warned against the tendency to mistake "difference of organization and function for difference of position in the scale of being" (Clarke, 1884, p. 15). He viewed the "relation of the sexes [as] one of equality, not of better and worse, or of higher and lower." However, while Clarke emphasized sexual complementarity rather than superiority, he endorsed the biological essentialist view of the sexes, promoting separate spheres for men and women: "[The sexes] are different, widely different from each other, and so different that each can do, in certain directions, what the other cannot…each shall be perfect in its kind, and not be hindered in its best work" (Clarke, 1884, p. 13-15).

According to Clarke, women's reproductive organs were the source of this difference:

> Woman, in the interest of the race, is dowered with a set of organs peculiar to herself, whose complexity, delicacy, sympathies, and force are among the marvels of creation. If properly nurtured and cared for, they are a source of strength and power to her. If neglected and mismanaged, they retaliate upon their possessor with weakness and disease, as well of the mind as of the body. (Clarke, 1884, p. 33)[2]

Locating difference in the reproductive organs provided support to the theory of separate spheres. Women's primary role was reproduction; entering into the male realm of education was wrong because it not only threatened social norms, but also violated the destiny prescribed to women by nature.

This argument was reinforced further by popular medical beliefs about menstruation. In his 1869 paper *On the Real Differences in the Minds of Men and Women,* Dr. J. McGrigor Allan similarly located woman's difference in their reproductive organs. He went further to argue that menstruation permanently prevented women from achieving educational and social equality:

> In intellectual labour, man has surpassed, does now, and always will surpass woman, for the obvious reason that nature does not periodically interrupt his thought and application...Women are unwell…on the average two days in the month, or say one month in the year. At such times, women are unfit for any great mental or physical labour. They suffer under a languor and depression which disqualify them for thought or action, and render it extremely doubtful how far they can be considered responsible beings while the crisis lasts. Much of the inconsequent conduct of women, their petulance, caprice, and irritability, may be traced directly to this cause. It is not improbable that instances of feminine cruelty (which startle us as so inconsistent with the normal gentleness of the sex) are attributable to mental excitement caused by this periodical illness. (Allan, 1869, p. cxcix)

Both Clarke and Allan used their scientific conclusions to prescribe fixes to social problems. The proof of intellectual difference they provided undermined the feminist call for equal education by rendering it both damaging and futile. Education, while perhaps feasible if only considering the anatomy of the brain, harmed woman's reproductive ability, health, and character. In doing so, it undermined her true purpose of reproduction as designated by nature:

> Nature has declared, in language which cannot deceive, that woman's chief mission is maternity…in woman, nature has produced a being whose principal functions are evidently intended to be love, leading to gestation, parturition, and nutrition. The whole form of woman, carefully and judiciously considered, testifies to the grand purpose of her existence. Her exquisitely perfect organisation is fashioned to aid directly and indirectly, the function of reproduction… in spite of all the nonsense uttered and written on the subject, woman's mission is maternity. (Allan, 1869, p. ccvi)

[2] In addition to education, Dr. Clarke blamed women's eating habits for their weakness and disease: "We live in the zone of perpetual pie and doughnut; and our girls revel in those unassimilable abominations." (Clarke, 1884, p. 23)

Even if education didn't violate the designs of nature, Allan argued, the very existence of female menstruation made the exercise futile: "nature disables the whole sex, single as well as married, from competing on equal terms with man." (Allan, 1869, p. cci)

Social and educational channels were not the only way in which this science infiltrated society; just as the scientific studies of anatomy and the brain were incorporated into legal and political institutions, so too was the new science of reproduction and education. Its influence reached even the U.S. Supreme Court, as the decision in the 1872 case *Bradwell v. State of Illinois* demonstrates. Myra Bradwell, a fully qualified and educated citizen, had appealed to the State of Illinois for a law license. She was denied on the basis of her sex and marital status—as a married woman she was bound first to her husband, and would not be able to enter into contracts independently with clients as the standards of the legal profession demanded. The Supreme Court upheld this decision, and in doing so, appealed to the scientific arguments about woman's capacity for intellectual activity and her maternal destiny.

Justice Bradley cited these arguments in his decision, arguing that "the civil law, as well as nature herself [sic], has always recognized a wide difference in the respective spheres and destinies of man and woman…[and] the natural and proper timidity and delicacy which belongs to the female sex evidently unfits it" for intellectual pursuits (Bradley, 1872). According to Bradley, a woman pursuing a career would undermine the traditional family: "The harmony, not to say identity, of interest and views which belong, or should belong, to the family institution is repugnant to the idea of woman adopting a distinct and independent career from that of her husband." (Bradley, 1872) This challenge to the family was so dangerous because women's roles as mothers and wives and the importance of them occupying "different spheres of action" was an "axiomatic truth" of nature. The difference in natural mental capability and the consequences of divergence from traditional gender roles meant that it "belonged to men to make, apply, and execute the laws." (Bradley, 1872)

Not only did the Court uphold the decision to bar women from the legal profession, but it once again asserted the moral authority of nature. Bradley asserted that "it is the prerogative of the legislator to prescribe regulations founded on nature, reason, and experience." Nature, as revealed by science, was accepted as the foundation upon which to structure societies and make laws:

> In view of the peculiar characteristics, destiny, and mission of woman, it is within the province of the legislature to ordain what offices, positions, and callings shall be filled and discharged by men, and shall receive the benefit of those energies and responsibilities, and that decision and firmness which are presumed to predominate in the sterner sex. (Bradley, 1872)

To elevate nature to this position of moral authority implies a belief in its status as unchanging and unbiased. Yet as Anne Fausto-Sterling argues in

Sexing the Body, in this case and many others, pre-existing "conceptions of the nature of gender difference shape, even as they reflect, the ways we structure our social system and polity." (Fausto-Sterling, 2000, p. 45) The study of education and maternity shows that in practice, research priorities are not objectively set, but shaped by social needs—as these needs shifted, so too did the focus of scientific study and the knowledge created. As a result, distributing rights and opportunities based on this knowledge ultimately reinforces existing biases and inequalities.

Fighting Science with Science: Countercurrents and Activism

In addition to providing insight into the ways in which social context influences research directions, the study of maternity and education also highlights a common trend in resistance to biased knowledge. Scientists and lawmakers did not issue their declarations about human nature unopposed. Throughout history, dissenting voices attempted to argue against those claims by fighting science with science. In doing so, however, they ultimately reinforced the view of science as a moral authority, and as such, their claims were suppressed by those situated within scientific institutions.

Starting in the eighteenth century, proponents of equal rights opposed the ideals put forth by scientists regarding anatomical differences and their consequences for social status. They argued against the complementarian portrayals of female skeletons that emphasized women's role as mothers, instead proposing an egalitarian view of the body. Theorists like Mary Wollstonecraft and Olympe de Gouge claimed that women were just as naturally suited for public life as men. This argument "grounded [the] call for equal rights in nature" in an attempt to shift views within the framework of science as a moral authority (Schiebinger, 1989, p. 227). Yet insofar as science was a "privileged mode of discourse," proponents of equality simply did not have the "authority" or the "privileged access to truth" that scientists did (Schiebinger, 1989, p. 228-9). Excluded from scientific institutions and confronted with overwhelming evidence of physical difference, they were unable to ground support for their arguments. While these efforts laid the foundation for activism in the future, by attempting to work within the bounds of scientific authority rather than challenging the belief that science should ground morality this criticism failed to change the dominant public views of the sex and the body.

As the scientific focus moved to craniotomy in the nineteenth century, proponents of equality continued attempting to fight science with science, and continued to be thwarted by scientific authorities. The most frequent strategy proponents utilized was to highlight studies of "exceptional women or blacks" who had succeeded in universities (Fausto-Sterling, 2000, 190). In theory, the success of these individuals was meant to undermine the dominant view that members of the groups they represented were incapable of intellectual thought. In practice, however, these

experiments were easily explained away by scientists and theorists. One such example was the case of Francis Williams, a Jamaican man sent to school at Cambridge University. Despite Williams' clear academic success, the scientific community concluded that the experiment was, on a whole, a failure. They argued that too "much learning made [Williams] mad," and took this supposed madness as clear proof that "every African head is not adapted by nature to such profound contemplations." (Long, 1774, p. 476) Despite at first appearing to provide a way to challenge dominant scientific beliefs, case studies were explained away by scientists. Their subjects were denied entry to scientific institutions, and proponents of equality did not have the authority to successfully refute these explanations.

In the late nineteenth and early twentieth centuries, first- and second-wave feminists took up this fight. The arguments they put forth in support of gender equality followed the trend of activists before them, relying on case studies of successful women, calls for natural rights, and attempts to undermine arguments for difference. Like those of their predecessors, however, arguments made by feminists were rebuked by members of scientific institutions. In their texts on maternity and education, doctors J. McGrigor Allan and James Clarke drew on the authority they had as scientists to undermine the validity of feminist arguments. Allan charged "advocates of sexual equality" with "[making] light of, or utterly [ignoring], woman's mission of maternity," and pre-empted rebuttals by saying that woman's education would only be defensible if "sex [was] abolished altogether, and some more delicate way of perpetuating the human species invented" (Allan, 1869, p. ccxiii). Clarke, appealing to the affluent white women dominating the feminist movement at the time, went so far as to argue that the future of the white race was at stake: "A training that yields this result [of infertility] is neither fair to the girls nor to the race," for "members of the poor, uneducated, and immigrant classes would soon outnumber the middle class." (Clarke, 1884, p. 113; 77) These arguments were not only used by Harvard and other institutions to deny women entry, but also permeated mainstream society—demand for Clarke's book was so high that he published seventeen editions over the course of two years (Tuana, 1993, p. 76). Yet again, advocates attempting to fight science with science struggled to gain the authority and support granted to practitioners of science.

Civil rights advocates in the twentieth century employed similar tactics of fighting science with science, with varying results. In his 1916 book *American Civilization and the Negro*, black physician C.V. Roman attempted to reclaim science as a tool for equality by disqualifying biased knowledge from the realm of science. He portrayed ethnological claims about black inferiority, including the analogical comparisons of African-Americans to animals and the claims about their resulting lack of intelligence, as "contrary alike to science, common sense, and daily experience." (Roman, 1916, p. 5) Real science, Roman argued, was the

"enemy of prejudice" and "[knew] no innately superior race." (Roman, 1916, p. 21) Roman's argument rests on the assumption that true, unbiased science exists, and endorses the idea that this science can and should act as the moral authority in society. This assumption, however, proved flawed in both theory and practice.

While science has the potential to be more or less biased, and the potential to be influenced by values of equality rather than those of discrimination, the more widespread process through which scientific knowledge is accepted and integrated into society limits its use in practice. Theories are neither generated nor accepted in a vacuum; those in positions of power tend to favor the approaches that reinforce their existing biases, and support their continued assertion of privilege. These selection processes, as historian Nancy Whittier notes in regard to the feminist movement against child sexual abuse, generally result in discriminatory theories and knowledge gaining traction over those that undermine power structures (Whitter, 2009, p. 11). The failure of Roman's theories of racial equality, despite their being more accurate than the earlier ethnological claims, to gain public acceptance was one such manifestation of this trend.

A decade after Roman's book was published, Walter White, head of the NAACP, continued the fight against science with science. White identified scientific racism—particularly the "theories of racial superiority and inferiority based upon faulty or insufficient scientific evidence"—as a precipitator of lynch violence (White, 1929, p. viiix). Instead of taking on the daunting task of questioning the logic behind this use of science (i.e., regardless of what science says, lynching is both immoral and illegal), White began a campaign to combat racial violence by debunking the central claims of scientific racism (Stein, 2015, p. 261). He enlisted the help of prominent white scientists and was able to galvanize support by capitalizing on their authority and influence, showing that theories of black inferiority were under attack not just by activists but also by "scientists and scholars worthy of the name." (White, 1929, p. 114-5) As historian Melissa Stein argues in *Measuring Manhood,* while this approach was pragmatic and likely necessary in face of more "immediate racial concerns that were, quite literally, a matter of life and death," it had its consequences.

In "dismantling the master's house using the master's tools…White lent a certain degree of legitimacy to the very science he set out to undermine." (Stein, 2015, p. 270) He implied that the problem was not that "racial science was…inherently flawed" but that it should simply be done better. Yet White could not escape the reality that much of this science, "even at its most sympathetic to the black race, was premised on innate biological difference between the races." (Stein, p. 270) The scientists White partnered with, while privately warning against reading too much into racial differences, continued to produce work supporting their existence. White was able to strip theories of scientific racism of

"some of [their] power and legitimacy;" however, in working within the boundaries of the current scientific paradigm, he ultimately "lent a certain degree of legitimacy" to the very science he was fighting.

Proponents of equality have been fighting racist and sexist violence for as long as it has existed, and the value they provided to society cannot and should not be disregarded. In attempting to undermine and replace biased knowledge before addressing the more widespread inequalities that would preempt public acceptance of these theories, activists often strengthened the authority of the very scientific institutions that produced it. While their efforts yielded varying levels of success and helped change untenable social conditions, fighting within the boundaries of science and basing arguments for equality on evidence against biological difference ultimately reinforced the authority of science in grounding morality. Over time, this facilitated the creation of a dangerous paradigm that holds today, in which scientific evidence for difference threatens equal access and opportunity.

Raising the Stakes: Sex and the Brain

Throughout the history, differences between sexes and races have been exaggerated and used to justify continued structures of social and political subordination. It is easy to look back on this history and identify where the science went wrong—today, the ideas that brain weight determines intelligence and that education limits reproductive capabilities would be viewed as laughable. It is far more difficult to examine the current state of science—in which the search for biological difference has not disappeared but intensified—and identify what theories people will look back on incredulously a century from now. For one, there may not even be any such theories—we cannot infer that science today is wrong simply because it has been in the past. For another, as our technology and methods have improved, so too has our ability to accurately detect previously imperceptible biological differences.

Recent insights into biological difference have proven invaluable in attempts to improve human welfare, from allowing researchers to develop targeted drugs to facilitating the creation of effective educational programs and social interventions. Yet when taken in the broader social context in which biological sameness continues to be conflated with political equality by both opponents and proponents of equality, this research has also threatened the rights and opportunities afforded to different groups. As a consequence, both science and society have suffered—the clear and imminent social consequences of theories have prevented the scientific community from striving for objectivity or reaching consensus in certain fields, and gains made towards social equality based on theories of sameness are now being threatened by the emergence of credible scientific evidence for difference.

In the mid-twentieth century, scientists had questioned the existence of sex differences in the brain. Dismissing eighteenth and nineteenth

theories as biased and outdated, they built on the work of early twentieth-century reproductive biologists to claim that reproductive organs, not the brain, were the source of difference between males and females. As neuroscientist Margaret McCarthy wrote, the predominant view of the time was simply that "males behave like males because they are bigger and have a penis, full stop." (McCarthy, 2016) The general consensus in the 1960s and 1970s was that any neurological sex differences would be "small, subtle, and limited in scope." If these differences did in fact exist, they were a result of socialization—not biology.

In the 1990s, however, both social context and technological advances facilitated a shift in scientific theory. The new third wave feminist movement pushed for a radical re-conception of gender from a binary to a continuum and brought issues of gender identity and sexuality into the public sphere. With this movement, however, came significant backlash against gender equality and a conservative movement pushing to restore traditional gender roles. At the same time, advances in technology such as the invention of fMRI gave scientists unprecedented insight into the human brain. This insight, combined with the renewed need to justify traditional views of gender in the face of radical feminist demands, led scientists to return to a familiar site of study: the brain.

As a result of recent investigations, the scientific community has concluded that "small but real sex differences" in the brain exist (Jordan-Young, 2011, p. 52). Scans of adolescent and adult brains show differences between males and females; males tend to have stronger connections within cerebral hemispheres, where logical thinking occurs, and females have stronger connections between hemispheres, where intuitive thinking occurs (Ingalhalikar et al., 2013, p. 824). There is still disagreement, however, on the extent and nature of these differences. Some scientists say that the brain can be viewed as "sexually dimorphic" (either "female" or "male"). Others argue that it must be understood as a "mosaic" of features, each of which may be more common in one gender but overlap in a way that prevents a distinct categorization—a theory supported by the fact that even a neurologist cannot accurately sort or "sex" a human brain as male or female by simply examining or scanning it (Joel et al., 2015; Jordan-Young, 2011). Scientists also disagree on the effect of this difference; though the theory that sex pre-determines ability in certain fields has been thoroughly debunked, it has been replaced with an equally controversial theory that attributes gender inequality to sex-based differences in preferences and interests—a theory that is often drawn upon to explain the lack of women in analytical fields, such as science and engineering.

The issue drawing the most controversy, however, is the cause of these differences. Scientists subscribe to one of two predominant causal models: 1) the linear hormonal model (the "nature" argument), which claims that sex differences in behavior and interests result from pre-natal hormones and relies on the existence of a binary system of sex, or 2) the

socio-cognitive model (the interactionist or "nurture" argument), which proposes that the brain is "plastic," and "changes as a function of different experiences," both social and biological, and any evidence of difference cannot be traced back to hormones alone (Longino, 1990, p. 135, 158). These models are used to explain any observed differences in brain structure and behavior—i.e., if men are found to perform better on a math test than women, the linear hormonal model would explain it as a result of differing exposure to testosterone in the womb causing a natural inclination towards mathematics and the development of skills in that field, while the socio-cognitive model would attribute it to the social expectations and norms that shape the brain.

Given our tendency to take natural differences and use them to both justify and expand the unequal distribution of rights and resources, both of these models have significant social implications. As scientist and historian Rebecca Jordan-Young notes, even "before the research leaves the pages of scientific journals, hormones are directly linked to career choices and chances, education, the division of labor in families, and the 'drive' to be a leader versus a 'nurturer'" (Jordan-Young, 2011, p. 198). Under this paradigm, in selecting a theory, scientists are also taking a stand on social policy.

The linear-hormonal model implies that calls for gender equality are futile. Linear hormonalists explain women's underrepresentation in analytical fields such as science and engineering as a result of lower exposure to testosterone during fetal development, which decreases their natural inclination towards these fields and leads them to self-select out. Ultimately, linear hormonalists argue that differences in natural preferences, not social barriers, cause inequality. Head of the American Psychological Association Roy Baumeister outlined this argument in his 2007 address to the group:

> When you look at what men and women want, what they like, there are genuine differences. Maybe women can do math and science perfectly well but they just don't like to. After all, most men don't like math either! Of the small minority of people who do like math, there are probably more men than women…and by the same logic, I suspect most men could learn to change diapers and vacuum under the sofa perfectly well too, and if men don't do those things, it's because they don't want to or don't like to, not because they are constitutionally unable (much as they may occasionally pretend otherwise!). (Baumeister, 2007)

Despite the fact that, as Jordan-Young notes, "we'd be hard-pressed to find many women who *like* changing diapers or vacuuming under sofas, either," this explanation is frequently utilized by scientists and academics both in research journals and public addresses—most famously, when Larry Summers, president of Harvard University, attributed the lack of women in engineering in a 2005 address to "taste differences" and "issues of intrinsic aptitude" rather than social barriers (Summers, 2005).

In deeming underrepresentation natural and therefore inevitable, linear-hormonalists take a social stand against interventions for gender

equality. As Jordan-Young explains, "claims about innate sex-type interests are central to the way 'male brain' and 'female brain' arguments are built in relation to important policy issues...some argue that parity should be dropped altogether as a goal, because they interpret brain organization research to show that men and women 'self-select' into occupations based on interests." (Jordan-Young, 2011, p. 107) If women's lack of representation in science and engineering is a result of natural difference in interest, not social barriers, then there is no obligation to support interventions to overcome it. Furthermore, any such interventions would be futile; it is pointless to "develop a social policy calling for equal representation of men and women in fields such as engineering and physics [because] you can't, after all, squeeze blood out of a stone." (Fausto-Sterling, 2000, p. 118)

Many linear hormonalists (like the anatomists and craniologists of the eighteenth and nineteenth century) have incorporated prescriptive claims to this effect in their work. In a 2000 study on the correlation between prenatal testosterone levels and gendered behavior, North Carolina University sociologist J. Richard Udry found that "males and females have different and biologically influenced behavioral predispositions." From this, he concluded that "if [societies] depart too far from the underlying sex-dimorphism of biological predispositions, they will generate social malaise and social pressures to drift back toward closer alignment with biology," and recommended that traditional gender roles be maintained to avoid this need (Libry, 2000, p. 454). Reproductive biologist R.V. Short concluded his work on sex determination and differentiation with this bold claim: "physically speaking, there is not justification for believing in the equality of the sexes; *vive la difference!*" (Short, 1979, p. 70) In explicitly embracing the social consequences of their work and taking the existence of difference as justification of inequality, these scientists reinforced the long-standing paradigm in which biology is destiny and nature is the moral authority.

On the other side of the debate, socio-cognitivists argue for an interactionist view of difference that supports social interventions for gender equality. They view behavior and interests as a result of interaction between the social environment and the brain, as "initial propensities are reinforced by social learning, and gender-bifurcated reinforcement in turn amplifies the original differences"—a process which creates "a literal incorporation of social gender into the physical self." (Jordan-Young, 2011, p. 201) This model incorporates the generally accepted scientific view of the plasticity of the brain; rather than developing in full and remaining static, the brain is able to "constantly change as a function of different experiences, to react differently in different contexts and respond differently to different attitudes and expectations." As Aston University cognitive neuroimaging professor Gina Rippon argues, in understanding that the brain is plastic and behavior is a result of a person's interactions with societal forces we must recognize that "biology is not destiny" and

overturn the "apparently 'fixed' nature of brain differences claimed back in the 18th century." (Bawden, 2016) Furthermore, according to socio-cognitivists, inequality is not a function of nature, but of man-made barriers. As members of a democratic society, if we accept this theory then we are obliged to remove these barriers and intervene to provide equal opportunities for all.

In a field where theory selection has high social stakes, it is nearly impossible to purge values from experimental design and data interpretation. Value-laden theories about what constitutes "male behavior" and "female behavior" dictate how an experiment is designed, and how the results are generalized to the broader population. To find evidence that hormones directly cause behavior, linear-hormonalists frequently conduct experiments in which they compare the interests of "normal" population with "outliers" (androgenized women or hypo-gonadal men) (Longino, 1990, p. 155). Making these comparisons requires researchers to "'sex-type' the interests of their subjects" as proxy-indicators for "masculinity" or "femininity" (Jordan-Young, 2011, p. 205). In most studies, researchers deem "masculine interests [to] include vigorous activity, competition for leadership, and achievement in a career, while feminine interests include self-adornment, nurturing—whether the dolls of childhood or one's own children in adulthood—and romance and marriage." (Jordan-Young, 2011, p. 205)

Generally, the findings of these studies point to the existence of an effect of pre-natal hormone exposure on the sex-typed interests identified by researchers. These findings, however, are heavily influenced by the researchers' pre-conceived notions of sex and gender. Researchers categorize traits as masculine or feminine based on background assumptions and values, and the classification system itself relies on a binary view of gender. In reality, differences between the sexes for these traits are small and vary by individual; a researcher cannot predict, for example, the sex of a subject based on only his or her aggression score. The correlations to sex only emerge when the data is aggregated, and even then, there is significant overlap between males and females (Jordan-Young, 2011, p. 98). Additionally, because each researcher brings different assumptions to the table, there is "no specific type of sex-typed interest that is consistently linked to prenatal hormone exposures by more than one research model," a phenomenon which supports the view that values are influencing experimental design and outcome (Jordan-Young, 2011, p. 228).

Socio-cognitivists reject the results of most linear-hormonal studies because of these issues and their view that the linear-hormonal theory is incompatible with arguments for social equality. They perform experiments showing the impact of social influence on behavior, arguing that traits are not inherently "male" or "female" but masculinized and feminized by society. These experiments tend to consist of extended studies on behavior and brain development over time, and take differences

to demonstrate a correlation of stereotypically sex-linked behaviors with social context (i.e. culture, education, class, and race). Socio-cognitivists interpret the presence of correlation as proof that the linear-hormonal model is insufficient to explain gender behavior. Their studies, however, are few and far between, and often have less quantitative support than linear-hormonal studies do. Additionally, while values do not shape the experimental design as strongly as they do in linear-hormonal studies, they do drive research priorities and questions, and shape data interpretation as well as theory generation. Socio-cognitivists are also similarly likely to draw social conclusions from their results; psychologists Sheri Berenbaum and Melissa Hines, for example, included an explicit warning in their work against ending efforts to "increase the participation of girls and women in science and engineering, because it is likely that other factors are also involved in the underrepresentation of girls and women in those fields" (Berenbaum and Hines, 1992). Given the clear effect of values on this research, and the tendency of socio-cognitivists to draw social conclusions from their work, many linear-hormonalists have rejected their results as groundless.

The strong influence of values on the generation of evidence, taken in conjunction with the social consequences attached to each explanation, results in scientists on both sides making decisions based primarily on non-empirical factors. The supposedly empirical evidence is value-laden, resulting in scientists with different views being unable to accept each other's data (let alone conclusions). Without commonly agreed upon empirical evidence, scientists rely on their own non-empirical values to choose which data to accept and which theory to subscribe to.

Additionally, neither theory is completely proven by the evidence taken to support it—there is a gap between data showing differences in hormone exposure and differences in behavior, and one between data showing differences in social experience and differences in behavior. For example, in studies performed by linear hormonalists, just people with different levels of pre-natal testosterone exposure display different behaviors does not automatically mean testosterone exposure causes these behaviors; that jump must be made by man and is not explained by logic alone. In *The Fate of Knowledge,* Longino argues that rather than being a result of pure empirical reasoning, this conclusion is reached based on a "background of assumptions that are neither self-evident nor logically true…[but] context-dependent." (Longino, 2001, p. 128) Ultimately, values and social context, not direct logical reasoning, inform evidentiary support and theory acceptance. Scientists who value traditional methods and explanations, and who hold conservative views of gender, are likely to support to the linear-hormonal model, while scientists who are more accepting of radical, frame-breaking thought and who support gender equality will subscribe to the socio-cognitive model.

In such a politically charged issue with little empirical evidence, the scientific community has failed to reach a consensus regarding the cause

of sex differences. Instead of debating the evidence, scientists engage in ideological and personal attacks on each other's views. Linear hormonalists attack socio-cognitivists for being "politically correct ideologues" who are "on a collision course with the findings of science and the spirit of free inquiry." (Jordan-Young, 2011, p. 1; Pinker, 2005) Socio-cognitivists accuse linear hormonalists of being sexist, narrow-minded, and simplistic in their use of sex as a "catch-all cause of any kind of difference." (Bawden, 2016) Values, not facts, are being used to justify theory acceptance, and scientists cannot agree on one set of values.

As long as theory choice regarding neurobiology and sex is dictated by non-empirical factors, the scientific community will not be able to reach consensus without first aligning on social values. Ultimately, as Anne Fausto-Sterling explains, "choosing a scientific path acceptable to most, and littering that path with agreed-upon facts, is only possible once we have achieved social and cultural peace about gender equity." (Fausto-Sterling, 2000, p. 145) Without achieving that peace, scientists will continue to reject each other's theories because the evidence supporting them is value laden and the social consequences of doing so go against their beliefs. This view does not "deny the existence of a material, verifiable nature, nor does it hold that the material—in this case the brain…—has no say in the matter." Rather, it acknowledges that values shape the way scientists see the world, and in a society where policy is structured around scientific theory, the stakes are simply too high for scientists to accept a theory that does not align with their beliefs.

The reality, however, is that such a consensus around gender equality is unlikely to occur in the near future, and if it does, it will take participation from a much larger and more diverse group than the scientific community alone. Given this fact, we seem to be at an impasse. Scientists will continue to produce value-laden and contradictory evidence. Politicians and theorists will use these single scientific studies to support whatever view they already hold. The public will rely the latest incendiary headline declaring once and for all that men and women either are or are not from different planets. And women will continue to be underrepresented in science and engineering fields. The solution is not simply to wait for something to change. Nor is it to entirely discredit the field of study—the little we understand about brain difference has already contributed to the improvement of human welfare, from scientists developing better drugs and treatments, to educators and activists designing targeted programs and interventions.

Instead, we must learn to disconnect theory acceptance from political and social implications. The social consequences of a theory are not inherent in the knowledge itself; they exist because we as a society have elevated science to a position of moral authority in which fact-based claims displace value-based ones. Accepting that sex differences exist does not require us to conclude that men and women should be treated unequally, or that one is better than the other. Even if, for example, sex

differences are innate and mean that women are less naturally interested in analytical fields, I do not believe it logically follows that we are not morally obliged to intervene to increase women's representation in these fields, or even that intervention of this type would be futile. If we value equal opportunity, we should provide a fair chance to women who do want to enter these fields (although the methods and extent of this effort can and should be debated). In addition to the ethical claim, there is also a pragmatic argument to be made—general analysis adds new perspectives to studies, and their inclusion in scientific research has been shown to result in an improved quality of findings that save time, money, and lives (Schiebinger et al., 2017).

Rather than relying solely on science to dictate the distribution of rights and resources, we should draw on ethical, moral, and practical frameworks—not only because these frameworks account for values of equality and self-determination and allow us to incorporate pragmatic considerations, but also because, as the debate surrounding sex differences in the brain shows, using science to distribute rights has prevented scientists from making progress in the field. Removing social consequences from the scientific debate would reduce the stakes, allowing scientists to debate on evidence, not values, and reach consensus on a theory to further scientific progress without ethical consequences.

Conclusion

From the anatomical research in the early stages of democracy to the current debate surrounding sex difference, proof of differences between genders and races have long been taken as proof that these groups are unequal and should be treated as such. That conclusion, however, is not an inherent feature of science itself; even if racial differences in skull size or sexual differences in brain development existed, it does not logically follow that these groups should be denied the privileges and opportunities of citizenship. We have made this leap as a result of the widespread faith in the objectivity of science, and the continued democratic framework in which biological sameness is conflated with political equality. Tracing that framework back to its origins shows that it is not a foundational necessary element of democracy; rather, as the work of early democratic theorists and the references to nature written into laws show, it was an add-on established for the explicit purpose of justifying systems of inequality and oppression that at first seemed irreconcilable with the aim of liberty for all. While we have abolished most of those systems, their legacies live on, in large part because of the continued use of science to mark certain groups as different and therefore inferior and our continued acceptance of science as the ultimate moral authority.

In order to end this cycle, we must recognize the role values play in science, from driving research priorities, to shaping each step of the scientific method, to influencing theory acceptance and consensus. Recognition alone, however, is insufficient. As long as we allow fact-

based claims to displace value-based ones, science will perpetuate inequality. As the case study of neurobiology and sex shows, even science done in the best possible way, with the best possible aims, can prove difference and have morally problematic consequences if this framework holds. Avoiding these consequences requires us to learn to insulate theory acceptance from policy creation. Scientific proof that people are different should not serve as moral justification for treating them unequally; politicians, theorists, and scientists alike should take proof into consideration alongside pragmatic considerations and ethical arguments, rather than allowing it to overrule them.

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