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HOW MEDIA SHAPES PERCEPTIONS OF SCIENCE AND TECHNOLOGY FOR GIRLS AND WOMEN

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The medium of television is not homogeneous or monolithic, and content viewed is more important than raw amount. The medium is not the message: The message is.
- Early Childhood Television Viewing and Adolescent Behavior: The Recontact Study. [1]
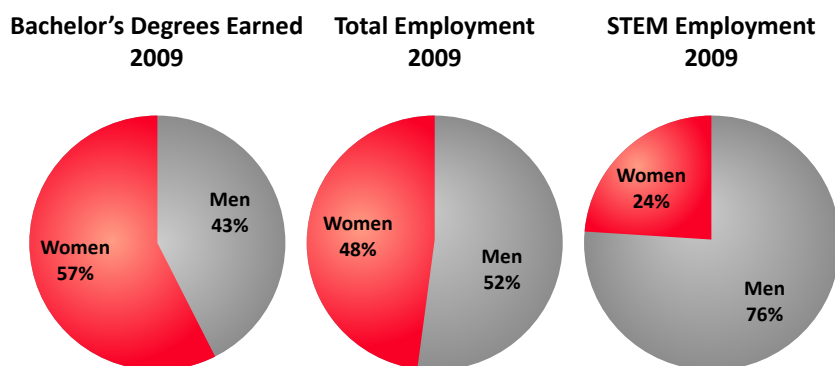
Fem Inc. is dedicated to promoting diverse and empowering images of girls and women in popular entertainment using technology and partnerships with content producers.

OVERVIEW: WOMEN AND STEM – AN ISSUE OF NATIONAL IMPORTANCE

The United States is experiencing a huge deficit in properly trained scientists and engineers.[2] This deficit is hurting America's competitiveness: a recent report from Harvard Business School cites the lack of science, technology, engineering and mathematics (STEM) talent as a major reason that business leaders consider moving jobs outside of America.[3] The U.S. has been trying to resolve this with policy initiatives aimed at granting green cards to foreign students with advanced STEM training.[4, 5] **Importantly however, the U.S. has an opportunity to meet this demand for science and technology professionals by addressing the significant gender gap in STEM**. Despite some claims to the contrary, in 2009 only 24% of scientists and engineers were female, a number that had remained virtually unchanged for a decade.[6] This gender gap represents an unacceptable waste of potential STEM candidates precisely when the supply of talent is scarce.

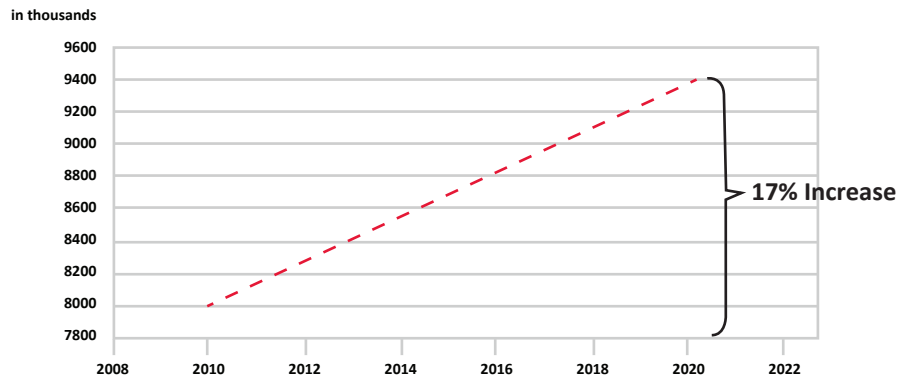As First Lady Michelle Obama stated on September 26, 2011:

If we're going to out-innovate and out-educate the rest of the world, then we have to open doors to everyone. We need all hands on deck. And that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering and math.

Bachelor's Degrees Earned 2009

Total Employment 2009

STEM Employment 2009

Women 57% / Men 43%

Women 48% / Men 52%

Women 24% / Men 76%

[6-8]

Despite earning more than half the college degrees, and making up half of the workforce, women only make up 24% of the STEM workforce.

EXEMPLIFY. EMPOWER. ENDOW.

Projected STEM Jobs

in thousands

17% Increase

[9]

2008 2010 2012 2014 2016 2018 2020 2022

At the same time the Bureau of Labor Statistics projects nearly 17% growth in demand for STEM jobs over the next decade.

Image by Deryck Hodge

Children spend nearly half their waking hours consuming media

Initiatives to increase the participation of women and girls in STEM have included programs focused on increasing work flexibility, creating mentorship opportunities and providing training programs.[10] **However, pervasive negative stereotypes about women and science and math constitute some of the most important and insidious roadblocks to attracting and retaining women in STEM fields.**[11] Mass media, including television, film, and the ever-expanding world of digital content, has a significant role in forming and reinforcing these stereotypes. By encouraging the creation and consumption of diverse and empowering images of women in STEM we can effectively use media to disrupt and reshape these stereotypes.

THEORY OF CHANGE: MEDIA DRIVES BELIEFS, AND BELIEFS DRIVE BEHAVIOR

Media affects the way we view ourselves and the rest of the world. Mass media presents us with stories and images that influence how we develop our basic beliefs about the world. As America moves into the twenty-first century, the volume of information that we gather from media sources on the Internet and through television may eventually exceed our direct experiences with the "real world". A 2010 study from the Kaiser Family Foundation showed that children between the ages of 8 and 18 spent an average of 7 hours and 38 minutes a day consuming television and Internet media, up from 6:21 in 2004.[12] This means that children are spending nearly *half their waking hours* consuming media and that the number will continue to increase with the proliferation of Internet-enabled devices.

EXEMPLIFY. EMPOWER. ENDOW.

One of the most important ways in which media shapes people's perception of the world is by helping to build or break stereotypes. Stereotypes are simply patterns of behaviors and characteristics that we attribute to a group of people. **In many cases, these associations are deeply subconscious**. **People with no measurable explicit prejudice demonstrate implicit biases, not only towards other people, but also towards themselves**.[13-15] These associations are the direct result of our minds' natural tendency to find patterns in the world. This is a subconscious process where all experiences, including the stories and narratives experienced through media, are incorporated to build these patterns. There is a large body of research showing that once these patterns are in place they can have significant effects on a person's behavior and achievement.

Stereotypes are of particular importance to women and minorities. We see rich and diverse imagery of the Caucasian male experience. However, this range of attention and representation simply does not exist for many other groups. When other information is limited or unavailable, stereotypes gain the power to control our perceptions and behavior. **If most of the images of women that a young girl sees fall into a limited number of categories, she will have limited beliefs about who she can become**. Because of this lack of diverse representation, negative stereotypes surrounding gender and race have the capacity to limit expectations and often create self-fulfilling prophecies. A recent study showed that television exposure was positively correlated with self-esteem for young white boys, but negatively correlated with self esteem for young girls and African American children. [16] This process is of particular interest with regard to the large gender gap in STEM. We assert that the widespread stereotypes about STEM causes girls to drop out of these areas of study from an early age. This drop out effectively limits career options for women. It also immediately decreases the pipeline for qualified STEM professionals – at a time when there is high global demand and financial opportunities for candidates in these fields.

MEDIA DRIVES BELIEFS

Mass media has the power to spread messages to millions of people. People have often used this power proactively for social change. Albert Bandura's influential work on Social Learning, which determined that **individuals adopt behavior changes based on the observation and imitation of other individuals, including fictional characters appearing in mass media** – has been tremendously influential in understanding these issues.[17] Researchers found that, when implemented correctly, entertainment-education outreach was an extremely effective and cost-efficient method of changing individual attitudes, behaviors and beliefs.[18]

In the past thirty years, the entertainment-education strategy, has become a fixture in Hollywood.[19] For example, a group at the University of Southern California consulted on 384 TV health storylines aired over 2010-2011. Impact evaluations of these storylines have found evidence of both attitude *and* behavior change among viewers. After watching an organ transplantation storyline in the TV show *Numb3rs*, ten percent of viewers who were not already registered as organ donors said the episode directly motivated them to do so.[20] An episode of *ER* successfully prompted viewers to get screened for breast cancer by addressing the myth that cutting into cancer during surgery causes it to spread.[21]

Even when programming is not consciously directed to inform and change behavior, it can have a powerful impact on people's underlying beliefs and perceptions. In a 2003 survey of media consumption and civic attitudes, 44% of adults under 50 listed television as the biggest influence on their views of the federal government, second only to personal experience (45%).[22] Data like these illustrate the profound role of media in how we see the world.

Some of the most compelling evidence of the role of media in shaping and reinforcing *stereotypes* comes from psychological and sociological studies examining the effects of media on racial attitudes. Numerous studies have shown that representations of African Americans in news, scripted dramas and video games can have significant effects on people's racial attitudes [23-30], with direct consequences for their beliefs around specific policies, such as Affirmative Action [24, 26] and welfare.[31]

Similarly, other studies show that stereotypical portrayals of women can significantly impact people's beliefs about women. In one psychological experiment, researchers found that showing subjects video clips portraying stereotypical versus non-stereotypical women had significant effects on subjects' subsequent ratings of the relative credibility of women on important issues such as sexual harassment. [32] Another recent study showed that the presence of strong, positive female role models in scripted dramas could decrease the negative emotional effects of sexually violent media. These role models decreased anxiety in women and sexist attitudes held by men towards women.[33] Girls who watch more sexually objectifying media are more likely to objectify themselves and internalize the ideals of beauty portrayed in such media.[34-37] Finally, **one study found that viewing media images of powerful women decreased women's negative self-perceptions and increased women's leadership aspirations**.[38] All of these studies indicate that media plays an important role in the formation and enforcement (or destruction) of cultural stereotypes surrounding race and gender.

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Cultural stereotypes categorize women into boxes, limiting how they can see their own potential

Recent studies have shown that representations of women in science can have similar effects on people's general understanding and perception of women's scientific ability. A study showed that exposure to commercials with stereotypical women caused women to avoid math questions on an aptitude test and show less interest in math-related educational and vocational opportunities.[39] In another study of American television viewers, researchers found that **people who had seen representations of women as computer professionals were more likely to deem this profession appropriate for women**.[40] All this research indicates that mass media can have a profound effect on how people see women *and* how they see STEM.

BELIEFS AFFECT BEHAVIOR AND PERFORMANCE

Media portrayals of people in science and math tend to create and support specific, *gendered* stereotypes about what a scientist "looks like." These stereotypes can have significant effects on young women's decisions to pursue STEM in school and afterwards. We will consider two prevalent stereotypes in media 1) women are inherently worse at science and math than men and 2) that being a scientist involves having character traits, such as being asocial, that are unappealing to young women.

## STEREOTYPE: "WOMEN ARE BAD AT SCIENCE AND MATH"

The belief that women are inherently worse at math and science is widespread. **In reality, girls consistently perform as well or better than boys at math and science through elementary school and into middle school**.[41] The societal belief that girls are inherently inferior in technical fields can affect their performance in those fields in a variety of ways. **One of the most important aspects of these societal beliefs is how it affects girls' beliefs about their own ability: their "self-concept" with respect to ability in math**. A large body of psychological research has shown that these "ability" self-concepts can have significant effects on girls' educational and vocational choices.[42]

> *Studies of brain structure and function, of hormonal modulation of performance, of human cognitive development, and of human evolution have not found any significant biological differences between men and women in performing science and mathematics that can account for the lower representation of women in academic faculty and scientific leadership positions in these fields ,. . . [M]easurements of mathematics - and science-related skills - are strongly affected by cultural factors, and the effects of these factors can be eliminated by appropriate mitigation strategies, such as those used to reduce the effects of 'stereotype threat.'*
>
> – National Academies of Science: *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*.[43]

EXEMPLIFY. EMPOWER. ENDOW.

A well-studied phenomenon in social psychology that addresses this issue is known as "stereotype threat." **A number of experiments have shown that reminding people of harmful or positive task-relevant stereotypes can significantly affect their performance on the task**. The seminal study on stereotype threat by Steele and Aronson showed that African American students performed significantly worse than white students on standardized tests when they were told these were "diagnostic" of intellectual ability. But they performed as well as white students when the same test was presented as a "problem solving" task.[44]

The stereotype threat phenomenon has been well studied with respect to gender and scientific ability.[45-50] In one particularly relevant study, Asian women performed better on a math test when *subtly* reminded of their Asian identity (positive stereotype) as opposed to their female identity (negative stereotype) prior to taking the test.[51] Subjects in this study were all mathematically gifted undergraduates who had scored between 700 and 800 on the math portion of the SAT. However, even these highly able women were susceptible to subtle reminders of their gender. Interestingly, this study also shows that the elicitation of a positive image could actually improve performance, supporting the premise that **cultural images have the capacity to empower underrepresented groups instead of disabling them**.

Percent Correct Answers on a Math Test
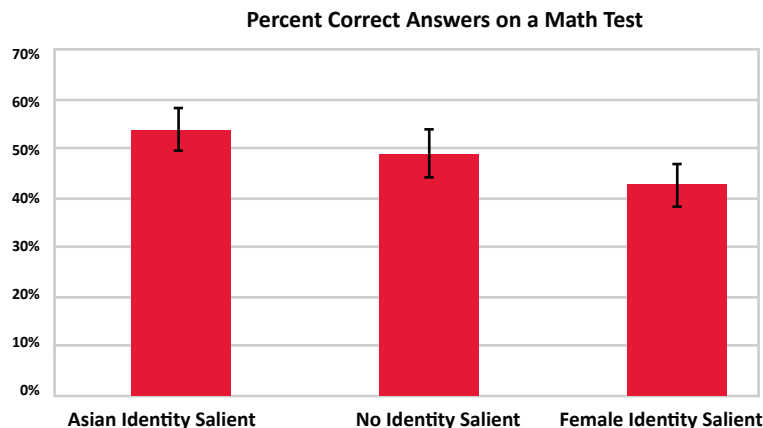
[51]

When Asian women were reminded of their Asian identity, they performed significantly better on a math test than when they were reminded of their female identity.

Finally, initial evidence from neuroimaging suggests that these influences are strong enough to even change the way that people use their brains. **When women are reminded of their gender before a quantitative task, they are less likely to activate areas of the brain associated with mathematical processing and more likely to activate an area of the brain often associated with conflicting goals and social processing**.[52]

This effect has been replicated in the classroom setting,[49] indicating that the existence of the stereotype of women's inferior quantitative abilities could have a pervasive detrimental effect on girls' interest and performance in science and math. Studies show that *implicit* beliefs about gender-math associations can have a significant effect on women's performance on mathematics tests, attitudes toward math, and desire to pursue math-related careers.[53, 54] **A large-scale study found that the gender gap in science and math achievement in a country is significantly correlated with implicit gender-science stereotypes in that country**, [55] further supporting the hypothesis that the implicit stereotypes created by media, parents, teachers, and social peers can have *systemic detrimental effects* on overall female participation in STEM fields and therefore decrease overall labor force competitiveness.

One study found that **women may form these implicit stereotypes more strongly and at an earlier age than men**, [56] **indicating that young girls are somehow more prone to develop these harmful implicit associations**. In another study by the same group, language/gender and math/gender associations were measured separately in adolescent and undergraduate students. The researchers found that women and girls tended to curtail how they saw themselves, associating math with male and language with female. On the other hand men and boys tended to associate both math and language with being male. The implicit associations of young men give them freedom to pursue their individual interests and strengths while young women's associations were self-limiting, directing them toward verbal rather than quantitative occupations.[57]

In addition to these direct influences on women's self-concept, **societal stereotypes can affect the way women and girls are treated in the workplace and school, decreasing their enjoyment and value when actually participating in STEM fields and impeding the development of related skills**. In one study of academic sexism, researchers found that adolescent girls who had experienced episodes of explicit academic sexism in math or science tended to feel less competent in science and math and to actually devalue math and science skills as they got older.[58] Another study showed that female engineering students who interacted with sexist male peers performed worse on engineering tests than those who interacted with non-sexist men.[59]

Even in the absence of explicit sexism, research shows that the implicit expectations of teachers can have significant effects on outcomes. In the classic "Pygmalion" experiment by Rosenthal and Jacobson, teachers were told that a group of randomly selected students had unusual potential for intellectual gains at the beginning of the school year. After eight months these students showed significantly greater gains than their peers despite their random selection.[60, 61] Hundreds of subsequent studies have shown that these "expectancy effects" are widespread, if small.[62] These effects are especially important for chronically stereotyped groups. **In one study, researchers showed that teachers' implicit (though not explicit) bias against ethnic groups was correlated with ethnic achievement gaps across classrooms.**[63]

Finally, the stereotypes held by decision-makers, in particular those in charge of hiring, can have a significant effect on outcomes. An analysis of 49 controlled studies examining the effects of applicant gender on recruitment, selection, and compensation decisions surrounding virtual job applicants showed that "gender-appropriate" applications were more likely to be selected. Specifically, **female applicants were more likely to be selected than male applicants for female-gendered jobs and vice versa, reinforcing gender-based occupational segregation**. Virtual male applicants also received higher compensation than identical female candidates when applying to male-gendered jobs.[64] A 2012 study used the same basic methodology of asking subjects – in this case biology, chemistry and physics professors – to evaluate the resume of a virtual job applicant for a laboratory management position with either a male or female name. Consistent with previous studies, **faculty members judged the *identical* female applicant to be significantly less employable, less competent, and less deserving of *scientific mentorship* than the male applicant**. These effects persisted regardless of the gender of the faculty member.[65]

This research indicates that cultural stereotypes impact women's representation in STEM in multiple ways. First, these stereotypes directly effect young girls beliefs about their own capacity. Second, these stereotypes affect whether teachers and parents expect girls to be interested in and do well in STEM fields. Both these beliefs have measurable effects on how girls perform in the classroom. And finally, the implicit biases held by decision makers mean that even when women do have the same qualifications as men, they are still less likely to be hired into the STEM workforce and receive mentoring in order to become leaders and managers in the field.
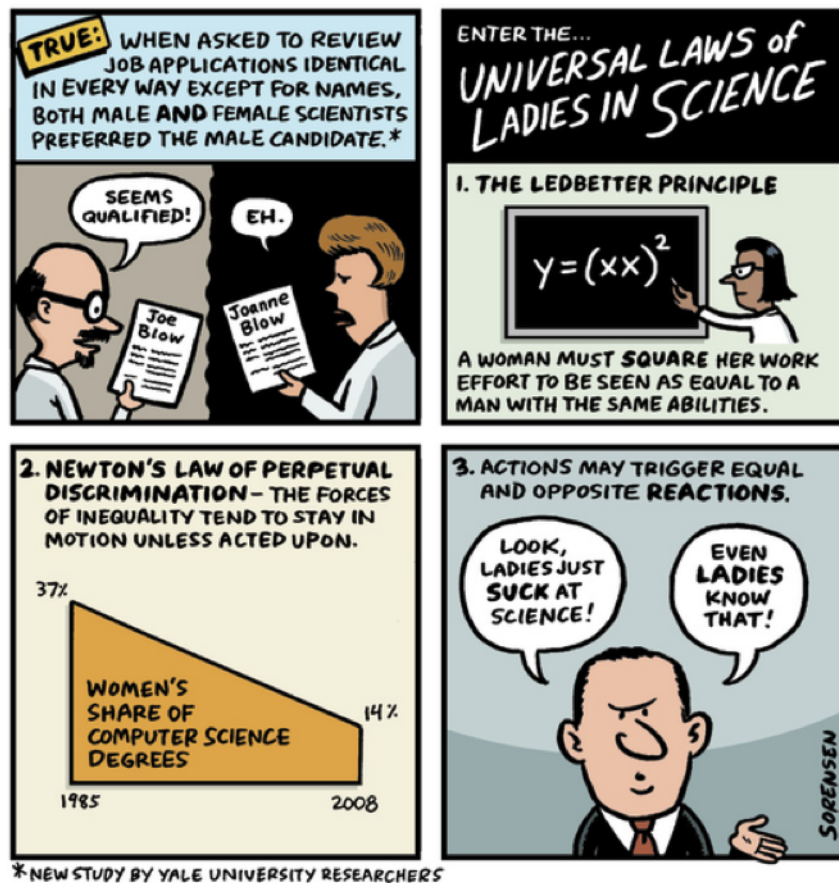
Comic by Jen Sorenson: http://jensorenson.com

STEREOTYPE: STEM PROFESSIONALS ARE ASOCIAL AND UNFEMININE

It has been argued that professional attributes associated with the "ideal" image of a scientist are in opposition to what is generally considered acceptable social behavior for women. In one survey study, researchers found that despite the greater prestige and expected income of a career in engineering or research science, most people thought that men would find an elementary school teacher to be a more attractive spouse.[40] This same study found that *women* were likely to deem computer technician to be an "unacceptable" profession for a woman. In this way, women are limiting themselves by eliminating a potentially lucrative and fulfilling career from their options.

In a similar vein, stereotypes of scientists and engineers are sometimes perceived to be unappealing to women.

For example, a young woman with excellent math skills may reject the possibility of becoming an engineer or a computer scientist because she has a limited view of what engineers and computer scientists actually do. She may stereotype engineers as nerds or as folks who focus on mechanical tasks with little direct human relevance, when in fact, many engineers work directly on problems related to pressing human needs. If so, she may well select herself, or be encouraged to select herself, out of a profession that she might both enjoy and find quite compatible with her life goals and values.

– Jacquelynne Eccles from *Studying gender and ethnic differences in participation in math, physical science, and information technology*[42]

These stereotypes are reinforced by mass media. One of the most popular depictions of science on TV today is "The Big Bang Theory". Although the show has successfully introduced more female scientist characters in recent seasons – the show often conforms to the stereotype that scientists are socially awkward. **These portrayals tend to make STEM fields seem unappealing to both genders, but might have a larger effect on women**.

One study exposed students to stereotypical vs. non-stereotypical computer science (CS) majors of both genders and examined the effects on their beliefs about their own potential success in computer science. Stereotypical computer science majors were poorly dressed, wore glasses, played lots of video games and enjoyed science fiction, while the non-stereotypical computer science majors enjoyed playing sports and listening to music and reading *Rolling Stone* magazine. When female students interacted with stereotypical CS majors of either gender, their perceptions about their own potential success in CS decreased significantly. However, this was not true for male students.[66] When adolescent girls are exposed to *real* working scientists, they tend to broaden their ideas about what scientists look like and are more likely to show interest in science.[67]

This research indicates that exposing young women to more well-rounded and relatable images of scientists and engineers can have an important impact on their participation in STEM.

HOW CAN WE HELP?

Luckily, there are ways to alleviate the detrimental effects of stereotypes on women's interest and performance in STEM. **Numerous studies have shown that providing girls and women with positive role models, both real and fictional, has**

the potential to reduce stereotypic beliefs and alleviate the effects of stereotype threat.[68-71] In one study, just exposing undergraduate women to a female experimenter who was described as highly competent in math completely alleviated the effect of stereotype threat.[69] Similarly, having a gender-matched career role model significantly increased women's estimation of their own competence and capability. In fact, **both men and women had increased estimations of their own capacity after seeing female career role models**, though the effect was not statistically significant in men.[70] Finally, one study indicated that showing women multiple descriptions of positive female role models had a cumulative positive effect on their performance on a math test.[71]

All the studies described above use detailed representations of women in science: however, even simply representing women in STEM can help alleviate the effects of negative stereotypes. In one study, experimenters presented a chemistry lesson to high school students with either a male or female scientist in the illustration. When the students were then tested on the material, female students who were given the lesson with a female scientist showed significantly better comprehension of the material.[72] Another study of Stanford undergraduates showed that when female STEM majors watched gender-imbalanced videos of a STEM conference, they exhibited increased physiological signs of anxiety compared to those who watched an identically scripted, but gender-balanced video. In addition, both men and women expressed a greater desire to participate in a similar conference after watching the gender-balanced video.[73] This study is of particular interest, because as STEM majors at a highly selective university, these women had already proven themselves and their abilities in these fields. However, a simple portrayal of the gender imbalance that they already experienced daily was enough to create significant amounts of stress. The study also demonstrates that **more equal gender representations might positively influence both men and women to participate in STEM activities**.

These studies show that positive female role models significantly moderate, and sometimes eliminate the effects of negative cultural stereotypes around gender. [68-71] **Increasing representation of women in these fields, even with something as simple as a textbook image or a video with a gender-balanced crowd, can help mitigate these effects**.[72, 73] The ability to curate a wide variety of realistic female role models in STEM fields can help expand the implicit choices women and girls give themselves by breaking some of these harmful stereotypes. This is where media can make a real difference.

Sally Ride
- First woman in space

Image by NASA/GSFC/Bill Hrybyk

Shafi Goldwasser
- Two time winner of the Gödel prize in theoretical computer science

Image by Weizmann Institute of Science

IMPLICATIONS FOR MEDIA AND ENTERTAINMENT:

There is an exciting opportunity for content producers and policy makers to make a positive difference in the overall competitiveness and composition of our top talent. The media has a vital role to play and we have provided a few recommendations below that can yield the greatest results based on current research in this field and best practices, including:

Representation: depict more well-rounded portrayals of scientists and technologists.

- Show more stories of real women in STEM fields: their lives, their struggles and their accomplishments.
- Demonstrate that being interested in science does not imply an inability to have friends or a family.

Participation: include more female characters in all the STEM fields in scripted dramas and comedies.

- Scientists
- Computer Programmers
- Engineers
- Mathematicians
- Executives

CONCLUSION

This abundance of multi-disciplinary evidence indicates that the existence of widespread, negative, cultural stereotypes associating gender with STEM ability lowers societal expectations for women in STEM. This decrease in expectations, especially as it relates to young girls' self-concept around math and science, creates a self-fulfilling prophecy in which we observe a significant gender gap in these fields. **Most of these studies show that these lowered expectations are largely the result of implicit, non-conscious associations rather than explicit bias**.

Studies imply that these stereotypes may be stronger and more self-hindering in women than men.[40, 56, 57, 66] These recent results are preliminary, and the reasons for such disparities are unclear. There may be biological factors making women more sensitive to the social cues that create gender stereotypes: this would be in line

with recent neuroimaging research showing that women might be more sensitive to social comparison than men, leading to measurable *transient decreases in IQ*.[74] On the other hand, it might be that negative stereotypes are more salient to the underrepresented group. However they occur, these lowered expectations have the capacity to impair women and girls' performance on tests of STEM ability; lower their intrinsic value for work in these fields, and decrease girls' interest in pursuing education and careers in STEM fields.

However, showing girls non-stereotypical images of women in STEM has the capacity to significantly alleviate these effects, giving young girls a more positive image of science generally, and of their capacity to be good at science. While there is limited evidence on the long-term effects of exposure to non-stereotypical images on implicit biases in general, what exists is promising.[68] **Our current understanding of learning and memory indicates that these underlying implicit biases may be changed over time with repeated exposure to non-stereotypical images.**[75-78]

Given the increasing amount of time spent by children and adolescents consuming mass media – especially on television, computers, and other digital devices – we have a unique and powerful opportunity to present young girls with different images of women and STEM. In light of the research on the potential detrimental effects of stereotypes, **we firmly believe that the key to allowing women and girls to fulfill their potential is to break stereotypes – which means exposing women to narratives showing as many diverse but realistic paths to STEM success as possible.** It is telling that preliminary evidence suggests that men may have weaker implicit associations between gender and academic discipline than women – we believe that this lack of association is part of what frees young boys to pursue their individual talents and interests in a way that young girls often feel they cannot.

Interventions that increase women's interest in STEM need not always decrease the interest of men in these fields. Showing men female role models[70] and a gender equal scientific setting[73] improved their self-concept and desire to participate in STEM activities as well. While women may be more sensitive to the negative social stereotypes associated with STEM careers, more diverse portraits of scientists and engineers would likely improve STEM retention in both men and women.

A recent report from Nielsen suggested that young women (between the ages of 13 and 34) respond more strongly to "aspirational" images of women in advertisements.[79] A statement like this from **one of the** most influential voices in

By promoting a variety of diverse images of women – we can disrupt stereotypes allowing women to find their own path.

marketing implies that more advertising should be aimed at helping young women visualize new models for professional success and personal happiness. These aspirational images *could* be diverse and empowering. In addition, advertising could include more images of women in STEM. But without more input and control from those of us that demand better and more diverse representation, they are more likely to remain limiting and one-dimensional, portraying women in a narrow set of roles and careers.

In order to affect this sort of change we must take action. The people who create and distribute media are part of the same culture, and prey to the same subconscious biases as the rest of us. Without conscious effort to change the environment, media is more likely to reinforce stereotypes surrounding STEM rather than break them. We need to inform content creators about the real effects of the underrepresentation of women in science. More importantly – we must demand to see more women in more diverse roles, both in STEM and other areas. If we direct our attention and our viewership to the existing TV shows, movies and online content that support and promote strong female characters and role models in STEM – **then hopefully** the supply will follow, to the benefit of us all.

ABOUT FEM INC.

FEM Inc. is a technology venture that focuses on popular entertainment as a potential lever to drive positive outcomes in society, with an emphasis on girls and women. We are building a curated video content platform that matches what people care about most with the best, most entertaining, content available. This will provide a customized viewing experience that is empowering, especially for girls and women.

Our vision is to "Exemplify. Empower. Endow": we showcase positive examples of female leadership and strong female characters (role models). The content we curate and recommend will help our viewers feel more empowered through the experience. Finally, we will invest in the next generation of female leaders by endowing young girls with the resources, pathways and confidence needed to succeed.

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