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"She made a mean beef stroganoff": Gendered portrayals of women in STEM in newspaper articles and their effects

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ABSTRACT

Media articles about women in STEM often emphasize gender in ways that may reinforce stereotypes. In an archival study examining 172 articles from four major US and UK newspapers on women, Nobel laureates from 1903 to 2020, we find that over time, reporters are more likely to describe the scientist as a woman and less likely to mention her husband's job. A follow-up experiment ($N = 452$) revealed no significant effects of an article that emphasizes the gender of a woman scientist on gender biases. These findings suggest that articles about women in STEM may emphasize gender rather than scientific accomplishments, but the ways in which they do so have changed over time and this emphasis may not affect readers' gender bias.

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When rocket scientist Yvonne Brill died in 2013, the *New York Times* published an obituary that began with the following: "She made a mean beef stroganoff, followed her husband from job to job and took eight years off from work to raise three children" (Martin, 2013). After public accusations of sexism (Davidson Sorkin, 2013; Sullivan, 2013), the obituary was revised instead to read: "She was a brilliant rocket scientist who followed her husband from job to job and took eight years off from work to raise three children" (Martin, 2013). It is striking that even in the attempt to reduce the sexism in the introduction of this exceptional rocket scientist, the revised version still emphasized her role as a wife and mother.

The portrayal of women scientists in the media can both reflect existing stereotypes and perpetuate those stereotypes. One stereotype affecting women scientists is what Eagly and Mladinic (1994) have termed the "women are wonderful" effect: the idea that women should be warm and nurturing, rather than competing in traditionally male-dominated fields. This effect can be explained by social role theory, which suggests that these stereotypes arise from the roles that men and women have traditionally held in families and societies (e.g., Eagly, 2013; Eagly & Steffen, 1984). Specifically, women have historically been more likely to be homemakers and caregivers, roles which are consistent with communal traits (e.g., helpfulness, warmth) rather than agentic ones (e.g., independent,

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dominant). While the stereotype of women as nurturing has positive elements, it can also be detrimental to women by suggesting that they are not suited for fields that require high levels of intellect or mathematical competence. Indeed, women academics who feel that they do not fit with this agentic stereotype (the "academic superhero") have lower engagement in their work (Van Veelen & Derks, 2022), and more generally, gender stereotypes contribute to gender disparities by reducing women's sense of fit and inclusion in science fields (Schmader, 2023). Media coverage that focuses on domestic aspects of the lives of women scientists may reinforce such stereotypes.

In contrast, while media presentations also include some negative stereotypes about male scientists, these stereotypes generally are not about men's competence or belonging in the field (Haynes, 2003). For example, scientists may be stereotyped as odd or as workaholics, and occasionally as dangerous (e.g., Gerbner, 1987; Haynes, 2003; Losh, 2010). Stereotypes about computer scientists include a lack of interpersonal skills and a focus on technology but also include high intelligence or brilliance (Cheryan et al., 2013). Indeed, Cheryan and Markus (2020) argue that some science fields, particularly in the United States, have a masculine default. That is, these fields value and reward characteristics stereotypically associated with the male gender role (e.g., individualistic, competitive).

The issue of gender equality in science fields remains an important societal concern (Avolio et al., 2020; Moss-Racusin et al., 2021). Multiple government, university, and individual programs have been formed to attempt to increase the representation of women in science. For example, the United States National Science Foundation has funded grant programs such as ADVANCE to promote the advancement of women in academic science and engineering careers, the Girls Who Code program provides resources to introduce girls and women to computer science, and many universities have organizations that support women in STEM.

Despite these and other initiatives, the UNESCO Institute for Statistics estimates that worldwide, less than 30% of science researchers are women, with substantial variation across countries (UNESCO, 2019; World Economic Forum, 2020). In the United States, approximately 35% of the STEM workforce in 2021 was women (National Center for Science and Engineering Statistics, 2023). The gender disparity is more pronounced in some fields than others; for example, fields such as biology show more gender equality than physics, computer science, and engineering (Cheryan et al., 2017). A variety of explanations have been proposed for these gender gaps, including a lower sense of self-efficacy among women in physics, computer science, and engineering (although the evidence is mixed for this possibility), as well as masculine cultures that lead to a lower sense of belonging among women in these fields (Cheryan et al., 2017).

Media presentations can play a significant role in the development of gender stereotypes (e.g., Ward & Grower, 2020), and negative media representations can create stereotype threat and impair performance for individuals in stereotyped groups (Appel & Weber, 2021). Women scientists have been less likely to appear in media portrayals of scientists, and when they are present, they are less likely to have speaking roles and may be portrayed in stereotyped or lower-status roles (e.g., Eizmendi-Iraola & Peña-Fernández, 2023; Steinke & Tavarez, 2017; see Steinke, 2017 for an overview of research in this area). There is also a greater emphasis on appearance or attractiveness for women scientists compared to men, both in fictional portrayals such as movies as well as news

reporting (e.g., Kitzinger et al., 2008; Steinke & Tavarez, 2017). Even media professionals who engage with science as part of their job may still hold gender stereotypes, such as the incompatibility of a science career with family life (Corsbie-Massay & Wheatly, 2022).

To promote gender equality in science, it is important that the media's portrayal of women in STEM serves as a counter-stereotype to the notion that women are ill-fitted for STEM fields (e.g., Carli et al., 2016; Leslie et al., 2015; Nosek et al., 2002). Girls can benefit from strong role models and descriptions of successful women scientists to serve as examples that they too can succeed in STEM. From an early age, there are already stereotypes that support the notion that boys are better at math than girls, and these stereotypes can influence girls' self-perceived mathematical ability (Cheryan et al., 2015) and their interest in computer science and engineering (Master et al., 2021). Similar stereotypes such as the "nerd genius" can reduce women's STEM motivation (Starr, 2018). That is, scientists may be stereotyped as socially awkward and unattractive, which may conflict with women's goals or self-perceptions. Conversely, counter-stereotypical beliefs, such as the belief that scientists have a variety of interests and talents and do not work in isolation, can encourage women and students of color to pursue STEM fields (e.g., Nguyen & Riegle-Crumb, 2021). Counter-stereotypical media portrayals can help combat the negative effects of stereotype threat (Luong & Knobloch-Westerwick, 2017). Thus, research is needed on both the content of media coverage of women in science and the effects of this coverage on audiences.

The Finkbeiner test

The timing of Brill's obituary coincided with science writer Ann Finkbeiner's blog post in which she described how she would be writing an article about a woman astronomer without writing about the fact that the astronomer was a woman (Finkbeiner, 2013). Journalist Christie Aschwanden formalized the "Finkbeiner test" based on this blog post (Aschwanden, 2013, 2017). The Finkbeiner test is a checklist for journalists to follow when they write articles about women in STEM (Gelman, 2015). Aschwanden argues that when journalists write about women in STEM fields, they should not include the following:

> the scientist's gender, her husband's job, her childcare arrangements, how she nurtures her underlings, how she was taken aback by the competitiveness in her field, how she is a role model for other women, or how she is the 'first woman to … '. (2013, 2017)

As mentioned above, Brill's obituary fails this test in both the original and revised version by the end of the first sentence. Although journalists frequently add the elements in the Finkbeiner test when writing about women, they rarely deviate from discussing anything but the scientific achievements of men (Schall, 2015).

The Finkbeiner test has received widespread attention in journalism (e.g., Brainard, 2013) and has been used in research on gender biases in biographies on Wikipedia (Wagner et al., 2016). Because of the influence of the Finkbeiner test in popular culture and media writing, we used the criteria from this test to guide our first study, a content analysis of news coverage of women scientists.

The objective of the Finkbeiner test is to highlight the accomplishments of women in science instead of focusing on their gender (Aschwanden, 2013, 2017; Finkbeiner, 2013).

Although the Finkbeiner test was created to promote gender equality in journalism, we note that following the guidelines of this test may have unintended negative consequences. In some situations, applying the Finkbeiner test might prevent the conversation about how systemic forces can prevent women from entering scientific fields (Mukunth, 2018). For example, childcare struggles can be a particular challenge for women scientists. In addition, it is possible that following the Finkbeiner test could ironically hinder gender equality because it does not allow the media to highlight successful women in science as role models for other women (Gelman, 2015).

One proposed solution to the issues of gender biases in science journalism is that journalists should write about personal and familial aspects of all scientists regardless of their gender (Gelman, 2015). Incorporating aspects of a scientist's life and work that have more communal themes (e.g., being a role model) can positively influence the stereotypes of scientists. In fact, a recent analysis of scientist profiles in newspapers showed that both men and women scientists' profiles contained communal themes (Benson-Greenwald et al., 2022) indicating that this may be a newer strategy that reporters are using.

Trends in coverage of women scientists

Starting in the late 1970s, newspaper and magazine editors began making their publications more inclusive by highlighting women in a broader range of careers (S. H. Miller, 1975). After criticisms of sexism and the unequal portrayal of men and women in the workforce, popular media outlets shifted the depiction of women as caregivers and family-centered role models to women as workers in the labor force alongside men (Tuchman, 1979). Although the number of women in STEM in the United States has grown from 8% to 27% since the 1970s (Martinez & Christnacht, 2021), the portrayal of women scientists in the media has focused more on their achievements as women and less on their achievements as scientists (Shachar, 2000).

Despite an increased awareness of the marginalization and stereotyping of women in STEM, biases still exist in the media coverage of men and women in STEM (Chambers, 2022; Macdonald, 2021). When writing about women in STEM, journalists often explicitly state the gender of women scientists but do not do so when they write about men in the same fields. For example, in a recent analysis of *New York Times* profiles about scientists, articles about women were more likely to describe the scientists in terms of gender (e.g., emphasizing how women are a minority in science; Mitchell & McKinnon, 2019). The gendered nature of media coverage of women in STEM is also seen when reporters highlight domestic aspects of the scientists (e.g., family life) in a way that is not seen with coverage of men in STEM (Mitchell & McKinnon, 2019; Shachar, 2000). Furthermore, media coverage about women in STEM often includes a description of their physical appearance and choice of clothes (Chimba & Kitzinger, 2010; Mitchell & McKinnon, 2019). Women STEM professionals who engage in public communication of their own work are also subject to stereotyping, including being described as bossy or emotional (McKinnon & O'Connell, 2020).

Furthermore, journalists sometimes engage in the social tokenization (i.e., the use of a marginalized individual as a symbol for inclusion) of women scientists (Shachar, 2000). Social tokenism is seen when women who are positively portrayed for their achievements in STEM are labeled as super-scientists, glorifying them as an exception from the norm,

whereas men who are recognized for achievements in STEM are depicted simply as brilliant scientists (Chimba & Kitzinger, 2010; Shachar, 2000). Additionally, the focus of articles on women in STEM often centers on the obstacles that they have had to overcome rather than their professional accomplishments, and this pattern is seen less frequently in articles about men in STEM (Shachar, 2000). However, a recent analysis of articles about scientists found no gender differences in the portrayal of overcoming obstacles (Benson-Greenwald et al., 2022). Thus, it is important to consider how biases in reporting about scientists may be changing over time and what the consequences of those reporting biases might be.

Consequences of gender biases in the media

Journalists' focus on the gender of women in STEM rather than their achievements may contribute to a larger problem regarding the differences in perceived intelligence between women and men. The pattern of gendered perceptions of intelligence and brilliance begins at an early age. Despite girls having better grades than their boy peers, boys are more likely to be referred to as gifted. Furthermore, around age seven or eight, children begin to endorse gender-based stereotypes about intelligence: children at age five describe their own gender as being smart, but children at age seven begin to favor boys as being smarter than girls (Bian et al., 2017).

This trend continues into higher education: although women have higher graduation rates in college than men, men are still more likely to be described as brilliant (Bian et al., 2018). In STEM, where such brilliance is highly valued (Leslie et al., 2015), women may feel discouraged from pursuing STEM because they have internalized gender-based stereotypes about intelligence (Bian et al., 2018; Leslie et al., 2015; Meyer et al., 2015). Furthermore, individuals see men and scientists as sharing more similarities than women and scientists (Carli et al., 2016).

Media depictions of men and women scientists can contribute to these perceptions. It is perhaps unsurprising then that women who read a stereotypical depiction of computer science employees (e.g., geeky and masculine men) from a fabricated news article were less likely to be interested in pursuing computer science than women who read a non-stereotypical depiction (e.g., employees that do not fit into traditional stereotypes; Cheryan et al., 2013). Additionally, women who read a non-stereotypical depiction of computer science employees were more likely to be interested in pursuing computer science than women who did not read any fabricated news article (Cheryan et al., 2013). More broadly, meta-analytic evidence suggests that media stereotypes can have negative consequences for members of negatively stereotyped groups (Appel & Weber, 2021). Taken together, the ways in which news articles describe women in STEM may affect women's perceptions of their own potential for a career in science, as well as their interest in pursuing an education in STEM fields.

Based on these empirical findings, researchers studying women's representation in STEM have suggested that news articles should focus on scientists' achievements and accomplishments, rather than their levels of brilliance or genius. Regardless of scientists' actual intelligence, the traits of brilliance or genius are often solely associated with men, but not women, in STEM (Meyer et al., 2015), and so avoiding these terms might be a way of addressing this discrepancy. Furthermore, an article that focuses on a woman

scientist's cooking skills or her parenting may be less likely to leave an impression of her as highly intelligent. It is therefore critical to examine how descriptions of women in STEM in the media have evolved over time and whether using specific framings, such as those advocated by the Finkbeiner test, positively or negatively affect views of women in STEM.

Present research

In the present research, we conducted two studies examining how women who have won a Nobel Prize in a STEM field have been portrayed in newspaper articles and the effect of those portrayals. Specifically, we use the Finkbeiner test as the lens for examining articles. The first study was an archival study examining the historical use of the items in the Finkbeiner test in newspaper articles from four major news publications. In this study, we examined how these portrayals have changed over time. In the second study, we experimentally manipulated the presence of the two most commonly found items from the Finkbeiner test in an article about two recent winners of the Nobel Prize in Chemistry. We tested whether the inclusion of those items influenced perceptions of the intelligence of the Nobel laureates and gender stereotype endorsement. The data, materials, and code are available on the Open Science Framework at the following link: https://osf.io/j4bfv/.

Study 1

In Study 1, we examined the frequency at which the items present in the Finkbeiner test appear in articles about women Nobel laureates in STEM fields. We also tested whether the presence of those items has changed over the past century by coding articles spanning from 1903 to 2020. This study was an exploratory study designed to assess whether elements of the Finkbeiner test are relevant to articles about Nobel laureates and the ways in which coverage of prominent women scientists has changed over time. Therefore, no a priori hypotheses were specified.

Method

We first compiled a list of women who have won a Nobel Prize in a STEM discipline: physics, chemistry, and medicine. A total of 22 women have won a Nobel Prize in one of those fields (with Marie Curie winning twice: once in chemistry and once in physics). Four major newspapers were examined for the purposes of this study: *The Baltimore Sun, The New York Times, The Times of London*, and *The Washington Post*. These four newspapers were chosen for three reasons: (1) they each have articles dating back to the first Nobel Prize won by a woman (i.e., when Marie Curie won in 1903), (2) they are major daily newspapers spanning two countries, and (3) we had institutional access to all four archives for the time period of 1903–2020.

For each newspaper, two research assistants searched for articles about each of the Nobel Prize winners that specifically mentioned that they had won the prize. There were 160 unique articles published between 1903 and 2020 (see Figure 1). Eleven of the articles described two winners and one described three winners: these were coded multiple times (once for each winner) for a total of 172 articles for coding. Within the

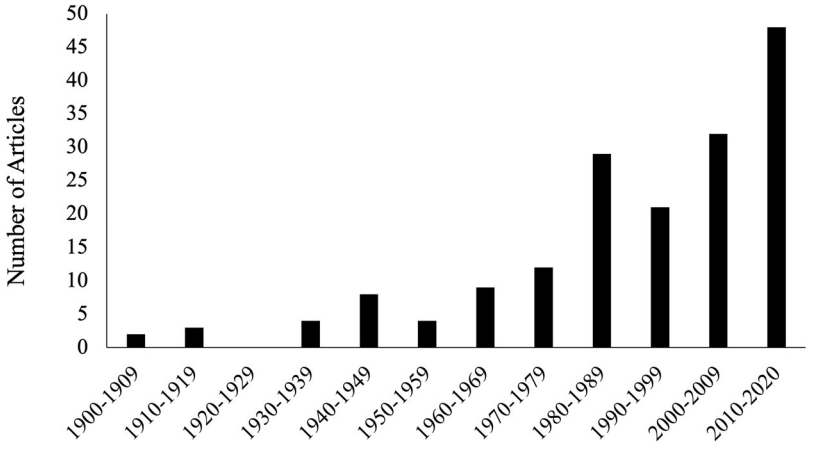

Figure 1. *Number of Articles Coded Per Year in Study 1*

160 articles, there were also seven articles that were summaries of more than three women who had won: these articles were coded once for their overall take on the Nobel laureates. Of the 172 articles (including the 12 duplicates), 45 were from the *Baltimore Sun*, 53 were from *The New York Times*, 38 were from *The Times of London*, and 36 were from *The Washington Post* (see Figure 2 for the percent of articles from each publisher that contained each element of the Finkbeiner Test).

Two research assistants coded each article for the presence/absence of each of the items in the Finkbeiner test: (1) "The fact that she's a woman," (2) "Her husband's job," (3) "Her child care arrangements," (4) "How she nurtures her underlings," (5) "How she was taken aback by the competitiveness in her field," (6) "How she's such a role model for other women," (7) "How she's the 'first woman to … '" (Aschwanden, 2013, 2017). For the seventh category ("first woman"), articles were coded as containing that item if they described the woman as any number (e.g., "first," "second," etc.) or if the woman was described as "the only." The unit of analysis was any mention of the item in each category; most typically, the items appeared in a sentence in the article. Coders were

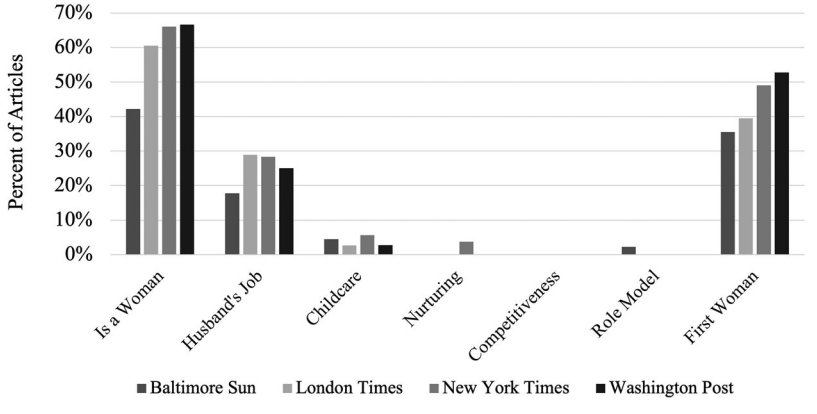

Figure 2. *Percent of Articles Containing Each Element of the Finkbeiner Test Based on Publisher*

trained on four of the articles before they each coded the remaining articles. The coders achieved acceptable inter-rater reliability with all categories reaching over 90% agreement. Discrepancies were resolved via discussion between the two coders.

Results

The most common categories found in the articles were mentions of the Nobel laureate being a woman (58.7%, $n = 101$) and being the "first woman" (44.2%, $n = 76$). Twenty-five percent of the articles ($n = 43$) included information about the husbands' jobs. The other categories were infrequently mentioned: childcare arrangements (4.1%, $n = 7$), nurturing underlings (1.2%, $n = 2$), being a role model for other women (0.6%, $n = 1$). The category of being taken aback by competitiveness was not found in any of the articles.

To examine how the presence of these categories may have changed by year of publication, point biserial correlations were conducted for the three categories with the highest frequencies: being a woman, first woman, and husband's job. There was a significant positive correlation between year and articles mentioning that the laureate was a woman [$r(170) = .21$, $p = .005$] and that she was the first woman [$r(170) = .20$, $p = .008$]. In other words, more recent articles were more likely to include instances of mentioning that the scientists were women and that they were the first (or only, or another number; e.g., "second woman to win"). There was a significant negative correlation between year and articles describing the husband's job: $r(170) = -.39$, $p < .001$. That is, the more recent articles were the less likely to mention husbands' jobs compared to older articles. Because the data were skewed (fewer articles in earlier years and more articles in later years), we conducted bootstrap analysis on the correlations (1000 bootstrap samples). The results remained the same: for mentions of the laureate being a woman, 95% CI (.049, .337), mentions of her being the first woman, 95% CI (.051, .33), and mentions of her husband's job, 95% CI (−.55, −.25).[1]

We also examined the role of the specific science field in mentions of the items from the Finkbeiner Test. Of the 159 articles, seven were not coded for field as they were about multiple laureates. Of the 152 remaining articles, 36 were about the chemistry prize, 22 were about the physics prize, 94 were about the physiology or medicine prize, and 5 were about chemistry and physics (as they focused on Marie Curie's multiple prizes). Chi-square tests were performed between the combined chemistry and physics articles and the physiology or medicine articles. There were significant differences in the mentions of the laureate being a woman ($\chi^2(1) = 8.83$, $V = .24$) with a higher proportion of the articles about chemistry/physics mentioning this ($n = 42$ out of 58 articles) compared to articles about physiology or medicine ($n = 45$ out of 94 articles). Similarly, there were significant differences in the mentions of the laureate being the first woman ($\chi^2(1) = 18.64$, $V = .35$) with a higher proportion of the articles about chemistry/physics mentioning this ($n = 38$ out of 58 articles) compared to articles about physiology or medicine ($n = 28$ out of 94 articles). Finally, there were significant differences in the mentions of a husband's job ($\chi^2(1) = 8.61$, $V = .24$) with a higher proportion of the articles about chemistry/physics mentioning this ($n = 23$ out of 58 articles) compared to articles about physiology or medicine ($n = 17$ out of 94 articles). No other items showed significant differences based on field (all $p > .26$).

Discussion

Across over 150 articles describing the women who have won a Nobel Prize in a STEM field, many of the items from the Finkbeiner test were infrequently mentioned. The most commonly mentioned categories were that the laureate was a woman, that she was the first (or other number or only) woman to win the award, and her husband's job. Furthermore, an examination of year of publication indicates that although reporters are less likely to mention husbands' jobs as years pass, reporters are more likely to call attention to the fact that the laureate was a woman or the first woman to win. Taken together, Study 1 points to the need to consider whether describing a woman in STEM as a woman and as a "first" or "second" or "only" woman in that context is a positive development. On the one hand, emphasizing gender highlights the fact that there are only a small number of women who have received the prize, which could lead readers to think that the winners are a rare exception and women in general are less talented as scientists. On the other hand, emphasizing gender may demonstrate the opposite, that women can be outstanding scientists. Emphasizing gender may make it more likely that the women laureates could be a role model for younger women in STEM.

Additionally, items from the Finkbeiner test were more likely to appear in articles about chemistry/physics laureates rather than those in physiology/medicine. This pattern is consistent with general trends toward greater gender equality in health fields, with disparities persisting in fields such as physics (e.g., Cheryan et al., 2017; Su & Rounds, 2015).

Study 2

Given Study 1's findings about the most common ways that women Nobel laureates were described in newspaper articles, Study 2 was designed to examine how framing articles about women Nobel laureates in a way that emphasizes their gender (or not) affects perceptions of women scientists and the specific scientists in the articles. An underlying assumption of the Finkbeiner test is that an emphasis on gender should be avoided because this emphasis may highlight stereotypes rather than keeping the focus on the science. However, as noted above, this assumption is not necessarily warranted; in some cases, a focus on gender may have positive outcomes, such as allowing a woman scientist to serve as a role model to other women and girls.

Thus, in Study 2, we experimentally manipulated whether gender was emphasized in an article about Dr. Emmanuelle Charpentier and Dr. Jennifer Doudna, the winners of the 2020 Nobel Prize in Chemistry. After reading the article, participants completed measures about their perceptions of women scientists and of Drs. Charpentier and Doudna. We preregistered (https://osf.io/tzpjm) competing hypotheses as it is possible that emphasizing gender could increase stereotyping of women scientists by making a minoritized identity salient, but it is also possible that emphasizing gender could make it salient that women are equally as capable of engaging in science as men:

> *Competing Hypothesis 1*: Participants in the Gender Emphasized condition will view Drs. Doudna and Charpentier as more intelligent compared to participants in the Control condition (H1a) or participants in the Gender Emphasized condition will view Drs. Doudna and Charpentier as less intelligent compared to participants in the Control condition (H1b).

Competing Hypothesis 2: Participants in the Gender Emphasized condition will show lower levels of stereotype endorsement than participants in the Control condition (H2a) or participants in the Gender Emphasized condition will show higher levels of stereotype endorsement than participants in the Control condition (H2b).

As exploratory measures, we also assessed the attributions that individuals made for the scientists' success. Research on the STEM stereotypic attribution bias (LaCosse et al., 2016) suggests that success in STEM is considered typical for men but not for women. Thus, when men have setbacks in STEM, these challenges are attributed to external factors (e.g., a difficult exam), whereas when women have setbacks, these difficulties are attributed to internal factors (e.g., insufficient ability or intelligence). Previous research has focused on negative outcomes, but these stereotypes may also affect attributions for positive outcomes. For example, people might be more likely to think that a woman scientist's success is due to luck rather than intelligence. Thus, we examined whether emphasizing gender makes readers more likely to think that the scientists' success was due to factors such as luck or building on the contributions of others, rather than their own intelligence.

We also examined whether emphasizing gender in these articles would affect perceptions of how welcoming the field is for women. As with the other measures, it is possible that emphasizing that women have won the top award in a field may increase perceptions that the field is supportive of women; on the other hand, the fact that a woman winning is rare and noteworthy may highlight the difficulties of succeeding as a woman in chemistry. The study was approved by the St. Mary's College of Maryland Institutional Review Board (FA21_13A).

Method

Participants

The target sample size was 350, based on a power analysis conducted in R for independent samples t-tests with $d = 0.3$, 80% power, alpha = .05. To account for potential exclusions, we aimed to recruit 450 participants. We set up a stopping rule of ending data collection when the sample reached at least 450 participants or by 31 March 2022, whichever came first. Data collection ended on 9 March 2022 with a larger sample than initially intended.

We recruited college students from a small public liberal arts college and a large public university. Participants who completed the survey received extra credit in a psychology or neuroscience course of their choosing or were entered into a raffle for one of three $50 gift cards. A total of 540 participants completed the study, with 163 participants excluded for failing attention checks. The final sample consisted of 452 participants, ($n = 255$ cisgender woman, $n = 170$ cisgender men, $n = 2$ transgender women, $n = 3$ transgender men, $n = 17$ nonbinary individuals, $n = 3$ identified as multiple genders, and $n = 2$ preferring not to respond; 9.1% African/African American/Black, 0.2% American Indian/Native American, 10.6% Asian/Asian American, 67.7% European American/White, 0.2% Pacific Islander/ Pacific Islander American, 5.5% Hispanic/Latino/a American, and 0.4% preferring not to respond; $M_{age} = 19.83$, $SD_{age} = 3.36$). Participants came from a wide range of majors/intended majors (over 30 different majors listed).

Procedure

In this study, we manipulated whether there was an emphasis on gender in news articles about Nobel laureates Drs. Charpentier and Doudna. Participants were randomly assigned to either the Control condition ($n = 217$) or the Gender Emphasized condition ($n = 235$). In the Gender Emphasized narrative, participants read about the scientists and their win, and it was emphasized that both scientists were women, and this was the first time two women jointly won a Nobel Prize in STEM (e.g., "These are the first two women to jointly win the Nobel Prize in Chemistry, a groundbreaking achievement for women in science."). In the Control narrative, participants read about the scientists and their win, but their gender was not emphasized (e.g., "This is the first time the use of CRISPR has been recognized for the Nobel Prize, a groundbreaking achievement for these scientists.").

After providing consent, participants read the assigned narrative and answered an attention check. If they failed this first attention check, they were redirected to read the narrative again. Next, participants completed measures assessing their trait ratings of Drs. Doudna and Charpentier and women scientists in general, attributions for scientific success, stereotype endorsement, and climate for women in STEM. Participants then completed another set of attention checks. Finally, participants provided demographic information and were debriefed.

Measures

Trait ratings

Participants completed the Intelligence Trait Rating on a 1 (*not at all*) to 7 (*very*) Likert scale. Participants were asked to "please rate each trait in terms of how characteristic it is of Dr. Doudna and Dr. Charpentier," and "please rate each trait in terms of how characteristic it is of women scientists in general." Intelligence trait rating items included: "brilliant, smart, clever, and unintelligent." Average scores were calculated for Intelligence Trait Ratings (Drs. Doudna and Charpentier $\alpha = .61$; women scientists $\alpha = .75$).

Stereotype endorsement

Participants completed the adapted 3-item Stereotype Endorsement measure (Schmader et al., 2004) on a 1 (*strongly disagree*) to 7 (*strongly agree*) Likert scale. Participants were asked to rate their agreement with three statements regarding men and women's chemistry abilities. An example statement included "in general, men may be better than women at chemistry." Average scores were calculated for Stereotype Endorsement ($\alpha = .73$).

Attributions

Participants completed a 4-item Attributions of Scientific Success measure on a 1 (*not at all*) to 7 (*entirely*) Likert scale. Participants were asked to rate "to what extent do you think Dr. Doudna and Dr. Charpentier's discoveries were due to each of the following: their hard work, their intelligence, luck, their support networks, and building on the contributions of other scientists."

Climate of chemistry for women

Participants completed 2 items on a 1 (*not at all*) to 7 (*extremely*) Likert scale. Participants were asked "do you think that chemistry is a welcoming field for women?" and "do you think that women in chemistry are supported by their colleagues?" Average scores were calculated for Climate of Chemistry for Women ($\alpha = .80$).

Attention checks

After reading the narrative, participants were asked "What field do both Dr. Doudna and Dr. Charpentier work in?" If participants did not answer "biology/chemistry," they were redirected back to the narrative. Following the measures on stereotype endorsement, attributions for scientific success, trait ratings, and climate, participants were again asked "What field do both Dr. Doudna and Dr. Charpentier work in?" and "What is Dr. Doudna's gender?" (the correct answers being "biology/chemistry" and "woman," respectively).

Results

We analyzed the data using independent samples *t*-tests. Contrary to the competing hypotheses (H1a, H1b), there were no significant differences in perceptions of intelligence for Dr. Doudna and Dr. Charpentier ($t(450) = -0.64$, $p = .524$, $d = 0.06$, 95% CI [−0.20, 0.10]) or women scientists in general ($t(448) = 0.76$, $p = .450$, $d = 0.07$, 95% CI [−0.11, 0.24]) based on narrative. Perceptions of intelligence for Dr. Doudna and Dr. Charpentier were high regardless of whether participants viewed the gender-emphasized narrative ($M = 6.35$, $SD = 0.80$) or the control narrative ($M = 6.30$, $SD = 0.80$). Similarly, perceptions of women scientists' intelligence were high regardless of whether participants viewed the gender-emphasized narrative ($M = 6.18$, $SD = 0.95$) or the control narrative ($M = 6.25$, $SD = 0.92$). As would be expected, participants did view the Nobel laureates as more intelligent ($M = 6.33$, $SD = 0.80$) than the average woman scientist ($M = 6.21$, $SD = 0.94$; $t(449) = 3.01$, $p = .003$, $d = 0.13$).

Also in contrast to the competing hypotheses related to stereotype endorsement (H2a, H2b), there were no significant differences in endorsement of stereotypes between the gender emphasized ($M = 1.81$, $SD = 1.07$) and control narratives ($M = 1.67$, $SD = 1.01$; $t(450) = -1.45$, $p = .148$, $d = 0.14$, 95% CI [−0.33, 0.05]).

Finally, a set of exploratory analyses were conducted to examine whether narrative framing impacted the attributions participants made for the success of the Nobel Laureates as well as how participants perceived the climate for women in chemistry. There were no significant effects of gender framing on any of the attributions: hard work ($t(449) = -0.31$, $p = .757$, $d = 0.03$, 95% CI [−0.18, 0.13]), intelligence ($t(449) = 0.51$, $p = .611$, $d = 0.05$, 95% CI [−0.12, 0.21]), luck ($t(443) = 0.51$, $p = .613$, $d = 0.05$, 95% CI [−0.23, 0.39]), support networks ($t(447) = 0.79$, $p = .429$, $d = 0.08$, 95% CI [−0.14, 0.34]), contributions of others ($t(448) = 0.002$, $p = .998$, $d = 0.00$, 95% CI [−0.24, 0.24]; see Table 1). There was also no significant effect of narrative on perceptions of climate ($t(450) = -0.02$, $p = .986$, $d = .002$, 95% CI [−0.25, 0.25]) (Table 2).

We also examined possible moderating effect of participant gender on the dependent variables using 2 (participant gender) × 2 (narrative) ANOVAs. For this analysis, we included only cisgender women and cisgender men, because the number of people

Table 1. *Finkbeiner Test: Examples of Categories Present in Nobel Articles*

Finkbeiner category	Example
That she is a woman	" … the modest, self-effacing woman whom the world knew as Mme. Curie." (*The New York Times*, 1934)
Her husband's job	"Married in 1937 to Thomas Hodgkin, historian … " (*The Baltimore Sun*, 1964)
Her childcare arrangements	"I have watched her little by little, become a good housewife and deeply attached to the two children she has borne." (*The Baltimore Sun*, 1936)
How she nurtures her underlings	"Sharing the excitement, too, were what Dr. Yalow calls 'my professional children' young research assistants who have served their postdoctoral training with her … " (*The New York Times*, 1977)
How she is a role model for future women	"She's a role model for a new generation of scientists … " (*The Baltimore Sun*, 2009)
How she is the "first woman to … "	"Arnold is the fifth woman to win a Nobel Prize in Chemistry and the first since 2009 … " (*The Baltimore Sun*, 2018)

who selected other categories was too small for reliable statistical analysis. There was no significant interaction between gender and narrative on perceptions of intelligence for Dr. Doudna and Dr. Charpentier, $F(1, 421) = 0.01$, $p = .92$, perceptions of intelligence for women in general, $F(1, 419) = 1.24$, $p = .26$, or stereotype endorsement, $F(1, 421) = 0.001$, $p = .973$. A significant main effect emerged such that men endorsed stereotypes more than women, $F(1, 421) = 23.07$, $p < .001$ ($M_{men} = 2.05$, $SD = 1.17$; $M_{women} = 1.56$, $SD = 0.91$).

There was also no interaction between gender and narrative on perceptions of the climate for women in chemistry, $F(1, 421) = 2.26$, $p = .133$, but a main effect again emerged such that men perceived the climate as more positive than women ($M_{men} = 4.50$, $SD = 1.23$; $M_{women} = 3.66$, $SD = 1.32$). MANOVA revealed no significant interactions between gender and narrative on any of the attributions (all Fs < 1, all ps > .50), but there were main effects of gender on attributions of hard work, $F(1, 413) = 16.21$, $p < .001$ ($M_{men} = 6.11$, $SD = .90$; $M_{women} = 6.44$; $SD = .77$) and intelligence, $F(1, 413) = 10.31$, $p = .001$ ($M_{men} = 6.04$, $SD = .83$; $M_{women} = 6.32$; $SD = .83$), such that women attributed the Nobel Laureates' success more to intelligence and hard work than did men.

Discussion

The gender emphasized compared to non-gender-emphasized narratives about two recent Nobel Laureates in Chemistry did not differentially affect how participants viewed the intelligence of the laureates, the intelligence of women scientists more broadly, or how much participants endorsed stereotypes about women in chemistry. Furthermore, the narratives did not affect the degree to which participants made attributions

Table 2. *Means and Standard Deviations for Attributions about the Nobel Laureates' Success in Study 2*

Attribution	Control *M* (*SD*)	Gender *M* (*SD*)
Hard work	6.31 (0.82)	6.34 (0.84)
Intelligence	6.24 (0.80)	6.19 (0.96)
Luck	3.27 (1.60)	3.19 (1.73)
Support networks	5.14 (1.24)	5.05 (1.33)
The contributions of others	5.25 (1.29)	5.25 (1.29)

about the laureates' scientific successes or how participants perceived the climate for women in chemistry. Thus, the negative effects implied by the Finkbeiner test standards did not emerge, but our measures also did not suggest positive effects from emphasizing gender. Gender did not moderate the effect of the narratives, although men showed greater stereotype endorsement and more positive perceptions of the climate for women in chemistry. A limitation of these analyses is that we did not have enough participants who selected gender categories other than cisgender men and cisgender women (e.g., nonbinary, transgender) to include them in the moderation analyses (although they were included in the primary analyses).

General discussion

It is clear that there are biases in how women scientists are described in the media, but how has the portrayal of women scientists changed over time? And what is the effect of those portrayals? Across two studies, we examined how women who have won a Nobel Prize in a STEM field are portrayed in the news media and how those portrayals may affect perceptions of women scientists. We used the Finkbeiner test as a lens into understanding how women Nobel Laureates have been described and found some important changes have occurred over time.

In the first study, we used an archival approach and applied the Finkbeiner test to newspaper articles spanning the years 1903–2020. This longitudinal study provides valuable insights into the changing descriptions of women scientists over the decades. The most common Finkbeiner categories present in the articles were mentions of the Nobel laureate being a woman and being the "first woman." Furthermore, although reporters are less likely to mention husbands' jobs as years pass, reporters are more likely to call attention to the fact that the laureate was a woman or the first woman to win that Nobel Prize. These categories were also more likely to occur in stories about laureates in chemistry and physics as opposed to physiology and medicine. Finally, the Finkbeiner categories of childcare arrangements, nurturing underlings, being a role model for other women, and being taken aback by competitiveness were infrequently mentioned across the 172 articles.

In the second study, we used an experimental approach to test how the categories related to emphasizing gender (i.e., describing the scientist as a woman or describing how she is the first woman to achieve the accomplishment) affect perceptions of women scientists. In other words, we examined whether the trend in which it was more likely over time to see gender being emphasized was a positive or negative development for how society thinks about women in science. Specifically, we tested whether emphasizing the gender of the Nobel laureates positively or negatively affects perceptions of women scientists' intelligence and general stereotype endorsement. Contrary to our competing hypotheses, there was no evidence for an effect of gender emphasis on how the readers perceived the Nobel laureates or how they generally perceived women in science.

From the perspective of gender equality, the findings from our archival study were somewhat encouraging in that the emphasis on the husband's job decreased over time and the other categories most closely related to the gender stereotypes of women as more suited for domestic tasks appeared only rarely in the coded articles. Thus, this

form of gender stereotyping appears to be less prevalent over time, showing evidence of positive change. This pattern is also consistent with findings from social role theory, which suggest that as women move into different roles (e.g., positions or professions that require more agency, competitiveness, and so on), the stereotypes will begin to change accordingly (Diekman & Eagly, 2000; D. I. Miller et al., 2015).

Our findings also showed differences in reporting by the field of the Nobel laureate. It may be particularly important to combat gender-biased presentations of women scientists in fields where they remain significantly underrepresented, such as physics and computer science. Media presentations can be used to counteract both field-specific stereotypes (e.g., the computer nerd Cheryan et al., 2013) and the tendency to rely on the "masculine default" (Cheryan & Markus, 2020) of valuing male-oriented characteristics or behaviors.

Although it is encouraging that reports on women scientists' accomplishments are less likely to be overshadowed by mentions of their domestic life, one other stereotype that may discourage women from pursuing scientific careers is the perception that science careers do not allow for work-life balance (e.g., Losh, 2010). Media stories that mention family life for both men and women scientists might be a more valuable approach. Such efforts could draw on research suggesting that women value communal goals (e.g., helping and interacting with others), and that showing that scientific careers are congruent with these goals can help recruit and retain women in STEM (Diekman et al., 2015).

Similarly, the null findings for the comparison between stories that emphasize or do not emphasize a woman scientist's gender can be viewed as a positive outcome for gender equity. The extent to which articles mentioned gender increased over time in Study 1, but contrary to the underlying assumptions of the Finkbeiner test, this way of writing about women does not appear to trigger negative attributions or stereotypes.

Taken together, the present research suggests that more work needs to be done to better understand whether the Finkbeiner guidelines are the best guidelines for writing about women scientists. Updated guidelines should incorporate findings from communication and psychology, including research about gender bias more broadly. For example, research suggests that letters of recommendation for men applying for chemistry/biochemistry jobs are more likely to use adjectives that emphasize their ability and that they stand out from the crowd than letters for women (e.g., Schmader et al., 2007); journalists should be encouraged to avoid similar biases.

More broadly, the present research points to the potential benefit of journalists, psychologists, and communication scholars working together to understand how women scientists are being described and the effects of those writing decisions. Regardless of the specific guidelines that journalists and researchers develop, it is clear that articles about women in science are changing over time, and it is in society's best interest to make sure those changes are positive ones.

Limitations and future directions

One key feature of the present research was the specific focus on women who have won a Nobel Prize in a science field: the most prestigious award in those fields. It was important to focus on the Nobel Prize in this set of studies as it provided a basis for comparison over

time: the Nobel Prize has been awarded to women since 1903 with Marie Curie's Nobel Prize in Physics. However, this specific focus is also a potential limitation of the second study as it is possible that gender emphasis may have more of an effect when writing about scientists who are less well-known or who are not considered "superstars" in their fields. For example, the intelligence ratings of Drs. Charpentier and Doudna in Study 2 were all very high regardless of condition indicating a potential ceiling effect. It would therefore be important for future research to test the effects of emphasizing gender on women scientists who have not won the most prestigious award in the field.

Furthermore, in Study 2, we only tested the effects of gender emphasis as it represented the two Finkbeiner categories that were used the most across the articles in Study 1. However, simply highlighting gender may not activate or reinforce stereotypes of women as nurturing or less intelligent in the same way that other elements of the Finkbeiner test might. Another key category to test in future research would be descriptions of the spouse's job as that category was also represented in the articles. Furthermore, based on controversy surrounding whether it is better to remove any mention of families in articles about women in science or if all articles should include descriptions of family, it would be useful for future researchers to test how inclusion of family descriptions affect perceptions of all scientists, regardless of gender. Additionally, our study did not investigate other potentially problematic aspects of reporting on women in STEM, such as an excessive focus on appearance.

Our studies also focused only on women scientists. Thus, we do not know the extent to which articles about men Nobel laureates emphasize their gender or gender-related characteristics, and what effect (if any) emphasizing gender might have for perceptions of men scientists. Future work could examine explicit comparisons between the way that men and women scientists are described in the media.

In addition, the sample of media in Study 1 and the sample of participants in Study 2 provide some constraints on generalizability. In both sets of studies, we only used the medium of articles; we did not examine other forms of media such as videos or podcasts. One practical reason for this was that we wanted a form of media that has existed since the early 1900s to track changes over time. In addition, the Finkbeiner test has traditionally been applied to written media. However, with the increasing number of media forms that are used to educate the public about science (e.g., podcasts, video interviews, animated clips), it will be important to understand how the guidelines from the Finkbeiner test or other approaches to encouraging gender equality in science may be relevant and how those guidelines affect perceptions of women in science when they are presented in these other forms of media. Additionally, social media has provided new opportunities for women scientists to share their work and experiences in new ways, which may also affect perceptions of women in STEM (e.g., Huber & Baena, 2023; Pietri et al., 2021) and provide opportunities for challenging gender biases (Alkhammash, 2019).

Additionally, the articles used in Study 1 were from newspapers in Western, English-speaking, democratic nations; the way that women scientists are described in other countries or cultures may differ. For example, a recent analysis of Spanish/Basque newspapers found that although women scientists are becoming more visible in media, some articles still emphasize women scientists' role as caregivers (Eizmendi-Iraola & Peña-Fernández, 2023). Articles about women scientists who have other marginalized identities may introduce additional complexities.

In terms of the participant sample, although we were adequately powered to detect effects, the majority of the participants were White and cisgender women. Thus, it will be critical to evaluate how gender emphasis in stories about women in science affects perceptions of women in science with a more representative sample. Additionally, our sample showed very low levels of stereotype endorsement (that is, they did not generally feel that men were better than women at science); it may be that the effects of gender emphasis would differ in a sample that holds gender stereotypes more strongly.

Furthermore, we examined news stories and their effects on adults. A key consideration for future research is how stories about women in science may affect younger children and their interest in pursuing careers in science. For example, could the Finkbeiner item of describing how the scientist was a role model for other women have a positive effect on younger would-be-scientists?

Conclusion

Our results suggest that, contrary to the Finkbeiner test standards, emphasizing gender in an article about women scientists does not necessarily have negative effects on perceptions of either the particular scientists or women in science more generally. However, given the continued underrepresentation of women in some areas of science, it is important for future research to identify the best practices for writing about women scientists to encourage participation of women in these fields.

Note

1. As an additional exploratory analysis, we conducted 2 (narrative: gender emphasized or not emphasized) × 2 (school: public university versus liberal arts college) ANOVAs on the dependent variables. There were no significant interactions between narrative condition and school (all interaction Fs < 0.5, all ps > .50). (These analyses excluded the two participants who reported attending other schools.) We also conducted exploratory analyses examining participant race. Because of the relatively low numbers of participants in categories other than European-American/White, we compared White to non-White participants in our analysis to maintain statistical power. These analyses revealed no significant interaction between narrative condition and participant race on any of the dependent variables, all interaction Fs < 1.50, all ps > .20. However, we recognize that this approach is not ideal and may mask differences between racial or ethnic groups, so we have also provided a table of means and standard deviations by condition and race as supplementary material on the Open Science Framework: https://osf.io/bdgae. To further examine the relationship between year and the items from the Finkbeiner test, we calculated the ratio of articles containing each item over the total number of articles for each year and then conducted a correlation of year and that ratio. In this analysis, mentions of the laureate being a woman (r(39) = .21, p = .192) and mentions of her being the first woman (r(39) = .18, p = .251) are non-significant; however mentions of her husband's job remain significant (r(39) = −.48, p = .002).

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Data availability statement

The data are available on the Open Science Framework: https://osf.io/j4bfv/.

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