

Two-headed Gorillas, Alchemists, Peacocks, Quilters, and Canaries:
A Bestiary for Women Scientists
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March 12, 1999
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Statistics through the late 1990s continue to proclaim that there is a gender gap in science, particularly at Ph.D. granting institutions within chemistry, physics, and mathematics, but not within biochemistry. What can two-headed gorillas, alchemists, peacocks, quilters, and canaries tell us about this gender gap?

Let us begin with two-headed gorillas. Scientists are neither dumb nor unobservant. A common topic of conversation is, Why aren't there more women X, Y, or Zs (electrochemists, etc.)? As recently as 1994 one of my colleagues put forward the hypothesis that more women are in biochemistry than in chemistry because women are afraid of the math. They start in chemistry and then migrate to biochemistry because biochemistry has less math. I call this the Barbie archetype for the short lived Barbie doll who said, "Math is hard." It is a continuing permutation on a now discredited theory of human intelligence called phrenology. Stephen Jay Gould's book "The Mismeasure of Man" gives a good account of the theory by which the size of one's skull was a measure of one's innate aptitude. From his book we find a quote from 1879 by Gustave Le Bon on the data showing cranial size of women is smaller (1):

In the most intelligent races, as among the Parisians, there are a large number of women whose brains are closer in size to those of gorillas than to the most developed male brains. This inferiority is so obvious that no one can contest it for a moment; only its degree is worth discussion. All psychologists who have studied the intelligence of women, as well as poets and novelists, recognize today that they represent the most inferior forms of human evolution and that they are closer to children and savages than to an adult, civilized man. They excel in fickleness, inconstancy, absence of thought and logic, and incapacity to reason. Without doubt there exist some distinguished women, very superior to the average man, but they are as exceptional as the birth of any monstrosity, as, for example, of a gorilla with two heads; consequently, we may neglect them entirely.

The idea is that rational thinking, the weighing of costs, is a mathematical matter, and that women fail to indulge in this thinking because of the smaller capacity of their brains. I will not dwell on this idea, except to point out that women, in general, excel over boys in math in the earlier grades (<5th and 6th). In addition, all children appear to enjoy science until the 6th and 7th grades when it becomes unconnected to their lives. This suggests that there is some fundamental flaw with the scientific education process.

A second archetype is that of the monk/alchemist. Structurally western science grew out of the monastic tradition. The only literate members of society were in the religious orders, and it was not uncommon to find even the priests illiterate. The great experimentalists of the

Western model of science were monks: St. Albert the Great, Roger Bacon, a Franciscan, and The Black Powder Monk (inventor of the first gun used in western conflict). The imagery that goes with the monk/scientist is that of long hours, poverty, and a dedication to science as an encounter with the unknown. The elements of this encounter with the unknown can be found in the old testament (among other religions) where the Hebrew use of the word Yahweh for the personal name of God, is really the pronunciation of the acronym for God, whose name could not be pronounced because God was unfathomable by humanity, mysterious, unknowable, unnameable (2). Scientific inquiry is a permutation on the monastic seeking of the unknown. It is, at it's essence, a spiritual journey into truth that only the chosen may make.

Women do not appear to resonate with this image in the same way as men do. This too can be traced to Western religious history. The number of religious houses for men was typically four times the number of religious houses for women in France during the 12th century (3). Similarly in England the number of monasteries founded by the conquering Normans far exceeded nunneries (4). Only one of the three religious orders had a moderately comparable foundation rate for men and women. And in that order, that of the Benedictines, the dollar value of the nunneries was much more modest than the wealth associated with the monasteries.

There were practical reasons for this disparity. The first involved the fact that only men could intercede with God in prayers. Thus if one were to endow some of the ill gotten gains from the pillaging of the middle east during the Crusades, one would chose to endow that wealth to a monastery where the large number of prayers necessary to make-up for a psychopathic lifetime were available. The wealth of a nunnery, in contrast, came nearly entirely from the dowry payments made for the support of the entering nun in lieu of her marriage. The consequence of this is that only those women from the aristocracy could afford to and were deemed fit to follow the call of God (5).

The clear moral of this is that if you are a rich woman you can afford to encounter God with a daily passion. The rest of us have to work. Today only a woman with good child care and a housekeeper can afford to encounter science. A recent study of women in the physical sciences finds that the disparity between women and men in the sciences is less in more class stratified societies, such as Latin America or Europe where household or governmental help is more common (6). By the same token, American women enter other equally demanding fields like law and medicine. The difference between women entering law and medicine vs the sciences may simply be the salary that allows them to have adequate housekeeping and child care.

In this model of science virtue is it's own reward. The search for truth is the meaning behind the science and the search transforms the searcher. Science is alchemy. Roger Bacon, an alchemist Franciscan monk of the 12th century, and the gentleman scholar of Victorian England become our role models.

Our next, more insidious, model is the peacock. Historically, the alchemist is supplanted by the modern man of science. 12th century Roger Bacon is supplanted by 16th century Francis Bacon. Science is cut away from it's encounter with the unknown as a religious or transformative process and is left with a materialistic view point, that the encounter with the unknown, simply expands the sphere of the known, and that expanding sphere of the known can be owned and controlled. Science is the ultimate expression of the new economic model in which workers are packets of information which flow to jobs and projects as freely and as

necessarily as capital flows. The worker is unconnected without past, future, or present encumbrances. The logical basis for this view of science initiated by Francis Bacon culminates in the economic science by which what is rationale and right is measured in the market place of ideas (7).

The last Gordon electrochemistry conference I went to in 1997 was lamented by one of my cohorts as not a good one. He said: “There were no good fights, where people really went at it”. In this model, science is the process by which the best idea in the market wins. The market place of ideas not only guides us to truth but it guides us the most efficiently. It is this image of science that is so antipathetic to the idea of gendered science. Science is merely a method by which information is discovered. It can not be related to gender, race, or ethnicity, for if so, truth is relative. And we all know that, should we choose to do so, regardless of our gender, race, or ethnicity, we will all independently discover that water boils at 100 C. The problem with this model and why it is explicitly gendered is that women don’t fight, and when we do fight we fight differently.

Last fall I was at the grocery store waiting for my turn in the check out lane. As the man in front of me left, the male teenage teller turned to the male teenage bagger and said, “Did you see the size of those arms? They were as big as my thighs. No way was I going to argue with him about the price, even though he was wrong.” Women live in a world where statistically 50% of the people have bigger biceps. We learn by the age of 12 that we can no longer beat up our little brothers to solve an argument. We resort to alternative methods of problem solving. A direct head to head confrontation, in general, is not our method of choice. We do fight, as one female electrochemist friend of mine says, but when we do it is over something particularly important, and we will fight to the death and we will not forgive. This is, of course, why parents will tell you that raising teenage girls is infinitely more stressful than raising boys.

Men fight all the time. They then generally make up. Often the fighting is more about making a show than about winning the war. When I first started attending electrochemistry conferences it was common for there to be held a ritual football game between the academics and the industrial chemists. I felt compelled to insert myself into a game I don’t even like, simply to uphold the honor of women. What I found out was that the industrial chemists within 3 minutes of their first huddle had selected a quarterback who had past experience and set up their first three calls based on the assumption that the point of the game was to collectively win. My academic group spent 15 minutes debating who got to be quarterback. After finally settling on a quarterback, all subsequent plays called by the quarterback were aborted as he decided that not only was he the only competent thrower, he was the only competent receiver and runner. Each play he called was contested within the group. We were, of course, roundly trounced.

I have served on women-only committees and on mixed-gender committees. The women-only committees tend to come in focused on the product and work to achieve the goal of the product. The mixed gender committees spend a lot of time in displays and noise. That is, a guy is willing to make a lot of noise about his idea even if it derails the process entirely.

Fighting garners attention. Aggressive questioning at a meeting garners attention. Aggressiveness gets my ideas on the table in much the same way that kinetic boys in a preschool end up with a preponderance of the teacher’s attention. Questions at a meeting are often intended to show one’s one superiority, rather than to explicate a point or pursue curiosity. When I gave a talk at University of Illinois Urbana-Champaign one young woman told me she

was opting out of academic science because while she thought she was as smart as her professors she had no taste for the aggressiveness by which scientific ideas were questioned.

The person whose ideas get put on the table (and funded) is the one who makes the most noise and who is the best salesperson. Do you know any good car salespeople who are women? I don't. Salespeople project confidence and manipulate a bad situation into a good one. One way to do this is to pro-actively start conversations which establish pack rank. At all chemistry conferences I have gone to the opening conversational gambit is: "So how big is your..... (research group)?" If you can't pull rank by the size of your (group) then you pull rank by the nature of your pedigree. This is the peacock spreading his feathers.

The peacock who displays the best is the one noticed, the one whose name is known, who may be suggested for a seminar visit or talk. Women just don't get this, our reaction is that this is a failure of maturity. A chemist from Northwestern visiting my institution told me that there were two faculty members in his department who will not enter a meeting when the other one is present. He found this admirable because it was a sign of complete confidence in one's own integrity. My kids do this too, but my husband and I try to curb it. We are not entirely successful, but we can at least tolerate it because our kids, unlike my colleagues, are cute.

This leads to another archetype which melds the alchemist with the free market peacock. This is the model of the genius/scientist who is given dispensation from ordinary human civility and tasks because of his immense contributions to society. My favorite model for this is Gauguin who left his wife and family to sail to Tahiti to paint expressionist paintings. He returned with his 12 year old native mistress in tow whom he subsequently let loose among the Parisian artists. I can not look at a painting of Gauguin without thinking about my 12 year old daughter.

Our next archetype is that of women as quilters, which bears upon the gender gap in politics. Some political pundits have suggested that women tend to vote more Democratic than Republican because they don't have enough self esteem to think that they can handle their finances and create their own nest egg. They haven't yet learned to say: "I don't want the government taking my money, I can do better with it." This is one possible interpretation.

Pundits of the opposite political persuasion suggest that the gap arises because women have historically not come to the table (market) equal, that women biologically can be physically connected to other people in ways that men will not experience, and that because we do not fight, social interactions have greater importance for us than men. We therefore tend to value schools and aid for the poor and elderly, hence the gender gap in politics.

How does this archetype play out in science? The economic model of people as unconnected packets of information competing in the market place affects how we teach science. Ideas are communicated efficiently as random packets of information to be assembled. It is small wonder, then, that we do so poorly at science education. At one faculty meeting a colleague made the point that 30%-40% of our students in freshman chemistry will not make it to second semester and he wondered what we could do about this. I immediately began to wonder what we are doing wrong in our teaching and it took me some time to realize that the point being made was that there should an efficient way of identifying the failures earlier to get them out of the system. It seems to me that part of why we lose so many people is that ideas are thrown out as mathematically compressed factoids of complex phenomena severed from their human connection. Those who survive will have garnered a large amount of information in a

short period of time. They will have participated in what is, for the survivors at least, a highly efficient process.

The desire for connections that women bring to their learning styles, they also bring to their research. Women come to the table trailing threads, that connect them to other images and other parts of life. Women are both part of and are the creators of quilts. In terms of doing science this has three implications. Women, as a generalization, are comfortable in quilting bees. Women work collaboratively more than men do. The problem with collaborations is that the individual with the least power and name recognition remains the person with the least money and name recognition. Even a woman working alone makes her work into an entire quilt. Her work tends to contain more background. In the crucial years of one's tenure track this plays against women because they trade depth for quantity. A man will present a block and thus lay claim to the entire idea of the design of the quilt.

The quilted woman finds herself in a landscape that is not sexist, but alien. At the time of the Gulf War I was hurrying around the house trying to pry my legs loose from the clutches of my 4 and 2 year olds in order to drive to another Midwestern university where I was to give a talk. As I prepared to get out of the house and on my way I listened to the accounts of the sheer number of planes flying over Baghdad and I imagined those planes over Chicago. I imagined trying to decide if now was the time I should take my children down to basement or not. After my talk several of us went out to lunch. During lunch my host exclaimed that he had been glued to the television coverage of the Gulf War the night before. I asked why. He said, "Every time one of those smart bombs hit, I think, yes!, another million for laser research." I, in turn, shared my morning thoughts, which, not surprisingly, killed the whole conversation for the rest of lunch.

The same sort of disconnect happened when I was in Japan for an international meeting. We few Americans went out to eat and during dinner one colleague excused himself from the table as he had to make a phone call home for his child's birthday. Without thinking I asked, "You are traveling on your child's birthday?" My other colleague, a much more accomplished scientist than I could ever hope to be, said, "When your career takes off, you'll find that often happens." My answer was, "Well, I'm Mom, if I am gone, who is going to blow up the balloons?" And by the look on his face I knew that this was an idea that had never occurred to him.

In the final analysis, women find the culture of science alien. It is not about posters of naked women in the fume hoods, or about pi orbital theory explained by reference to Dolly Parton's anatomy, it is about civility and perceptions of maturity, where maturity is measured by one's grace in juggling large numbers of connections. Women tell me that they resent the fact that they must wear a mask, they must learn to drink beer not wine, to talk sports, to assume the persona of a used car salesman, and to not notice when one's colleagues are unable to master the necessary social skills to respond to simple greetings. Not surprisingly, many women opt out between graduate school and tenure track or during tenure track. Why stay if you can proceed on a journey of discovery into the unknown in some other culture, like biochemistry, where there are enough women present so that you can get your agenda on the table in other ways. Biochemistry has what is called a "critical mass" of women (8).

Current (1998) statistics from NSF's Science and Engineering Indicators show that women are only 22% of all scientists. Of those scientists 50% are in the social science, 35% are

in life sciences, 29% in computer/math sciences; 22% are in math, physics, chemistry, and 8% are in engineering (9). This number is remarkably consistent with the number of women who have attended Gordon Conferences on Electrochemistry the last 14 years. While faces change, with as many women exiting as entering, the number of women as maintained at 15-20%. These statistics hold despite a large rise in the number of assistant professors in the late 1980s. Women have been opting out.

All of these remarks have been addressed to women, but it has been consistently pointed out to me by my male colleagues that many men feel these same pressures. I recently learned that the relationship between how women feel and react to these pressures and how men feel has a label. Women are the canaries in the mine, the early warning system.

On a more cheerful note the same NSF statistics from 1998 indicate that there has been an enormous increase in women at the assistant professor level in the 1990s. We will find out in the next few years if this particular large bump in women will make the conversion into tenured associate professors and, if in so doing, the entire field reaches critical mass. I sincerely hope so because I am not prepared to single-handedly account for the weight gain necessary to reach "critical mass".

If I work in an alien culture how did I get here and why do I stay? I am here because I got a C in chemistry in high school and my astronomer father and artist mother told me that the fighting with my father over homework was debilitating to the family. I, alone of all my siblings, was told that I would be unable to stand the boredom of science, that I was not suited for science, and that I should stick to art. It doesn't take a Freudian to figure that one out.

How do I tolerate the constant changing of masks and persona? My undergraduate degree is in cultural anthropology and I spent a number of years living as a member of other societies where I belonged and yet did not belong. Or perhaps a sense of otherness is more bred into me as a child of the desert where all of humanity is fundamentally alien to the landscape. At any rate, I find that I have had practice wearing masks and that the cost of wearing a mask is more than balanced by the fact that I am, in spite of my father's prognostications, never bored. More importantly, I really do believe that science is a transformative journey of discovery into the unknown with God and with people I care about, and that it is occasionally a lot of fun.

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