

Nature As Mother: Perceptions of Women in Science and the Natural World

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NATURE AS MOTHER:
PERCEPTIONS OF WOMEN IN SCIENCE AND THE NATURAL WORLD

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A THESIS SUBMITTED TO THE FACULTY OF GUILFORD COLLEGE IN PARTIAL
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Introduction

The root of the word genius is “genus”, meaning birth or life. The word is dedicated to synthesis but its root sets itself parallel to reproduction. Isaac Newton was considered a genius because he gave new life to the universe through mathematical reasoning and a connection between the cosmos and man. Using this imagery isn’t limited to how we describe great thinkers. Centering new ideas and innovation on reproduction is common. People will describe their idea as a “brain child”, a new project as “their baby”—one of the most famous characterizations was the atomic bomb that was eventually dropped on Hiroshima and Nagasaki, Japan. Heads of the project coded the bomb as “Oppenheimer’s baby”. They would call it a bouncing boy, describing its mass destruction as “loud” and lively. More than a hundred men contributed to this one piece of weaponry that would kill more than one hundred thousand people. Not many people realize that women contributed as well, even though the bomb was personified as a child and women are considered to be natural caretakers. Whether it was considered a bouncing baby boy or a uranium atrocity, this work of genius was credited to the male scientists and left the women on the perimeter of the mushroom cloud.

Many of the women involved played integral parts in the chemistry and construction of the bomb. A mineralogist named Helen Bartlett developed the non-porous porcelain that lined the inside; it was the same kind of porcelain that would eventually be used in spark plugs. Margaret Foster, the first female chemist for the United States Geological Survey, innovated new methods to analyze thorium and uranium, two elements that were fundamental in the bomb’s chemistry (Rossiter, 1995, 10). But one of the most famous women to work on the project was Leona Marshall Libby. When Enrico Fermi decided to build the world’s first nuclear reactor, Libby was the sole female scientist to be a part of the project:

In an interview in 1995 interview, she was asked about her private bathroom at the lab in Hanford, how she cared for her child, and if she was a “babysitter” for the reactor. She consistently passed off those questions and focused on the cohesion of the physicists in her field. They were all motivated by fear which decreased any gender-based friction:

“[T]he Germans were ahead of us. That was a persistent and ever present fear, fed of course by the fact that our leaders knew those people in Germany and had gone to school with them at every major university. So we were terrified.” (Voices of the Manhattan Project, 1986, transcript of recording)

Yet she was still singled out in the interviews for her role as a woman in the project. Like many of the contributors, she believed in the project and therefore wanted to be seen as an equal contributor for her work. But after the war, the Rosie the Riveter caricature fell out of style (Howes and Herzenberg, 1999). The women who were thrown into the war effort were deemed as obsolete, only good for fueling the American dream:

“The public-relations mechanisms that had actively encouraged women to work for the war effort now appealed to them to give their jobs to returning soldiers. The popular press lauded the women who cooked and cleaned for her family and bore children for her husband.” (Howes and Herzenburg, 1999, p. 181)

Women were aligned as agents for reproduction rather than taken seriously in an academic setting. This attitude has resonated for centuries through language, rhetoric, and philosophy. Although men can take the roles of creators or inventors of thought, women are underestimated consistently. While some of these limits are systematic, like the policies that barred women from voting, education, and job opportunities, many limits are a result of societal expectations. Women can create new life biologically, but synthesizing ideology or logic has

historically been considered to be beyond their sex. Female scientists have directly challenged this thought process by simply putting themselves in the arena of academics: re-connecting themselves with both the modern definition and the root of genius.

In exploring the history of science, more and more women have come into the spotlight. Whether they were initially ignored, or newly discovered, these women are notable for their diligent work and notoriety within their field. But social barriers still come into play, including how we characterize female personalities, and how we overtly set expectations for a woman's behavior. In Libby's case, she was expected to have a different kind of role in her field due to her sex. Whether this assumption was based on her role as a mother or her rationale behind the bomb, she is still understood as not just a scientist—but a female scientist. This alignment implies connotations and patterns that have been implicitly and explicitly reinforced by society and individuals. Tim Hunt, a physiologists and biochemist who won the 2001 Nobel Prize in medicine, made a comment in June 2015 about his relationship with women in the lab: "Let me tell you about my trouble with girls ... three things happen when they are in the lab ... You fall in love with them, they fall in love with you and when you criticize them, they cry" (Greenberg, 2015, p. 1). This news story escalated quickly and female scientists responded by posting sarcastic remarks on social media, digging at Hunt's comments. One "Twitter" post read "I'm glad [Marie] Curie managed to take a break from crying to discover radium and polonium" (Remeikis, 2015).

While many news sources have noted that the quote was taken out of context, Hunt's comments reflect on a trope that has been projected on women for centuries: an emoting damsel. Women are deemed emotional beings, and since science is considered an objective study, they are unable to participate. Their natural state is perceived as simply too subjective.

Although these traits are imparted on a woman's personality or habits, it also reflects on our physical portrayal of women. After World War II, the informal "American Dream" campaign that dominated media in the United States portrayed women as housekeepers and mothers, and they were expected to look presentable and uniform. But this imagery goes further when we start to delve into how women's bodies have been aligned with larger entities that are often controlled by masculine forces. One of the greatest examples is personifying of nature as mother, and therefore as woman. Emily Dickinson called nature the "gentlest mother" in her poetry and we see countless depictions of nature as a mothering figure throughout mythology and art. The idea of nature as a female can be connected back to pre-Newtonian philosophy that compares the earth to a womb. In 1500, an alchemist named Basil Valentine described this relationship through explaining that the earth is not just a stagnant place we inhabit:

"This spirit is the life and soul that dwell in the earth, and are nourished by heavenly and sidereal influences...fed by the stars and is thereby rendered capable of imparting nutriment to all things that grow and of nursing them as mother does her child while it is yet in the womb."
(Merchant, 1980, p. 7)

Intertwining nature's role with birth gives a distinct character to our earth, but the perception of that character has developed through different lenses and ideologies. When natural processes and phenomena are interpreted through a male-dominated perspective, the role of science can start to take a gendered lens. Since women have been considered anatomically and intellectually inferior to men—passive, ductile, and only valued if untouched—we have seen the same characteristics being passed onto the development of land. Changes in the philosophy, language, and imagery surrounding nature are parallel to perceptions of women in Western

society and how women interact with the natural world. Studying the shared rhetoric between woman and nature can help us understand this interaction.

In the following analysis, I explore how nature is understood as female and how that affects the language used in scientific discourse. I also map out the ways that men have not only commanded influence in scientific inquiry, but also appropriated certain studies and practices from women. Through accounts of women in science, I will analyze women have entered their respective fields, and the adversities they've faced by doing so. By conveying their steady influence, I also explore how women in the 20th and 21st centuries have adopted the tactics of the female scientists that preceded them, but also developed their own sense of identity through solidarity, activism, and a new definition of science.

Chapter 1:

Aligning women with nature and science, the appropriation of science and nature

Part 1: Pre Newtonianism

Characterizing nature as feminine

The concept of nature as a mother, a nurturing female figure, has been embedded in history, philosophy, and oral tradition. Ancient Greeks credited Gaia with the creation of the earth. Egyptians worshiped Isis as a patroness of nature, the perfect mother to all. While goddesses were seen as ultimate providers, there was also a certain prowess to the caricature of nature. Natural disasters, weather patterns, and climate determined the fate of humans, so the goddesses who embodied nature sometimes walked a tightrope between being feared and romanticized.

For example, the Roman goddess Minerva was the patron of agriculture along with being the goddess of wisdom. One story noted her famous short temper, which piqued the interest of a weaver named Arachne (Alic, 1986, p.16). Arachne challenged Minerva to a contest of skill, boldly stating that she was a better weaver than Minerva. Minerva accepted the challenge and won easily, and Arachne was punished by being transformed into a spider. But this vengeful act is speculative: since this myth has been passed down through generations, there are many different perspectives. While some believe that Minerva acted only out of spite, some stories argue that when Arachne lost the weaving contest, she was so ashamed that she plunged her shuttle into her heart. Minerva took pity on her and transformed her body into a spider so she could weave webs for eternity (Alic, 1986, 17). Whether Minerva's act was merciful or malicious, her power still remained unchallenged and unconquerable.

These two oral histories shed light on the mannerisms of a goddess who embodied part of nature, and essentially characterized nature for centuries. The concept of “mother nature” can be traced back to these goddesses throughout the development of Western Culture. Early philosophy and rhetoric explored whether or not nature could be considered a force of benevolence or a force of wrath, nurturing versus chaotic.



Fig 1.1 Lucas Cranach's *The Nymph of Spring*, Merchant, 1980, p. 9

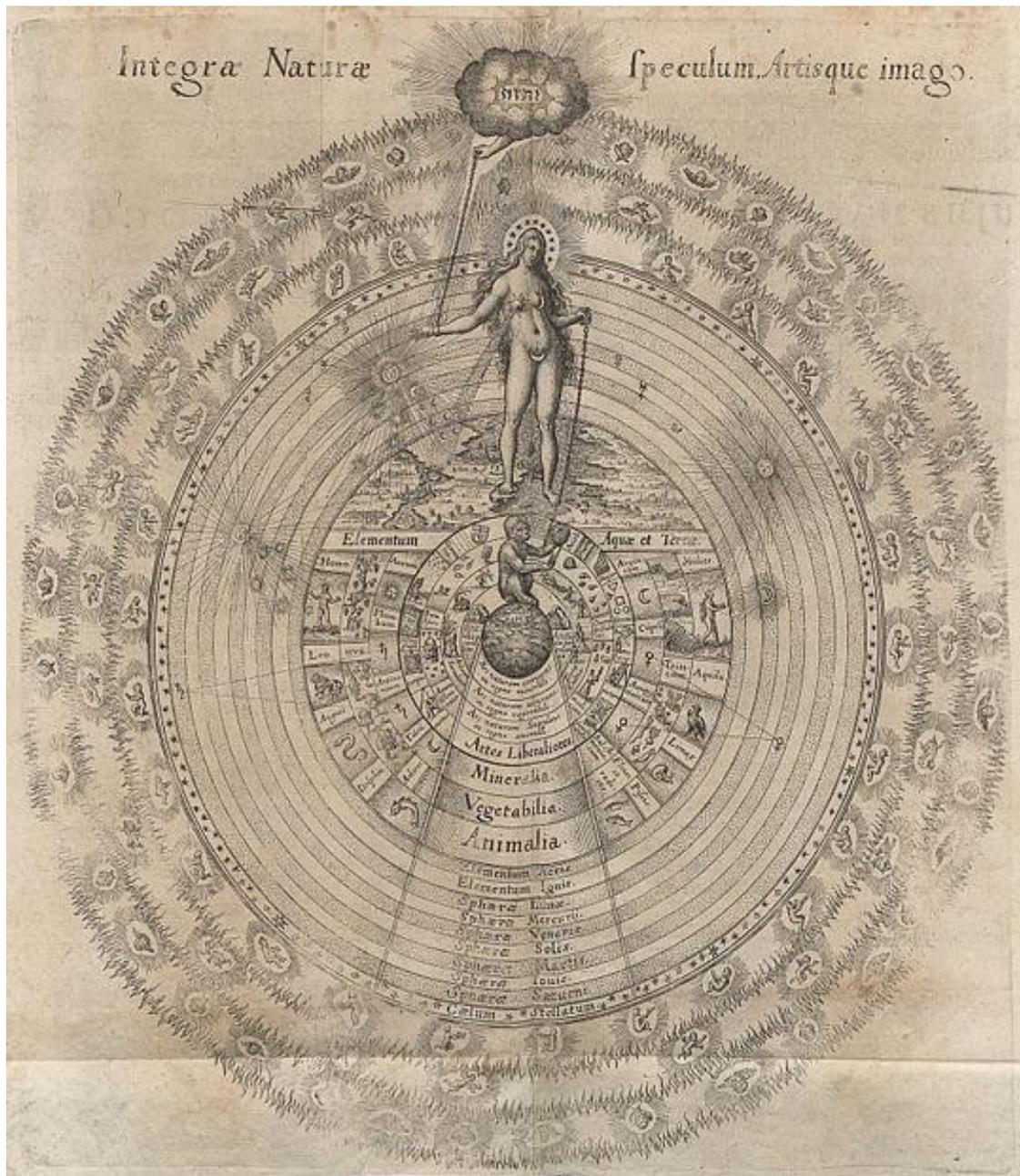


Fig 1.2 The Female Soul of the World, John Theodore de Bry, conceived by Robert Fludd (1617-21), Merchant, 1980, p. 12

Before Newton or the scientific revolution, artistic expression and pastoral poetry explored the relationship between nature and man. *The Nymph of Spring*, a painting by Lucas Cranach (Fig. 1.1), illustrates a benevolent version of nature and captured the essence of nature in the early Renaissance. In the image, Nature is passive and lounging in the grass, her bow and arrow hung up on the tree next to her—she’s harmless and on display. While nature was passive, its beauty still provided an escape to city woes; a virginal landscape that was attributed to a divine creator (Merchant, 1980, p. 9).

The role of Mother Nature was seen as a secondary to a higher power: nature was a motherly provider but worked through the power of God. In 1593, Richard Looker describes nature as an “instrument” to God’s voice (Merchant, 1980, p.6). John Theodore de Bry illustrated a woman standing amongst creation (Fig. 1.2), with a chain wrapped round her wrist and fastened to a disembodied limb, meant to represent God. This implies that nature answers to a divine being, and with the popular rhetoric at the time, it was also a masculine being. Nature can be nurturing or destructive, but she only works under God’s will. While Cranach and de Bry’s depictions were about a century apart, they both emphasized the how nature was understood as beautiful, yet controlled.

Plato argued that the earth needed to be “ruler and mistress”. The Earth’s soul could survey natural phenomena but ultimately had a divine connection that dictated its actions (Merchant, 1980, p. 27). This belief emphasized nature and man’s subservience to God and placed value in the image of a “passive” earth. Implying that nature is a mistress inherently sets her subservient to a master, and sometimes master’s are violent. In 1160, Alain of Lillie engendered nature as not only woman, but as virgin, depicted a theme of lost innocence when consume natural resources: “In aggressively penetrating the secrets to heaven, they tear Natura’s

undergarments, exposing her to the view of the vulgar.” (Merchant, 1980, p.10) Not only does this statement depict sexual themes, it also places value in the nature’s virginity. It was common for land to be highly valued if untouched. Designated forests would be reserved simply for monasteries and aristocracy (p. 62). While this may be considered preservation, it didn’t put

value on the forests, but rather on the people who they were meant for.

This connection between nature and the divine was consistently challenged and opposed by different ideologies, even some that came before Christianity. Gnosticism dictated that there was a unity of opposites—that nature consisted of a male and female creating together. This created an androgynous vision of God and nature: men represents the sun and the air, women represent the water and the moon (Fig 1.3, Merchant, 1980, p. 22). The Christian church eventually rejected these theories as vulgar misrepresentations of God (Merchant, 1980, p.

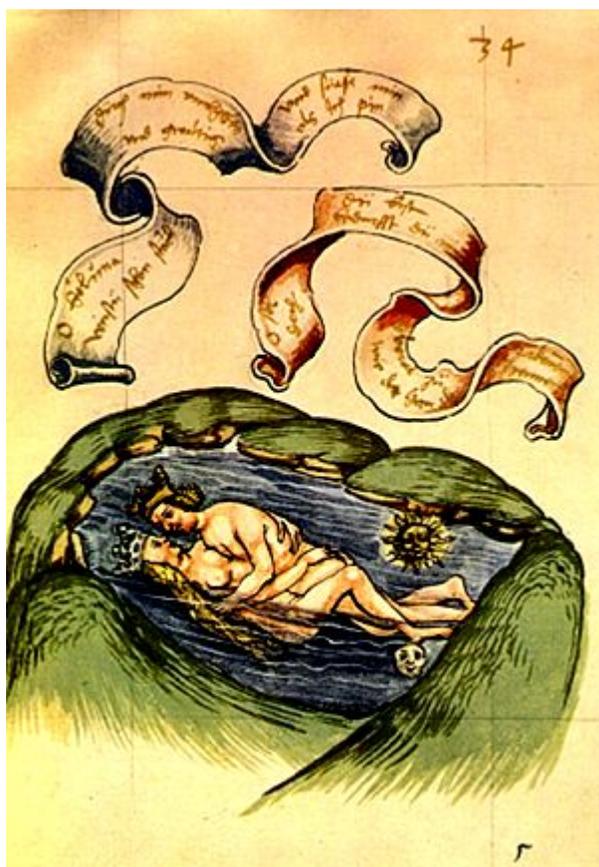


Fig 1.3 *Rosarium Philosophorum*, sixteenth century, by Arnold of Villanova. Merchant, 1980, p. 22

17).

Alchemists had a different view of nature completely. The believers considered the Earth alive and vital, rather than passive or victimized. Alchemist Basil Valentine considered the Earth a womb for minerals and metals: “This spirit is the life and soul that dwell in the Earth...capable

of imparting nutriment to all things that grow and of nursing them as mother does her child while it is yet in the womb.” (Merchant, 1980, p. 27) The Earth still remained a female body, but it was considered a living and breathing, independent soul that could go barren if treated unfairly. Alchemists believed that there were normative standards for mining the Earth and earthquakes could be a sign of Earth’s indignation. In 1595, an author named Edmund Spenser noted that mining or harvesting the earth only encouraged greed and moral sin: “Digging into the matrices and pockets of the earth for metals was like mining the female flesh for pleasure” (Merchant, 1980, p. 39). Since the female body has been historically sexualized, the language around Mother Nature sometimes centers on her body and the violation of said body. This imagery reinforces how we have blurred women’s roles in society with nature’s passive state. This weak, virgin figure of Mother Nature reverberated into not only how women were portrayed, but also how they were understood biologically.

Interpreting women’s bodies and intellect as inferior

The Greek philosopher Aristotle associated activity with maleness and passivity with femaleness. He believed women were stunted males whose “coldness...would not allow [their] menstrual blood to perfect itself as semen.” (Merchant, 1980, p. 13) This suggests that women are biologically lesser to men. In Christian text, women are merely made from the rib of Adam, an afterthought of God’s grand creation. These early ideas stemmed into grander anatomical assumptions about the female body.

Studying the biological and cerebral differences between the sexes was common in the Enlightenment. Philosophers like William Alexander and Pierre Roussel observed the physiological and social aspects of the female gender and found inequality but they also considered themselves as liberators. Benjamin opined, “their work only served to facilitate a

conceptual shift in the understanding of women's oppression from implicating the tyranny of men to implicating the tyranny of their ovaries." (Benjamin, 1993, p.11) Although they worked to understand the biological differences between the sexes, they were quick defend women's "tyranny" as internal rather than external. Roussel sought out to define women's differences in his integral work, *Systeme Physique et moral de la femme*, 'The Physical and moral system of a woman.'" (Vila, 1995)

Roussel's "*Systeme*" was published in a medical journal in 1775 and described the physical and moral differences between men and women. Roussel believed that gender and sex shaped the modern body and that this combination forms a person's "sensitivity". This idea was spawned from philosophical medicine, which dictated that the body is a network of actions and reactions, which are predictable through study. Roussel believed that morality and sensitivity were determined by ones gender and social status. Working under the assumption that women are not equal to men, Roussel justified that women were biologically frail because this trait sustained the population, with men as the innovators, and women as a caretakers (Vila, 1995, p. 78). Any women who challenged this role was considered disorderly, a witch in the public eye.

Understanding woman as witch, nature as chaos

The concept of a witch originated out of the Judeo-Christian church; it was a phenomenon to explain corruption. While women were seen as subordinate and modest, many believed that women were inherently lustful. Aristotle's Masterpiece (1684), by an author who wrote as a Pseudo-Aristotle, stated that women receive more pleasure from sex along with seeking out "stallions" (Merchant, 1980, p. 132). In These assumptions derived from the idea that women were more connected to nature, making them more susceptible to its power. Crops dying, children falling ill, and any bodily corruption were blamed on a woman's folly, "an image

of widespread chaos and uncontrolled nature dominated by women engaged in exuberant, frenzied activity.” (p. 134)

Trials, sexual exploitation, and punishment were doled out to women who fell out of social order. While nature had always been an instrument of God, the idea of nature as a destructive force was still possible. But instead of reverting to God’s will, nature’s chaos fell to the responsibility of a darker power: the power of woman. Through violence and accusations, philosophers and empirical thinkers were starting to challenge previous views of nature by challenging nature’s relationship to God.

When Copernicus published his theory of heliocentricity in 1543, astronomy became a popular science. Also a divine power controlling natural occurrences became a more farfetched ideology. Nature became a disorderly force that didn’t follow the control of an all-powerful God, but rather took her own course. Isaac Newton’s *Principia* gave insight into the routine processes of Earth’s systems; he even sought to prove Copernicus’ theories through mathematics (Arianhod, 2012, p. 18). The *Principia* also pitted empiricism against religious philosophy. With the rise of the sciences, Newton played an important role in emphasizing empiricism over divine power, and his followers found that studying phenomena in the universe would not only expand their understanding, but it could also be considered a moral act.

Part 2: Newtonianism

While we know Isaac Newton as the man who was hit with the apple, his work represents a shift in how we understand science as a masculine space. Newton’s work gave insight into physics and mathematics that could explain phenomena in the cosmos. It was also an era where knowledge was considered greater than idleness. This is why women were allowed into the world of science as patrons or observers, so that they may advance in their knowledge. Lady

Mary Chudleigh believed that knowledge would raise her from her condition of femininity, ultimately making her a whole person. She lauded science as a way to discover nature, in all her glory: “Physicks...will show us Nature, as she variously displays herself,” (Mullan, 1993, p. 43). But their participation was scarce due to men barring women from science systematically and appropriating sciences as masculine.

Making Newton accessible through popularization

Chudleigh was not alone in her attitude towards women and knowledge. Many authors sought accessible forms of education for the “female spectator”; those who believed that philosophy was a cure for their femininity (Mullan, 1993, p. 41). Theatrical dialogues were written to help educate women in Newtonian philosophy. A surge of plays were published after Newton’s *Principia* that followed a pretty consistent format: one man, a Newtonian, would explain Newton’s philosophy to a woman. Benjamin Martin, the author of “The Young Gentlemen and Ladies Philosophy”, argued that this structure would make the most sense, since women were simple souls that could obtain more sympathy: “the art of explaining Philosophy to a woman is a demonstration of its truth.” (p. 45) John Harris and Francesco Algarotti had flighty female characters that would delight in their new knowledge and feel lifted from their feminine wiles. In his “Astronomical Dialogues”, John Harris’ female character reflected on her new education and noticed how it had changed her perspective, “You have Philosophised me out of many a fair Pleasure already; Censure, Satyr, and Gossiping are almost gone” (p.47).

These dialogues were charged with gender expectations and limitations; Martin insisted that studying the natural world is a “darling science for man” and a “peculiar grace in the fair sex” (Mullan, 1993, p. 46). Most of all, they endorsed the idea that men were more likely to understand science and philosophy. Algarotti’s female character, The Marchioness of E, was

almost childlike in her wonderment, “asking appropriate questions...[with] compliant delight” (p. 45). When she had been educated by a male peer, she could finally be considered a “real” Newtonian. These dialogues illustrate the learned arrogance of male philosophers at this time—but this arrogance was shared with poets, authors, and politicians as well.

While Newton, Algarotti and Harris wrote about the rapturous power of the universe, some writers explored women’s interest in Newton’s philosophy. Edward Young poked fun at female philosophers, emphasizing their flighty behavior “*Some Nymphs prefer Astronomy to Love/ Elope from mortal men, and range above*” (quoted in Mullan, 1993, p. 48). Many poets wrote satirical work, but many of them romanticized Newtonian women—twisting their interest in science as moral platform. Richard Steele insisted that there was modesty in knowledge and natural philosophy. If women studied the natural world, they will be less likely to get into trouble: “curious Minds are always in Action, and want of nobler objects descend to Scandel and Impertinence.” (Mullan, 1993, p. 44) Observing the cosmos could help women connect with their lord and savior essentially: “Women are therefore employed by writers or appealed to by lecturers as ingenuous witness to the religious probity of Newtonian Philosophy” (Mullan, 1993, p. 45). As “ingenuous witness” to this movement, women had little opportunities within studying and understanding Newton’s work. It was also the beginning of women being pushed out of spaces where they originally thrived. Agriculture, industry, and even obstetrics were being pulled from their fingertips and redesigned as masculine practices.

Appropriating science, birth and midwifery

One of the most prominent and obvious sciences that was appropriated by men is gynecology and obstetrics. Before the 17th century, midwives were trained by the church or apprenticeship. When other medical practices were being professionalized, such as dentistry and

surgery, midwifery was still considered a craft. In 1616, Huguenot Peter Chamberlain sought to organize proper instruction, approval, and licensing of midwives, but was rejected by the College of Physicians. The approval of midwives was harbored out to City Fathers and “*matrones jurées*, women supervised by the king’s chief barber- surgeon” (Schiebinger, 1989, p. 106). It wasn’t until 1642 that midwifery was seen as surgical practice. Traditionally midwives were women, but when the academies and universities started to recognize the need for medical intervention, more men were encouraged to study gynecology. New techniques were developed to improve the birthing process and traditional female midwives were left behind: they were not eligible to attend schools to learn about these new practices.

Although midwifery was originally performed by women exclusively, all of the collected knowledge seemed to be undermined by the new systematic approach:

“Generations of women’s accumulated experience was discredited as many perpetuating ignorant and unscientific practices, even though in many quarters, parturition continued to be regarded as a natural rather than morbid process.” (Roberts, 1993, p. 61)

Dr. Maria Mulvey Roberts considers Mary Shelley’s *Frankenstein* (1818) a commentary about this “reproductive appropriation” (p. 60). Roberts compares Frankenstein with the obstetricians that took over midwifery; the mastery that Frankenstein holds over his monster represents the inherent sense of male entitlement to reproduction at the time. Shelley also uses the monster and Frankenstein to demonstrate the double standards of virtues for men and women. Although the doctor can re-animate life without consequence from society, the monster is attacked for its form and actions. Contemporary writer John Bennett agreed with this sentiment when he wrote in his *Letter to a Young Lady* a “bad man is terrible” but an “unprincipled woman is a monster.” While

men dominated fields of poetry, literature, and science, women were still held in a box of gendered expectations and if they broke out—they were disorderly, unworthy.

But for the typical romantic poet, this monstrous woman didn't exist. Although they would write a woman as emotional, subjective, and passionate, she would still be pigeonholed in her expected role as a curious but ignorant creature. This arrogance to dictate a woman's place, or "God-like" attitude was accepted in Shelley's time without question, and so she writes her male scientist, Frankenstein, as an egotistical creator: [To the Monster] "Remember that I have power...I can make you so wretched that the light of day will be hateful to you." (Roberts, 1993, p. 72) The power dynamics between the monster and creator is similar to slave and master, women and man. Shelly's writing reinforces the idea that being a scientist is a privileged authority. One who identifies as a scientist assumes that he has a point of view outside of a man-made culture and is thought to be a source of "true knowledge" (Benjamin, 1993, p. 7)

A male's entitlement to science intertwines with the expectations of women in this time to create a narrative similar to *Frankenstein*; a man scrambling for control over a monster with her own mind. Although women were deemed as passive according to their biology and sensibility, they still fought to enter the sciences. They knew they could patronize or observe, but it seemed impossible to participate unless they were admitted to university, had a partner, or just struck out on their own. Many women continued to persist in sciences—never backing down for their true passion.

Chapter 2: Breaking in and Breaking out

Women who challenged their roles in pursuit of knowledge

Marie Curie's notebooks are encased in lead. After years of experimenting with radium her furniture, clothes and laboratory materials still emit high levels of radioactivity, enough for France's National library to hand out waivers and protective gear to anyone who wants to see the artifacts up-close (Tasch, 2015). While Curie is the popular archetype of the female scientist, what remains is toxic and tucked away. Her image is held up next to Newton, Tesla and Einstein, as the singular woman, almost implying that her female prowess as a scientist was an isolated incident. But her legacy ran parallel to many other women who were developing their own curiosities, like the glowing green notes found in Curie's notebooks: persistent but contained.

Curie was one of the many who pushed past boundaries and put her passion into action. With the growth of universities and academies in the 17th and 18th centuries, research was thriving. For women, university was seen as a route to employment and financial independence but it was only seen as an option to single women. Bethlehem Female Seminary, now known as Moravian College, was the first women's college founded in the United States in 1742 (Moravian, 2016). Multiple colleges and seminary schools cropped up, making education more accessible but not necessarily encouraged. Once women entered the scientific arena, they were not expected to do as well as their male counterparts, and they were not given the resources to do so.

During the industrial revolution in the U.S. (1760-1820), manufacturing and development accelerated, increasing in population and industrial diversity. As a result, lab spaces were moved out of the home into universities. Although women had newly found access within these institutions, sexism and discrimination reigned. Even after winning her first Nobel prize in 1906,

Curie was denied full membership from the French Academy of sciences (Gregory Kohlstedt and Bystydzienski, 2006, p. 25). So what made Curie successful? Women who pushed past gendered expectations paved the way for women like Curie to succeed, dating back to the popularization of Newton. As we explore the factors that played into the growth of women's participation in the sciences, we see a pattern of women who have broken into the sciences and those who have broken out. They are the women who initiated the removal of boundaries between women in science systematically and philosophically.

Part 1: The Nurturing and the Scandalous

As Newton's work was popularized in the 18th century, some philosophers and scientists were up in arms, arguing that the *Principia* went against previous theories from Descartes, Leibniz, and the church. Newton's theory of gravity and materialism, in which all particles have mass and therefore have gravity, was a radical notion at the time. Not only that, but he approached physics on a purely mathematical level: "no-one before Newton had created such a comprehensive, predictive, mathematical *theory* about the *underlying principles* behind such a phenomena." (Arianrhod, 2012, p. 6) It was a true turning point for science across Europe: divine revelation was consistently challenged by empirical reasoning and scientific discovery.

Scholars like Francesco Algarotti capitalized on this transition by using Newton's work to inspire his dialogue *Newtonianism for Ladies*. He was finishing up the piece while he was staying in a house in Cirey, a house owned by a woman named Émilie du Châtelet: 'Here, far from the bustle of Paris, we lead lives full of intellectual pleasures...my *Dialogues* [on Newton], which have found grace in the eyes of the belle Émilie and savant Voltaire.' (Arianrhod, 2012, p. 40)

Émilie and her lover, Voltaire, entertained various guests at her summer home in Cirey; they were a couple that enjoyed intellectual exchanges and refined company. But while the ‘voluptuous philosophers’ Algarotti and Voltaire, discussed Locke and Newton, Émilie refused to sit on the sidelines (Arianrhod, 2012, p. 40). She argued and studied furiously to keep up with current knowledge and philosophy. Voltaire admired her for being so well-spoken, integrating her ideas with his work ‘When Émilie is ill, I have no imagination.’ (Arianrhod, 2012, p. 42) While Voltaire’s work like *Candide* and *Oedipus* are still celebrated today, Émilie du Châtelet’s story is blurred and sometimes skipped over.

Émilie du Châtelet was considered an extravagant, spoiled and scandalous woman of her time. At an early age, she was ravenous for knowledge and sought higher education—but this was impossible in France. Instead she reverted to self education. She hired tutors to help her learn Cartesian and Newtonian philosophy. Although she was married to Florent-Claude, marquis du Châtelet, a prominent and wealthy lord, she had a very public affair with Voltaire. They depended on each other as lovers, but also as intellectual muses; she considered him her ‘guide in the country of philosophy and reason’ (Arianrhod, 2012, p. 42). But while she spent years building up her knowledge, she couldn’t help but feel frustrated. She saw that her society excluded women from knowledge systematically and philosophically:

“She had grown up in a world that assumed women were easily seduced by sensuality and romance, but which denied them real passion - a society that forced women into loveless arranged marriages and superficial affairs, but allowed them no active role in society, and few educational opportunities.” (Arianrhod, 2012, p. 35)

But attitudes towards women in education varied across Europe. In Italy, progressive women were celebrated and lauded for their patronage of sciences, and some women even dared

to enter the fray as academics. As an outsider, Émilie observed and highly regarded women in Italy who were starting to take up space in university and in publication, marking a turning point in Émilie's intellectual journey. A great inspiration to not only her, but her admirer, Algarotti, was the philosopher and scientist Laura Bassi.

Another Minerva

In 1732, Laura Bassi became the second woman to receive a degree from a university. Elena Piscopia was the first woman to earn a degree in philosophy in 1678, but her acceptance and success wasn't made accessible to other women at the time. Piscopia was celebrated as the "Venetian Minerva", but after her death in 1684, she was ruled by officials as the first and last woman to enter the University of Padua (Findlen, 1993, p. 445). Gaining the title of "Minerva" set Piscopia apart a goddess-like figure; this status made her seem untouchable and exceptional. As Bassi came up through the ranks, she would be dubbed with this same status.

Bassi graduated from and lectured at the University of Bologna. She was also accepted as a full member of the *Istituto delle Scienze*, or the Academy for the Institute of Sciences. The French Academy of Science didn't accept a woman as a full member until the 1962 (Borzendowski, 2009, p. 91). Bassi lectured on Aristotle and Cartesian theories, studying Newton later in her life. She was characterized as a woman who had an elite and specialized knowledge that extended to the "Reach of the 'new science'" (Messbarger, 2002, p. 74). She challenged paradigms and her male peers' assumptions of her amateurism by publishing and defending her work. She only had four works published but this was still only a small portion of "the dissertations that she prepared and defended annually at the Institute Academy" (Findlen, 1995, p. 443)

After Piscopia, Bassi inherited the idyllic Minerva status; she represented a woman who was motivated by wisdom. But this image was “tarnished” when she married to Giuseppe Veratti, a peer and academic. She was considered a “learned virgin” that should be married to Christ rather than “blemish [her] glory” (Findlen, 1995, p. 455). This put value in her chastity and virginity, rather than her accomplishments. When she had children, her husband ignored criticism from neighbors and peers and helped her create a domestic lab (Cavazza, 2009, 117). Their partnership was considered controversial by most but it resonated with Émilie du Châtelet for many reasons.

Finding power in partnership

Like Bassi, Émilie had a partner in her journey. Voltaire challenged her as a thinker and writer, but he also provided many opportunities for her to publish. He wrote a perspective on Newton’s *Principia* called *Elements of Newton’s Philosophy*, published in 1738. Émilie was more than a collaborator on this work: she was the principal mathematician. Hashing out proofs and creating comprehensive explanations, Voltaire brought his work and hers together to publish but didn’t credit her in the byline, only thanking her in the preface. Nevertheless, Émilie had the support of Voltaire to carry out her legacy, and Laura Bassi had a leg up by being apart of a university. But while Laura was credited for her published work, she was also considered a more of an “ornamental” element of the university. Her true support came from her husband. Both Émilie and Bassi would not have thrived on their own due to the gender expectations at this time, and they were both criticized for crossing a line in their roles as Minerva figures.

Émilie was sometimes called a “Femme servante” and considered by most as a woman with a pretentious ambition (Arianrhod, 2012, p. 21). Her female peers thought she chose knowledge as a way of impressing men, considering her affair with Voltaire and correspondence

with male tutors. In popular culture, Émilie was expected to follow society's expectation of modesty and silence. Both of these traits fell to the wayside, as she vocalized her frustration with social and political inequality; "there are great countries whose destiny the law permits us to rule and yet there is no place where we are taught to think." (Arianrhod, 2012, p. 9) Her eye for injustice and misrepresentation translated into anger, but also critical analysis.

Even though she fit the main female character of Algarotti's play *Newtonianism for Ladies*, he dedicated it to another philosopher, Fontenelle: "neither woman, nor Newtonian" (Arianrhod, 2012, p. 77). Émilie found Algarotti's work problematic and trivializing of a woman's approach to sciences. Even though he was deeply enamored with Émilie and Laura, Algarotti portrayed his female character as completely ignorant, with no understanding of the physical world. Émilie also didn't care for his metaphoric explanations that cornered women into double standards. In a letter to her tutor Maupertuis, she specifically inveighed his comparison of Kepler's third law to a "love of a Lover":

'I confess to you that I don't like its style on scientific matters: the love of a Lover decreases in the ratio of the square of the time [away from his beloved, and also in proportion to] the cube of the distance between them, appears to me to be difficult to stomach... a love of a lover who has not seen his mistress for eight days loves her sixty four times less! I don't know what pleasantry he would have come up with for the inverse-square law of distances [in the theory of gravity].' (Arianrhod, 2012, p. 77)

To be fair, science was considered a pastime in this period; scientific inquiry was reserved for the wealthy (Benjamin, 1993, p. 7). Algarotti simply reiterated that science was something fashionable for women, rather than a serious passion or occupation (Messbarger, 2002, p. 74). But Voltaire saw that Émilie's quest for knowledge was sincere and considered her

a peer. They would spend months together at Cirey, a haven for knowledge and place where Émilie could have “real passion” (Arianrhod, 2012, p. 35). This was where she explored Newton’s *Principia*, changing Émilie’s life and her course of study. She integrated methods and terminology from other enlightenment thinkers like Leibniz to expand on Newton’s mathematics and eventually translated the *Principia* into French. This was one of the first publications from a woman that globalized popular science, but in the public eye, it was seen as derivative to the great men who fueled and supported her work (Arianrhod, 2012). It took two centuries to re-discover and evaluate her work on not just a scientific level, but in an understanding of gender roles at this particular time. Laura and Émilie’s publications remain relatively tucked away, but their legacy ingrained a pattern that would define a woman’s place in science for years to come.

Understanding Environmental Context

When Madame de Graffigny visited Émilie at Cirey, she was astounded by the conversation and energy that Voltaire and Émilie brought to the table, but she was most impressed by Émilie’s almost uncensored passion for scientific inquiry. In a letter she wrote during her visit, she asks ‘how many centuries does it take to produce a woman like [Émilie]?’ (Arianrhod, 2012, p. 44). Like a one hundred year storm, Émilie was a force that was exceptional, singular, and effective. But instead of being put in a place of power, she was criticized and considered scandalous. One anonymous claim said her work only portrayed ‘a madwoman who knows atoms better than her own family, and who believes herself a philosopher despite the disarray of her passions, through which she has confused useless things’ (Arianrhod, 2012, p. 148). French critics took a heavy hand with Émilie, but Italian society welcomed Laura Bassi as a progressive icon. By the age of sixty-five, Bassi would earn a full professorship, making her the first woman to be appointed to faculty at a university in Europe

(Arianrhod, 2012, p. 162). Both women defied expectations and fought tooth and nail, but were received differently in the public eye. To understand this inequality, one must consider the societies in which these two women were living.

In Italy, the Renaissance blossomed cities into radical stages for innovative writing and art, but it also affected views on nature. The Venetian Arsenal was one of the first governmental powers that created policy around sustainability in 1470 (Merchant, 1980, p. 65-66). With a great ship-building industry, Italy realized that it needed to regulate timber harvesting. Officials would press wax seals onto trees that could be cut down, and leave the unsealed trees to grow for the next harvest. This preserved forests and also mobilized a sense of conservation among popular society. These sustainable practices weren't widespread. Throughout England and France, farms were increasing production without regard for soil quality and cities were growing rapidly throughout the sixteenth and seventeenth century. With the increase in coal rise and tension within the feudal system, France treated nature as something to be subdued.

The differences between Italy's sense of conservation and France's urban expansion can be linked to their differing perceptions of nature. While Italy treated nature with respect, like a nurturing mother, France's economy and agriculture indicated nature was perceived as chaotic. A Fifteenth century, Italian philosopher, Giovanni Battista Della Porta wrote about nature as a soul of the world but he also described nature as a chain of being: "Seeing the spirit cometh from God, and from the spirit cometh the soul, and the soul doth animate and quicken all other things in their order (Merchant, 1980, p. 106). It wasn't until the sixteenth and seventeenth centuries, that Newton and his peers asserted that matter is inert unless it was affected by an external force. A balance was struck between understanding nature as a chaotic force that must be controlled, or

a passive force that is subject to the wills of men. Either way, nature was understood as a female and meant to be harvested.

Both Émilie and Laura's role in science evoked this goddess-like, "Minerva" complex, portraying them as women who were motivated by wisdom. But it also characterized them as both chaotic and nurturing. Laura adapted her role as a "thinking creature" while also acting as a mother and wife. Émilie challenged her peers in both society and sciences in order to gain access to scientific inquiry. But whether these women were deemed as scandalous or brave, the portrayal of their sex in nature intersected with their identity as female scientists. Eventually, this intersectionality would resonate with female scientists in the 20th century. Women would employ these relationships with nature to break into and break out of sciences.

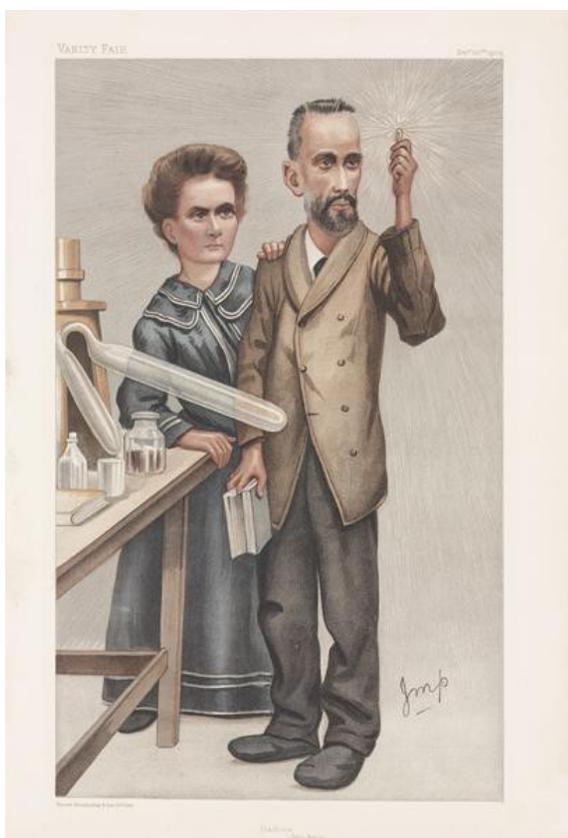


Fig 2.1 Vanity Fair cartoon, 1904, Chemical Heritage Foundation collection

Part 2: Mothers of Modern Science

When we consider the legacy of Laura Bassi and Émilie Du Châtelet, we have to consider limitations and expectations for women in their time period. They were banned from formal education like university and their roles in the scientific community were almost considered ceremonial rather than integral. It seemed like university education became more accessible, with the development of new institutions and programs for women, but it was conditional to women with

money, or women who were not married, or women

who were not able to help in the home. Women still used this access to enter higher education, constantly trying to prove themselves within the scientific communities. To gain access, women adopted two common mechanisms: breaking in and breaking out. Women who broke into the sciences would look for alleyways for research through partner work and overcompensating to prove themselves. Those who broke out of the sciences found studies that centered on their identity as women and developed new methods out of that. The women who followed in Bassi and Châtelet's footsteps employed these mechanisms in order to gain greater acceptance, but to also develop their own sense of identity in science.

Radioactive women: women breaking in

Marie Curie is a great example of a woman who broke in. Curie won a Nobel Prize in Physics in 1903 with her husband Pierre. Their caricature was published in a copy of *Vanity Fair* in 1904 (Fig 2.1), depicting Marie as “the little woman behind the great man” (Bystydzienski and Bird, 2006, p. 25). Even after Pierre's death, she went on to take a Nobel Prize in Chemistry in 1911 for her isolation of radium. Like Bassi and Châtelet, she gained momentum from having a partner, but her second Nobel Prize signified her independence and talent. But rather than recognizing her talent, many of her male peers considered her an exception to all women, not necessarily an attainable goal or role model for other girls.

For years to come, institutions and professors would use Marie's reputation to argue against admitting women to science programs. In 1935, Robert A Milliken wrote in a letter to a president at Duke University when he learned that they had hired a female physicist. He insisted that younger males were more likely to succeed than experienced women. He singled out Curie and her peer Lisa Meitner as women who were exceptions to this rule:

“In Europe Fraulein [Lisa] Meitner of Berlin and Madam [Marie] Curie of Paris are in the front rank of the world’s recognized physicists... I picked one or two of the most outstanding younger men, rather than if I filled one of my openings with a woman. I might change this opinion if I knew of other women who had the accomplishment and attained to the eminence of Fraulein Meitner.” (Bystydzienski and Bird, 2006, p. 79)

Margaret Rossiter, a historian for women in science, dubbed Milliken’s bias as the “Curie Effect” (p. 25). If we compare Curie’s reputation with Émilie Du Châtelet’s, we can draw many similarities. They were both passionate about physics and scientific inquiry, yet they were both denied from the French Academy of sciences. In a way, they were both characterized by their personal relationships and affairs. In 1914, Curie was accused of having an affair with one of her husband’s former students and a married man, Paul Lengevin (Krulwich, 2010). Gossip spread like wildfire and Curie was even warned not to go to Stockholm, Sweden to accept her second Nobel Prize. Even Albert Einstein weighed in, encouraging Curie to ignore the “riffraff”: ‘If the rabble continues to be occupied with you, simply stop reading that drivel. Leave it to the vipers it was fabricated for’ (Krulwich, 2010). Like Châtelet, Curie was determined to be remembered for more than her affair, so she set aside the public ridicule and went on to Stockholm.

Curie inherited the “Minerva” status that weighed on Châtelet and Bassi; she was expected to be motivated only by wisdom and held on a pedestal as a singular example, rather than a possibility for all women. Curie fought to be recognized in her field for her accomplishments but her own work would be her downfall. Eventually she succumbed to aplastic anemia in 1934, a result of exposure to radiation (Borzendowski, 2009, p. 102). She left behind a series of notebooks, remnants of her critical work on each page in writing and radioactive counts. But while Curie left a legacy of success, some female scientists used their

footing to create more systematic changes that would open up institutions so that anyone who aspired to be like Curie.

Looking beyond limitation: Women breaking out

Part of Robert A. Milliken's letter in the section above read: "Women have done altogether outstanding work and are now in the front rank of scientists in the fields of biology, and somewhat in the fields of chemistry and even astronomy, but we have in this country as yet no outstanding women physicists" (Bystydzienski and Bird, 2006, p. 78-79). It was altogether true; there were more women were entering biology than women entering physics. Female biologists had some of the same advantages as women like Bassi and Curie, such as the support of a partner. Initially, Anna Bolsford Comstock illustrated animal life for her husband, a wildlife biologist. But this soon developed into a full blown curricular series for New York elementary schools (Bystydzienski and Bird, 2006, p. 25). Part of her greater success was the fact that she had fewer limitations in her particular field. Universities were still discriminatory against women, and 96% of faculty at co-educational schools consisted of men (p. 27). But biology has one characteristic that made it appealing for women at the time: it was outdoors. The fieldwork could not be limited by lab space like physics or chemistry. Observation and literacy were the only two things required, making it the most accessible science at the time. But this didn't stop other women from reaching for new ways to make science accessible.

Ellen Swallow Richards, a graduate of Vassar and the first female professor at M.I.T. in 1884, saw that men dominated labs and underestimated women. Richards combatted this discrimination by creating fields of science that were exclusive to women such as home sanitation and chemistry. She dedicated her time to analyze methods that would provide health, sanitation, and nutrition to the greater public (Chemical Heritage Foundation, 2016). She saw

that co-educational schools had exclusively male degrees, such as agricultural sciences. By innovating a science that was considered more feminine, she could make the resources in chemistry department accessible, generate more job opportunities for women, and create an internal structure that would encourage more women to enter the sciences (Bystydzienski and Bird, 2006, p. 26).

Émilie, Laura, Marie, and Ellen were not the first nymphs to prefer science to love, they barely represent a fraction of the great thinkers and practitioners at their respective times. But the women who've been profiled represent the women who had more than wisdom on their minds. They were activists who were also able to explore how women can support each within the sciences. As we generate more interest in scientific inquiry, female scientists can use the history and techniques of the women preceding them to compare current tactics understand what limitations remain.

Chapter 3:

Redefining and Re-appropriating Sciences

Actualizing science and woman through language

Popular scientific rhetoric is usually characterized as “true” or absolute, devoid of emotion: “Science carries the authority of objectivity within itself...in opposition and as corrective to the subjectivity of literature and the arts” (Benjamin, 1993, p. 7). But the definition and role of science has never been clear or completely defined; it is greater than just a specific course of study or series of experiments and conclusions. Modern physicists use uncertainty theories to distance the concept of science from truth, deeming science as more of a “metaphor for reality.” Granted, science is the best metaphor we have to explain universal phenomena. And although we may consider science as an “objective” study, it is distinguished by its competitive edge and consistent critical analysis. Those who have set the standards for scientific integrity and inquiry consist of a narrow population determined by class, race, religion, and gender. Those who have defined a majority of scientific processes have been upper-class men from a protestant background:

“By overlooking the relationship between masculinity and knowledge production, the new science criticism fails to deal with how intimately gender is bound in with subjecthood. The result is that while science’s power to name is effectively compromised, men’s power to name remains unchallenged.” (Benjamin, 1993, p. 8)

Marina Benjamin (1993) used this quote to criticize the authority that men have asserted over sciences by studying (or in some cases, deciding) how women align with the natural world. Part of this alignment actualizes through the shared language we use to describe women’s bodies and biological processes.

Women's connection to nature has been understood as philosophical yet simultaneously anatomical. Alchemists interpreted the lunar cycle and the tides as a "feminine" force, while the sun and the Earth are "masculine" forces. (Merchant, 1980, p. 17). But philosophers like Aristotle interpret this connection to the lunar cycle as a metaphor for the menstrual cycle, a biological hindrance (See "Chapter 1: *Interpreting women's bodies and intellect as inferior*" for detail).

This attitude persists in scientific language today, drawing connections between women's bodies and a sense of disorder. Emily Martin, the author of *The Egg and the Sperm: How Science has Constructed a Romance Based on Male-Female Roles*, found that textbooks extol woman's reproductive organs as a place of reproduction and birth, but when it comes to menstruation, the blood is referred to as debris: "implying that a system has gone awry" (Martin, 486). Contemporary feminists would argue that this oppressive thinking is due to "a system gone awry." Affirming that science is "true knowledge" brings weight to textbook definitions and may imply that women are physically flawed. And it's hard to argue with this when a woman's internal system and external environment seem to be working against her.

Women's bodies are constantly influenced by environmental threats. Toxins and behavior are translated through offspring: what women ingest during pregnancy is transferred their children, and what they choose to consume will affect what their children will consume in the future. While men may impart hereditary factors on their children at conception, women will come into contact with hazards throughout pregnancy. In many cases, women do not have as much control to moderate what they ingest from environmental hazards. They are just as vulnerable as the fish in the sea.

Since the 1940's, Japanese women have been giving birth to children with neural damages and disorders. After public outcry and thousands of mutations, they were finally able to determine the cause of their seemingly toxic wombs. A bioaccumulation of methyl-mercury off the coast of Minemata caused the neural damage—all thanks to a chemical factory upstream, owned by the Chisso Corporation (Harada, 1995, p. 1). Sadly, this isn't the only cautionary tale that could stimulate environmental regulation. Leeanne Walters in Flint, Michigan is still trying to pursue justice after her son's blood test confirmed high amounts of lead from drinking river water (Davey, 2015). Standing by their palsey ridden children or looking upstream to a browning river, mothers have carved out a pivotal role in the environmental movement today. Women are centered as not only environmental indicators, but also as activists. They are taking back control of their own body in order to improve the lives of their children. And some women have taken it a step further by integrating the sciences in order to recognize the environmental factors that influences women's health.

Although women have been barred from “true knowledge” previously, there is a movement to re-appropriate the scientific experience as feminine and feminist. Throughout the 20th and 21st century this new science has developed and spurred a common theme of solidarity, activism, and interdisciplinary ideals. Since Ellen Swallow Richards, Marie Curie, and countless other trailblazers, the opportunities for women within scientific study and employment are more abundant and institutional. Many women have struck a balance between recognizing the need for equity within diverse representation and building solidarity in order to foster a sense of female identity within sciences. By re-appropriating sciences to include their personal context, women have innovated new ways to approach scientific inquiry and address environmental threats.

Women see their role in science as a rise to a challenge: they're challenged to take up space within traditionally male fields and take control of their bodies, physically and philosophically.

Women and Activism

The G.I. Bill was instituted in 1944, after World War II, as a promise to service men to provide benefits for their service. Part of those benefits included education. The universities that were previously designated for women started to become flooded with men coming home from war. Women's universities were flooded with veteran soldiers, pushing out women who were just as qualified to be there. Women who were applying to the universities were asked to defer their acceptance, in order to accommodate this drastic change. Female faculty that were placed in positions during the war were terminated or demoted. There were also multitudes of policies that worked against women in the scientific fields at the time including rules against nepotism and birth, and a general bias against women in the academic sphere (Rossiter, 1995, p. 29- 49).

Women were encouraged to seek out educations but weren't allowed to enter universities as faculty. Universities and colleges were afraid of nepotism so if a woman was married to a faculty member, she was immediately barred from working for that same university. In small university towns, this caused many women to compromise and work in the public spheres, industry, and lower education. Many well-known women in science followed this trend including Margaret Mead, who was never offered a full time faculty teaching job yet still managed to work in the field and publish nationally renowned anthropological analyses. Like Mead, Rachel Carson thrived as a published author and speaker after she left her government job in 1956. Carson received a Guggenheim Fellows in the Sciences award in the same year for her work with

animal life on the East Coast, resulting in her book *The Edge of the Sea* (1955). But she revolutionized scientific inquiry when she published *Silent Spring* in 1962 (320-1, Rossiter).

Silent Spring exposed the bioaccumulation of dichlorodiphenyltrichloroethane, or DDT, a popular pesticide. This chemical would collect in the systems of the tertiary predators like the bald eagle. This pesticide acted as a teratogen, making eagle's eggs brittle and thin so when they sat on them, they would crack and the hatchling would perish. Suddenly booming agriculture was a lot more ominous. Thousands of acres were being sprayed with this post-World War II super-pesticide. In 1963, Carson addressed congress in order to create more mandates around the spraying of DDT on crops.

“The contamination of the environment with harmful substances is one of the major problems of modern life. The world of air and water and soil supports not only the hundreds of thousands of species of animals and plants, it supports man himself.”

(Carson, 1963, p. 1)

Carson was only one of the many who believed the government needed more regulation since it expanded in the 1950's, including the expansion of the United State's Food and Drug Administration. Regulations were starting to come to the forefront to include mandates about industrial chemicals like DDT. This would be a feat that would challenge government works and big agriculture. At the same time, Frances Kelsey, M.D. was a pharmacologist who “resisted much pressure from the industry and her own bosses” to start manufacturing a sleeping pill that was linked to malformed children in Germany. Her brave choice coincided with *Silent Spring* and brought women to the forefront of the environmental movement (Rossiter, 1995, p. 320).

Kelsey and Carson's work gave momentum for other women to step into roles of activism in contemporary scientific culture. Carson's research was one of the first mainstream

environmental justice movements, in that she hoped to decrease the risk of toxicity for animals, but also protect any farmers who came in contact with DDT. While this work included the context of her environment, it also included the context of her role in science community. She had found a way to break into the scientific community as a woman with a mission. Other women followed her path, teetering between different paths of activism including those who wanted to change their environmental context, and those who just wanted to encourage more participation.

The environmentalist movement spurred more and more women to take action in their communities. The women at Love Canal, NY, begged and bargained for answers from a Hooker Chemical Company after their children showed signs of poisoning from toxic chemicals. Women in the Appalachians collaborated to document the threats to their family from mountaintop mining and acid mine drainage. One of the major environmental activists of today is Majora Carter, an urban revitalization strategy consultant. She worked for years to create the South Riverside Park, a greenway spanning across the waterfront in the South Bronx. At a young age, she realized that she had a responsibility to her community to create change: “Those living in the environmental justice communities are the canary in the coalmine. We feel the problems right now, and have for some time...no community should be saddled with more environmental burdens and less environmental benefits than any other.” (Carter, 2006). In her TED talk, “Green the Ghetto!”, she advocates for green roofs, sustainable living, and environmental education for children living in lower income areas. While she doesn’t practice scientific inquiry, she has innovated an intersectional and sustainable model for empowering the disenfranchised through simple and affordable science.

Activism Colliding with Interdiscipline

While Majora Carter works more as a social scientist and activist, many women are bringing specifically female voices forward by following Ellen Swallow Richards and increasing access to science through curriculum. Jill Schneiderman, a geology professor at Vassar College, wanted to create a holistic and interdisciplinary experience for women in sciences. In her article “Curriculum Transformations in the Earth Sciences” she emphasized that sciences should be less heterogeneous in order to prevent misconceptions like the biologic factors that may affect intellect: “a racist and sexist nineteenth century unsurprisingly produced a false intelligence hierarchy based on craniometry that ranked Caucasian men most intelligent and African men less so. According to craniometry, women, in general, were less intelligent than men.” (Schneiderman, 1994). This gross miscalculation minimizes the experience of the woman and the person of color and only works to the advantage of the white male.

Creating a healthy intersectionality of race, sex, gender, and income, students can better educate one another and while also validating their purpose for being in class. Schneiderman believes that women can have a better discourse if they feel comfortable educating others on their experience in order to “relate the details they learn in a course to their own lives.” This gives them better access to each other, but also better understanding of how other identifiers like race and class affect experience and environment. She breaks the curriculum in four units that focus on ecology and geology, environmental policy, their specific environment, and “alternative paradigms”. Here we see the fruition of the feminine science; a re-appropriation of sciences as interdisciplinary and considerate of a person’s identity, including gender.

Solidarity and Representation

Although the early twentieth century was riddled with gender expectations and limitations, women fought against these stereotypes by creating groups that focused on addressing issues for women in science, including the American Association of University Women (AAUW) in 1881. This was one of the first institutions to collect data about women's representation in faculty across co-educational universities in the United States (Bystydzienski and Bird, 2006, p. 27). Before World War II, women collected achievements using the power of national organizations like the AAUW. Collectively they provided more incentives and challenged “gate keepers”—deans, editors and employers. Individual universities like Cornell and Berkeley created organizations for graduate women in science, supporting women in their own institutions. These organizations acted as a safe haven for women to discuss what opportunities were available. It also provided a sense of activism and collective strength. But when a second war propelled men to fight, there was a missed opportunity.

When the war started in 1939, propaganda and editorial news advertised that women were expected to enter traditionally male roles in order to serve their country (Rossiter, 1995, p. 1). The Office of War Information glorified industrial positions as “scientific” and even recruited talent. The Westinghouse National Science Talent Search sought young adults at universities and colleges for entry level war jobs, but required a percent to be female. Equal pay and actual employment wasn't promised (Rossiter, 1995, p. 12). This still opened the door for women to participate in the Engineering, Science, Management War Training program (ESMWT). Almost two million students enrolled in this program, including 300,000 women but they were often blamed for higher turnover due to lack of experience and mechanical know how (Rossiter, 1995, p. 7).

The Office of Scientific Research and Development (OSRD) was responsible for a majority of jobs in government science. It was based on an “old boy” recruitment attitude and left women in the periphery for major government projects like the atomic bomb. But they were recruited as wives, students, or experts in the field but they rarely headed projects for the OSRD (Rossiter, 1995, p. 7)

Since the wages were low in the ESWMT, there was little success for retaining women in those jobs (Rossiter, 1995, p. 15-16). Women were convinced that they had to overcompensate in order to be recognized in the fields of science—but some stood up and lobbied for congress to be more inclusive in their policy for women involved in war sciences and women in the military. Solidarity continued as the war drew to a close. The American Chemical Society had a meeting about “the perennial problems of hostile employers,” and the “lack of advancement”. In the notes for the meeting, issues “seem to have been discussed...yet no action suggestion” (p. 17). Most women stayed quiet and hoped they could keep their job after the war, not wanting to stir up any trouble. This attitude was common since women had no upper hand; they had little to no voice in government and higher education.

New hope and equal opportunity

Silenced activism was rampant amongst young women in sciences, but new hope came when Title IX was passed in 1972. This policy banned discrimination against women who were entering jobs or universities. Multiple groups started to come forward and create greater awareness for underrepresentation. One of the most successful groups is the American Physical Society’s committee for Women in Physics. They have been able to create a comprehensive series of conferences called the Conference for Undergraduate Women in Physics (CUWiP).

Bringing together these women with a shared passion, these conferences center on sharing positive and negative experiences along with institutional research.

Organizations like CUWiP have been able to carve out spaces for women to explore research methods and instill solidarity, but there are still needs that are more complex and rooted in developing new research, participation, and understanding. Women are still perceived as less than capable when it comes to sciences. A study in 2008 from Doreen Kimura had significant data that indicated that males were more prone to better visuospatial skills and mathematical reasoning (Kourany, 2010, p. 6). While an army of women in the AAUW or American Women in Science may resent this statement and strive to prove it wrong, even the knowledge of this data may hinder their general performance in math in science.

Understanding contemporary disparities in science: the Stereotype Threat

Opinions from philosophers like Francis Bacon, Pierre Roussel, and Aristotle insisted that distinct differences in anatomy and psychology dictated aptitude and expectations for each sex. While these theories are not mainstream today, they have become embedded into the culture of scientific inquiry making women feel vulnerable or unwelcome in scientists.

Some psychologists believe that there is an active “stereotype threat” that inhibits women’s performance in sciences. Claude Steele and Joshua Aronson coined this term in 1995 when they found that when emphasizing racial differences before a standardized test, black students did more poorly than expected but the white students experienced no change in performance. After this publication—many psychologists have speculated about how this study could be applied to other underrepresented groups, such as women (Sommers, 2009, p. 114).

Aronson went on to study women’s testing abilities in two high-level calculus class at the University of Texas. Both classes were given a test that would measure their abilities in calculus

but one class was also informed that “the test had never shown gender differences in the past, a framing of the test that had been shown to reduce stereotype threat in laboratory studies” (Sommers, 2009, p. 115). In the control group, male and female test scores were equal. But when there was a statement about the *lack* of gender bias presented before the test, women performed better than the men—indicating that there is a stereotype threat within women in higher levels of math and science.

Without the stereotype threat, these women had the ability to outperform men in higher level calculus—but even this will not guarantee them equal treatment. Women are expected to overcompensate in the academic and professional world. A study in 1990s found that women in fields of science are perceived as less qualified than men. Two researchers named Wennerås and Wold found that the Swedish Medical Research Council, when considering a male and female application, would consider the male’s experience more than two times as valuable as the female’s: a woman would have to have twice as many publications, citations, and qualifications just to get the same job as a man (Sommers, 2009, p. 68).

But it seems like the greatest evidence for the stereotype threat lies within the personal narratives from women like Minna Mahlab, the Assistant Director of the Science and Math Learning Center at Grinnell. She described her adversity in earning her PhD: “when confronted with confidence... all the years of messages that women could not do physics that I had ignored but absorbed internally finally surfaced and took hold” (Pattatucci, 1998, p. 28). She focused on how her peers, professors, and community members emphasized her determination over her talent—marking a trend in how women, even young girls, are treated within the professional and academic arena. Jacquellyne Eccles, a professor of psychology helped Mahlab understand her dilemma better by analyzing how communication between a parent and daughter may affect the

child's perception of their talent: "Their daughter is in the 98th percentile on performance. But they explain that by focusing on her hard work rather than her talent...she starts to believe that she is doing well because she is a hard worker rather than because 'I am good at this.'" (Pattatucci, 1998, p. 31). Mahlab reasoned that this eventually leads women like her to doubt her abilities and compare themselves to their male colleagues. This may cause a feeling of isolation or competitiveness with other women in departments due to "limited resources" (Pattatucci, 1998, p. 34).

Considering diligence and talent is important when we discuss the challenges of women in science today. Although we may employ activism, inter-discipline, and solidarity, women must also have a sense of self-esteem. Shifting the paradigm so that natural esteem is possible may seem unlikely, but as we consider all that goes into women's place in science, we can see how scientific inquiry can be redefined through the lens of gender and nature.

Conclusion

Algarotti originally wrote his dialogues in Italian. A woman named Elizabeth Carter later translated them into English, hoping to expand his writing to make it accessible to “her countrywomen” in the United Kingdom (Agorni, 2002). Part of his introduction read “I have endeavored to set Truth, accompanied with all that is necessary to demonstrate it, in a pleasing Light, and to render it agreeable to that Sex, which had rather perceive than understand” (quoted in Mullan, 1993). Carter, an esteemed woman, would go on to translate Algarotti’s poems and other dialogues. A colleague, Thomas Birch reviewed her work and called her “a very extraordinary Phaenomenon”, deeming her as an exception to her sex with her “uncommon Vivacity”. She did write her work to honor Algarotti’s language, tone, and message to women, but she also recognized the implicit misogyny in his style. The words of Algarotti’s introduction still resonate with the continuous discussion surrounding nature, science and gender. But they are no longer a call to women’s admission of ignorance. They are, rather, a pointed remark at women’s misrepresentation historically, and in a contemporary context.

Scientific inquiry is still a competitively fueled course of study or career. Women are rising in representation and success within sciences, but there are still disparities. While women received 57% of all US bachelor's degrees in 2012, they only received 50.5% of science and engineering (S&E) bachelor’s degrees. This number narrows further when women enter graduate school: 45% of S&E master program graduates are women, and 41% of S&E doctorate degrees are awarded to women (NSF, 2012). This illustrates what is commonly known as a “leaky pipeline”: women are dropping out of sciences as they move to higher levels of study. In chapter three I named three ways in which women have combatted this disparity: interdisciplinary

curriculum, activism, and solidarity. Women take control of their place within science using these tactics. But while the number of women in the sciences is growing, we are still fighting against unfair prejudices that are not always within our control.

Tim Hunt's off-the-cuff comments about female scientists in the laboratory demonstrate that overt and covert sexism still exists within in the scientific community. Like Marie Curie and Elizabeth Carter, Tim Hunt is not an exception. Angela M. Pattatucci collected testimony and memoirs from over twenty women in science describing their experiences in tokenizing and sexist environments (1998). One of the chapters by Pattatucci (1998) revealed that there is not only individual bias, but also institutional prejudice against women. One of the more haunting examples is the story of Dr. Margaret Jensfold. While completing a fellowship at the National Institute of Mental Health (NIMH), she found incongruent results to a study surrounding the abuse histories of pre-menstrual syndrome patients. Her findings didn't match up with those of a male colleague, so her competency came into question and her fellowship was pre-maturely terminated by the institution. Jensfold spoke out and fought the wrongful termination to no avail. In addition, her colleagues would later describe her as a dissenter or a "whistleblower", discrediting her further (Allen: Pattuci, 1998, 161). Nevertheless, Jensfold continued independent research in the same field, with future findings consistently supporting her initial results. Her personal outcry against her superior and a larger institution like the NIMH is one example of women recognizing discrimination and speaking out against it.

The reactions to Tim Hunt's comments in 2015 demonstrate the sense of voice that women have found through sciences. Call it "uncommon Vivacity" or outspoken anger, it is clear that women have gained traction since the creation of the "American Dream", and their subjugation to decades of quiet protest. But a peer of Hunt's, Athene Donald, issued words of

caution after Hunt resigned from his position at University College London: “It’s too late to save Hunt’s reputation. But it’s not too late to use the energy gained in this debate to renew efforts to root out the ills that make life difficult for women in science” (Donald, 2015). Donald implored both women and institutions to continue this discourse and find new ways to make science more accessible to women. This discourse has become more plausible through the development of social media, and third-wave feminism has opened up the conversation about woman as subject and object.

Woman is still aligned with nature, but this alignment is more than an image. Women are taking the reins of environmental justice movements and public health initiatives with much success. Each woman is not the passive, pale, virgin nymph we see in Lucas Cranach’s *Spring* (Fig. 1.2, p. 7). They are women who come from all backgrounds and ethnicities. Like Rachel Carson, they are putting their work into the context of their environment—combining the two worlds in which they participate. Majora Carter noted on this separation between work and context in a talk in 2006: “I am in between these two worlds with enough of my heart to fight for justice in the other” (Carter, 2006). Instead of changing how we characterize nature as woman, modern feminism has set out to gain more respect for women. Treating women as subjects or historical agents humanizes and personifies our Mother Earth as something to be respected, rather than something to be dominated. In the eyes of many women in science, justice comes from simple recognition for their context, which includes the earth on which they live.

I will end this paper by re-iterating the words of Algarotti through the lens of Elizabeth Carter—but with a minor alteration. I have endeavored to set Truth, accompanied with all that is necessary to demonstrate it, in a pleasing Light, and to render it agreeable to anyone, in order to honor the women who perceive, understand, and synthesize.

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