Amare et Sapere: Bodymind in Contemporary Neurofeminism

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As of my writing this particular sentence, 6.19 million people internationally have died due to COVID-19 or its related complications. This number has increased by 3,808 since yesterday. As a result of the Pandemic, Science! in its vaguest terms has taken on new cultural meaning. One's belief in Science is suddenly a signifier of belonging to a particular liberal political agenda. It is difficult to critique or even express distrust of the medical system and biosciences without being tied to an alt-right conspiratorial agenda. Even in circles on the left that are historically critical of the medical and scientific establishment, there seems to be a certain comfort in "carefronting" individuals about personal responsibility rather than pressing the state to provide better support for marginalized communities in a particularly vulnerable moment.

"Belief" in Science, and blind faith in the scientific process, is altogether incredibly dangerous. As I intend to demonstrate throughout this document, the past and present of science is deeply flawed, marked by large-scale atrocities and day-to-day injustices. It has been made evident that the global public can no longer afford to take Science at its word, nor can scientists continue uncritically in a failing process.

Still, science is not evil. I must admit I have a deep love for the sciences. Since I was a little girl with a terrible bowl cut and dinosaur t-shirt, I have been fascinated by sticks and bugs, stars and planets, and everything in between. Questions about consciousness and perception haunted my ten year old dreams. Do we all see the same colors? What do other people's dreams look like? Why can't I remember my multiplication tables? Eventually these tormenting questions led me to the study of the brain. We neuroscientists like to think of brain science like the deep sea or infinities of the universe is contained in all our heads. We are on a quest to

understand each other and ourselves in a vast space of unknowable truths. The intricacies of the brain and mind are endlessly fascinating. There is a sense of magic about it all.

Like many science geeks, I was also a closet case. As the unknowing bisexual daughter of a staunchly feminist bisexual mother, I became invested in queer and feminist politics very early. Interrogating heterosexism was not so much an interest as it was a necessity. It followed shortly that as a comfortably lower-middle class white kid, I ought to interrogate some other issues a little more closely. I developed a passion for social justice. Somehow, I found myself here, writing a love letter to contemporary feminism.

I took on this thesis out of a mutual frustration with my two loves, who seem never to love each other. It is often difficult to engage the sciences in a strictly feminist academic space, and even more difficult to engage feminist issues and a strictly scientific space. The two are often at odds, and it is easier to ignore one to focus on the other. When I walk into the lab, I shut off the feminism switch. When I sit in feminist discussion, my science goes out the window. Why?

I do not need science and feminism to be lovers, or even friends, but simply colleages: collaborators at one time, competitors another, always ready to critique each other, making us stronger and wiser in the process. This thesis is meant to address both by providing a feminist framework from which to understand and utilize science for the benefit of all. I embark here on a project to define (neuro)science as a particularly useful epistemology; to combine the worlds of symbol, experience, and selfhood with the material body, structure and function from cell to soul.

I have chosen neuroscience as a focus for this paper firstly out of necessity; it's all I know! However, I also believe it is uniquely situated to bridge the gap between queer/feminist theory and the sciences. As I will note in greater detail in later chapters, current research in neuroplasticity is a uniquely useful tool to describe how abstract symbols and constructed social

meanings are imprinted on our physical bodies and impact our health and behaviors. The brain, situated culturally both as the center of the conscious/unconscious mind, as well as the core of our material living body through the control of sleep, breath, and life itself, provides a useful meeting point for theories to merge. Neuroscience thus allows the potential to merge the material and semiotic, to conceive of experience and body and mind simultaneously and without fragmentation. I argue here that nearly every urgent feminist isuee may be bolstered by the study of the human nervous system.

As an additional note, I'd like to address the role of scientific terminologies within this paper and beyond. Ideally, this work will speak equally to experts of both fields, but this is a challenging proposition. Topics in neuroscience can quickly become overly complicated or incomprehensible to the layperson. Equally, neuroscientists to whom the phrases Butler's performativity and Haraway's cyborgs mean nothing will find uncertain ground. While in some circumstances it is useful to pass over detail in favor of clear understanding by both parties, these discipline-specific terminologies serve an important purpose, and to disregard these languages limits our ability to communicate. To the best of my ability, I will use specific examples and terminologies, but with enough explanation and detail to suit the layperson of either field. Additionally, I utilize exclusively identity-first, rather than person-first language throughout this work. While there is still significant debate on the most appropriate terminology within circles of disability studies, I write prominently about autism and neurodiversity, and in these circles identity-first language is preferred (if not required.)

So welcome! Attend my fantastic circus and see my magic trick! Simultaneously, in ONE SINGLE THESIS, I will demonstrate why feminism needs science, why science needs feminism, and how to get this odd couple together once and for all!

(Ha! As if!) In truth these questions will come with no easy answers. Like most other important feminist debates, in the words of the great Uma Narayan, it'll give you a headache! I hope to engage with this thesis as a journey of thinking out loud, by reiterating and reframing the words of those before me, and hopefully bring even slightly closer my two great loves.

Chapter 1: The Issues

Before I can engage in the great queer emancipatory project, I must first identify some of the most prominent issues in both fields. There is quite a bit of ground to cover. Feminism, across all related disciplines, tends to focus simply on abstract critiques of social structure, and not enough on material circumstances and embodiment. This drastically limits the applicability of theory onto all bodies, and tends to ignore the physical manifestations of social structures through pain, trauma, and disability. Equally, neuroscience fails across the board in measures of intersectionality (both in staffing and in research), and has fallen desperately behind even the most mainstream feminist conventions on sex, gender, disability, race, and identity. It is plagued, like most other academic fields, by capitalist and neoliberal tendencies, as well as an entirely racist, heteropatriarchal, and imperialist history it has not adequately contended with.

In this chapter, I will briefly break down the histories of some of these pitfalls and the contemporary circumstances we must now take on.

Why Feminism Needs Science

For decades, most mainstream feminist projects and even more radical groups have avoided engagement with the "hard" sciences. Often there were more pressing issues, like the overwhelming whiteness and heterosexuality of mainstream feminism, that needed contending with first. Many groups explicitly derided association to the sciences as an essentially colonialist,

capitalist, racist, and patriarchal structure[1]. The perspective among some was that "science.. serves primarily regressive social tendencies" (Harding 1986).

One of the largest sites of contention was the insistence of the sciences on deterministic and essentialist frameworks, most specifically through social darwinist concepts of biological determinism. In clear terms, biological determinism is the idea that biological factors, often aspects of the visible body, like secondary sex characteristics or genitalia, or less visible but still detectable factors, like genetics, are the reason we are what we are.

The estrogenic reproductive system in particular was and is still a matter of great deterministic speculation. Owners of uteruses are tied down fundamentally to the body, to reproduction, childbirth, and domesticity. White womanhood has been explicitly defined through the ovaries, uterus, and breasts, and dictated a life of fragility, emotional rollercoasters, and having lots of babies. When the body is racialized, womanhood is made much more complex. In an American context particularly, Black women have been stereotypically defined as defeminized workers, breeders, motherly domestics, or otherwise hypersexualized jezebels.

Such stereotypes also fit well in a neuroscientific context through the use of phrenology. Now considered a pseudoscience, phrenology is a way of measuring the skull that's meant to predict mental traits and personal character through patterns of shapes, bumps, and ridges. The practice was first popularized by so-called "father of phrenology" Franz Gall, who investigated sex difference by palpating women's skulls to determine the "distinctive female character." The field was incredibly popular in the 19th century, and even Paul Broca, for whom the frontal lobe speech production area is still named, was a firm proponent of phrenology and biological determinism. In Broca's own practice, he classified hierarchies of sex and race, idealizing the normative Anglo-Saxon male, and went so far as to explicitly classify left-handed people as

[1] which, to their credit, is probably true…

essentially inferior to right-handed people due to their head shapes (Cornel, 2020). Although phrenology soon fell out of favor in the scientific community, biological determinism and the naturalization of existing bias has continued for centuries. In examples I will return to in later chapters, determinist traditions, even involving comparative anatomy correlated to theories of neural superiority, are still alive and well in the sciences, just more quietly and insidiously.

In response to these offensive and damaging stereotypes populating the material sciences, much of feminist study chose to engage instead in more theoretical semiotic research. In the early-mid 20th century, and feminists preferred to engage with the larger social and cultural structures of sex and gender rather than bow down to the body, radically rejecting the determinist ideal of an "essential" womanhood or femininity. While this led to many important moves in theorizing, it has simultaneously resulted in lack of engagement with the physical body and experiential embodiment. In her 2016 book The Brain's Body, feminist scholar Victoria Pitts-Taylor writes, "A focus on the symbolic representation allowed studies of consciousness, the psyche, the self, the subject, and behavior to proceed without reference to the brain or neurophysiology. Crucially, this also enabled a more or less strict division between biology, as that which is given by nature, and politics, as that which is amenable to social contest and transformation" (Pitts-Taylor 2016). As a result, biology became a dirty word, and the binary between nature and culture was reified. While this was not the case universally, the mainstream feminist project preferred to focus on spaces that seemed more open to change, or at least more artificially constructed and therefore capable of deconstruction.

This lack of attention to biology (and therefore embodiment) has far-reaching ramifications. In the fields of Disability Studies and Crip Theory, the current prevailing social model of disability has been subject to critique for not adequately addressing the embodied

experience of impairment. The social model, which was revolutionary for citing disability in context with systemic barriers rather than in individual physical conditions, may unfortunately ignore or pass over the physical impact of impairment and pain on the body, and tends to universalize disability into a single unit. (Price, 2015). In the more eloquent words of Liz Crow, "Impairment is problematic for people who experience pain, illness, shortened lifespan or other factors. As a result, they may seek treatment to minimize these consequences and, in extreme circumstances, may no longer wish to live. It is vital not to assume that they are experiencing a kind of 'false consciousness' – that if all the external disabling barriers were removed they would no longer feel like this." (Crow, 1996). Most other major feminist issues, including intergenerational trauma, poverty, domestic abuse, medical racism, reproductive justice, and sex work have suffered from a lack of attention to the material world.

These issues are not simply imagined and performed within an abstract social context; they have physical impacts on the body that shape the way we relate to one another and the world. Pitts-Taylor thus argues that today "asserting the importance of nurture over nature, culture over biology, or representation over materiality has lost its critical purchase. Seeing biology as irrelevant for understanding the social, for example, underestimates the effects experienced on biological bodies, as well as bodies' own material agency." (Pitts-Taylor, 2016). In other words, we can no longer afford to ignore the biological when we discuss social issues. The lives we live change us, both in our imagined/constructed selfhood as well as in our material bodies.

A Sense of Urgency

Outside the realm of theory and methodology, the need for feminist intervention in the sciences is growing exponentially. We can no longer afford as a field to completely ignore or

reject the sciences. In doing so we risk the safety of all marginalized populations globally, and put to waste the effort of hundreds of feminist scholars.

Since the Cold War, capital-S Science has become by far the largest single source of global power. Computing and digital technologies essentially run our daily lives, and privacy appears to be a thing of the past. Now that we've cracked the human genome, we hold unprecedented power to control human populations. In current neuroscience, we can image *in vivo* human neural tissue and manipulate sensation and behavior with pharmacologicals or neuroprosthetics. It is becoming increasingly possible with current advances in neurotechnology that science may be able to one day predict our behavior before we have consciously considered doing it, which raises urgent questions of biopower and free will. It is ultimately impossible to ignore the state of science and technology within our critiques of social hegemony and state power. If anything, it is now more dangerous *not* to engage with the sciences.

While self-preservation is not the only reason for feminism to engage with the sciences, we must keep this urgency in mind when we do our theory. Intervention in (neuro)science has direct implications on not only mental healthcare, which will become increasingly important as the pandemic continues, but also on institutionalized treatment of physical disability, biopower and social control, data security, and gender theory. Engagement with the sciences may proceed in good faith, but with the simultaneous understanding that time is of the essence.

Making the Hard Sciences Impotent[2]

> "Materialism does not absolve the need to critically access neuroscientific knowledge and practice."
>
> Pitts-Taylor, 2016

[2] Title courtesy of the prolific Shalissa Otero

As the previous section illustrates, the sciences represent a uniquely dangerous institution, and have numerous urgent issues to address. The overarching problems in contemporary neuroscience can be understood as twofold: firstly, the structural issues from capitalist and neoliberal attitudes within academia largely, and secondly, the theoretical issues from inherently flawed paradigms that cannot adequately contend with human biodiversity and social intersectionality. This chapter will serve as a brief introduction to some of these issues.

The Structure of Science

Can I be honest with you for a moment? I am sick to *death* of #WomeninSTEM.

In the past few years, #womeninstem initiatives have grown across the world to encourage women and girls at all levels, from elementary school to PhD programs, to get excited and involved in STEM. These are efforts to encourage women and girls to pursue science education and engage in the sciences by increasing access to education and employment, and empowering the entry of women into another male-dominated field. Various scientific institutions and workplaces, particularly those "dedicated to diversity and inclusion" will boast statistics on their websites and media pages. So what are the results?

Despite these efforts in the past few decades, overall representation in the sciences has not significantly changed. Although women (as a demographic group) make up half the workforce, as of 2019 they represented only 27% of STEM employees, with varying degrees depending on the field. Of all engineers, for example, women make up only about 10%. Unsurprisingly, the total STEM workforce is also 67% white, but up to 71% depending again on the individual field. Despite Hispanic workers making up 17% of the US workforce,[3] only 8% of STEM employees are Hispanic. Numbers for Black, Indigenous, and "other" races are even

[3] These statistics come from census data, so actual numbers of Hispanic and Black people in the total workforce may be much higher.

lower. Across all racial and ethnic groups, women in STEM still earn far less than male counterparts. Black and Hispanic women in STEM on average earn 37% less than their white male colleagues (Martinez & Christnacht 2021). While these statistics are not much different than most white-male-dominated fields, it points to the failure of #womeninstem initiatives to adequately provide for women, particularly women of color. These attempts to increase diversity are surface level, and have consistently failed to address the real experience of minority groups within the fields.

Scientists and feminist scholars alike have argued for decades that it is the identity of researchers that is key to the disentanglement of neuroscience (and the sciences in general) from oppressive systems and problematic cycles. Using some of the frameworks of standpoint theory, proponents argue that women, queers, and people of color will have particular insight based on their societal position that will directly impact the research community and body of work. Traditionally white-cis-het-male dominated fields will have research questions almost entirely directed from the standpoint of privilege. “If the community of ‘qualified’ researchers and critics systematically excludes, for example, all African-Americans and women of all races and if the larger culture is stratified by race and gender and lacks powerful critiques of this stratification, it is not plausible to imagine that racist and sexist interests and values would be identified within a community of scientists composed entirely of people who benefit - intentionally or not - from institutionalized racism and sexism.” (Harding 1993). Scientists in a monolithic environment will never recognize their biases. If minorities are injected into these circles, perhaps the field will change for the better!

Unfortunately, this has long proved to be untrue. Even in more diverse scientific communities, culture-wide issues of academic prestige, harassment, and racism perpetuate the

silence of marginalized groups and maintain hegemonic bias in research. Over 30 years ago, writing in 1987, Londa Schiebinger identified along with a growing circle of feminist scholars that representation alone would not be adequate to address the problem. She writes that "the task of opening science to women must be combined with the task of making science more responsible." (Harding, O'Barr 1987). As early as 1964, feminists identified that the unwillingness for women and girls to engage in the hard sciences is based not only in lack of access, but also in deep socio-cultural structures. Hilary Rose described this succinctly in 2004: "A woman, especially if she has any ambition or education, receives two kinds of messages: the kind that tells her what it is to be a successful person; and the kind that tells her what it is to be a 'real' woman" (Harding, 2004). Even with the support of educational initiatives, minorities in the science workplace are still subject to tacit discriminiation and social pressure. While it is more acceptable today than 50 years ago for women of all identities to enter the sciences, there are still huge issues precluding their success, including institutional racism, flawed Title IX and HR programs, and discriminatory funding practices. Ironically, as much as the sciences want to disregard that the sociopolitical identity of a researcher matters, their hiring practices, community cultures, and funders seem to care quite a bit about identity.

From a personal perspective, I was cautious to engage in further discussion of representation in the scientific community. While I agree that representation in these areas is important, I do not believe that it will have significant impact on institutional practice and systemic discrimination on its own. Frankly, the issue has become a simple issue of publicity for most institutions. It is comparatively easy to slap a #WomeninSTEM sticker on your university website than to directly evaluate hiring practices, availability of tenure positions, community culture, and research ethics. The perspective of BIPOC, women, queers, and disabled people will

be fundamental to these changes; this is undeniable. But the simple "inclusion" of marginalized identities will not ever be enough without widespread radicalization, or at the very least some open discussion, which most institutions are completely shut off to. Just like in the corporate workplace[4], it is not enough to hire a few girlbosses here and there. A well-informed and deeply feminist critique is required, rather than a simple change in staffing.

Margaret Price articulated this issue particularly well in her 2016 paper, Un/Shared Space[5] in a discussion of disability and "inclusive architecture." Price writes that "We use the term inclusivity as if we could take up its good parts without also confronting the historical and present-day practices of violent exclusion that make its emphasis necessary in the first place." (Price 2016). Sara Ahmed, also speaking on accessible spaces, concurs. "It's a logic assuming that intentions are equivalent to actions, that structural inequality is 'no one's fault' and that representations of diversity (or inclusivity) can be folded into existing institutional norms without changing the institutions themselves." (Ahmed 2012). While these two authors speak specifically about accessibility and the inclusion of disabled people, the same concept is applicable to any historically marginalized community. Research institutions, which are not only historically white-male-dominated, also have a history of not only implicit discrimination but explicit violence against women of color, disabled people, and low-income people. While yes, science is now far more regulated and diverse than it was 50 years ago, it is still a deeply racist and heterosexist establishment. Additionally, the assumption that Ahmed identifies, that inequality is "no one's fault" continues to put the burden of education and self-advocacy on the newly-induced marginalized individual, and amplifies the pressure earlier identified that the simple presence of minorities within a community will change its overall culture.

[4] An early mistake from white upper-middle-class feminism…
[5] Price was inspired to write the piece following a visit to perform a lecture at Vassar College when she found the campus inaccessible. For those at the college who are interested, the pdf is widely available online.

I appreciate that these efforts towards inclusivity and representation are well-intentioned, but in most cases they give highly problematic institutions an out from much-needed critique. There are larger issues that must be addressed before #WomeninSTEM or any other hashtag initiatives will be meaningful.

Perhaps even more than other academic spaces, scientific research is deeply under the control of capitalism and neoliberalism[6]. In the late 19th and early 20th centuries, scientists and social critics alike mostly agreed that science was the one institution capitalism could not crack. Feminist sociologist Hilary Rose offers a history of socialist critique of science, noting that until about the 1960s, most believed that "the advances of science would automatically create problems that capitalist society could not solve; hence in some way science as at least 'neutral,' at best allied to those working for a new and socially just society." (Rose 1983). This "neutral" and abstract science would be uninterested and unmoved by class or politics.

This changed in the mid-20th century. The use of science and technology to kill and pollute across Southeast Asia and within the United States revealed to most that "those in charge of science were overwhelmingly white, male, and privileged occupants of positions in advanced industrialized society. The antihuman technologies that science generated were being used for the profit of some and the distress of many." (Rose 1983). So what changed?

Various authors have found the source of industrialized capitalist science in different places. Jerome Ravetz identifies that science today is wildly different from research in the days of Marx. Whereas in the nineteenth century science was a craft, with a single worker and a few apprentices laboring alone, (think of Tesla or Edison), today's research involves large groups of experts with clear divisions of labor and with goals set and managed by bureaucratic directors

[6] Yeah, yeah, another Vassar thesis on the woes of capitalism.

and administrators. Science that is so closely tied to the state and industry loses its critical force and becomes, like state industry, an agent of oppression. (Rose 1983, Ravetz 1971).

As a capitalist mode of production, science today commodifies knowledge itself as a product of labor. In an age where data is bought and sold like gold or oil, this is all the more obvious. Knowledge of all kinds is sealed from the public behind arbitrary publisher paywalls, maintaining the scientific illiteracy of the masses. The most money goes to those who publish big results first, and researchers are encouraged to seek out new findings and positive results, rather than replicate others' research. As a result, science across virtually all fields is experiencing a replicability crisis, and the public is left to doubt the reliability of results. Corporate and institutional secrecy policies to maintain the bottom line prevent collaboration of scientific research and enforce global power dynamics, making research simultaneously more competitive and more difficult. Influential journals do not publish negative results. Big Pharma maintains patents that gouge the public for life saving medications.

In a contemporary context, the issue of capitalist neuroscience is expanded in an increasingly neoliberal American culture. Authors Sabine Maasen and Barbara Sutter, in speaking on the "neuroscientific challenge" in neoliberal politics, contend that neuroscience and the hard sciences generally fit well within a neoliberal society. Self-management, they note, through the use of "neuroceuticals" and other pharmacological interventions aligns perfectly with the idea that individuals should be entrepreneurial and self-governing, rather than anticipate external aid that may be provided by a welfare state. (Maasen & Sutter 2007). From a Marxist-feminist perspective, this is closely associated with the unwillingness of a deeply capitalist governmentality to address the root causes of such "individual" neurological conditions, like poverty, racism, and pollution (to name a few) which would directly threaten the

success of the so-called free market. Curing the entrepreneurial and industrious individual is simpler, and maintains the assumption that the system works. As Tabea Cornel writes, “Pills certainly cost the majority population less than tackling the root causes of most social problems - bigotry, discrimination, and unequal distribution of resources” (Cornel 2020).

Many tend to find fault with the researchers and employees themselves, but this is not always the case. Academia and the sciences at large are plagued by institutional underfunding, and increasingly researchers are supported by private corporations, including the notorious pharmaceutical companies. Even federal funding, while often regarded publicly as more neutral than a corporation, is just as guilty of digging for a particular result to support a particular agenda. Regardless of an individual researcher’s personal interests and sociopolitical leanings, they’re pushed by grant committees and other funders in particular directions, often towards a “neuroceutical” individualist approach. It becomes much easier to capitulate through grant proposals towards a particular (more lucrative) direction of research, rather than attempt to investigate other more controversial realms of study. Neoliberalism and capitalism within academia, particularly the hard sciences, is thus self-sustaining and cyclical, just as it is in all other parts of current American society. These funding dilemmas are an open secret amongst academics, and often might one hear a bemoaning scientist in the middle of another unbearable and anxiety-inducing grant proposal, or rushing to complete a project before the grant runs out.

I find it interesting that the general public rarely takes these factors into consideration when we describe current trends in research. While we make complaints, however well-warranted, about the reluctance of the medical sciences to address key systemic issues, we tend to ignore the same systemic issues taking place within those sciences. We forget to ask how these individualistic tendencies limit the day-to-day life of underpaid grad students and

researchers, or how the high cost of publication bars research from the margins from being shown to the public. Regardless, it is undeniable that current neoliberal trends present in most US workplaces have infiltrated the scientific community, and will continue to do so without direct intervention.

Theoretical Issues

Linked to the overarching structural issues come more specific issues in the paradigms of human neuroscientific research. Capitalism and neoliberalism pervade these topics in unique ways. The topics that I have chosen to include in this section are reflected in great numbers in the literature, and are particularly popular in contemporary human neuroscience. I see these topics as potentially informative for a combined feminist-neuroscientific endeavor, but before that is possible I want to summarize the major critiques of this work.

The single largest theoretical issue with (neuro)science today is the question of objectivity and empiricism. Scientific epistemology is ruled by empiricism. It is a field of pragmatism and practicality, where nothing is known for certain until it is objectively observed and replicated with physical evidence. The field relies on experience and experimentation, rather than intuition, social influence, or other reasoning. It is strictly rational, uninformed by affect and personal opinion. At least, in theory.

Feminist methodology is a similar practice of observation and experience, but it does not limit itself in an attempt to ignore social constructions or affect and emotion. It is, as some critics of feminist science have noted, a deeply biased methodology, as much of the theory is based on personal embodied and affective experience. This is most often where the two disciplines come into conflict. A critique of empiricism and pragmatism points out that it is impossible to separate the individual researcher from the social structures in which they are entrenched. It is quite

literally impossible to be unbiased. For example, a white researcher in a racist society, at an institution that actively benefits from white supremacy, regardless of intention, will be informed by racist and white supremacist modes of thought. A cisgender, heterosexual man, in a transphobic and heterosexist society, regardless of intention, will be informed by that heterosexist and transphobic experience. Even in sciences uninterested with humans and biology, bias will influence the scientific process. Nondisabled engineering and architectural scientists, for example, have historically constructed buildings and structures without regard for universal accessibility unless specific legal regulations require such additions.

Further, researchers are *always* fundamentally biased towards data that support their hypotheses. Funder institutions are more likely to support researchers with fast and positive results, sometimes regardless of validity and objectivity, although this is not communicated outright. Various fields have attempted to rectify this problem through preventative experimental procedures like double-blind randomization, but even these solutions are imperfect, as bias can enter even in the formulation of the question itself. To return to the issue of biological determinism, early neuroscience did much of its work asking the question, why are women so different from (inferior to) men? Why are Black people so different from (inferior to) whites? As we can reflect now, these studies are not at all objective. The fundamental question asked is based on the assumption that men are superior to women, or that white people are superior to Black people. While this seems egregious, these questions are still quite common. As Harding writes,

> "Conventional conceptions of scientific method enable scientists to be relatively good at eliminating those social interests and values from the results of research that differ within the scientific community… but scientific method provides no rules, procedures, or techniques for even identifying, let alone

> eliminating, social concerns and interests that are shared by all (or virtually all) of the observers, nor does it encourage seeking out observers whose social beliefs vary in order to increase the effectiveness of scientific method. Thus culturewide assumptions that have not been criticized within the scientific research process are transported into the results of research, making visible the historicity of specific scientific claims to people at other times, other places, or in other groups in the very same social order" (Harding 1993).

Scientific writing is just as much in danger of bias as the experimentation itself. As Emily Martin famously pointed out in her essay "The Egg and the Sperm", the language and use of metaphor in scientific writing can (and do) maintain hegemonic social structures. As she points out, textbooks and publications maintain the activity and agency of the sperm, by stating that it penetrates the waiting passive and non-motile egg, despite the fact that the actual process of fertilization is much more complex and much more mutual. (Martin 1991). This type of language, which at face value attracts little attention, is a massive problem in scientific writing and research. These baseline assumptions and casual anthropomorphisms emphasize the agency and autonomy of manhood, and maintain a feminine passivity and wastefulness. As findings from poorly worded studies are spread to the public through media headlines or textbook chapters, these little quirks of language maintain cultural standards. Even in practice, it becomes difficult to reword the technicalities of science. As a quick exercise, try it for yourself.[7] How would you describe the process of fertilization and conception without prioritizing the masculine sperm? It's harder than you think.

The claim of pure objectivity that is ascribed to the sciences does double duty, helping to underscore the neutral "expertise" of Science in general. Media and news sources are able to

[7] This exercise is lovingly borrowed from Dr. Colleen Ballerino Cohen

latch onto any available study and apply a tagline of results that tells us all how to best live our lives. "'Science says..' we are told. Whose science, we can ask? The drug and cigarette companies'? The Surgeon General's? The National Institute of Health's? The science of the critics of the NIH's racism and sexism?" (Harding 132) As Harding points out here, the goal and perspective of each of these groups is radically different. How can a cigarette company be objective about its own research? How can we trust the NIH, if there are competing results from critics of its racism and sexism? More directly: "how can science claim to be ideologically pure, value-free, and above all neutral, when even a well-regarded text entitled The Scientific Method offers an example of scientific development the making and testing of napalm on a university playing field, without any references to ethical or political problems" (Hilary Rose 71). We could say the same today about texts like the widely-used DSM-5.

One of the most salient examples of this in the scientific literature of the past two decades comes from a 2009 debate hosted by the premier journal Nature, which hosted experts to consider the question: "Should scientists study race and IQ?" English neurobiologist Steven Rose, known also as the husband of feminist sociologist Hilary Rose[8], wrote No, "It's just ideology masquerading as science." Rose argues that these questions lack scientific merit simply because there is no empirical evidence establishing commonly-used groups like race as linked in any biological sense. While perhaps certain measures of "biogeographic ancestry" may identify certain phenotypic differences, the category of race used in research, particularly the United States, has historically been variable, fragile, and dangerous. He writes, "the categories judged to be relevant to the study of group differences are clearly unstable, dependent on social, cultural, and political context… This calls into question the motivation behind looking for such specific group differences in intelligence, sheds doubt on whether such research is well-founded, and

[8] And WHAT an ideal combination!

begs whether answers could possibly be put to good use." Most saliently, he writes, "In a society in which racism and sexism were absent, the question of whether whites or men are more or less intelligent than blacks or men would not merely be meaningless - they would not even be asked" (Rose 2009).

Conversely, psychologists Stephen Ceci and Wendy M. Williams argue, Yes: the scientific truth must be pursued. They argue that the censure of any kind of research, particularly research that challenges "politically correct" or "acceptable" work, is a violation of freedom of speech. They write that "the specter of Lysenkoism lurks in current scientific discourse on gender, race, and intelligence. Claims that sex- or race-based IQ gaps are partly genetic can offend entire groups, who feel that such work feeds hatred and discrimination." Ceci and Williams believe earnestly that censure of such questions will silence vigorous scientific debate, and cite the career-ending assertions in 2007 from Nobelist James Watson's that "African intelligence" is inferior to whites, and that "people who deal with Black employees know this is true" as a tremendous loss to the scientific community[9] (Ceci & Williams 2009).

Most relevantly to the question of empiricism, Ceci and Williams write that "Certainly, history offers examples of great harm befalling individuals due to flawed scientific claims. Such problems, however, arise *not from scientific discourse*, but from *political applications* of those ideas. This is another matter entirely and must be subject to checks and balances."[10] (Citation). This false idealism in the purity of scientific research is one of the single most dangerous mentalities in academia today. These debaters approach the question from completely different rhetorical standpoints. One side, Rose, wishes to take into account the racist/sexist position of

[9] Watson, known best for stealing the discoveries of Dr. Rosalind Franklin in the molecular structure of DNA, resigned from his laboratory chancellorship following this racist tirade in 2007. Unfortunately, it seems the 94-year old still holds these beliefs, as a similar 2019 tirade in a documentary caused his laboratory to sever all ties and revoke all honorary awards in his name.
[10] Italics mine.

researchers. By utilizing empirical research and without disregarding the values of the scientific academy, he points out that these groups are falsely constructed and that questions investigating them ought not be pursued out of a lack of scientific merit. The other side, Ceci and Williams, see their research as pure and unmodulated by sociocultural implications, and therefore to censure their work, or by extension even to critique it, is therefore comparable to fascist dictatorship! While they cannot ignore that marginalized groups have been harmed and victimized by science, they take no responsibility for it, as *society* and *politics* are to blame for their clearly unbiased research being tarnished. The two most centrally disagree not on the topic of IQ and race, but instead on the very presence of politics and sociocultural bias within science. The assertion that science is unbiased, pure, and empirical, thus allows researchers like Ceci and Williams to justify explicitly racist conventions. And this is only one example. When we consider also the more insidious institutionalized forms of racism or heterosexism within academia that this mindset maintains, the problem only becomes larger and more difficult to rectify.

Many of the most problematic trends in neuroscience and psychiatric research stem from similar trends. Of particular concern to feminists is the topic of a sexed/gendered brain. As we've seen, the existence of a sexually dimorphic[11] brain has been historically fertile ground for neuroscientific research. Although we've moved on from caliper measurement of skull ridges and jaw angles, contemporary techniques have moved into examining comparative neuroanatomy and related behaviors of cis men and women. Much of this work stems from early influential work on the 'hardwiring' paradigm, that suggests that behavioral and personality traits

[11] Sexual dimorphism: differences in size/appearance between the sexes of an animal in addition to gonadal differences

of binary sex/gender are encoded at birth through androgen[12] exposure. This paradigm is based on early influential work that examined the developmental effects of early testosterone exposure on female rodents. Female rats and guinea pigs treated with testosterone *in utero* or in early development demonstrated "masculinized" reproductive behaviors and fundamentally altered the structure of their brains, while male rodents who were castrated early in development demonstrated "feminized" reproductive behaviors. (Phoenix et al. 1959, Raisman and Field, 1973).

Researchers in the past few decades have searched hard for sex differences in brain structures. Research in rodents has pointed many to examine the SDN-POA (sexually-dimorphic nucleus of the preoptic area) which was found to be several times larger in males than females, dependent on early testosterone exposure. (Gorski et al 1978, 1980; Jacobson et al. 1981; Dohler et al. 1984, Hines et al. 1985, Roselli et al. 2004). In humans, the POA is incredibly functionally diverse, but seems to be primarily related to homeostatic mechanisms, rather than levels of intelligence or sexual identity[13]. Most notably, it lacks a blood-brain barrier, which allows it to detect hormone levels and direct that information to the rest of the brain to regulate blood composition and volume. (Saper, 2012). With this information, it's unsurprising the region would be impacted by early hormone exposure!

As is hopefully evident, the search for sex-specific brain regions has had little success. Some researchers turn instead to sex/gender-based behaviors to classify females and males as inherently different. However unlike mice and rats, who tend to have relatively clear sex-based behaviors, humans are notoriously complex. Various studies have attempted to identify

[12] Androgens are a group of sex hormones present in both males and females that mediate male reproductive activity and secondary sex characteristics.
[13] Some have pointed to the SDN-POA as a source of homosexuality, as rams with a smaller SDN-POA have been found to prefer male partners. (Roselli et al. 2004). Correlation without causation, anyone?

particularly female or male behaviors to varying degrees of statistical success. Some of the most common to be considered are measures of empathy (higher in females), physical aggression and social dominance (higher in males) or "performance on a specific 3D mental rotation task" (higher in males) (Hines 2020). However, as a particularly large 2005 metaanalysis from Janet Shibley Hyde points out, most behavioral sex differences are negligible, and not statistically significant (Hyde 2005).

Most of these studies are quite obviously searching for a difference based on social construction, rather than biological fact. As I'll note in greater detail in Chapter 2, even the binary division of sex (male vs. female) is not as clear as it seems. Bias, in the ideological assumption that men are innately different than women, pervades this research. Additionally, studies of comparative behavior or anatomy view sex as strictly binary, male and female. This is problematic for many reasons, the most notable of which is that this practice entirely ignores the existence of intersex people. Anne Fausto-Sterling famously wrote in her article The Five Sexes in 1993, "Biologically speaking, there are many gradations running from female to male; and depending on how one calls the shots, one can argue that along that spectrum lie at least five sexes - and perhaps even more." The term intersex has traditionally been used as a catch-all term for various subgroups "with some mixture of male and female characteristics" (Fausto-Sterling 1993), and has developed various new meanings over the years. Often the definition of intersex has been concerned primarily with genetalia, for example, the presence of both testes and ovaries, or otherwise "ambiguous genetalia." In more modern definitions the term intersex can apply to almost all variations in biological sex, including chromosomal genetics or ability to produce gonadal hormone. Many intersex activists have found shared ground with transgender or nonbinary communities in expanding ideas of normative sex and gender identification.

More recently, neuroscientific work has moved past sex and into gender. As unstable distinctions between sex/gender terminologies have become implemented in scientific academia, much of this research has shifted into the search for the source of "gender identity" in the brain. One of the most convenient methods scientists found to do this research was to investigate so-called "aberrant" or "dysfunctional" gender identity.

Until the publication of the DSM-V in May of 2013, the transgender identity was explicitly pathologized as "Gender Identity Disorder", characterized by "a strong and persistent cross-gender identitfication." (APA, DSM-IV). In the DSM-V, the American Psychological Association aimed to destigmatize the transgender identity and focus their diagnoses on the actual discomfort of gender diverse people, so that diagnostic criteria was made explicitly in relation to discrimination against trans people and would improve access to healthcare. (Llaveria Caselles 2021). What was once GID is now diagnosed as Gender Dysphoria. Terminology, however, can only go so far. Across neuromedical fields, trans and nonbinary identities remain highly pathologized.

In the quest for a *gender*-dimorphic neural correlate, many studies have latched onto the central subdivision of the bed nucleus of the stria terminalis (BSTc). This region has connections to the amygdala, hypothalamus, and thalamus, and acts as an integrative hub for various limbic functions, including stress and anxiety regulation and appetitive behaviors. One oft-cited 1995 paper compared BSTc size between cis men and women and six trans women, which found that the BSTc was larger in cisgender men than cis women, and transgender women tended to have a BSTc of approximately the same size as cisgender women. (Zhou, Hofman, Gooren, Swaab 1995).

This paper and the majority of research into differences between cis and trans brains has been done by esteemed researcher Dick Swaab (who is, frankly, making it too easy…[14]) Swaab and colleagues' have put much effort into the cause of being transgender, and the single neural source of 'gender identity' which notably they have tremendous difficulty defining. (Llaveria Caselles 2018). According to Swaab, both gender identity and sexual orientation are hard-wired *in utero* through testosterone exposure, "since sexual differentiation of the genitals takes place in the first two months of pregnancy and sexual differentiation of the brain starts in the second half of pregnancy, these two processes can be influenced independently, which may result in transsexuality." (Savic, Garcia-Falgueras, Swaab 2010). They cite that the "disease state of transsexual people" (Hahn et al 2015) is entirely pre-programmed, and that "there is no proof that social environment after birth has an effect on gender identity or sexual orientation." (Savic, Garcia-Falgueras, Swaab 2010). These studies, ironically, do not identify cis men or women as having a gender identity. It is never mentioned, nor are any cis people evaluated for their self-account of gender.

This research is obviously problematic for countless reasons. Some of these studies are not even a decade old, and sound to any gender studies scholar to be from twenty or thirty years ago. Again, we see clearly in this research a predetermination first that the trans experience is inherently disordered, and that men and women (cis or trans) are inherently different. Their definition of sex (as based on genitalia) is incorrect, as well as their definitions of gender. This is not to mention the fact that finding a "cause" for being transgender has deep political ramifications. If anything, these particular studies serve only to further pathologize trans and

[14] Our dear friend Dick is not a stranger to queer taunting, as he reports himself being subject of death threats for his continued pathologizing of homosexuality, and a victim of "feministics agitation." Sorry not sorry Dicky.

gender non-conforming people, and once again dig through data and potentially harm communities for a difference that may not even exist.

Studies like these utilize specific margins of identity to dig for group-level differences based on social stereotypes and conventions. Yet in other contexts, when socially constructed oppressive systems may have real consequences on physical and mental health, (neuro)science often struggles to contend with the complexities of identity and difference. Along with the biological sciences in general, neuroscience often exhibits a lack of attention to intersectionality and multiplicity of identity. Human research requires that subject groups be narrowly defined to eliminate potential confounding variables, but this limits the applicability of research to a narrow "normative" population that in practice includes very few. These studies, differentiated by anything from race, sex, age, sexual orientation, or right/left-handedness, make the implicit recognition that these intersectional factors will have significant impacts on various neural activities, and yet are meant to be ignored for the purpose of direct research. This demonstrates that there is generally an understanding even in the sciences that the various facets of identity are inherently complex and mutually-interactive, influencing both a sense of selfhood and identity as well as physical neuroscience and cognition.

To suggest that such differentiation is a problem, rather than a tool to provide clearer and data, may seem a naive suggestion to most neuroscientists. On the one hand, yes, these practices do serve a purpose. It is undeniably difficult to recruit ANYONE for human research, let alone a perfectly diverse group of applicants. Right and left-handedness, for example, is a useful tool to control for lateral dominance in imaging studies. However, the more important aspect I want to note here is the issue of the normative body. Within (neuro)science, the rule of averages is law, but on the whole this "average" is skewed towards a particular normative population, most often

cisgender, heterosexual, white, middle-class men. If we desire a fuller understanding of the human brain, we must be able to accommodate a larger range of variation.

As these examples show, neuroscience often fails to appropriately address intersectionality. Numerous studies have identified that socioeconomic status (termed SES in the literature) has a profound impact on neural development, affecting cognition, academic achievement, and overall mental health. (Hackman, Farah, & Meaney 2011) However, as Victoria Pitts-Taylor points out, most of these studies are incredibly limited by race, class, and other measures. She notes that most studies are "ethnically-matched", which most often means that poor Black children are compared to middle-class Black children. She writes, "This means that the research is curiously both racialized (every poor subject is Black) and race-blind (only class is measured) even while other categorizations are created." (Pitts-Taylor 2016). Unfortunately this issue is not uncommon. Often highly specific populations are chosen in an attempt to eliminate potential confounding variables, in this case the impact of race and racial discrimination, through the assumption that all Black people face discrimination in the same way and to the same degree.

Since the term "intersectionality" entered the public forum through the work of Kimberle Crenshaw, its utilization has seen mixed results. Her original writing centered on law and legal spaces, particularly speaking to Black women's experience with domestic violence and the law. Unfortunately, like many other social justice terminologies, intersectionality has been co-opted as a corporate buzzword for middling attempts at diversity, leading other scholars to address the problem through new verbiage (e.g. Jasbir Puar's *assemblage*). I'm personally inclined to support Crenshaw's original definition of intersectionality, as it relates especially to institutions that deal directly with the convergence of various systems of power.

The sciences, interestingly, have not been made to engage directly with intersectionality, except in the spheres of representation among researchers. Identity is highly categorized in the sciences for participants of studies, and often completely ignored for the researchers. The question of the studied vs. the studier is central to many feminist interpretations in the social sciences, particularly anthropology and sociology. These fields which consider affect, relationships, and social structures so inherently must reasonably reckon with personal identity and the role of the researcher in regards to the groups being researched. However, it seems much less common that such an issue is broached in the so-called "hard" sciences, despite the fact that the consequences of such research may potentially just as dangerous for the communities involved, if not more so.

Poor people of color, and often poor *children* of color, are subject to especially intense scrutiny with little nuance. Any good feminist scholar would easily object to the idea that any one identity group, be it race, class, ability, gender, etc. experiences discrimination identically, or even that these identities are essential and operate the same way in every context.

In fact, it is only recently that women as a group (or females, in the case of animal studies) are routinely considered for broad neurological study. Particularly in rodent models, one of the largest fields of neuroscience, it was (and is) incredibly rare to utilize female animals, unless the study was particular to reproduction and pregnancy, mating, estrous, or other sex-specific factors. This was widely true across human studies as well; unless a specific population of women was required, they would be altogether ignored. Although this has begun to change in recent years, and more institutional boards and journals require approximately equivalent sexed groups, the existing (and highly referenced) body of research is almost entirely male.

We see these issues reflected in psychiatry and neurological diagnoses as well. As an example, I'll return to neurodivergent diagnoses. ASD is reported to occur in all populations, across sex, gender, race, and SES. However, males are four times more likely to be diagnosed than females, and white children are significantly more likely to be diagnosed than Black and Hispanic children. (CDC 2021). Various scholars have attempted to reconcile these differences through genetic testing or other biological methods, but I find it much more likely that these barriers are due to a lack of access to evaluations and support services, bias among medical staff, and issues with diagnostic criteria specialized for a normative white male.

Again, the flaws of such research makes a highly-specialized neoliberal approach all the more convenient. Pitts-Taylor notes that poor children of color are often the targets of specialized intervention, like computer games designed to increase executive function and other cognitive skills, without, for example, increasing their parent's income or providing families with material resources. Instead of removing lead from the pipes in poor communities, schools will implement a few more poorly-trained special education tutors. Institutional support, as always, is available to those who can afford it.

Notably, variation does not stop with large identity categories like race or gender. Medical fields involving the work of human neurobiology often come into conflict with disabled activism. Medicalization and standardization of mind-body variations often complicates or eradicates the possibility for self-identification and self-advocacy, and contributes to ableist structures. One significant conflict of note is between neuroscience and psychiatry with the neurodivergent community.

Neurodivergent (ND), briefly, is a term referring to "a mind that functions in ways which diverge significantly from the dominant societal standards of 'normal'" (Walker, 2021). Most

know the term to refer to autism and ADHD, but more recently neurodivergence has come to include most forms of mind-body variation, including epilepsy, dyslexia, TBI[15], schizophrenia, and Down Syndrome. The opposite to neurodivergent is neurotypical (NT), which means "having a style of neurocognitive functioning that falls within the dominant standards" (Walker, 2021). Social justice organizing among neurodivergent people has created an overarching Neurodiversity Paradigm, which emphasizes that neurodivergence (in whatever form) is not an inherent defect or disease, but an alternate experience of the world that normative or NT society is not adequately equipped for or willing to accept. They suggest that the person cannot be separated from the neuro-type, and that an embrace of those non-normative cognitive patterns is essential to one's identity. While this description does not sum the whole of the movement, these points are where the neurosciences most often tend to come in conflict with it. Research into autism is one of the clearest examples.

In recent years, autism spectrum disorders (ASD) have become one of the most prominent and lucrative directions for neuroscientific research, and not for purely evil reasons. Despite its frequency in the general population: diagnosed in approximately 1 in 54 children in the US[16], there are few if any conclusive findings about how such cognitive and sensory experiential differences are represented structurally in the brain. As well, many autistic people tend to suffer from anxiety, depression, seizure disorders, sleep disorders, and gastrointestinal disorders, which there is equally little data to explain, and which many autistic people seek supportive care to treat.

However within certain branches of neuroscience and particularly neuroscientific medicine, aims are more often targeted specifically at elucidating the cause or risk factors of

[15] TBI: traumatic brain injury
[16] these numbers are likely conservative, as women and people of color tend to be underdiagnosed

autism and potential medications or therapies to address it as a disorder. Doctors and psychiatrists suggest that many autistic people have incredibly severe associated health issues that cannot be ethically reconsidered as an identity category. Some retort that more prominent autistic activists have relatively "mild" symptoms[17], what used to be called high-functioning, or level 1, and should not speak for the whole of the autistic community and their caregivers.

The neurodiversity movement simply asks that the scientific and medical communities re-evaluate what it means to have a 'disordered' brain, and open scientific arenas to a greater world of accepted variance and diversity. But again, we see the scientific community turn to a point verbalized cogently by Tabea Cornel: "Why accommodate different kinds of people and guarantee equal rights for all if neuroscience can fix diversity?" Need we offer welfare programs or accessible spaces and technologies and cost the taxpayer a pretty penny when eugenics is so much more elegant? Again, we return to the issue of capitalism and neoliberalism. It begs the question, without the commodification of such research, would we be able to ask questions that benefitted both neurotypicals and neurodivergent people? How can we better understand the brain and human variation without pathologizing and stigmatizing difference?

In order for neuroscience and Science in general to be utilized in feminist frameworks, we must first prevent neuroscience from becoming a powerhouse of ableism, eugenics, and social control. Having identified some of the most blatant structural and theoretical issues of the sciences, we are now able to create frameworks that can address these issues towards a mutually beneficial emancipatory project.

[17] "Mild" or "high-functioning" autism is also a highly controversial term that tends to ignore contextual variability and intersectional identity categories.

Chapter 2: Guiding Frameworks

> "Again I say the the nearest an ordinary person gets to the essence of the scientific process is when they fall in love"
>
> Goodfield, 1981

The goal of this project, above all, is to move towards an emancipatory framework that can facilitate mutual understanding and possibilities for multidisciplinary thinking. This work has the potential to improve not only feminist methodology and theory, but also improve healthcare and human research, particularly that directed towards at-risk and traditionally marginalized communities. To do so, there are a few major frameworks I will account here to guide my thinking. I begin by drawing from neuroscience, with the concept of experience-based neuroplasticity and the social brain. I will then draw from feminist-materialism to illustrate the concepts of material-semiotics, and extend into the worlds of disability and mad studies to describe the bodymind and neurodiversity. Finally, I want to emphasize the role of love. Without love and compassion, the work we do is meaningless. These frameworks, while originating from vastly different worlds, fit together perfectly to provide an overarching framework for neurofeminist imaginings.

Neuroplasticity and the Biosocial Brain

Until quite recently, the brain was assumed to be essentially static following birth, capable of decay and damage but not growth or change. It was generally believed that unlike the rest of the body, the brain is nonrenewable, and it was impossible for new brain cells to grow. This theory allowed social darwinist arguments to persist, as it was concurrently presumed that intelligence and cognitive abilities were innate and inherited.

However, in the early 1900s, 'father of neuroscience' Santiago Ramón y Cajal pioneered the concept of neuroplasticity. In simple terms, neuroplasticity means that the brain is able to change and adapt throughout an individual's lifetime as a result of environment and experience. While studying the central nervous system as early as 1894, he noted regeneration and shifting connections in the cerebral cortex, cerebellum, and spinal cord, with a level of sophistication that mirrors modern understandings of neural plasticity. (Stahnich & Robert, 2002). In his 1917 memoir he summarized these findings optimistically by stating, "every man can, if he so desires, become the sculptor of his own brain" (Ramón y Cajal 1989).

Obviously, these claims were contentious at the time, as the majority of the scientific world still considered most human biology to be generally static. As a result, neuroplasticity was not a widely used term as recently as the 1960s. Even today, neuroplasticity is "more of an umbrella term" that varies in meaning among neuroscientific subfields (Shaw and McEachern, 2001). These can be divided into two major types: structural neuroplasticity, which investigates changes in the strength of connections between cells (synapses), and functional neuroplasticity, which describes changes in synapses due to learning and development (Demarin, Morović & Béne 2014).

One of the most straightforward explanations of the mechanism of neuroplasticity is Hebbian theory, as postulated by Donald Hebb in his 1949 book *The Organization of Behavior*. In simple terms, Hebb's rule is this: "cells that fire together wire together." When one cell repeatedly excites a nearby cell, physical and chemical growth in the receiver cell will increase the efficiency of their synapse connection. Thus, connections that are used more often or with more intensity will strengthen, and weak or unused connections will wither[18]. While in truth the

[18] As anyone familiar with neuroscience will recognize, this is a BIG generalization. The mechanisms of plasticity are so nuanced that they have warranted their own fields and subfields.

mechanism of synaptic plasticity is *much* more complex, this phrase is useful to the layperson in conceptualizing how the brain can essentially rewire itself to suit various purposes and adapt to changing environments.

One example of plasticity used in most intro neuroscience and psychology classrooms today is the 2000 study from Maguire and colleagues that compared the brains of London taxi drivers. In the study, 50 experienced taxi drivers (age 32-62) were demonstrated to have significantly larger posterior hippocampi[19] than the average Londoner. At a time without GPS, these drivers needed to essentially memorize the fastest routes to any destination in one of the world's largest cities. As a result of such highly developed spatial memory, particular regions of their brains physically changed (Maguire et al. 2000).

Since this study and other foundational research, the field of neuroplasticity has exploded. Researchers are fascinated by the possibility for the very structure of our brain to adapt to our needs in a changing environment. These experiential changes, both in childhood development and throughout adulthood may be particularly useful for feminist thought. Firstly, they eliminate the validity of a good deal of determinist or essentialist arguments. When expanded into broader fields like social neuroscience and cultural neuroscience that examine the influence of sociocultural structures on neurophysiology and behavior, we are able to formulate direct challenges to reductionist biological determinism, while still accounting for "the bodily materiality of mind and experience" that has so often been missing from feminist and social theory (Pitts-Taylor, 2016). We can accept, firstly, that we exist in a society that is deeply heterosexist, racist, colonialist, and ableist. We experience this world first as children, in a vulnerable developmental period, and then come to terms (or not) with the social structures we

[19] The hippocampus is a complex midbrain area that is known best for its role in learning and memory, particularly spatial memory.

find ourselves in. Following Butler, we perform our gender daily. We work jobs and spend money, consume media and rhetoric, and contend with discriminatory practices (to varying degrees). It follows that throughout these experiences, minute to minute from birth to adulthood, that the plastic brain is constantly adapting to our needs and experiences, and influences our cognition, behavior, and physical health as a consequence.

More broadly, the notion of a plastic brain capable of responding to experience and socially constructed performance opens a wider theoretical framework from which to base feminist thinking. Pitts-Taylor emphasizes how neuroplasticity is particularly useful for the social sciences and feminist thought: "The plastic, social brain challenges the separation of mind and body, culture and nature, that is characteristic of twentieth-century thought." The ascendance of neuroscience is not a threat to the social sciences. Rather, in the words of Rosse and Abi-Rached, it represents an "opportunity for collaboration across the two cultures." (Rosse & Abi-Rached) Contemporary feminism, queer theory, and disability studies desperately need to better contend with the material body, and theory will continue to suffer when we ignore the physical consequences of oppression. Plasticity allows us to combine our existing knowledge about hegemonic social structures and imagined futures with tangible biological structures. Using this framework, we can attend better to our mental and physical health when doing the difficult work these fields require. We can investigate the role of trauma, poverty, isolation, racism, and transphobia on our physical and emotional beings with greater vigor and more compassion. We can finally return to the body without the fear of essentialist arguments. Without a body, where else would our theory come from? Mainstream collaboration across this divide appears then, while difficult, mutually beneficial.

Living in a Material World

Some of the most transformative work in contextualized embodiment comes from the work of materialist feminist disability scholars[20]. Materialist feminism, briefly, has roots in socialist feminism and Marxist feminism, and highlights the role of capitalism in racist heteropatriarchy. Unlike some other branches of feminist thought, materialist feminism notes how the constitution of the body (through race, class, gender, nation, etc.) contributes to a lack of "material freedom" (often in a socioeconomic sense) while simultaneously these identities are contextually-defined and in a constant state of flux. In a materialist-feminist-disability context, the body is additionally contextualized as a necessarily physical object. (Price, 2015; Erevelles 2011).

In 2015 Margaret Price, frustrated with the inability of feminist and disability theories to adequately and deeply contend with "able-mindedness" and mental disability, wrote the foundational text, *The Bodymind Problem and the Possibilities of Pain*. Price utilizes materialist-feminist-disability work to illustrate her term: *Bodymind*. In her words, the bodymind is "a sociopolitically constituted and material entity that emerges through both structural (power- and violence-laden) contexts and also individual (specific) experience)" (Price 2015). Bodymind is not simply a placeholder term for the combination of body and mind, but the overlapping effect of the two. In other words, "because mental and physical processes not only affect each other but also give rise to each other—that is, because they tend to act as one, even though they are conventionally understood as two—it makes more sense to refer to them together, in a single term" (Price, 2015).

I see bodymind as a particularly useful framework for neurofeminist pursuits. To neuroscientists, it would be ridiculous to think of the brain as distinct in any way from the rest of

[20] That's a mouthful…

the body. Just like any other organ, it is influenced directly by the body's health and exposure from environmental stimuli. In fact the brain controls many of the body's homeostatic and immune mechanisms. If we infer also that the brain and mind are co-constituted, simply different names for the same physical whole, then it is made clear how the mind and body are functionally inseparable and interdependent.

In a feminist context, the concept of the bodymind facilitates conversations about the material causes and consequences of sociopolitical structures. Price herself sees the bodymind as fitting well within Rosemarie Garland-Thomson's materialist-feminist conception of *misfit*. Misfit is a concept of disability that complicates the social model by emphasizing context, relation, and mediation in relation to the physical body. Garland-Thomson famously uses the example of a square peg in a round hole, noting that "the problem… inheres not in either of the two things but rather in their juxtaposition, the awkward attempt to fit them together." (Garland-Thomson 2011). She continues, "The utility of the concept of misfit is that it definitively lodges injustice and discriminiation in the materiality of the world more than in social attitudes or representational practices, even while it recognizes their mutually constituting entanglement." (Garland-Thomson 2011). Particularly for "invisible" mental disabilities, Price sees misfit as demonstrating the intermittent visibility of mental disability and other bodymind variations, and the complication of context on how that disability is negotiated.

Using these frameworks, we can begin to untangle the complex relationships that result in pathologized and unitary conventions in neuro(science). As well, we can begin to more closely interrogate the highly contextual and often deeply physical implications of discrimination and oppression.

Price's bodymind may be particularly useful in conjunction with the Neurodiversity paradigm. As articulated by one of the original authors of the Neurodiversity Movement, Dr. Nick Walker, the paradigm encapsulates three key concepts. Firstly, that "neurodiversity is a natural and valuable form of human diversity," as well as the rejection of the idea that there is any single "normal" or "healthy" brain/mind, or that any one style of neurocognitive functioning is "right". (Walker, 2021). Finally, the paradigm illustrates that the social dynamics that emerge surrounding neurodiversity are "similar to the social dynamics that manifest in regard to other forms of human diversity (e.g., diversity of ethnicity, gender, or culture.)" (Walker, 2021). Most importantly, it rejects that autism or any other neurotype are disorders or ought to be pathologized. Neurodiversity is easily understood thusly as a bodymind variation, that is constituted socially in different material and cultural contexts.

Price herself uses stimming[21], a classic neurodivergent practice, as an example for the bodymind as misfit in particular contexts. She writes that "stimming… might be read by various observers as impolite fidgeting, a pathological need to self-soothe, or an expression of Autistic identity… Stimming is a highly contingent phenomenon, contingent not upon a physical metric such as the height of a step, but on the affective response of those who observe and interpret it" (Price, 2015). Different forms of neurodivergence can often appear invisible to the unfamiliar eye, and as such characteristic behaviors like stimming may incur various contextual reactions.

These frameworks are perfectly aligned to contribute to the betterment of neuroscience. As previously noted, (neuro)science has a historic difficulty dealing with intersectionality and human variance. Opening the boundaries of "acceptable" or "normative" bodies and cognitive styles to include a more representative set of the human population will not only improve

[21] Stimming is a practice characterized by making repetitive motions or sounds, like rocking back in forth or shaking one's hands

research methodologies and benefit marginalized communities, but will also contribute to a larger societal acceptance of such neurotypes. When highly-regarded scientific institutions classify identities as pathological, it opens the door for all other institutions, from government to private healthcare and insurance corporations, to openly discriminate against those identities. Walker demonstrates this issue saliently in a discussion of person-first language: "If you read an article in which the author consistently referred to gay people as 'people with homosexuality, adults who have homosexuality, and individuals living with homosexuality, what would be your impression of that author's attitude towards being gay?" (Walker 2021). While she is speaking here to the issue of person-first language when speaking about disability and autism, Walker also clearly identifies the issue of pathology. Until not too long ago, queerness was highly pathologized, enough to be published as a form of psychopathology in the DSM. (Dresher, 2015). It is not too great a leap to infer that in another 50 years, autism and other forms of bodymind variation might be widely accepted as absolutely healthy identity categories.

This does not mean that all research into bodymind variation of all kinds should stop altogether. Instead, research into autism and other forms of neurodivergence ought to proceed with caution. Research for a "cure" for autism, or for a single genetic cause for autism to be used in prenatal testing, should cease. But any fascinated neuroscientists will recognize that to open the frame of a "healthy" brain opens a world of questions into neural structure, function, and consequences for behavior. We might even ask, as I will in later chapters, how alternate modes of socio-affective and socio-cognitive processing influence our perception of existing social structures…

Where is the Love?

Following a chapter-long tirade on all the reasons science sucks, it must be difficult to come back to investigation with any optimism. In writing this paper, I honestly asked myself many times, why do research at all? Can I in good conscience advocate for such work, after witnessing the atrocities science is capable of? On most days, I didn't know for sure.

I was stopped, finally, by a chance encounter at a table of discarded books in an empty hallway. Evelyn Fox Keller's 1985 book, Reflections on Gender and Science, was my answer. In the text, she offers what seems to me to be a love letter to science.

She writes, "the scientist employs a form of attention to the natural world that is like one's ideal attention to the human world: it is a form of love. Such intense interest in the world, and such total absorption in the object before one, is especially familiar in young children" (Keller 1985). I am immediately returned to my own childhood, and long days spent collecting rocks and craning my neck to stare at the sunshine streaming through the treetops.

In many ways, Keller crossed the bridge that I couldn't, trying to find the good amongst the bad. She describes the "aggression expressed in the common rhetoric of science." The researcher is set opposed to the object of study, like predator and prey. The question is one to be mastered, eliminated, or solved. She cites biologist T.S. Painter, who she quotes as saying "research is much like deer hunting. You have to be in the right place at the right time to see your prey and, of course, you must carry a loaded gun and know how to use it" (Painter 1971). How terrifying. Yet, she argues, this does not have to be our mindset in the sciences. For those of us without sadistic tendencies[22], the work needn't be so vicious.

[22] For those scientists do exist…

Perhaps then, what has been missing from this analysis is love[23]. I don't mean this in a vague, abstract sense. Genuinely, I believe we often lose our sense of compassion in science.

But the love is certainly there. We wouldn't do this work if we didn't care about it. As much as we may try to distance ourselves from our studies, we still have feelings. We are upset when the gels don't run, or the computers crash. We sigh with relief when the project is over. We laugh together in lab meetings. More often, we cry. Researchers, at least those with much sense, do not enter the world of laboratory academia for fame and fortune. Any professor at this college, I believe, would openly tell you that. Science of this kind is pursued out of passion, desire, out of love. As much as those in the sciences preach a strict code of ethics and calculation, emotion pervades the lab hallways. Under fluorescent lights and chemical hoods, drifting through chilly hallways and passcode-guarded basements, and rushing from the doors and windows are excited gasps, exhausted sighs, and exasperated moans. I have known students and faculty alike to breathe these spirits into being, to be absorbed in the walls of Olmstead and the Bridge. Particularly at a small institution such as ours, science is a labor of love.

Rationality and emotion need not be so oppositional. They are mutually informed. The most useful framework then, to guide all our work, feminist and neuroscientist alike, is a framework of compassion. In conjunction with the other frameworks I've noted here, we must exercise compassion for the vast spectrum of human experience. We can approach first with that intense childlike curiosity, rather than with the eye of the distrustful cynic. We can imagine bigger and better worlds, and equitable futures.

"In order to have an object speak to you, you must take it for a certain time for the only one that exists, the only phenomenon which, through your devoted and exclusive love, finds itself placed in the center of the universe" (Schachtel 1959)

[23] Jesus, how fruity can you get??

Haraway approached her work with love, and it allowed her to envision a cyborg utopia, where the divisions between nature and culture have dissolved, and endless forms of variation are normalized and encouraged. Neurotechnology has improved exponentially since Haraway's manifesto. What utopias might we imagine now?

In the following chapter, I'll return to some of the previously mentioned political issues, this time with the frameworks of bodyminds and neurodiversity, in the production of a more compassionate neurofeminist science.

Chapter 3: Addressing the Solutions

It is comparatively easy to critique and problematize issues of academia, particularly in fields whose methodologies we see as so contrary to our own. Putting these issues into practice, however, and creating actionable change, is often much more difficult. As Hilary Rose wrote in 1983, "the task of developing a feminist critique of existing science and of moving toward an as yet unrealized feminist natural science is at once more difficult and more exciting that the academcially respectable activity of making descriptive reports on women's position within science" (Rose 1983).

I don't believe that the issues between the fields are necessarily intractable. Is that undergraduate idealism speaking? Naivete? Perhaps. But scholars much more experienced than I have maintained throughout the years that a relationship between the sciences and gender studies is indeed possible, even barring a total revolution and overthrow of the capitalist regime.

The issue is not that critique doesn't exist or hasn't been made. It's not difficult to stumble down a rabbit hole of feminist criticisms for every niche and micro-field in the sciences. However the singular disciplinary nature of the sciences causes the field at large to disregard all

but the most moderate, mainstream, and well-known of these critiques. “You may have written a paper that settles a fierce controversy once and for all, but if readers ignore it it cannot be turned into a fact.” (Latour 1987). As well, the factor of expertise and terminology complicates how critique of science is communicated. Eric Llaveria Caselles writes, “If I want to comment on neurological research on sex and gender, I have to grasp a certain amount of knowledge produced in this field not only to understand but also to be acknowledged and heard. On the contrary, neuroscientists who look into matters of sex and gender are not expected to learn from or do the same groundwork in gender studies, and as such their ignorance on these matters won’t invalidate their claims within most of the scientific community” (Llaveria Caselles 2018, 153). This point is true not only for sex/gender research, but virtually all human neuroscience. Researchers examining questions with direct sociopolitical implications are not required to be experts in that political topic, just the neurophysiology or psychological profile. While there are authors in the field who take the time to engage consciously with the ramifications of their work outside personal aspirations, it is never required for a scientist to proclaim expertise, and as a result such authors are few and far between.

The following examples are meant to illustrate how our two fields can be mutually-informative. Collaboration across disciplines, particularly for those who identify that they aren’t experts in the topics they wish to investigate, will undeniably improve the research questions themselves, and the results that follow. Utilizing the frameworks of neurodiversity, the bodymind, and with a compassionate and optimistic spirit, I’ll return to several key issues.

Approaches to Objectivity

In the past 5 years, the question of objectivity has new relevance. Particularly in the present post(?)-Pandemic world, when Science as a concept is its own political issue, even those

on the left seem to worship science as a righteous and pure pursuit of knowledge, unlike any other field. I believe one of the most significant moves towards a feminist neuroscience in the coming years is to make all researchers aware, by whatever means necessary, that science is not and cannot be unbiased.

Feminists have taken several different approaches to this problem. One of the first is Standpoint theory, which operates on the basis of situated knowledge. Worked and reworked by Donna Haraway and Sandra Harding, standpoint theory attempts to address the epistemological issues of pure objectivity. As demonstrated in Chapter 1, true objective empiricism in the sciences devoid of social, political, and historical influence is impossible. Standpoint theory and the idea of situated knowledge "not only acknowledges the social situatedness that is the inescapable lot of all knowledge-seeking projects but also, more importantly, transform it into a systematically available scientific resource" (Harding 129).

Expanded by the work of Patricia Hill Collins, standpoint theory is now understood to be non-essential, as the standpoint may come from any individual woman, rather than one idealized universal Woman. As Harding later writes, "there is no single, ideal woman's life from which standpoint theories recommend that thought start. Instead, one must turn all of the lives that are marginalized in different ways by the operative systems of social stratification. The different feminisms inform each other; we can learn from all of them and change our patterns of belief" Different issues in neuroscience may be approached uniquely by different groups. For example, Black low-income mothers are particularly targeted in studies of SES and maternal development. How would the standpoint of these women change the variables examined or the methodologies used? Neuroimaging studies on brain region sex/gender dimorphism tend to target transgender women. How might these women reframe the question of gender dimorphism at the start?

However, as Harding has pointed out, this does not give, for example, a cis white man, an excuse for not understanding and producing feminist analyses! She writes, "Far from licensing European-Americans to appropriate African-American thought or men to appropriate women's thought, this approach challenges members of dominant groups to make themselves 'fit' to engage in collaborative, democratic, community enterprises with marginal peoples. Such a project requires listening attentively to marginalized people; it requires educating oneself about their histories, achievements, preferred social relations, and hopes for the future; it requires critical examination of the dominant institutional beliefs and practices that systematically disadvantage them; it requires critical self-examination to discover how one unwittingly participates in generating disadvantage to them… and more" (Harding 135). In short, it is no longer acceptable to claim well-wishing ignorance, particularly as an "expert" in the sciences. Regardless of one's own identity, there is a necessity to self-educate and engage productively with centuries of theory and practice.

Critics of standpoint theory and its efficacy in the sciences may conclude that there is no way to have a fully socially situated form of knowledge and knowledge production. Harding writes back by reframing the question: if there is no fully socially situated form of knowledge, then there can be no true objectivity for anyone. If science is to maintain an air of objectivity, it *must* use standpoint theory; take into account the social position of the researcher and researched, and evaluate all aspects of the method from a variety of marginalized perspectives.

An alternate, but quite similar, framework comes from Evelyn Fox Keller and others, called dynamic objectivity. In Keller's words, dynamic objectivity is "the pursuit of a maximally authentic, and hence maximally reliable, understanding of the world around oneself. Such a pursuit is dynamic to the extent that it actively draws on the commonality between mind and

nature as a resource for understanding." (Keller, 1985). She describes this objectivity as "not unlike empathy" in that it draws on common experiences and feelings to enrich scientific understanding. Perhaps, then, dynamic objectivity is just another name for a compassionate standpoint theory, that attempts to understand someone else's situated knowledge and embodied affect towards the goal of an authentic truth.

In practice, standpoint theory could be applied in a number of ways. Most generally, it requires a broader understanding of the sociopolitical implications of various human neuroscience questions. Scientists of any human research field must then educate themselves on these topics before embarking on potentially incendiary research, no matter how well-intentioned that research may be. This may require neuroscientists and feminists alike to take a joint approach to research! Rather than a barrier to the scientific process, I see this as an opportunity to create a new multidisciplinary field, with compassion at its heart.

On Sex/Gender Research

As noted in earlier chapters, study of comparative neuroanatomy in various populations has been compared to modern day phrenology. Size, shape, and structure of basically arbitrary brain regions are used to justify the existing social structure, particularly in sex/gender questions, but also in questions of race, sexuality, class, and other factors. We know so little about the human brain at all that it is difficult to justify any of these findings as particularly conclusive. Judgements about a larger, smaller, denser, or more active brain area being better or worse are often purely conjecture, and there are always exceptions that prove the rule. As authors Rebecca Jordan-Young and Rafaella Rumiati write, sex/gender neuroscience research is "a bit like the sun: there is a limit to what we can learn by looking straight at it, and we might just go blind trying." (Jordan-Young & Rumiati 2012).

There is some debate as to whether sex/gender questions of neuroanatomy, cognition, and behavior should even be asked at all. If the investigative questions themselves are based inherently in stereotype and social norms, rather than actual biological data, what effort do they actually serve? Jordan-Young and Rumiati suggested in 2012 that "even careful studies of sex/gender differences, at this time, may be missing the point. Rather than continuing to build and revise the list of differences (which are inevitable so long as social life is pervasively structured by gender), the question to ask know is *why* is it that we want to know about sex/gender differences? What do we wish to do with or about them?" They note that since scientists cannot ethically assign random human fetuses to various hormone exposures to test the 'hardwiring paradigm,' and that the only available designs to correlate sex/gender behaviors to neuroanatomy are "quasi-experimental" at best, there is little to be gained and a high potential cost to such research. "In particular," they write, "the notion of innate sex differences has led both lay observers and some scientists to suggest that social policies directed towards gender equity in education, occupation, or other aspects of life are either useless or actually damaging" (Jordan-Young & Rumiati 2012). This is not even to speak of the potential fodder for TERFs and transphobes that studies like these might serve. Perhaps studies like these should not be done at all.

Again, these studies emerge with the baseline assumption that men and women differ tremendously in some essential aspect, from behavior, opinion, emotion, or brain function. By reframing the question, and operating not on the assumption that men and women (or cis women and trans women, cis men and nonbinary people, etc.) are essentially different, but are instead statistically quite similar. To reiterate: "In a society in which racism and sexism were absent, the

question of whether whites or men are more or less intelligent than blacks or men would not merely be meaningless - they would not even be asked" (Citation).

In more recent work, however, Jordan-Young has collaborated on projects speaking also towards sex/gender neuroscience research, this time more favorably. She, alongside authors Gina Rippon, Anelis Kaiser, and Cordelia Fine, proposed in an article for Frontiers in Human Neuroscience a straightforward and comprehensive blueprint for theoretical and methodological changes in sex/gender neuroimaging research. Aside from essentially providing a handbook for all neuroscience researchers (or at least those involved in neuroimaging) on sex/gender distinctions, the authors provide clear recomendations for the future of the field, including sample sizes, statistical interpretation, and implications for neuroscience broadly. As they write, "unless they have specific expertise or knowledge in gender scholarship, [neuroscientists] too are laypeople with respect to gender research" (Rippon et al 2014). By addressing the hole in the scientific literature in regards to sex/gender neuroscience in a highly-regarded journal, Rippon, Jordan-Young, Kaiser, and Fine have made it near impossible to continue to claim ignorance on many of these topics. Work like this 2014 paper and others have condensed nearly a century of critique into realistic and actionable goals for the field. They illustrate four key principles, guided by decades of feminist work in sex and gender: overlap, mosaicism, contingency, and entanglement.

The idea of Overlap derives significantly from a series of thorough meta-analyses that have demonstrated that sex differences, both in performance and brain structure, tend to substantially overlap (Hyde 2005; Miller & Halpern 2013; Hyde 2014). Just like averages of height, some women will be much shorter than the average man, and some will be taller. Brain volume tends to scale with body size, so men tend to have slightly larger brains than women on

average, but there is still a similar degree of overlap. When volume differences are controlled for, several studies found that any regional size differences are nonexistent. (Leonard et al 2008). As an example, take the corpus callosum. This structure is a thick bundle of fibrous nerves (estimated to be about 300 million on average) down the midline of the cortex that connects and facilitates communication between the two hemispheres of the brain. For many years researchers have claimed that the female corpus callosum is larger and "more bulbous" than males'. However several other studies that have matched between sexes by brain size have found no support for this claim (Bishop and Wahlsten 1997; Luders et al. 2014). Most human sex-difference studies investigating areas tied to behavior, cognition, and emotion find considerable overlap (Juraska 1991, McCarthy and Konkle 2005, Cosgrove et al 2007 Koscik et al 2009, Lenroot and Geidd 2010).

The brain mosaic model builds well on this overlap framework, and has been written about primarily in the work of neuroscientist and neurofeminist advocate Daphna Joel, although the model has been recognized since the 1990s. The mosaicism model suggests that no brain can be completely male or female. In other words, a brain that has a particularly large (male) callosum, may also have regions that tend to be larger in females. The same seems to be true in measures of brain activity in tasks traditionally sex-differentiated tasks, like language or emotional processing. Thus, it is not possible for an individual to have a "single-sex" brain. Indeed, no researcher would be able to consistently identify a brain as male or female by looking at it. Instead, Joel puts forth that brains are intersex, and cannot be identified as a binary (female/male) brain, since there is no replicable evidence to suggest that dimorphism is an accurate characterization of neural sex/gender differences. (Rippon et al. 2014) As Joel writes, "there are no 'true' 'male' and 'female' brains out there to discover." (Joel, 2011)

The final two frameworks of contingency and entanglement address intersectionality within sex/gender neuroimaging research, particularly by pointing out how social contexts complicate measured task performance and brain characteristics. Contingency, in the words of Rippon et al, describes the way in which gendered *behavior* arises from multi-level factors, including structural factors (cultural norms and policies), social factors (status, context, interpersonal dynamics), and individual factors (biological characteristics, gender identity, self-concepts, and experiences). Using various famous examples from the literature, they demonstrate that performance is contingent on the framing of a task, amount of experiential training, and social context (Fine 2010a). One of these examples is the "stereotype threat" phenomenon. In studies of the phenomenon, women tended to do more poorly on a mathematics test when the stereotype that women are bad at math was made salient during test presentation. (Nguyen and Ryan 2008, Spencer 2009). Intersectionality is also an important factor, even in this single example. Hyde 2014 found that gender differences in math performance in the US have decreased over time and vary by ethnic group.

Entanglement refers to variations in the nervous system that are impacted by contextual factors that reflect these behavioral differences. More specifically, it denotes that biological sex (determined jointly by genetics, gonadal hormone levels, and genital endowment) (Joel 2011), is inextricably tied to social phenomena of gender. Essentially, the tenet of entanglement ensures that researchers do not attempt to separate sex from gender as distinct factors, and that the context of gendered socialization cannot be taken as separate from sex.

If neuroscientific research into sex/gender differentiation is to continue, it must be consistent with contemporary gender theory. By following these (rather generous) recommendations, research might continue with better intentions and fuller understanding.

Despite the wealth of evidence that environmental changes, skill learning, and new events can alter brain function and lifelong neurocircutry, there is relatively little information about how plasticity relates to sex and gender. I tend to agree with Jordan-Young and Rumiati's earlier work. I do not see any utility to comparative or correlational sex/gender research, other than to serve a conservative and predatory agenda. Instead, they argued, we might ask more directly applicable questions. As Jordan-Young and Rumiati write, "We might build on Feng et al.'s video game intervention by identifying some skills and traits we can agree are desirable, and for which there seem to be reliable sex/gender differences at some point in the lifetime. Mental rotation is a good example, but there are others, like strong contextual verbal ability or empathy. Likewise, we could build upon experiments to show how invoking either positive or negative stereotypes can stimulate sex/gender differences as large as those that are usually taken to be innate." (Jordan-Young & Rumiati, 2012). This is once again fertile ground for multidisciplinary collaboration. A more thorough analysis of intersectional systems of oppression, combined with the ability to detect social structure on physiology and behavior, might grant much more useful data than any study on the bed nucleus of the stria terminalis. As well, these more carefully crafted investigations might better attend to intersectional identities and higher degrees of mindbody variation.

Disability and Extended Functionalism

Like Haraway, Pitts-Taylor, and other authors have argued, one way to introduce a more intersectional reading of brain sciences is to utilize the frameworks of Disability theory. Unlike most other structures of thought, the various theories of disability activism are uniquely capable of contending with fluidity, nuance, and heterogeneity. The human experience often diverges, and disability groups recognize that accessibility means something different to every person. In

the same way, disability offers a way of viewing the world with new possibilities, and ways of understanding that difference is not "abnormal" or "incapable." As Tobin Siebers accounts, "Blind hands envision the faces of old acquaintances. Deaf eyes listen to public television. Tongues touch-type letters home to Mom and Dad. Feet wash the breakfast dishes. Mouths sign autographs" (Seibers 2001, 737). "Such assemblages could in theory be offered as evidence for extended functionalism; they show that the same task can be achieved by multiple means and with different resources."

We see this "extended functionalism" reflected in the brain as well, which disrupts the idea that there is a single normal functioning brain. For example, consider Tobin's poetic account that "blind hands envision the faces of old acquaintances." Several papers have noted that the visual cortex of blind patients, which normally responds only to signals from the eyes, can respond to tactile and auditory stimuli, which is not possible in seeing people. Reading braille, for example, activates the primary visual cortex in a similar way that reading with the eyes would. (Sadato et al. 1996, Finney, Fine, & Dobkins 2001). This "cross-modal" plasticity completely reorganizes a major brain region, giving greater space to the other sensory modalities. Despite a difference a seeing person might consider debilitating, the brain completely reorganizes, and does essentially the same task in a different way. Neuroplasticity thus serves as a useful tool to subvert or at least reframe the ideal of a healthy, able, and normative body.

In fact, our definition of "healthy" or able brain might need to be expanded to a surprising degree. There are many famous case studies, some published, some not, of individuals with relatively normal neurocognitive functioning, who were later found to have little actual neural tissue. In a 2007 case study, a 44 year old French civil servant went to the hospital for mild leg weakness and was found to have severe hydrocephalus, a buildup of fluid which

destroyed brain matter to a huge degree. (Feuillet, Dufour, Pelletier, 2007). A 2014 case study found a normal-functioning 24 year old Chinese woman who was found to have the incredibly rare condition cerebellar agenesis, or the absence of the cerebellum. She suffered from dizziness and difficulty walking a straight line, but was otherwise unaffected. (Yu, Jiang, Sun, Zhang, 2014). These results, particularly tissue loss with normal function following severe hydrocephalus, have been replicated in rodent models as recently as 2019 (Ferris et al 2019). How did these individuals not only survive, but succeed with completely absent brain areas? If they are completely unaffected by such differences, there seems to be little sense to characterize these conditions as dysfunctional or unhealthy. Normative structure is not necessarily required for a perfectly functioning brain.

In patients with traumatic brain injury (TBI) causing permanent damage to particular functional areas, we see return of the abilities with practice - different areas can take the place of those that were damaged. Feet can wash the breakfast dishes because of a combination of human ingenuity and the rewiring of the motor cortex. Deaf eyes listen to public television with a visual cortex that responds to auditory information. Normative functioning is not necessarily required for a perfectly healthy brain.

Understanding these cases in conjunction with paradigms of neurodivergence completely subverts our current understanding of a normative bodymind. Reformulating or completely rejecting the norm may be the key to a shared understanding, and an increased attention to variability within the scientific community.

Neuroqueering Gender

I'd like to conclude this chapter by discussing some of the most exciting multidisciplinary work I've seen across the literature of both fields. It was suggested to me by a

number of different people to investigate the connection between being both autistic and transgender or genderqueer. At the time, I didn't know what to make of it. Just a weird coincidence maybe?

In fact, the research points to a real and replicable correlation. Several recent meta-analyses have noted that there is a strong statistical relationship between autism and gender-diversity (the overarching term in the literature to describe transgender, nonbinary, genderqueer, and other non-traditional gender categories) (Warrier et al. 2020; Van Der Miesen, Hurley & De Vries 2016; Janessen, Huang & Dunan 2016; Strang et al, 2014; Schiltz et al. 2021). Transgender people, both men and women, were found to be up to 6.36 times more likely than cisgender people to be diagnosed as autistic. (Warrier et al. 2020). This is true in both directions, as autistics have been found to be anywhere from 5.4 to 7.76% more likely to be "gender variant[24]" compared to an approximate 0.7% of neurotypicals (Strang et al, 2014; Janessen, Huang & Dunan 2016). Notably, these statistics were not affected by age, sex-at-birth, or education attainment, suggesting a surprising level of consistency across the dataset.

Various of these authors have cautiously suggested hypotheses for a causal relationship. Many authors, continuing to pathologize both transgender or other non-cisgender identites and autism simultaneously, suggest that this correlation may be due to psychological factors, early testosterone exposure, or gender confusion due to overly "black and white" thinking (Strang et al. 2014; Van Der Miesen, Hurley & De Vries 2016). Alternately, and more in line with the neurodiversity paradigm, Warrier and colleagues suggest that "autistic individuals may conform less to societal norms compared to non-autistic individuals" (Warrier et al. 2020).

[24] These particular studies define "gender variance" as "a child's wish to be the other gender." (Strang et al. 2014; Janessen, Huang & Dunan 2016).

Nick Walker, one of the foundational authors on Neurodiversity and Autistic empowerment, has much to say on this topic. Walker, for what it's worth, is herself queer, transgender, and autistic, and feels strongly that the experience of being autistic is quite similar to the experience of queerness. She writes that the experience of masking (the act of suppressing visible expressions of autism, like stimming) felt very similar to the experience of having to suppress her femininity to pass as a cishet man to survive. She suggests that the forces that confine individuals to perform heteronormative gender are not just similar to those that push autistics to perform neuronormatively, but are "deeply and thoroughly entwined with one another, with no solid dividing line between them," which infers then that "the process of liberating myself from the confines of heteronormative performance was also inseparably entwined with the process of liberating myself from neuronormative performance." (Walker 2021). To do so, one must simultaneously queer heteronormativity and neuronormativity, because they cannot exist separate from each other. This act, neuroqueering, has enormous potential for theory-building across bodymind variations and academic disciplines. To neuroqueer, in as close to an authoritative definition as she can muster, is 1) the act of being both neurodivergent and queer, 2) embodying/expressing neurodivergence in ways that queer the performance of gender/sexuality/ethnicity/identity, 3) engaging in practices to subvert one's sociocultural conditioning to reclaim the capacity of full expression, 4) engaging in queering one's own neurocognitive processes to diverge from neuronormativity and heteronormativity, 5) approaching/embodying/experiencing one's neurodivergence as queerness, 6) producing scholarship or other cultural artifacts to foreground neuroqueer experiences, 7) responding critically to other cultural artifactss that focus on neuroqueerness intentionally or unintentionally,

and 8) working to transform sociocultural environments to create spaces/communities where these practices are accepted and encouraged. (Walker 2021).

While this theory is still in its infancy, it opens tremendous opportunity in both neuroscience and feminist efforts. The simultaneous subversion of heteronormativity and neuronormativity creates a clear connection between bodymind variation and social structure that confines the authenticity of selfhood. The act of neuroqueering offers a direct subversion of both material and imagined structures. I hope that this theory is accepted more widely in the mainstream of femininist-disability work, as it will continue to inform my own thinking in the years to come. Neuroqueer imaginings seem to take us one step closer to a true queer utopia.

Conclusion

There is an inevitable difficulty when two completely polar disciplines attempt to speak across the divide to each other. And yet, there are countless incidences when feminist work comes into direct contact with neuroscientific work, and vice versa. While we may differ in our central ideologies, we work towards a common purpose: to pursue knowledge that may benefit all of humankind. If we are able to embrace a material-semiotic vision of neurodiverse bodyminds, what else might we imagine?

At the heart of the issue, we must reframe science as a tool of liberation. “If a true science is to reachieve the liberating role it had in the time, say, of Galileo, it must, like Galieo, once more stand in opposition to institutionalized science. It must become critical” (Rose 71). There is immense potential behind the doors of the lab. It has been hidden by the structures of capitalism, neoliberalism, and racist heteropatriarchy that have for so long limited feminist theory as well. If we desire to break those bonds and discover a more authentic and compassionate mode of being, we must be able to do the same across all academic disciplines.

The brain is a beautiful thing. It is something we all share. It is all we are. Now is the time to embrace it.

Personal Reflections

Many neuroscientists begin as children with the dream of becoming an astronaut. We dream of life among the stars, and memorize the names of the planets to tell our friends at school. Then somewhere along the way, perhaps deterred by the qualifications of space travel (I don't even like flying on airplanes very much) we find ourselves grounded. And yet there is still a hole in our hearts that yearns to understand the unknowable, to float in an infinite sea, to touch the stardust of creation and return to tell the tale.

There is an infinite and mysterious world within each of us. The brain, or rather, the mind, while measurable and tangible, is perhaps the single largest mystery of human existence.

My initial goal in undertaking this thesis was to investigate ways in which the two epistemologies could conceivably speak to each other, in a process of mutual improvement and towards the goal of queer and feminist emancipation. Like many projects, it has grown quickly out of hand. In many of my readings, the two fields seem to be asymptotes of each other, with theories that grow ever closer to each other but are never able to touch. Growth in one that draws it closer to the other only opens more questions, and weaves them farther apart.

I began this project without seeing the two as mutually exclusive, or even particularly different from each other. The academy in general is plagued across the board by the same issues we seem to identify primarily in the hard sciences. We in the study of gender, queerness, and critical philosophy tend to see ourselves as the moral matriarchs, perhaps not as good or pure as we intend, but at the very least doing a better job of it than everybody else. We in the study of matter and organism tend to see ourselves as guardians of fact, the laborers of academia, and

generally the only people who take ourselves seriously (apart from perhaps the economics departments, but I think we can both agree to remove capitalists from the equation at this time). Despite these arrogances, there is much similarity between our mutual goals. The search for knowledge, of self, other, and universe. The construction of things. Means and methods of change. Spirit, passion, love.

A week before I concluded this thesis, I watched a fragile life wither away in my hands for the first time. I looked on as a beating heart the size of my pinky nail slowed to a stop. I stood by, cold and unfeeling, blank.

When I made it back home, I cried. I cried for a creature with no name.

I don't know how to remark on this, except to say that the work is not easy. We often pretend that the burden of our work does not reach us. We are beings beyond emotion, loveless and soulless. This is not true. Nor should it be.

I have made many arguments in this document. However the biggest hope I have for a reader of this text, from any field and any interest, any pursuit of knowledge, is that we cannot lose touch with the love within ourselves. Even when the work is hard, when we witness loss or get hurt ourselves, when the burden grows too large to carry, when the frustration mounts and the urge to escape is more and more enticing, we must remember the love. "Of course," Haraway writes, "love is never innocent, often disturbing, given to betrayal, occasionally aggressive, no stranger to domination, and regularly not reciprocated in the ways the lovers desire… love is relentlessly particular, specific, contingent, historically various, and resistant to anyone having the last word."

We live in a terrifying and beautiful world that is both real and imagined; a world that we can touch and yet never understand. Our quest to know it, to understand our existence, is never going to end. We can only hope, then, to find a knowledge that represents all of us.

There is a reason for doing such difficult things. We are human. The search for knowledge exposes not just the truth of the universe, but the truth within ourselves.

To the little girl in the bowl cut and dinosaur t-shirt, I hope I've made you proud.

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