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A portrait of a woman as a scientist: breaking down barriers created by gender-role stereotypes

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Educational, attitudinal, and sociocultural factors create barriers that prevent girls and young women from pursuing opportunities in science. Of these barriers, gender-role stereotypes of science have been cited as a significant obstacle. This research analyses a US television series that counters gender-role stereotypes of science. The analysis found the images presented on this series challenge previously reported stereotypes of women scientists shown in the US media by emphasizing the expertise of women scientists, showing alternatives for balancing the demands of their professional and personal lives, and providing examples of role models who have succeeded in male-dominated fields. The significance of these results are discussed in light of gender schema theory and the need for future research on the effects of women scientist role models on girls' and young women's interest in science.

Many educational, attitudinal, and sociocultural factors create barriers that affect girls' and young women's interest and participation in science.[1] Girls start to lose interest in science between the ages of 9 and 14,[2] and, consequently, few later choose to pursue advanced degrees and careers in science. According to recent statistics, 39 per cent of all master's degrees and 31 per cent of all doctoral degrees in the agricultural, biological, and physical sciences awarded in 1992–93 in the USA were earned by women, and only 15 per cent of all master's degrees and 10 per cent of all doctoral degrees in engineering awarded in that year were earned by women.[3] Employment statistics show that only 27 per cent of employed natural scientists and 8 per cent of employed engineers in early 1996 in the USA were women.[4] Other statistics show that 4.3 per cent of the US labour force in engineering, 33.1 per cent in the social sciences, and 25.7 per cent in the life sciences were women with doctoral degrees.[5]

Research has documented many of the educational barriers that appear to contribute to the gender gap in science participation. These barriers include the preferential treatment of boys in science classrooms;[6] the use of curriculum, teaching approaches, and assignments that favour male intellectual styles;[7] teachers' gender-biased perceptions of girls' scientific ability;[8] the lack of female role models in science classrooms;[9] the under-representation of women in science textbooks;[10] and the unequal training of girls as a result of fewer experiences with science activities in the classroom.[11]

Researchers also have identified several of the attitudinal barriers that keep girls from participating in science. Studies indicate that girls and young women are more likely to think of scientists as male[12] and of science as a masculine subject;[13] to develop negative attitudes toward science, scientists, and extracurricular science activities;[14] to lose confidence in their ability to succeed in science;[15] and to view science as masculine.[16]

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More recently, researchers have examined some of the sociocultural barriers that contribute to the gender gap in science participation. Research has found a lack of discussion of scientific careers and a dearth of women scientist role models in the home.[17] Research also shows that parents hold gender-role stereotyped perceptions of their children's abilities in science and maths.[18] Other studies have found the overprotective behaviour of parents prevented girls from participating in scientific research opportunities.[19] In addition, several studies have documented the gender-stereotyped image of science conveyed by the mass media.[20]

Identifying strategies to promote greater interest in science and engineering among girls and young women has been the focus of much research in recent years. Prompted by the recognition that future scientific and technological advancements will require drawing on the scientific knowledge and technical skills of all people, many science intervention programmes have been developed to increase the participation of women in science. A recent national survey in the United States identified 109 programmes specifically designed to serve female middle-school students.[21] These intervention programmes focus on altering the existing cultural stereotype of science as masculine, changing school curricula to focus on the cognitive skills critical for learning science and maths, and reorienting school curricula to encourage learning by both boys and girls.[22] Such programmes have been offered in a variety of formal educational settings (such as schools, labs and universities) and informal educational settings (such as museums, on the Internet, and at home). Some recent programmes include, for example, single-sex science classes,[23] a 'female-friendly' science lab,[24] a telementoring project,[25] a mentoring 'Science-By-Mail' programme for girls,[26] an all-girls science camp,[27] and college- and university-sponsored science programmes and workshops for girls.[28]

Even television programming has been used as a way to increase girls' interest in science. In 1995, *Discovering Women* was broadcast in the USA on PBS, the Public Broadcasting Service, 'as part of a national educational programme to change the way middle-school students approach science.'[29] The six-part series, supported by the National Science Foundation, the Alfred P. Sloan Foundation and the Intel Corporation, was designed to 'enhance public understanding of the contributions made by women in science.'[30]

Given its focus on positive role models of women scientists, this series provided a unique opportunity for comparing the images on *Discovering Women* with previously reported stereotypical images of women scientists in the mass media.[20] One goal of this analysis was to provide some baseline descriptive data on the images of women scientists to add to our current understanding of media images of scientists.

This analysis explores the following questions: What are the images of women scientists presented on the series *Discovering Women*? How are women scientists portrayed on the series? How do these images differ from previously-reported stereotypical images of women scientists in the media? Open-ended questions were posed for this study because it was desirable at the early stage in this line of enquiry to assess the ways women scientists are portrayed before assessing the specific effects of these images on viewers. To assess the effectiveness of these images in encouraging girls' interest in science and scientific careers, future research will examine their actual responses to images from this series.

The potential impact of media images of women scientists

While it is beyond the scope of this paper to examine girls' actual responses to and interpretation of the images on *Discovering Women*, it is important to consider the potential impact of these images. Gender schema theory offers a useful framework for considering

how images of women scientists might affect girls' perceptions of scientists and scientific careers.[31] Although other information processing theories also would be useful for exploring potential media effects, the unique feature of gender schema theory is its emphasis on the dominant role of gender over other factors in the processing of information.[32] This emphasis on the role of gender during information processing is particularly helpful because of the focus of *Discovering Women.*

Gender schema theory describes how children learn cultural definitions of gender and gender roles. In a gender-polarized society, according to this theory, children readily process and organize information about themselves based on cultural definitions of maleness and femaleness.[33] As they process new information, children develop gender schemata, 'cognitive structures that organize an individual's gender-related knowledge, beliefs, attitudes and preferences.'[34] These schemata influence children's perceptions of the world.

Gender schema theory is based on two premises: (1) cultural definitions of gender embedded in discourse and social practices are internalized by a developing child, and (2) once predisposed to these cultural definitions of gender, a child will identify with them.[35] According to Bem's theory, children interpret information according to gender schemata rather than other types of schemata because they recognize the emphasis the social context places on gender. As Bem explains, 'the culture's insistence on the functional importance of the social category is what transforms a passive network of associations into an active and readily available schema for interpreting reality.'[36] Consequently, Bem argues, children view the world through gender-biased lenses or the 'lenses of gender.'[35]

Research in support of gender schema theory provides explanations of how media messages about the gender-appropriateness of science might influence girls' and young women's perceptions of science and scientists. Research indicates that subjects accept gender-appropriate attributes and reject gender-inappropriate attributes,[37] remember information that is compatible with existing gender schemata,[38] and alter information that is incompatible with existing gender schemata.[39] Research by Levy found that children organize their processing of social information based on existing gender schemata.[40] Similarly, Calvert and Huston found that children process television content based on existing gender schemata.[41] Studies also show that children show signs of gender-stereotyping of occupations as early as the preschool years.[42]

Studies also show, however, that direct educational intervention is effective in reducing children's gender-role stereotyping of occupations. Bigler and Liben found less gender-role stereotyping of occupations in children who were taught that gender is an irrelevant criterion for sorting people into occupations.[43] In a related study, O'Bryant and Corder-Bolz noted that girls rated traditionally male-dominated occupations more favourably after they saw televised female models in these occupations.[44] More recently, research by Griffin and his colleagues found that girls from low socioeconomic backgrounds chose less traditional occupations after exposure to television portrayals of female characters in non-traditional occupational roles.[45]

Images of women scientists in the US mass media

Analyses of media images of women scientists have found that the mass media in the USA often perpetuate the cultural stereotype of science as an inappropriate career for women. LaFollette explains:

> Historical analysis of American popular culture shows that, throughout this century, the mass media have also purveyed a strongly negative image of women scientists, depicting them as both atypical scientists and atypical women.[46]

The research literature indicates that media stereotypes of women scientists typically are reinforced in one of three ways: by downplaying the expertise of women scientists, by focusing on the conflicts faced by women scientists in balancing the demands of their professional and personal lives, and by presenting women scientists as lacking the masculine traits and skills needed to conduct scientific research.

Downplaying the experience and expertise of women scientists is a common theme in many media images of women scientists. For example, in her analysis of biographies of women scientists in popular magazines from 1910 to 1955, LaFollette found that the images emphasized the domestic abilities and feminine qualities of women scientists rather than their scientific expertise.[47] LaFollette found that journalists 'cultivated an image of domesticity, often overemphasizing researchers' femininity'[46] and referring to their abilities in activities such as cooking and sewing. Nelkin noted in her analysis of stories of female Nobel Prize winners in the press that stories about women scientists appeared not only on the science pages but also in lifestyle and women's magazines.[48] She also found that these stories emphasized the domestic abilities of women scientists, occasionally showing pictures of them in the kitchen or commenting on their baking practices.

Media images have discredited further the expertise and experience of women scientists by showing them more often as subordinate assistants rather than directors and leaders in the laboratory. LaFollette found that biographies of women scientists in popular magazines often presented women scientists in lower status, supportive roles, such as laboratory technicians.[47] In her research on Saturday morning children's programming, LaFollette found that two of the four women scientists on these programmes were shown as laboratory assistants.[49] Steinke and Long's analysis of popular children's educational science programmes found most of these programmes presented women scientists more often in secondary roles of lower prestige and presented noticeably few women as expert scientists or in positions of high prestige within the scientific community.[50]

Emphasizing the difficulties of balancing the demands of a scientific career with marriage or motherhood is another theme found in media images of women scientists. LaFollette found that magazine biographies of women scientists emphasized the extraordinary hard work and sacrifices required to be a woman scientist.[47] She argued that these images suggested 'that women—even women who were successful scientists—were still more fulfilled through marriage and motherhood than through research.'[51] She explained that images of women 'superscientists' indicated that 'the options of a regular family life, home, and possibly motherhood were closed for all but extraordinary female scientists.'[52] Nelkin found that stories about female Nobel Prize winners often mentioned the opportunities these women scientists missed by not being at home.[48] According to Nelkin, these stories suggested that 'the successful women scientist must have the ability to do everything—to be feminine, motherly, and to achieve as well.'[53]

Presenting science as a field that requires masculine traits and skills is another theme found in media images of women scientists. LaFollette found that scientific research was 'consistently portrayed as requiring certain "masculine" attributes such as intellectual objectivity, physical strength and emotional detachment'[51] in the biographies of women scientists. She noted that women were even described as a 'potential distraction to their male colleagues.'[54]

Methodology

The framework for this analysis of *Discovering Women* was developed from previous research on stereotypes of women scientists in the mass media described above.[55] These studies show that, in addition to under-representing women scientists, the mass media often present stereotypical images of women scientists by emphasizing science as an inappropriate career for women. Using the findings from previous research as a framework, each episode of *Discovering Women* was examined to determine how the portrayals of women scientists in this series compared with previously-reported stereotypical images of women scientists in the mass media.

Based on the findings from previous research, three themes were used to guide the analysis: (1) women scientists' expertise and competence; (2) women scientists' balancing of personal and professional responsibilities; and (3) women scientists' experiences working in a male-dominated field. During several viewings of each episode, I noted how these themes were addressed in the comments from the narrator, the featured scientists, colleagues of the featured scientists, and family members. A description of the different types of segments in which these themes typically were noted is provided below.

1. Women scientists' expertise and competence

   Segments that showed the scientists conducting research in the laboratory or at field sites; segments in which the scientists were shown explaining their research; segments in which scientists were shown teaching others about their research or science; comments from the featured scientists' colleagues about the expertise of the featured scientists; comments by the narrator about the featured scientists' expertise or their contributions to science.

2. Women scientists' balancing of personal and professional responsibilities

   Segments that showed the scientists with their children; segments in which the scientists talked about their children, having children or not having children; segments in which the women scientists discussed the choices they have made or will make about marriage and family; comments from family members, care-givers, colleagues and the featured scientists about combining work and family responsibilities.

3. Women scientists' experiences working in a male-dominated field

   Segments in which the featured scientists discussed their interactions with male colleagues; segments in which male colleagues discussed their or other male colleagues' interactions with the featured scientists; segments in which women scientists or their colleagues discussed gender-stereotyping of science.

All of the following six episodes of *Discovering Women* were analysed: *High Energy*, featuring physicist Melissa Franklin from Harvard University and Fermi Lab; *Jewels in a Test Tube*, featuring biochemist Lynda Jordan from North Carolina A&T University; *Earth Explorer*, featuring geophysicist Marcia McNutt from the Massachusetts Institute of Technology; *Secrets Underground*, featuring archaeologist Patty Jo Watson from Washington University; *Silicon Vision*, featuring computational neuroscientist Misha Mahowald from Oxford University; and *DNA Detective*, featuring Lydia Villa-Komaroff from Harvard University and the Children's Hospital in Boston.

Findings

Establishing expertise

Establishing the expertise of the women scientists on *Discovering Women* is a theme reiterated through the narrative and images presented in each episode. The expertise of the women scientists is established in one of four different ways. Expertise is established through the use of comments by the narrator about the featured scientists' credentials, major scientific contributions, and knowledge of the field; through the use of images of the featured scientists conducting field research or working in their labs; through comments from colleagues about the featured scientists' accomplishments and achievements; and through comments from the featured scientists about their research and the significance of their research.

The narrator's voice often is used throughout the series to establish the expertise of the women scientists. At the very beginning of each episode, the narrator introduces the featured scientist by name, briefly states her professional credentials and tells a little about her research programme. For example, the narrator introduces Melissa Franklin, a physicist, who tracks invisible subatomic particles using "her amazing microscope, the collider detector, at Fermi Lab Chicago." In the next episode, the narrator introduces Lynda Jordan, a biochemist, who is moving into a "sophisticated new biochemistry lab at North Carolina A and T University." In the third episode, the narrator introduces Marcia McNutt, a geologist, who "studies phenomenon that take place on a geologic time scale," In *Secrets Underground* the narrator introduces Mary Jo Watson, an archaeologist, who "has found remarkable evidence—bits of cloth, cane torches, and even footprints—of prehistoric people who passed this way nearly 5000 years ago, before the pyramids were built." In a later episode, the narrator introduces Misha Mahowald, a computational neuroscientist, who is "one of the new breed of young scientists trying to understand how the brain works." In the final episode of the series, the narrator introduces Lydia Villa-Komaroff, a geneticist, who is "trying to unravel the essential mystery of the human brain." By presenting the women scientists' professional credentials and affiliations at the very beginning of each episode, the narrator focuses attention on the expertise of these women.

The narrator's comments about the expertise of the women scientists during the opening scenes of each episode are further reinforced through images of the women at work in their labs or out in the field. Franklin, for example, is shown making adjustments to a supercollider; Jordan is shown inspecting her new lab; and Villa-Komaroff is shown working late at night in her lab, at a time when few people are walking down the streets and few cars stopping at the red traffic light shown outside her lab.

The narrator not only emphasizes the expertise of the featured scientists at the beginning of each episode, but often returns throughout the series to comment further on the expertise of the women scientists. For example, in *High Energy*, the narrator explains that "because she has built and maintained this detector for so many years, Melissa has special insights into the machine and the data it generates." The narrator explains that Franklin's work with the Fermi Lab detector has "attracted the notice of some of the field's top people," she has become "a public figure in her field," and has "found herself on a podium full of some of the most eminent names in physics."

The narrator also highlights the expertise of the other women scientists featured in the series. In *Jewels in a Test Tube* the narrator reports that "almost single-handedly Jordan raised a million dollars for a new biochemistry lab." In *Secrets Underground* the narrator explains that at age 61, Watson is at the top of her field and "one of a very few women in

the prestigious national Academy of Sciences," and that her refinement of the technique of water floatation has "made the process yield more reliable and scientific data." In *Silicon Vision* the narrator explains that the research on which Mahowald worked while a 27-year-old graduate student was featured in a cover story for *Scientific American.* In *DNA Detective* the narrator explains that Villa-Komaroff "was a key figure in a major scientific race—caught up in the hottest scientific controversy since the development of the atom bomb," and that her "name went down in textbooks and on the patent for a genetic engineering technique."

The expertise of the featured scientists is further reinforced by comments from colleagues who were interviewed for the series. These comments focus on the women scientists' professional status and their contributions or potential to contribute to science in the future. In the first episode of the series, for example, one of Franklin's male colleagues, explains that the faculty at Harvard University hired Franklin because of her "original and fresh point of view" and because she had become a public figure in the field. Several of Franklin's colleagues also describe her passionate commitment to science. For example, one of her male colleagues says:

> Melissa was actually quite important in this stage because she really believed passionately in the capability of the device. She led the team that got down and understood all the details and got all the dirty work done under sometimes not very encouraging circumstances.

In *Earth Explorer* a male colleague of Marcia McNutt discusses both her success at MIT and her status in the scientific community:

> When we reviewed her for tenure. We were able to develop a very strong case for tenure because she had contributed to the science in several very distinct ways. . . . To get tenure at MIT it's not enough to publish a lot of papers, you actually have to change the course of science. You have to take science somewhere it hasn't been before. In other words, you have to be a scientific leader.

A male colleague explains that McNutt is a "very persistent person" who "typically will not take no for an answer" when faced with adversities or roadblocks. One of McNutt's female colleagues describes McNutt's focus and discipline:

> It's not so much that all this stuff is so easy for her; I think she really pushes herself. She doesn't allow herself a lot of time for relaxation. Were I to try to have a lifestyle like Marcia's I think what I would be giving up is a certain, partly a certain time for myself, a certain sort of time for reflection. I sit around a lot. . . . I don't really think Marcia does that. She doesn't have time in this sort of tightly organized life that she leads.

In *Secrets Underground* one of Watson's male colleague describes her expertise in archaeology. He explains that her expertise has made her an effective consultant on field practice and analysis. He says: "She's got several decades of experience. She's learned all there is to learn about how to do it."

Another technique used in *Discovering Women* to establish the expertise of the women scientists is the use of images that describe and define their roles within the scientific community. Typically, these images focus on the two primary professional responsibilities of scientists, that is, their responsibilities as researchers and as teachers. These images further reinforce the comments provided by the narrator and colleagues.

Throughout the series, each episode features many images that show the women scientists' professional responsibilities as researchers. Franklin, for example, is shown

working in Fermi Lab with the detector she built and in a computer lab conferring with male colleagues. Jordan is shown working in her new lab and analysing data on a computer. McNutt is shown conducting field work in the South Pacific and at Lake Mead (she is shown on a helicopter, boat and ship), conferring with a colleague, meeting with officials from Nevada to get approval for her Lake Mead research project, working at a computer, calling a colleague to discuss a project, and analysing a map during her research at sea. Watson is shown wedged between rocks while groping her way in a cave for her cave research, conducting research in China's Yellow River Valley, leading a Chinese research team through a step-by-step demonstration of new archaeology techniques, collecting samples at Mammoth Cave National Park, and leading a group in Jaguar Cave. Mahowald is shown giving a scientific presentation at a meeting of computational neuroscientists in California, conferring with colleagues, and testing the computer she designed. Villa-Komaroff is shown meeting with colleagues in the lab, rushing along the corridors of the Children's Hospital, checking the progress of her research team and working in the lab. The narrator explains that, in Villa-Komaroff's lab, work goes on 24 hours a day, seven days a week.

In addition to the images of the women scientists as researchers, the series also presents images of the women scientists as teachers and mentors. Although less frequent than the images of the women conducting research, these images appear in five of the six episodes. For example, in *High Energy* Franklin is shown lecturing in front of class of high-school students visiting Fermi Lab, advising a female student at Harvard University, and instructing a female colleague or assistant at Fermi Lab. In *Jewels in a Test Tube* Jordan is shown giving instructions to students in the lab and teaching a group of students. In *Earth Explorer* McNutt is shown lecturing in front of a class. In *Secrets Underground* Watson is shown advising a female student, leading a group of student research assistants at the shell mounds near Mammoth Caves. In *DNA Detective* Villa-Komaroff is shown speaking to minority students interested in science. In this episode, Villa-Komaroff talks extensively about her role as mentor for one of the female students who works in her lab.

The role of teacher is a particular emphasis in *Jewels in a Test Tube.* This episode describes how Jordan balances her commitment to research with her commitment to preparing the next generation of African American scientists. Jordan's comments reveal her serious commitment to her students. She emphasizes the importance of this work:

> What is success? Is success a measure of just your number of publications rate, or is success a measure of your contribution to science. And what is a contribution of science? Is a contribution of science only what you do in the laboratory or the people you develop? What is a contribution?

Jordan is shown frequently talking with African American students about science. The narrator notes the seriousness with which Jordan undertakes this responsibility: "It has become almost a crusade for Jordon, to widen their aspirations, to encourage them to broaden their reach as she herself was encouraged at a critical time in her life."

Discovering Women further emphasizes the expertise of the women scientists through comments from the women scientists. These comments focus on descriptions and explanations of their research. For example, in the episode *Earth Explorer*, McNutt provides detailed descriptions of her research. McNutt's discussion of the significance of her research on plate tectonics displays her extensive knowledge of the topic:

> Basically what plate tectonics did was it gave us a framework through which we could connect all of these different processes that were happening on the earth's surface that were separated by very large distances, but nevertheless were all related through a common theme, namely the motion of the plates.

She further reveals her expertise by describing the research procedure she plans to use for the Lake Mead project and the knowledge she hopes to gain from this research:

> We will use the air guns to make a sound and then we will listen for the echoes from that sound being reflected off different rock units at depth. And the important thing for us is to understand where there are major discontinuities or major boundaries between different rock types, and those echoes are going to tell us something about when a continent breaks apart, how much is caused by bolting and how much of it is caused by rock just flowing from one region to another and how much of this is caused by volcanic activity pushing magna into the crust.

Through her descriptions of her research, McNutt displays her extensive knowledge of geology.

Balancing professional and personal lives

Another theme addressed in *Discovering Women* is the choices the featured scientists have made about balancing their professional and personal lives. Each episode focuses on slightly different issues because the personal circumstances each of these women faces vary. For example, two of the women are single; one woman is single following a divorce; another woman is a single mother of three young children and is engaged to be married a second time following the death of her first husband; one woman is married and the mother of one older child; and another woman is married with no children. In describing the featured scientists' personal lives, the series focuses on the decisions they have made, their reasons for making these decisions, and the strategies they use to support their decisions.

The issue of balancing family life with a professional life is most pronounced in the episode, *Earth Explorer.* The scientist featured in this episode is the only woman scientist shown currently raising young children while working. In the opening scenes of this episode, the narrator explains that McNutt lives in household of women that includes her three young daughters, a live-in housekeeper and her housekeeper's daughter. McNutt explains that her housekeeper, Ann, stays at home making sure "the refrigerator is full and the kids get off to school on time." Ann explains that McNutt does the traditional "father things" like the homework, taking the kids out for lunch and dinner at McDonald's on the weekends and bringing home the paycheck.

McNutt's daily life is full of activities that revolve around her professional and personal responsibilities. She is shown taking her daughter to school before going to work. Later in the episode, McNutt is shown away at sea sending an email message to a friend to send on to the girls telling them to "give the dog and guinea pig a hug." McNutt explains that this balancing act is just one of the realities of the profession she has chosen. She states:

> Unfortunately science is not a field where one easily drops out of it after having become a professional and raises a family and then drops back in. That's simply not possible. The field moves too fast and unless you keep up, you're left behind and you might as well start over again. Right now it is a balancing act.

But throughout the episode, the narrative and images indicate that this balance is important to McNutt. Her life does not solely revolve around cooking dinner and attending her daughter's soccer games nor solely around meetings with colleagues and research at sea. She is able to develop strategies that help her to best balance family and career.

During the episode, however, McNutt candidly discusses her occasional regrets when her work requires her to miss time with her daughters. In one scene she tells Ann: "I heard

you went swimming. I was so jealous, I just sat there under the glare of my fluorescent lights and thought of you." Later in the episode McNutt says:

> I think the worse part about it for me is when I have to miss sharing significant events in my children's lives. I really dislike it when there is something important going on at school and I can't be there for it or if there is something else that they are very excited about that I can't be part of.

McNutt's housekeeper adds that when McNutt is with her daughters "she's with them, she's really with them, and when she's gone I sort of take up the slack, and go to the soccer games."

To some extent McNutt is presented as a woman who can and will do it all. She appears to possess a limitless amount of energy as she balances work and family. In the episode, she is almost always shown working either in the field or at home. Comments from one of her female colleagues further emphasize McNutt's diligence, stamina, and drive:

> Marcia is incredible. If you look at her calendar she has something scheduled for every minute, you know, where as I do one thing or two things or three things and go, ah, I need to have time to recover from that. Marcia has a calendar which, I don't know if it is all filled up for this coming year, but, you know, she goes from work to home and has dinner with her kids and then they go out shopping, you know, for someone's birthday present or go to get their ice skates fixed or something like that. And she just goes on like this all day and she really never lets up.

McNutt's colleague adds that this energy is unusual, even impossible for most.

> One of my friends said, I was sort of complaining, oh that, you know, Marcia does this or Marcia does that, and I can't do that. And she said, oh, you can't compare yourself to Marcia, she's not a homo sapiens, she's some other species, you know, so don't worry about it.

McNutt's family situation is very different from the other woman scientist who has a child. Patty Jo Watson, who is featured in *Secrets Underground*, has an older daughter who is now in college. Unlike McNutt who we see facing the daily challenges of raising three young daughters and working as a scientist, the early child-rearing days are over for Watson. The narrator, however, describes the societal pressure Watson faced in earlier years to give up her scientific career to raise her child, Anna. The narrator explains that in early 1950s when Watson entered college, women were being urged to find fulfilment as homemakers not as career women.

Watson explains that she was able to successfully balance her work and parenting responsibilities because of the help of her husband. She mentions that when her daughter was six months old, she and her husband would take her with them while they did research. Watson explains:

> We just took her crib and put it in the back of our VW bus. And then when we got there we'd just set the crib out under a tree. We took turns taking care of her. We didn't even think about daycare although I suppose there was daycare of some sort available. It was not a time when that was a routine proposition. So we just took turns. In fact, sometimes he was a lot better than I was.

Watson adds that the support her husband provided when Anna was small was crucial. She says, "He was really good about all sorts of things that were outside of the traditional, normal bailiwick for a 50s kind of guy." She adds: "He brought me to my senses about

what we're supposed to be doing here as parents, not just as professionals and academics, but as mom and dad." Watson, like McNutt, developed strategies to balance work and family responsibilities.

The two younger women scientists in the series, Franklin and Mahowald, are not married and do not have children. Both Franklin and Mahowald, however, discuss the issue of combining work and family. Franklin says that while it might not be feasible for a physicist to have six children, she says she thinks "it's completely compatible to have kids and have a career in physics." Franklin jokes that it would be fun to have kids to help her with experiments.

Mahowald speaks more extensively about her feelings about having postponed having a child in order to focus more on her career. She says:

> I think having a family and having a child as a woman is one of the major transition points in life. And I find it difficult to know how to relate to myself almost. For whatever reasons, I think I always believed that having a child was almost the same as being a woman and deciding not to have children or waiting for a long time to have children, I have mixed feelings about my own maturity in a way.

Later in the episode, Mahowald explains that her perceptions of gender roles have changed in recent years. She says:

> I think if I had been married when I was 19 or 20, I would have gotten a tremendous amount of satisfaction out of fulfilling the traditional roles that I had learned as a child. I think that if I marry now, my expectations would be quite different, and I'll be relating to a person as that person and not as somebody who fits into a slot or a role.

When Mahowald talks about her sister who as just given birth to a son, she explains that "I can see it's not where I belong just now."

The other two women scientists featured in the series, Jordan and Villa-Komaroff, also do not have children. In *DNA Detective*, Lydia Villa-Komaroff discusses her decision to focus on her career rather than have children. She explains that she made this decision because the issue for her was one of not wanting to neglect either one of two very difficult jobs. She says that she feels bringing up a child is too important of a job to leave to someone else. While seated next to her husband, she adds: "There are times I think for each of us when we kind of wonder what it would have been like, or you know, what we've missed, because we have, we have to acknowledge that." Her husband mentions that they spend a lot of time with their nieces and nephews to fill a gap they feel. Villa-Komaroff says the decision to not have children made their "lives easier but not necessarily richer."

Working in a male-dominated field

Several of the featured scientists in the series describe the challenges they have faced as women working in a traditionally male-dominated discipline. Their experiences vary, as do their reactions and responses. The series focuses on the challenges faced by the women scientists who have faced gender discrimination and examines how they have dealt with this conflict.

Of all the scientists featured in the series, Melissa Franklin speaks the most extensively and candidly about the challenges of being a woman in a male-dominated discipline. Her experiences with gender discrimination may be more pronounced than those of the other women scientists because her area of specialization is one very few women choose. One of Franklin's former professors explains:

> High energy physics just isn't just physics, it's a very special specific branch of physics and it's traditionally been a man's game. So it's been particularly hard for any woman to establish a significant role in the field.

He adds that the images of hitting, splitting and destroying that are a part of high energy physics are masculine and military metaphors. He adds that it would be unusual for any woman to fit into that "locker-room camaraderie" of folks who are interested in hitting, splitting and shooting.

Later in *High Energy*, both the narrator and Franklin tell how male colleagues' misperceptions of Franklin have affected her professional career. The narrator explains that Franklin's application for a faculty position at the University of Toronto, in a department that had previously hired only one other female faculty member, was unsuccessful. The narrator says that "being a woman played a role" during the review of Franklin's application. One of her former professors at the university reveals that "all kinds of crazy things were said" when the faculty reviewed Franklin's application. He adds:

> One person even said to me that Melissa would be fine if she continued to do physics, but she was so interested in feminism that she wouldn't continue in physics research and teaching, but just get involved in women's issues.

Franklin mentions that many of the faculty perceived her as "a young woman with maybe a strange sense of humour and pretty outspoken." The narrator says that although the faculty voted for Franklin, she never received an offer letter, and her 'dream' of returning to Canada did not come true.

Throughout the episode we learn that some of Franklin's later interactions with some of her male colleagues have created conflict. A male colleague at Fermi Lab tells how he once advised Franklin not to pursue particle physics because this specialty requires working a night shift and "having women on night shifts only just complicates the matter" and it is really for men only, so they can focus on physics and "not be distracted." He says he knows that Melissa never forgave him for this comment.

Towards the end of the episode, Franklin describes in detail the frustrations of working in a male-dominated field. She explains that as she gains more responsibility her interactions with some of her male colleagues lead to conflict. She describes how counterproductive these confrontations are:

> And I try to understand what it is that makes it sometimes impossible to just have physics discussions and to have power struggles, which happen all the time in physics anyway, but for them to have power struggles with me being a woman. And it seems extremely difficult for them to accept the fact that I am their equal, in some sense, and to be able to have me sometimes tell them what to do. And they hate it. They go completely nuts ... . I can't describe to you how frustrating it is to feel so strongly about an issue ... and have some older man look at you and say, "you're being a little hysterical now."

Franklin says that she attributes some of her struggles with male colleagues to being a young woman in a traditionally male-dominated field. But, as frustrating as Franklin finds these power struggles, she explains that she expects her male colleagues to treat her as an equal. She says her message to these colleagues is:

> ... don't do this any more. I'm not your daughter, I'm not your wife, your first, your second, your third. I'm not. I'm even older than your present wife, knock it off, learn to interact with me as your equal.

In *Jewels in a Test Tube* neither the narrator nor Jordan mentions any specific problems Jordan has faced with gender discrimination, but both allude to possible discrimination when they describe an incident when Jordan's laboratory notebooks were stolen while she was a graduate student at MIT. The narrator also emphasizes Jordan's unique position as one of the few African American women in science. The narrator says: "In the 1970s only one tenth of one per cent of the nation's scientists were African American women. A number that has risen little even today." The narrator tells us that when Jordan entered MIT, 80 per cent of the students were men, only 3 per cent were African American and only two African American women received PhDs from her department.

In *Secrets Underground* the narrator explains that while Watson has never personally experienced discrimination, the field Watson has chosen has "not been very hospitable to women", and when Watson entered the field "there were still less than a dozen women PhDs in American Anthropology." The narrator adds that Watson "has supported many colleagues who battled everything from overt sexual harassment to subtle exclusion from important projects." In this episode, however, Watson describes the conflict she has experienced between her professional aspirations and societal expectations. In one scene, Watson jokes about her least favourite course in high school: home economics. Watson says: "I didn't like home economics, but I had to take two years of it, and those were the only B's I got my whole school career." Watson adds that she did not get any more B's until much later in her graduate career.

Watson also describes how research by her male colleagues has, in her opinion, misrepresented the role of women in history. Watson and one of her female graduate students have argued against the common assumptions in their field about the historical roles of men and women. They explain that the existing theory that claims men stepped into fields to invent farming does not make sense because the women were the ones who interacted with plants. The narrator tells us that Watson and her gradate student have found evidence to support that women, not men, were responsible for domestication of plants. Watson says that the earlier assumptions were based on the notion that "women can make babies OK, but they aren't creative." She adds that "men who still run the field just don't think of women as tough enough, smart enough, as supervisors." Seated next to Watson, a female graduate student proclaims: "We deny that, that women are incapable of running things. We've seen them do it; we've done it ourselves."

In addition to some of the problems she faces as a woman in a male-dominated field, Mahowald shoulders the added burden of being a young woman conducting controversial, innovative research. The narrator describes Mahowald's situation in this way:

> Twenty-nine years old, she already has an international reputation, but her work is controversial and sometimes she finds it hard to be taken seriously, partly because she is so young, but also because she is a woman in a male-dominated field.

Mahowald says that as a woman working in science, she has been aware of how her male colleagues perceive men and women differently. She adds:

> I think the biggest issue for me has been trying to present myself with authority. There is a saying that it is better to keep silent and let people think that you are a fool than it is to open your mouth and convince them of it. But what I find is that if you keep silent as a woman, people will assume that you're a fool, where if you keep silent as a man, people will assume that you're not.

One of her male colleagues, the director of the research team in the laboratory where Mahowald works, says he noticed that some male colleagues had difficulty making eye contact with Mahowald when they first met her.

Despite the challenges, hard work, and even discrimination some of the featured scientists in *Discovering Women* have experienced, the series emphasizes the women scientists' excitement for science and their dedication to their work. For example, McNutt's excitement for science is evident in her numerous descriptions of her research. She states that when the pieces of the puzzles fit together it is so much fun. She says:

> When it all came together and here was one simple model that explained everything—there was this feeling of joy, the same joy that you have when you worked out a complicated jigsaw puzzle and that all the pieces did fit in there, that the world really makes sense, that it is not arbitrarily complicated, that once you just have your physics and your observations right, that it will make sense to you.

In a later episode, Jordon describes the beauty of scientific research. She says: "You always find little jewels as you continue to dig for the information, so it's just beautiful." Watson's excitement for science is evident in her descriptions of her field work:

> It's that kind of particularistic thrill that some of us find irresistible and that brings us into archaeology rather than some other kind of anthropology or some other discipline. You're there. You're there in the past.

Mahowald's excitement for her research also is evident in her descriptions of her research. She says:

> Stereo is an interesting problem because it's something that happens in the brain. By the time you get into cortex you see a lot of activity resulting from the cortex itself. The brain is imagination. And that was amazing to me.

Discussion

The portrayals of women scientists on *Discovering Women* provide many positive messages about the opportunities and options for women in science. Unlike other television science programmes that under-represent women scientists or relegate them to secondary roles of lower prestige,[56] the women scientists take lead roles in this series. The women scientists are not only given prominent roles, but also hold prominent positions within the scientific community. These women scientists are leaders in their fields, run their own research laboratories, and direct their own research projects.

The images of women scientists presented in the series challenge previously-reported stereotypes of women scientists in the US media. These stereotypes often downplay the expertise of women scientists, focus on conflicts in balancing the demands of their professional and personal lives, and present scientific research as an activity that requires masculine traits and skills.[20] The images on *Discovering Women* present a far greater range of options and possibilities for women scientists.

One of the strongest image of women scientists on *Discovering Women* emphasizes the expertise of the women scientists. The scientific abilities and talents of the women scientists are showcased throughout the series. Comments from the narrator, colleagues, and the featured scientists establish and accentuate the expertise of these women scientists. The use of the individual voices of the female scientists on *Discovering Women* speaking about their scientific research is one of the most powerful techniques for establishing expertise. Their comments repeatedly reveal their competence, intelligence, determination, seriousness, resourcefulness and enthusiasm for science. This image shows that acquiring expertise is not a barrier for women interested in careers in science.

Although most images on the series reinforce positive messages about women in science, some images reveal some of the drawbacks and barriers women in science still face. Combining family responsibilities with a professional career in science, for example, is a recurring barrier discussed by some of the women scientists on the series. The image of the 'superscientist' and 'supermom'[57] found in previously reported images of women scientists resurfaces in this series, although in this case childcare responsibilities are shared with a live-in housekeeper. One woman scientist on the series says that she does not think she could have combined both work and family successfully given the demands of her career. Another woman scientist talks with some regret about her decision to postpone having children until her professional career is more established. Despite the strong emphasis on the women's strategies for balancing work and family responsibilities, the tension and frustration this issue brings into the lives of many of the women scientists surfaces in half of the episodes.

The images on *Discovering Women*, however, present a far greater range of options and possibilities for dealing with this issue than previously reported images of women scientists in the US media. The series focuses on the decisions each of the women scientists has made or plans to make to best support her goals both professionally and personally. The women scientists are shown as active problem-solvers thinking about possible alternatives that would allow them to combine work and family, if that is what they have chosen or plan to choose in the future. The series presents a range of options from sharing childcare responsibilities with a supportive spouse or care-giver, postponing having children until after establishing a professional career, or deciding not to have children. Most, although not all, of the comments from the women scientists dispel the myth that a scientific career and motherhood are incompatible.

The images of women scientists on *Discovering Women* also show the challenges some of the women have experienced working in a male-dominated profession. One woman scientist talks about the temporary setbacks to her scientific career because of gender discrimination, and both of the younger scientists in the series discuss the frustration they feel when their male peers do not treat them as equals. Still, the emphasis of these images is on the strategies the women scientists have used to assert their equal position within the scientific community and their equality with male peers. In addition, the frequent use of images of the women scientists in research laboratories and out in the field dispel the myth that science is a career that requires masculine traits and attributes.

While the actual effects of these images of women scientists on young female viewers is beyond the scope of this research, it is useful to consider the potential influence of these images in light of research on gender schema theory. The televised images of women scientists on this series provide young female viewers with the opportunity to observe positive women scientist role models. These images may encourage viewers to alter existing stereotypical gender schemata because, as gender schema theory points out, children acquire cultural definitions of gender from cultural discourse. An important question to ask, however, is whether new information and contradictory information about gender roles can alter perceptions derived from existing gender schemata.

While several studies have shown the resilience of existing gender schemata,[58] other studies have shown that direct educational intervention can bring about changes in gender stereotyping.[59] Thus, counterstereotypical models of women scientists may be a crucial first step in breaking down one of the prevailing barriers to girls' and young women's interest and participation in science: sociocultural stereotypes of scientists. Women scientist role models could play an important role in promoting greater interest in science among young females.[60]

In addition, research indicates that series like *Discovering Women* may be valuable sources of career information for young viewers. Research shows that television is a source of incidental learning about occupational information for children, and children as young as six years of age learn occupational knowledge from television.[61] When processing the images of women scientists on *Discovering Women*, young female viewers' gender-stereotyped perceptions of women and science may be altered by images of women scientist role models. Positive images of women scientists also may help in encouraging all children to adopt more diverse perspectives of science and to create a greater awareness of the contributions of women scientists.

Directions for future research

Future research on audience effects is needed to assess the specific influence of counterstereotypes of women scientists in *Discovering Women*, and other programmes, on young viewers. This research has documented positive role models of women scientists on television; now subsequent research in this area needs to assess the influence of these images on young viewers' interest in science and perceptions of the appropriateness of science as a career for women. Many questions remain about the potential influence of the images on this series. Are young female viewers interested in the series? Which viewers are likely to watch the series and why? Do young female viewers identify with any or all of the six different role models? Were the women scientists featured on the series persuasive? Which ones were most persuasive and why? Did young female viewers' perceptions of science, scientists, science courses, and scientific careers change after watching the series? Why, or why not? If young female viewers' perceptions changed after watching the series, how did they change? What is the impact of these images on young male viewers? Can one six-part series change attitudes and behaviours that were established during the early years of childhood? Can counterstereotypes alter existing perceptions of gender roles?

Further research also needs to explore how television functions within the context in which it is viewed. How do the viewing practices of young female viewers affect their responses to this type of television programming? Do young female viewers watch these programmes? How do they respond as individuals and as a group? What accounts for the differences in their responses? How will they use the information they obtain from these programmes? Do the narrative themes and images break down existing gender-role stereotypes of scientific occupations? How do social and cultural influences affect young female viewers' responses? These questions need to be considered not only for this series, but for other television science programming as well.

Research on science intervention programmes for girls and young women have found that contact with women scientists is an important factor in encouraging girls and young women to develop positive attitudes toward science.[62] As more intervention programmes have been developed, more educational media and materials have included women scientist role models. Few studies, however, have analysed the effectiveness of specific programme features, like the inclusion of female role models.[63] Research needs to directly investigate the influence of televised women scientist role models on children's interest in science and their perceptions of scientists.

This study focused on an analysis of only one type of barrier that can hinder the equal participation of girls and young women in science. While the influence of sociocultural factors on girls' and young women's perceptions of science and scientific careers needs to be examined carefully, these factors are only some of the many that exist. The cumulative impact of these barriers may have a significant impact:

> Unlike blatant sex discrimination, these differences are subtle and, taken individually, appear almost insignificant. Their collective effect, however, exerts a powerful force upon young women to think long and hard before committing themselves to a scientific career.[64]

Changing stereotypical media images of scientists is a start, but research also should examine how educational, attitudinal, and sociocultural barriers collectively contribute to the gender gap in interest and participation in science. Such research can better identify the support structures needed in schools, homes, workplaces and society to create environments supportive of women in science.

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