

The Gendered Culture of Scientific Competence: A Study of Scientist Characters in *Doctor Who* 1963–2013

Lindy A. Orthia¹  · Rachel Morgain²

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Abstract The present study examines the relationship between gender and scientific competence in fictional representations of scientists in the British science fiction television program *Doctor Who*. Previous studies of fictional scientists have argued that women are often depicted as less scientifically capable than men, but these have largely taken a simple demographic approach or focused exclusively on female scientist characters. By examining both male and female scientists ($n=222$) depicted over the first 50 years of *Doctor Who*, our study shows that, although male scientists significantly outnumbered female scientists in all but the most recent decade, both genders have consistently been depicted as equally competent in scientific matters. However, an in-depth analysis of several characters depicted as extremely scientifically non-credible found that their behavior, appearance, and relations were universally marked by more subtle violations of gender expectations. Incompetent male scientists were largely depicted as effeminate and lacking in masculinity. In addition, many incompetent male and all incompetent female scientists

served regimes that were problematically effeminate, collectivist and pacifist, or male-rejecting and ruled by women. Although *Doctor Who* avoids overtly treating women and men unequally, strong codes of masculine capability and prowess nevertheless continue to influence representations of scientific competence, pointing to the continued pervasiveness of such associations within wider Western culture. Professionals working to encourage gender-inclusive practices in science should look to subtle discourses about the masculine culture of science in addition to institutional and structural impediments to participation for women and gender minorities.

Keywords Science · Gender equality · Gender variance · Masculinities · Television · Media images · Popular culture · Content analysis

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✉ Lindy A. Orthia
lindy.orthia@anu.edu.au

Rachel Morgain
rachel.morgain@anu.edu.au

¹ Australian National Centre for the Public Awareness of Science, The Australian National University, Peter Baume Building 42A, Acton, ACT 2601, Australia

² School of Culture, History and Language, College of Asia and the Pacific, The Australian National University, HC Coombs Building, Acton, ACT 2601, Australia

The relationship between gender and scientific work has long been of interest to feminist scholars. Much has been written in recent decades decrying discrimination against women in science jobs, the male enculturation of science workplaces, and the allocation of research funds along gendered lines. Countless reviews, programs, and policies attempting to redress gender inequality in science have been written and implemented across the world, at every level from individual workplaces to international declarations. Yet statistics suggest that, at least in Western nations, there is still substantial gender inequality in employment, publication, and funding in science, technology, engineering, mathematics and medicine (hereafter “science”) (Miller et al. 2006; Moss-Racusin et al. 2012; Sheltzer and Smith 2014).

Scholars have identified enduring gendered discourses underpinning our cultural notions of reason, rationality, and science which help perpetuate the notion that women are not

capable of doing credible scientific work, or are not as capable as men are. Some of these arguments are biologically-based, for example in the idea, stretching back in particular to the Enlightenment, that women have biologically hard-wired limits to their intellectual abilities (Israel 2001; Le Doeuff 2003; Schiebinger 1989). Even where direct links are not made between the innate biological capacity of different gendered beings, elaborate distinctions of culturally coded gender saturate Western cultural notions—for example, of reason and technology as more masculine on the one hand, and aesthetics and emotion as more feminine on the other. Such distinctions are underpinned by what Butler (1993) has identified as the prevailing social configuration of gender in Western societies, that gender is rooted in biological sex, marked as sharp differences of two opposing and discrete categories of bodies and people, as opposed to an understanding of gender as both physiologically and socially fluid. As long as science is seen as a domain characterized by rationality and technicality, this web of entangled social ideas must further fuel the myth of women's scientific incapacity.

Persistent, pragmatic and ideological resistance to these gendered differences in science has considerably altered this terrain in Western countries, particularly since the Second World War. Shifts in public attitudes have translated into state-endorsed programs to actively recruit women into scientific careers and conduct research into women's underrepresentation in science. In Britain, where the television show under discussion is produced, the government commissioned such recruitment programs and research as early as the 1960s (reviewed by Blackwell and Glover 2008). Yet science remains a battleground for gender equality, a battle being fought on both demographic/equal opportunity and discursive/cultural terms. On the one hand, feminists seek to instate equal opportunities in science employment and science education. Laws, policies, and programs explicitly addressing gender equality at state and institutional levels reflect this approach, the success of which is typically measured quantitatively by the number of women and men (rarely other genders) in particular science disciplines or at particular levels. On the other hand, feminists also seek to challenge elements of culture and patterns of thoughts, feelings and words that seem to promote gender inequality in more subtle ways, especially given general societal support for gender equality in principle.

Within the social sciences, the latter approach was distilled by Scott's (1986, p. 1066) pioneering text on gender as a useful category of historical analysis, which separated the study of "gender as a way of talking about systems of social or sexual relations" from the material experiences of actual women and men (and others) in society. In the burgeoning literature that grew from this scholarly space, gender is viewed primarily as a structuring social code that produces (or co-produces) inequality, by reinforcing particular beliefs, practices, and habits and refuting or denying others. Th ery

(2009, p. 4) describes this as a view of a gender as a "mode of social relations" instead of as "an identitarian attribute of persons."

This has important implications for understanding gender and science. It suggests the need to move beyond demographic analysis into recognizing discursive processes that subtly frame and reframe every aspect of how science is lived, from institutionally endorsed sexual harassment, to metaphors of science penetrating nature's inner chamber (Bacon 1620). Lloyd (1984), for example, has argued that concepts foundational to Western scholarship, such as reason, have emerged through their history so thoroughly entangled with ideas about masculinity as to be effectively inseparable. Martin (1991) has shown how gendered framings of penetration and reception, action versus passivity, have pervaded biological representations of human reproduction. These discursive processes manifest through every aspect of social life. Among other things, they can foster subconscious but cumulative micro-inequities in the workplace (Bell 2009) and shape mass media representations of women in science (Kitzinger et al. 2008). Such phenomena are hard to measure quantitatively so they are more typically studied, and challenged, through qualitative approaches.

These two approaches, the demographic and the discursive, are most productively seen as interrelated, for example with gendered cultural discourses shaping individuals' choices of career path and thus creating large-scale social trends which in turn shape cultural conceptions of what the world is like. At the same time, institutional, demographic and discursive trends are always in flux to a degree, and they are constantly subject to the competing dynamics of challenge/protest/dissent and confirmation/reiteration/consent. What constitutes the hegemonic ideology at any given point will differ through time, space, and social relations, even if, at one level, there are relatively stable long-term trends. As a result, any single snapshot of the relation of gender to science will inevitably simplify complex dynamics.

The present study aims instead to capture some of that complexity. Broadly speaking, the question we will attempt to answer is: How is science gendered within a culture that is overtly committed to gender equality within the sciences? To address this question, we undertake a mixed methods content analysis of a popular, long-running television program.

Gender and Science in Fiction Film and Television

Since the 1990s, a number of scholars have examined representations of fictional scientists in film and television with respect to gender (Dhingra 2003; Flicker 2003; Flores 2002; Haran et al. 2008; Jackson 2011; Jones 2005; Long et al. 2010; Merrick 2010, 2012; Steinke 1999, 2005; Steinke et al. 2012). Many such studies were prompted by concerns about the

kinds of scientist role models (or lack thereof) presented to girls and women through television shows and films and by a desire to recruit, retain, and promote women in scientific careers equally with men (Long et al. 2010). Given this aim, surprisingly little human participant research has been conducted into how people respond to fictional representations of scientists in gender-related terms (notable exceptions being Dhingra 2003; Steinke et al. 2012). What has been published suggests that television fiction and films can and do affect people's personal relationships to and perceptions of science. In other words, fiction media contribute to the discursive space in which the battle for gender equality in the sciences is being fought. As such, studying them can help us understand the gender politics of the culture that both created them and is co-created by them; in Merrick's (2012, p. 750) words, it can help determine "the range of cultural meanings represented . . . and the ways in which they both reflect and intervene in cultural understandings of science."

Most content analyses of gender in science-themed fiction have revealed a dearth of women portraying scientist characters compared to men (Flicker 2003; Flores 2002; Long et al. 2010; Weingart et al. 2003). This seems to be the most consistent and persistent problem in this area, mitigated only by the few deliberate efforts to produce more gender-aware films and television programs (Long et al. 2010). Many have also suggested some evidence of gender-biased characterization of female scientists, although this is far from simplistically sexist and can vary with medium and genre (Flicker 2003; Haran et al. 2008; Jackson 2011; Long et al. 2010). For example, they suggest female scientist characters are generally represented as competent in their work, and they vary less than male characters do in this aspect (Haran et al. 2008; Jones 2005; Long et al. 2010; Steinke 2005). Steinke (2005), Flicker (2003), Haran et al. (2008), and Jones (2005) all contend that female scientists are generally realistically presented and do not tend to possess the traits stereotypical of fictional male scientists, such as madness, clumsiness, eccentricity, and outsider status. This difference could be seen as a manifestation of gender-biased characterization, though whether it is a problem is unclear.

On the other hand, on specific measures of credibility, female scientist characters are arguably represented as less credible than their male counterparts are. Several scholars note that female scientists often face challenges to their status from other characters as well as questions about their qualifications, are frequently subordinate or junior staff members, and, if on a team, are usually a token solo woman (Flicker 2003; Flores 2002; Haran et al. 2008; Steinke 2005). Jones (2005) notes that all the scientist characters he studied were called "Miss" not "Dr," with the Miss signifying a gendered attitude, lower status, and/or possible denial of their qualifications. Female scientist characters are often unrealistically young and beautiful, which possibly reflects adversely on their credibility when

these traits stray too far from audience expectations; and they are frequently depicted in romantic and sexual relationships, with this rather than science often the focus of their personal narrative and function in the plot (Flicker 2003; Haran et al. 2008; Jones 2005; Steinke 2005). Emotionality and social competence are common traits: female scientist characters can function as relational bridges between male rational scientists and everyone else (Flicker 2003), emphasizing their social roles over their scientific capability. It is worth noting though that this polarity can be reversed: Haran et al. (2008) found female forensic scientist characters were often depicted as hyper-rational compared to the more emotional non-scientist male characters with whom they interacted.

This complexity in part reflects the dynamic discursive landscape in which ideas about gender and science are negotiated. But it also reflects an under-studied, and somewhat haphazardly targeted, area of research. There are three obvious limitations of current research in this area, the first two of which are related. First, most qualitative studies, including most of those cited previously, have focused only on representations of female scientist characters, rather than making rigorous comparisons between genders. This limitation means it has not always been possible to test whether the elements of characterization that scholars identify as problematic are actually gender-biased, or if indeed male and other-gendered scientist characters are also characterized that way, making the traits gender-neutral.

Second, where rigorous gender comparisons have been conducted, they have almost always been limited to percentages of the relative frequency of female and male scientist characters, rather than testing for other kinds of differences, either quantitatively or qualitatively. As such, many of the insights recounted here warrant closer investigation. Recognizing the first limitation within her analysis of 23 female scientists in films, Steinke (2005) argued that a comparative study of female and male characters is warranted. Long et al. (2010) then conducted such a study of the scientist characters in several fiction and non-fiction television programs. They also responded to the second limitation by investigating quantitatively how often the characters exhibited gender-stereotyped behaviors, scientist stereotypes, and four "wishful identification" attributes, rather than just quantifying headcounts. Their criteria of analysis were selected specifically for their likely relevance to girls' scientific career ambitions, and they found there were some statistically significant elements of representation likely to encourage boys more than girls into scientific careers. They recommended further research be conducted in this field to expand the number of scientist characters studied and the range of attributes examined. Our study is consistent with those calls. We will attempt to probe, more rigorously, assertions about female and male scientist characters' credibility.

The third obvious limitation of this body of research is somewhat different. Most of these studies have taken a demographic approach and have located “gender” solely within individual characters rather than studying its presence as an abstract cultural code, perhaps because the texts being studied did not lend themselves to the latter. Merrick (2012) notes that studies of the cultural commitments of science have featured more prominently in literature studies, and even then they have only rarely dealt with gender. The unintended outcome of this narrow focus is that theorization about the relationship of gender to science has been limited. For example, some scholars have constructed typologies of different female scientist stereotypes (Flicker 2003) or descriptors of historical trends in representing female scientists (Jones 2005), but have not offered theoretical explanations for these, other than a general conclusion that there is gender discrimination present such that women are treated differently from men. Some studies have used their findings to theorize about genre and medium (notably Haran et al. 2008; Jackson 2011), but not about the cultural relationship between gender and science. These studies are useful building blocks for developing explanatory theory, but there is ample room for theorization in order to investigate more deeply the discourses and power relations that might be foundational to any depicted gender differences. In addition, the lack of a monolithically anti-female bias in these fiction texts suggests that a more complex gender topology is associated with scientific credibility, leaving room for new directions in qualitative analysis to explore further nuances.

In the present study, we sought to develop new insights into the relationship between scientific credibility and gender through the study of a large set of scientist characters from the British science fiction television program *Doctor Who* (1963–present). The study was inspired by a small subset of scientist characters who demonstrated a marked lack of scientific credibility and who also seemed to challenge gender norms. In the second part of our paper, we analyze these characters qualitatively to identify precisely what elements of gender correspond to that lack of credibility. Paying attention to the qualitative and narrative contexts of these “failed scientist” characters allows us to offer a theoretical model of the gender-science relationship as it plays out through complex social and attributional codes. To give context to that discussion, we present results in the first part of our paper from a quantitative comparison of all the non-regular female and male scientist characters in the program over a 50-year period, in terms of specific measures of credibility, to find out if one gender was represented less credibly than the other in general.

Our mixed methods approach affords both rigor and nuance. It allows us to straddle demographic, social, and cultural approaches to studying gender and science. Testing for statistical gender bias among individual scientist characters will establish *Doctor Who*’s dominant perspective on women’s ability to do credible science. Having calibrated our baseline,

we can then better distinguish between blanket gender bias and more subtle aspects of the gender-science relationship that infuse the program because male-centric actions and beliefs within science are often culturally normalized and unconscious rather than openly discriminatory (Merrick 2012; Miller et al. 2006). Based on our data, we argue that it is a character’s embrace or rejection of particular masculinist social codes and traits, rather than being a woman or a man as such, that determines their level of scientific credibility.

The Text: *Doctor Who*

The dataset for our study comprised the non-regular scientist characters appearing in *Doctor Who* during the program’s first 50 years. The British Broadcasting Corporation (BBC) originally devised *Doctor Who* to teach aspects of science and history to children and therefore included many scientist characters in its original series (1963–89), although this semi-educational brief was formally dropped some years into production. The BBC ceased production of the program in 1989 for operational reasons, but eventually revived it in 2005 in a continuing new series, and it continues to include scientist characters in keeping with the narrative and aesthetic conventions set by the original series. *Doctor Who* is serialized, with each serial comprising a self-contained story of 1–12 episodes (we hereafter italicize serial names). From 1963 to 2013, over 240 serials were broadcast, resulting in a diverse program that drew contributions from many hundreds of cast and crew members.

Despite serialization, the show has a high degree of continuity because it focuses on the adventures of its central character, an alien scientist known as “the Doctor” who travels through time and space, usually accompanied by one or more regular companions. The Doctor was portrayed by 13 actors in the show’s first 50 years, all White men. Because of the program’s global and enduring popularity, the gender of scientist characters in *Doctor Who* has been a subject of public discussion for decades (for example Stanish and Myles 2012; Thomas and O’Shea 2010; Tulloch and Alvarado 1983), including calls from the scientific community and others to cast a woman in the role of the Doctor (Anon 2008; Brown 2016). The program has responded to public feminist discourse in a number of ways over the decades including the creation of several female scientist companions (reviewed by Orthia 2010). The present paper focuses on a less-studied aspect of *Doctor Who*: its non-regular scientist characters who appeared in only one serial (rarely two). Non-regular characters have simpler, more consistent characterization than regular characters (that is, those appearing in more than one serial), making them amenable to coding for statistical analysis. This focus also makes the findings more comparable to previous studies, most of which examined film characters: these are usually

similarly under-developed, as opposed to regular television characters who tend to be more complex (Haran et al. 2008).

There are good reasons to study *Doctor Who* as a reflection of broad cultural attitudes. Its wealth of material enables trends in attitudes to science to be tracked through time and makes the program a large yet coherent case study. Long et al. (2010) detected significant differences between genres regarding representations of scientists, so using one program whose formula and genre remained the same may reduce such confounding factors. Although this narrowness has the potential to limit the generalizability of our results, it is balanced by *Doctor Who*'s numerous contributors across the decades and by its extensive borrowing from other texts (Harnes 2014). The resulting diverse frames for science and gender in *Doctor Who* may represent a broader sample of cultural trends than would be possible with a program driven by a single creator.

The moral and political commitments of the program are generally manifest because the Doctor and his companions almost always function as its moral compass (Fiske 1984; Orthia 2011; Tulloch and Alvarado 1983). These characters' words and actions are didactically directed to help viewers interpret the moral status of non-regular characters, directing a spotlight at the behaviors and beliefs which *Doctor Who*'s makers regard as "good" or "bad." This moralizing, combined with the fact that many characters hail from present day Earth, means the program can often be read as a commentary on contemporary cultural developments (Gregg 2004), including those related to gender and science. For example, a number of characters across the years have engaged in disputes about gender roles in ways that resonate with contemporary socio-political developments. These instances include some explicit acknowledgements of feminist politics, with characters employing language such as "anti-feminist" in the 1960s (*The Invasion*, 1968), "women's lib" in the 1970s (*The Time Monster*, 1972; *The Monster of Peladon*, 1974), and "chauvinist" in the 1980s (*Four to Doomsday*, 1982). However, the program has also often featured representations, overt and subtle, that have reinforced gender stereotypes (Amy-Chinn 2008; Stanish and Myles 2012; Thomas and O'Shea 2010; Tulloch and Alvarado 1983). *Doctor Who* thus gives an explicit nod to liberal values while reproducing conservative values. As such it is something of a political mélange, reflecting diverse elements of the culture that created it, a quality that makes it useful for understanding how that culture changed between the 1960s and the 2010s.

Methods

Scientist Characters Analyzed

We identified scientist characters to be used in our study by watching every *Doctor Who* episode in the study period, or, in

the few cases where video footage was lost, listening to audio recordings, reading episode transcripts, and examining still photographs available online. Our definition of "scientist" was ecumenical, including medical staff, mathematicians, archaeologists, engineers, and professional technicians. Characters were included if they had a prominent role in the narrative, on their own merits or as members of a prominent team, and did not appear regularly in the program. Regular characters (those appearing in more than two serials) were excluded for the reasons described previously, including the Doctor, companions, and recurring villains and allies. Also excluded were non-humanoid scientist characters. *Doctor Who* routinely features alien characters, androids, disembodied intelligences, and more. Most cannot be easily categorized under demographic categories such as gender, so they were excluded. Alien characters indistinguishable from humans were included. Thus our final dataset included 222 scientist characters.

Character Gender

Determining the gender of the included characters was not straightforward, although it is usually treated so in studies of fictional scientists. Given the contested nature of the concepts "gender" and "sex," and the diversity of sex or gender identities now commonly employed in Western society including intersex, transgender, genderqueer and non-binary, the act of classifying fictional characters into "female" and "male" effectively endorses a dichotomous gender and sex ideology. This negates the possibility that viewers might interpret a character as non-binary in some way. There are identified intersex, gender-changing, and transgender characters in *Doctor Who*, all of whom we excluded here because they are not scientists or not humanoid or are regular characters, but their visibility does not mean there are no "gender-closeted" characters. We cannot ask fictional characters how they identify, nor about the cultural regimes within which these identifications become meaningful, so there is no certain way to establish their gender or sex, other than imposing our assumptions on them. Indeed, given the conventional basis for the distinction between gender and sex in the Anglophone West is identity (gender) versus biology (sex), the category "sex" in particular is meaningless for fictional characters, at least insofar as their genitalia, chromosomes, and so on are not visible to audiences. For that reason we use the word gender rather than sex throughout our paper, but the concept's different ontological status for fictional characters and real people is important.

Despite these concerns, for pragmatic reasons of enabling statistical analysis we classified characters as "female" or "male," on the basis of conventional markers such as actor and character names, appearance, voice, and pronouns. Using these signifiers then, our dataset of 222 scientist characters

included 56 women and 166 men. This categorization is somewhat defensible because most audience members would probably interpret characters' gender dichotomously, consistent with the dominant Western model. However, queer fans are prominent within the *Doctor Who* community (Ellis and Thomas 2013; Tulloch and Jenkins 1995), and *Doctor Who* has actively depicted and discussed trans and queer characters over the years, most obviously new series companion Captain Jack Harkness who went on to lead the richly queer spin-off series *Torchwood* (2006–2011), so the decision is uncomfortable. In addition, characters' gender ambiguity or transgression was important in our qualitative analysis, raising further questions about the methodological soundness of examining fictional characters in gender-dichotomous terms.

Quantitative Analysis of Traits

To facilitate quantitative comparison of female and male characters, the first author coded characters for five traits signifying scientific credibility. Traits were derived from previous studies of female scientists in film and television fiction. The second author cross-coded a random selection of 27 (12 %) characters to evaluate the adequacy of trait definitions and replicability of the method. We assessed our level of agreement after the first pass using Krippendorff's Alpha Reliability Estimate (KALPHA) as per Lombard et al. (2002), calculating the metric in SPSS using a macro developed by Hayes (De Swert 2012; Hayes and Krippendorff 2007). We considered $KALPHA \geq .70$ an acceptable agreement level (Lombard et al. 2002), and cross-coding for three traits returned unacceptably low agreement. These were excluded because cross-coding suggested they were too subjective: (a) whether characters looked like a scientist cliché ($KALPHA = .32$), (b) characters' narrative function with respect to science (e.g. whether they embodied a moral message about science or not; $KALPHA = .38$), and (c) whether the characters were marked with a recognized area of scientific expertise ($KALPHA = -.10$). We discussed points of disagreement for the included traits, clarified trait definitions to minimize ambiguities, and identified coding errors. We then recoded characters using redefined traits to produce the final dataset.

Trait 1: Honorific

Characters were coded according to the type of honorific used to address or describe them: scientific (e.g. Professor, Doctor, Nurse); non-scientific specialist (Captain, Officer, Governor); gendered (Miss, Mrs, Mr); and none ($KALPHA = .84$). For statistical analysis, we merged the latter three categories as "non-scientific," dichotomously compared to the "scientific" category. We also tested other combinations but generally do not report them here. Previous content analyses (notably Jones

2005) suggest women, but not men, are more likely to carry gendered titles than scientific ones, foregrounding their gender over their scientific abilities and thus potentially undermining their credibility.

Trait 2: Performing Science on Screen

For this trait, characters were coded according to whether they were shown actively engaged in scientific activity on screen ($KALPHA = .80$). Talking about science and managing scientific operations were not considered "performing science," but theory-based research and conducting specialist technical labor was. This trait aimed to distinguish between those characters who were merely (perhaps as tokens) labeled "scientist" and those who visually proved their ability to "do" science. Performing scientific work has been noted as an important marker of credibility, or rather its lack may reinforce an image of female scientists as less credible than their male counterparts. For example, Jones (2005) notes that female scientists in post-war British films often performed non-science tasks below their skill levels, and Flicker (2003) documents the experiential naiveté of some female scientist characters who may have scientific qualifications but could not perform effectively.

Trait 3: Autonomy or Authority in the Scientific Workplace

Senior, independent or management level scientists were considered to be autonomous or to wield authority in their workplace, establishing their scientific capability by their responsibility for scientific operations ($KALPHA = .71$). This trait was compared to characters such as juniors and assistants who only worked under supervision or instruction. Both Jones (2005) and Flicker (2003) identify that female scientist characters are often relegated to "assistant" roles, potentially denoting dependence and lesser credibility. This trait has some overlap with what Long et al. (2010) call "professional status," but our emphasis was on scientific ability, not the hierarchical position examined by Long et al. (and by Steinke 2005). Since at least Kant's (1784) answer to the question "What is Enlightenment?," independence of mind has been associated with reason and, in turn, scientific capacity. Accordingly, characters who were junior to others but completed their scientific work independently were coded as possessing autonomy/authority.

Traits 4 and 5: Prominence and Discipline

Two additional traits, not cross-coded, were included in our statistical analysis. The first was designated "prominence," and distinguished between those characters who were included in the dataset because of their prominence in the plot as individuals and those included only as part of a prominent team. This trait was not directly related to scientific credibility,

but it was deemed a potentially important factor for understanding the extent to which characters had an opportunity to demonstrate credibility in terms of screen time and narrative attention. The second was a disciplinary classification into “medical/health fields” and “other.” Blackwell and Glover (2008) document the fact that, historically and today, the ratio of women to men has been more equal in Britain in medical and health sciences than in other sciences. We therefore hypothesized that medical/health scientist characters might be less likely to be represented in a gender-disparate way in terms of scientific credibility. The complete dataset of characters and coded traits is available as an online supplement (Tables S1 and S2).

Statistical Analysis

We used Chi-squared tests of independence to test for gender differences among these traits within SPSS Version 21. The null hypothesis we tested for each was that there would be no significant difference between the representations of the genders as scientific characters. To explore changes through time, we conducted Chi-squared tests on the whole dataset and also within each decade of *Doctor Who* productions: the 1960s (1963–69), the 1970s (1970–79), the 1980s (1980–89), and the 2000s (2005–13). We used Fisher’s exact test (two-sided, FET) when expected cell counts were less than five. We also performed a logistic regression to ascertain the effects of the three credibility traits, prominence, health/medical field or not, and decade on the likelihood that characters were female. We considered p -values $\leq .05$ as significant for hypothesis testing, but we also discuss those $< .10$ as indicative of a non-random relationship potentially worthy of further investigation with larger samples.

Qualitative Analysis

We considered the quantitative and qualitative components of our study to be equal but complementary, and we conducted them simultaneously (Hesse-Biber 2016). The study’s qualitative component focused on only a small subset of the data: those characters explicitly identified through dialogue and plotting as possessing little scientific credibility. Having observed informally that those characters were all depicted with unusual gender traits (described in the following), we sought to identify whether this observation had analytical significance, and if so, what the relationship between gender and scientific credibility was. This analysis employed a grounded theory approach (Birks and Mills 2011) involving iterative revisitations of the text in which we developed, tested, rejected, and refined hypotheses to explain the patterns. Our condition for accepting a hypothesis as a possible explanation was that it should explain all the examples with no discernable exceptions. As such, we tested our developing hypotheses in later

iterations by introducing characters to the qualitative dataset who seemed to challenge gender norms but were not marked by the same utter lack of scientific credibility.

Results

Quantitative Analyses

Male scientist characters ($n=166$) significantly outnumbered female scientist characters ($n=56$) across the dataset, $\chi^2(1)=54.51, p<.001$ (see Table 1). Men were similarly more common across each original series decade: 1960s: $\chi^2(1)=29.40, p<.001$; 1970s: $\chi^2(1)=23.68, p<.001$; 1980s: $\chi^2(1)=8.40, p=.004$. The average percentage of 21 % women across those three decades is consistent with studies of scientists’ gender in films (Flores 2002; Weingart et al. 2003). It is noteworthy, though, that the proportion of women rose each decade in *Doctor Who*, from 15 % in the 1960s, through 21 % in the 1970s, to 28 % in the 1980s (see Table 1). In the new series (2000s), there were still more male scientist characters (58 %) than female (42 %), but this difference was not statistically significant, $\chi^2(1)=1.333, p=.248$. These percentages mirror Long et al.’s (2010) study of scientist characters on recent U.S. television, which also found a 58:42 split. In terms of raw numbers, our findings then mirror previous studies, suggesting that *Doctor Who* broadly follows similar trends to feature films and other television programs.

However, our focus was on gender differences with respect to scientific credibility. The Chi-squared tests found no significant differences between the genders for any of the test traits at the .05 level, when measured across the whole dataset (see Table 1). Only one marginal effect (allowing for the necessarily small sample size) was noted: male (83 %) scientist characters were somewhat more likely than their female (71 %) counterparts to work autonomously or possess authority in the scientific workplace, $\chi^2(1)=3.19, p=.074$. When medical practitioners were excluded, this difference between male (82 %) and female (67 %) characters became significant, $\chi^2(1)=4.92, p=.027$. For most other traits the percentage differences between the genders were minimal and nonsignificant: 25 % of women and 30 % of men were addressed by a scientific honorific, 75 % of both genders performed science on screen, and 88 % of women versus 89 % of men had a prominent role in the narrative as individuals. These patterns broadly held when medical practitioners were excluded. In the trait of medical vs non-medical professions itself, the percentages differed by more than 5 % (20 % of women vs 12 % of men were medical professionals), which leans towards real world gender differences (Blackwell and Glover 2008), but it was not statistically significant, $\chi^2(1)=2.01, p=.156$.

The logistic regression results echoed those of the Chi-squared tests. The model was statistically significant,

Table 1 Male and female characters across time and credibility traits

	Total Characters <i>n</i>	Women <i>n</i> (%)	Men <i>n</i> (%)	Gender Comparison <i>p</i>
Characters across time				
Total	222	56 (25 %)	166 (75 %)	< .001
1960s	60	9 (15 %)	51 (85 %)	< .001
1970s	71	15 (21 %)	56 (79 %)	< .001
1980s	43	12 (28 %)	31 (72 %)	.004
2000s	48	20 (42 %)	28 (58 %)	.248
Credibility trait value displayed by character				
Honorific is scientific		14 (25 %)	51 (30 %)	.416
Performs science on screen		42 (75 %)	124 (75 %)	.964
Has autonomy or authority in scientific work		40 (71 %)	137 (83 %)	.074
Has prominent role in narrative		49 (88 %)	148 (89 %)	.735
Is in medical or health field		11 (20 %)	20 (12 %)	.156

Gender comparisons are made with Chi-Squared tests. The credibility trait values displayed by character involve all 56 women and 166 men coded

$\chi^2(6) = 15.54, p = .016$. It correctly classified 74.8 % of cases, though it only explained 10.0 % (Nagelkerke R^2) of the variance in gender, likely reflecting factors outside the model such as plot and casting that contribute to characterization. Of the predictor variables, only decade was statistically significant ($p = .003$), with women more likely to be present in later decades, whereas autonomy/authority was marginally significant within the model ($p = .068$). Again, this pattern suggests that for these traits, men are not significantly more likely to be depicted as scientifically credible than are women.

The weak difference in autonomy/authority can be partly explained by examining each decade (see Table 2). This table reveals that 1970s men (80 %) were significantly more likely than 1970s women (53 %) to possess workplace authority or autonomy (FET, $p = .046$). This was the only statistically significant difference between the genders in scientific credibility. In four small-sample cases, there were weak challenges to the null hypothesis. Women (27 %; 27 %) from the 1970s were less likely than men (51 %; 54 %) to be addressed by a scientific honorific, $\chi^2(1) = 3.00, p = .083$, or to be addressed by a specialist (scientific or non-scientific) honorific,

$\chi^2(1) = 3.66, p = .055$. The opposite was true for 1980s characters, with women (43 %) more likely than men (13 %) to be called Professor, Doctor or Nurse (FET, $p = .088$). On the other hand, female (42 %) characters in the 1980s were less likely than men (74 %) to perform science on screen (FET, $p = .074$); this pattern is in marked contrast to the nine women depicted in the 1960s, all of whom performed science on screen, compared to 71 % of 1960s men (FET, $p = .095$).

In part these marginal effects may be due to small sample sizes at the decade level, because in a few cases gender differences were still greater than or equal to 10 % even if not statistically significant (see Table 2). In the 1960s, only 67 % of women compared to 80 % of men possessed autonomy or authority in scientific work (FET, $p = .392$), and the narrative prominence of women changed from 100 % in the 1960s to 73 % in the 1970s, even though raw numbers increased by 67 % from nine to 15, whereas for men there was little change in prominence (82 to 88 %) or raw numbers (up 10 % from the 1960s). This is because in the 1970s a few women were cast as minor team members, and women continued to be cast in about 15 % of prominent scientist roles.

Table 2 Percentage differences for credibility traits within decades

Credibility trait value displayed by character	1960s		1970s		1980s		2000s	
	Women <i>n</i> = 9	Men <i>n</i> = 51	Women <i>n</i> = 15	Men <i>n</i> = 56	Women <i>n</i> = 12	Men <i>n</i> = 31	Women <i>n</i> = 20	Men <i>n</i> = 28
Honorific is scientific	11 %	20 %	27 %*	52 %	42 %*	13 %	20 %	29 %
Performs science on screen	100 %*	71 %	87 %	82 %	42 %*	74 %	75 %	68 %
Has autonomy or authority in scientific work	67 % ^a	80 %	53 %**	80 %	92 %	87 %	75 % ^a	86 %
Has prominent role in narrative	100 % ^a	82 %	73 % ^a	88 %	100 %	100 %	85 %	93 %
Is a medical professional	11 %	4 %	13 %	13 %	17 %	10 %	30 %	29 %

^a Difference ≥ 10 % but $p > .10$. * $p < .05$. ** $p < .01$

Quantitative Summary

We can broadly conclude from this analysis that, beyond the differences in raw numbers, *Doctor Who* has mostly treated its female and male scientist characters equally with respect to important aspects of scientific credibility. For the program as a whole, the percentages and statistics strongly support the contention that *Doctor Who*'s dominant perspective on women in science is that they are equally credible to men. At the decade level, given the sometimes large percentage differences, it is more accurate to say little inequality can be discerned at a statistically significant level. But even then, gender differences of 10 % or more only emerged for nine of 20 tested traits (see Table 2), leaving over half not obviously gender-biased.

The growing influence of public pressure to promote women in science through equal treatment and equal numbers is apparent from this quantitative overview. The percentage of scientists who were women increased every decade, and the 2000s was the only decade to display no statistically significant gender differences for any trait even at a marginal level. The huge increase between the 1970s and 1980s in the percentage of women addressed by a scientific honorific (27 to 42 %) might also be read as a symptom of this trend, particularly because there was a massive corresponding drop for men (from 51 to 13 %). The drop is mostly explained by futuristic stories in the 1980s, in which many characters were addressed without an honorific, but the high proportion of women retaining a scientific honorific even within futuristic stories suggests a conscious effort to depict women as figures of scientific seniority. The high percentage of women performing science on screen in the 1960s can also be read as a gesture promoting women's scientific credibility, although not necessarily their seniority. Most of the nine 1960s female scientists were young and relatively junior, though also depicted as highly technically proficient and capable of taking control of particular tasks, and sometimes wielding authority. Some dialogue reveals a conscious commitment to confronting sexist assumptions, for example an exchange from *The Web of Fear* (1968) when a soldier confronts scientist Anne Travers, who has been seconded to the military:

Soldier: What's a girl like you doing in a job like this?

Travers: Well, when I was a little girl I thought I'd like to be a scientist. So I became a scientist.

This contrast suggests that when stories depict characters as utterly lacking scientific credibility, we must look beyond superficial gender dichotomies to find systemically supportable explanations. If discourses of gender and of scientific credibility do interact in *Doctor Who*, then that goes beyond mere bias against women. Although women were vastly underrepresented as scientists during the show's first decades, where

they were represented, they were generally accorded a similar level of credibility as men. Thus femaleness or maleness alone are not sufficient to determine a character's scientific credibility in *Doctor Who*.

Qualitative Analyses

As noted previously, our study was initially inspired by a small number of characters in *Doctor Who* for whom a defining characteristic was a lack of scientific credibility. We found this interesting because each also seemed to challenge gender norms, both of contemporary English society and of *Doctor Who*. We investigated this dynamic to try to identify a consistent ideological thread to explain it. We followed a constant comparative approach, introducing new characters to test our evolving explanatory hypotheses.

We identified all the serials that included scientist characters whose narrative arcs were characterized by a high level of incompetence in their scientific labors. We found six: five from the original series and one from the new series. In each case, the characters' incompetence was central to their function in the plot, with part of their story's moral message connected to their incompetence and/or the reasons behind it. "Science gone wrong" caused by scientists' hubristic overreaching, incaution, amorality or evil is a common element of science-themed fiction (Flores 2002; Haynes 1994, 2003), but the characters discussed here were different in that their primary scientific traits were incompetence, ignorance, and naivety. They are more like Haynes' "foolish scientist" stereotype than her more sinister "inhuman researcher" or "evil alchemist" stereotypes (Haynes 2003). Although some competent scientists in *Doctor Who* become incompetent after directing their scientific skills towards evil ends (Orthia 2011), the examples in these six serials involve scientists whose science just does not work at all.

The three serials we later introduced to compare and test our explanations included scientist characters with questionable scientific competence. These scientists displayed some level of scientific effectiveness, but their competence was in question either because their science partially fails or because it is labeled or depicted as marginal or fringe by the Doctor or his companions. For the sake of simplicity, we discuss all cases together, but differences are noted textually and are clearly marked in the online supplementary material in Table S3.

On initial examination of the central examples, it was clear that many of these scientists held markedly gendered traits. Some were men who noticeably lacked certain key markers of masculinity. Others were women who appeared to be arbitrarily cruel and domineering towards men. Others still were scientists who seemed to come from social contexts marked by dependence or passivity. These three traits were the starting point for an iterative examination of all nine serials, and the 13

failed scientists depicted within them. Three central patterns emerged based on these starting points, which seemed to tie scientific competence to a failure of masculinity in different ways.

Effeminate Men

Several of the ineffectual or questionable scientists were male characters who showed a marked effeminacy in their appearance and behavior. A pronounced example is Hobbes, a character from *Midnight* (2008) and the only example from the new series. Hobbes is depicted as a dogmatic, unquestioning senior scientist whose theories about the planet *Midnight* prove dangerously wrong. Physically, he bears many traits that, as we shall see, are often associated with a lack of fully developed masculinity in these stories: he has soft features and paunchy cheeks, is bald, and is a little flabby. Socially, he is marked by impotence in two metaphorically linked ways: he shows complete sexual disinterest in his young woman companion and he is impotent to act in face of the story's crisis to the point where another male (non-scientist) character, bearded and with dark hair, asks him "What sort of a man are you?"

Botanist Harrison Chase from *The Seeds of Doom* (1976) displays similar traits. While he is shown to be intelligent and effective as a scientist in a number of ways, his marginal scientific views include a belief in plant sentience and emotions and a desire for vengeance against "plant eaters" (Orthia 2011). Chase is a camp man who has been described as "Mr. Humphries with psychotic tendencies," an allusion to a famous camp, gay British sitcom character (Nyder n.d.). He is clean-shaven, with soft features, a slight build and a perpetually pursed mouth. Chase's campiness and effeminate appearance mark him as both gender non-conforming and as rejecting or lacking the necessary masculinity to perform fully mainstream and acceptable science.

Five other male characters fit a similar profile to Hobbes and Chase (Clent, Balan, Teel, Jellicoe, Gilbert M; see Table S3 online), but they are discussed in the following because they also display other traits that further reveal the complexes of gender and scientific credibility depicted in *Doctor Who*. Together these characters suggest that a lack of masculinity is associated with questionable scientific capacity.

Female Dominated Regimes of Artificial Construction

Examining some female characters highlights a second key dimension to the question of scientific credibility: the naturalness or contrivance of the regime the scientist serves. The earliest serial depicting scientifically incompetent characters, *Galaxy 4* (1965), contrasts two alien races which have crash-landed on a doomed planet. One group, the male-voiced Rills,

are physically hideous but morally good aliens who ultimately escape the planet through their application of scientific prowess. The others are the villainous Drahvins, who are destroyed when the planet blows up. The Drahvins are all portrayed by women, physically represented as ultra-feminine with beehive hairstyles and short skirts. They see little need for men in their culture (a stance the Doctor disapproves of) with their leader stating, "We have a small number of men, as many as we need. The rest we kill. They consume valuable food and fulfill no particular function." They are also terrible at science: the Doctor and companion Steven observe that the Drahvins' spaceship is "not very well advanced," "old-fashioned," and "tough but not impregnable," being made from an "inferior" and "common" metal. The Doctor deduces that they are not "very intelligent." The Drahvins' scientific inadequacies are thus emphasized, culminating in their inability to repair their ship and leave the planet. The story implies that the Drahvins' culture is fundamentally flawed, resulting in both poor scientific abilities and poor morals. The underlying flaw would seem to be, at least in part, their female-dominated culture, and on first glance we could interpret this portrayal as straightforward sexism. But other examples suggest it may be more complex than that: that what is problematic is the contrivance of their social order, not simply the presence of many women.

The second example of a contrived, cruel social order comes from *Robot* (1974–75), in which an ultra-rationalist extremist group, the Scientific Reform Society (SRS), seeks to take over the world and implement a rationalist regime with the most intelligent (themselves) ruling the rest. While the two prominent members of the SRS display some level of scientific skill, their scientific views are depicted as marginal when the Doctor's companions describe them as "fringe," "cranks," and "somewhere between the flying saucer people and the flat-Earthers." The SRS leader is Hilda Winters, the director of a research institute called Thinktank. Winters is depicted as frumpy and butch (by *Doctor Who* standards), with short hair and severe features. More than that, she appears as the unpleasant face of feminism. When the Doctor's companion Sarah (*Doctor Who*'s well-known and well-liked champion of "women's lib") assumes Winters' male assistant is the Thinktank director, Winters mocks her sexist assumptions. Winters thus out-feminists the feminist in an unfriendly manner, taking on a tyrannical feminist persona counter-posed to Sarah's liberal feminist persona. Winters' assistant, Jellicoe (camp in his hand gestures and speaking voice, flouncing as he walks), defers to Winters' seniority. Both thus defy gender conventions and seem to reject normative masculinity: Jellicoe in terms of his personal behavior and Winters in terms of her arch defense of a mode of feminism depicted as domineering. But what is striking here is the thread common to these scientists and the Drahvins: their service to an artificially constructed, cruel, and domineering order, headed by a man-belittling woman.

Two further stories illustrate this pattern. *The Creature from the Pit* (1979) is set on a jungle-covered planet short on naturally occurring metals, which the Doctor considers backward and primitive because of its lack of agriculture (Orthia 2013). The planet is ruled by a tyrant, Lady Adrasta, who maintains her power by hoarding what metal exists. Adrasta has suppressed technological development and imprisoned a blob-shaped alien ambassador from a neighboring, metal-rich planet to prevent the establishment of trade, and thus maintain her power. The story draws attention to, and problematizes, Adrasta's rule as a woman. In a sequence designed to amuse for its depiction of the absurdity of the social understandings fostered under Adrasta's rule, Adrasta's second in command (also a woman) assumes the Doctor is subordinate to his female companion Romana. Adrasta recognizes the mistake, seemingly reflecting her awareness (unbeknownst to her subordinates) of the artificiality of the social assumption that a woman should automatically be presumed to be leader. Adrasta is ultimately killed by the alien ambassador, whose blob shape is differentiated only by a phallic protuberance. Peace, free trade, and democracy are introduced with the end of matriarchal rule (Fiske 1984), under the leadership of Adrasta's former guard, the male, hairy Huntsman.

This story thus presents the ideological message that technological progress is held back by a female-dominant regime. It reinforces this message via Adrasta's male engineers, employed to investigate the object that turns out to be the ambassador's ship. Their hypotheses are ridiculous, unfounded on any evidence, and reveal a closed-minded and ignorant attitude towards empirical investigation. In explaining why he knows the engineers are wrong, the Doctor facetiously quips that he had "a couple of gadgets that [they] didn't, like a teaspoon and an open mind." Notably, when Adrasta executes one of them, the Doctor defends him as "a conscientious idiot," implying that his ignorance is not entirely his fault, but rather the fault of the regime he serves. In short, *The Creature from the Pit* associates lack of scientific credibility not with women per se, but with the artificiality of a domineering form of matriarchal rule.

The Happiness Patrol (1988), a parody on Prime Minister Thatcher's Britain, further plays on these themes. It is set within a regime led by the sadistic Helen A, where men complain that "women always get the better jobs" and "the best guns" and hyper-feminized women hold most positions of power, including running the Happiness Patrol, which attempts to force the appearance of happiness on all citizens. Gilbert M is a fair-haired, balding, paunchy and camp scientist who serves the regime. For most of the story, he is shown doing very little science at all, appearing mainly as the victimized domestic partner of the vicious candy robot KandyMan. It is only towards the end, as Helen A's regime crumbles and Gilbert M conspires to escape with Helen A's husband, leaving their ruler behind, that he is revealed to have once been a

titled scientist and the creator of the KandyMan. It is thus in the moment of his betrayal of this hyper-feminized regime that he is shown to be an effective scientist after all.

Effeminate Regimes of Artificial Construction

A further set of stories illustrates a third dynamic of scientific incompetence: service to an artificially constructed order marked by effeminacy and passivity. The first example is *The Ice Warriors* (1967), which depicts a near-future Earth in a devastating ice-age. A major challenge with which scientists in the story grapple is holding a particular glacier at bay, and disagreements within the team almost lead to them losing this battle. On the one hand is the highly intelligent, individualistic, rugged, bearded and dark-haired male scientist Penley who refuses to be a slave to computers or bound by bureaucracy. He initially abandons the scientists' base and lives out in the cold using only his wits, but ultimately returns to save the base. His individualistic attitude is endorsed in the story not only by his final success, but also because other characters explicitly compare him to the Doctor, who also prefers to use his intelligent and creative mind rather than rely upon computers.

Opposing Penley are the male base leader Clent and the female computer specialist, Miss Garrett. Clent and Garrett, unlike Penley, defer to the advice of the base's computer, defend it as the greatest source of wisdom available, and act only with its approval. They thus demonstrate their intellectual weakness and lack of scientific credibility through their state of dependence: the antithesis of a Kantian model of enlightenment. The point is made repeatedly, via dialogue from the Doctor and others, that asking the computer's advice is "a waste of time." In the story's climax, the Doctor and Penley realize that a particular risky action must be taken to stem the glacier's advance, but Clent refuses because "The computer says no," and as Garrett affirms, "We must obey." Penley counters: "This is a decision for a man to take, not a machine. The computer isn't designed to take risks, but that is the essence of man's progress. We must decide." He does act, once the others have failed to do so.

The gendered aspect of this conflict is most clear when contrasting Penley's swarthy masculinity to Clent's more effeminate demeanor. Because the base leader is male, this is clearly not a simple case of credible male scientist versus non-credible female scientist; rather, it is a matter more of gendered discourses than gender identity, pointing to a series of characteristics that consistently mark Clent as less masculine than Penley. In comparison to Penley's rugged features and dark beard, Clent is soft-featured, fair-haired, has paunchy cheeks, and sports an unexplained limp and walking stick, the latter hinting at the long association in fiction of physical disability with femininity, dependence, and a lack of masculine individualism (Thomson 1997). Notably, many of these features are

exaggerated in the recently produced animation of *The Ice Warriors*' missing episodes, suggesting a subconscious awareness of the features' importance among the animation team. Clent is dependent upon the computer and Garrett's advice, and like Garrett he is field naïve. Whereas Garrett herself is rather androgynous in appearance, what they have in common is their service to an artificial regime designed to prioritize the collective good over individual achievement. The dependence and passivity of the regime they serve is reinforced by its leader Clent's effeminacy. The principle at play here is an idea of scientific credibility that goes beyond technical competence, entailing a creative, courageous intellect that acts with independent reason, discursively tied to masculinized traits and appearance.

A second example of this theme is 1968's *The Dominators*, which also depicts a clash of two cultures. On one side is the dogmatically pacifist Dulcians, whose planet Dulkis was partly irradiated by a nuclear war in the Dulcians' past. On the other side is a pair of radiation harvesters, the Dominators, who arrive on Dulkis to suck up the ambient radiation and to set off a nuclear device inside the planet to create more. The costumes of the two cultures establish a marked gendered contrast, mirrored by contrasting scientific capacity. The two Dominators are hyper-masculine, clad in black leather, including exaggeratedly large shoulders. Their faces are rugged, with strong square jawlines, and their hair dark. Both have prominent, heavyset eyebrows with pronounced ridges. They are also highly scientifically competent and almost succeed in their plan, outwitted only by the Doctor and his companions.

The Dulcians, though mixed in gender composition and led by men, all wear white pleated dresses—the men's low cut to their cleavage. Their features are soft, and many are clean-shaven and have blond or fair hair. They have some effective technologies, primarily weapons from their former society now housed in a museum. But the culture is explicitly depicted as scientifically idiotic through their team of three scientists: Educator Balan and his students Teel and Kando. As the story begins, the three inspect an irradiated site for an ongoing study of radioactivity. They discover the radiation has disappeared, unaware that the Dominators have harvested it. Balan's reaction to the missing radiation establishes the Dulcians' lack of scientific credibility:

Teel: It doesn't seem logical somehow, sir. We all know that there's been a steady uniform decrease in radiation during the past 172 years. Now suddenly it's all disappeared.

Balan: Well it has happened. Therefore it is a fact. We now know that the effects of an atomic explosion last for 172 years.

Teel: But why sir?

Balan: Oh, I daresay our atomic experts could provide a reason. But it seems pointless to spend time searching for reasons to prove facts. A fact is a truth!

This uninquiring attitude is foregrounded in the story, with the morally harmless Dulcians almost destroyed by the Dominators through their inability to question and resist authority, manifested in their dangerously passive pacifism. Science, then, is symbolically linked to societal progress and survival, and again, the story draws a discursive link between scientific credibility and masculinist social and personal traits.

Finally, *The Leisure Hive* (1980) features a male scientist character, Hardin, who fakes experiments for his female patron and lover Meena, who needs new technology to stay alive and preserve her species. Following the effects of war, Meena's society is infertile, incapable of reproducing itself and passively dependent on the goodwill of outsiders. Like Dulkis, it is also self-consciously pacifist, a position challenged in the story by the threat of opportunistic villains. Romana works with Hardin to improve his experiments, and they partially succeed, but new flaws in the work endanger Meena and the Doctor. The Doctor's technical interventions eventually set everything right, but Hardin's reputation as a scientist is never redeemed. His willing subordination to this weak regime, and his prioritization of love for a senior woman over scientific professionalism, seem to compromise his scientific prowess and signal his incapacity to do credible science.

Gendered Traits in Scientific Credibility

A number of common themes emerge in these stories which point to enduring cultural discourses that establish scientific credibility as a masculinist phenomenon, despite an overt commitment to gender equality in Doctor Who's depiction of scientists. The most consistent pattern is the depiction of most male scientists as effeminate in presentation and/or effete in manner, with Hardin as an ambiguous case and Adrasta's engineers as the only exception (they are neither particularly masculine nor effeminate). The male scientists' lack of some essentially masculine potency seems linked to their ineffectiveness as scientists. The ineffective scientist women, on the other hand, vary markedly in appearance and manner. They include women who are typically feminine, androgynous, butch or hyper-feminized, suggesting that manner and physical appearance in women do not mark scientific ineffectiveness in any particular way, as they do for men. From this analysis we conclude that gender non-conformity on its own is not necessarily associated with scientific ineffectiveness. The contrasting example of the elderly archaeologist Professor Emilia Rumford from *The Stones of Blood* (1978) further emphasizes this point. Rumford does not conform to expectations of feminine appearance, depicted in butch

clothing, with short hair, no makeup, and co-habiting with a woman who is an implied lesbian (Nyder n.d.). Yet she builds and uses an alien technological gadget and spends substantial dialogue discussing technicalities of her own work, recounting key scientific debates in her area and academically disputing the work of her fellow (male) scientists. Regardless of her gender non-conforming appearance, Rumford is depicted as fully functioning within the scientific establishment and accepting masculinist scientific traits such as individualism, competitiveness, and the pursuit of progress (Meyers 2004).

Thus, rather than individual gender role violation, scientific ineffectiveness among the women and many of the men appears instead as a consequence of service to an artificially conditioned social order: either one which is cruel and despotic, subordinates men as inferior, and invariably led by a domineering woman, or one which is passive, dependent or collectivist, and led in two cases by an effeminate weak man and in another case by an infertile, rapidly-aging woman. In the second set, the leaders' fatal flaw serves as a metonym for the passivity and dependence of their society, which in turn is linked to scientific ineffectiveness. In the first set, the contrivance of female rule coupled with the subordination of men marks the social order as scientifically incompetent or marginal.

The weakness of a scientist's credibility and capacity to perform effective science in *Doctor Who* can then be traced to one or more of three possible sources: (a) a notable lack in male scientists of cultural qualities marked as masculine, such as virility or brawn, and/or their adoption of physical or behavioral attributes culturally coded as camp or feminine; (b) loyalty and service to a matriarchal regime headed by a cruel woman, which artificially suppresses or sidelines men; and/or (c) loyalty and service to a regime headed by a woman or a feminine man marked for its passivity, dependence, and/or pacifism. The common thread uniting these three different narratives of scientific failure is the rejection or lack of masculinity and its associated socially-gendered traits of independence, confidence, and forthrightness.

The consistent appearance of culturally gendered traits as markers of scientific ineffectiveness is striking in a show that has, as the quantitative study shows, conscientiously developed positive depictions of women as scientists. It is the more subtle, pervasive cultural discourses of masculinity versus femininity, rather than the state of being male or female, that mark scientists as effective or otherwise. The durability of these markers through five decades of *Doctor Who* speaks to their potency as largely unconscious cultural norms that shape writers' and viewers' expectations of effective science. They suggest the need for researchers to look beyond simple demographic indicators into the domain of how gendered codes are mobilized in cultural discourses of science in order to fully apprehend how

gender and scientific credibility are intimately linked in Western contexts.

Many of the traits *Doctor Who* associates with credible science (e.g., virility, ruggedness, assertiveness/aggression and independence) are traits that have been widely identified in critical literature as being associated with masculinist Western notions of reason, rationality, and science. However, we have also identified a few less commonly discussed: the association of contrivance with culturally feminized attributes such as pacifism and collectivism; the tendency to mark masculinity by opposing brown haired male characters to their more effeminate blond, fair or balding counterparts; and the presence of disability as a possible marker of failed masculinity.

Discussion

Our study shows that, over time, the contributors to *Doctor Who* have consistently expressed a positive view of women's scientific credibility. On the whole, female scientists are depicted as equally credible contributors to scientific labor as their male counterparts. In contrast with the conclusions of some previous qualitative studies of female scientist characters, our results support the contention that contributors to *Doctor Who* have, overall, shared a liberal, pro-feminist attitude towards women in science, suggesting that women are largely as scientifically capable as men. Our quantitative gender comparison enabled a statistical test of previous studies' conclusions, and it is encouraging that the results revealed less gender bias than expected. Although our results were consistent with previous studies in the low percentage of scientist characters who are female, the fact that this increased between the 1960s and 2000s from 15 to 42 % demonstrates an ongoing and increasing awareness of the need to promote gender equality in casting scientist characters.

The qualitative analyses of serials featuring very incompetent scientist characters revealed a counterpoint to this conclusion. Although *Doctor Who* encourages individual women to succeed in scientific careers just like men, anyone entering science is expected to commit to a masculinist cultural paradigm. The creators of the *Doctor Who* stories that explore the sociopolitical significance of scientific incompetence seemed to share a belief that credible scientific work is built upon masculinist elements within Western culture. These include the prominent presence, and creative freedom, of normatively masculine men; a push towards a rugged, competitive, individualistic, intellectually independent persona for scientists; and resistance to social relationships and political regimes dominated by cruel women who reject men or by feminized values such as pacifism and collectivism. The program depicts all these traits as essential for credible science.

Conversely, if a culture sees men as lesser than women, if individual male scientists allow their masculinity to be compromised, or if scientists willingly subordinate themselves to a feminized regime, then scientific work is doomed to pathetic failure or questionable status. This is a powerful thread of gendered discourse that appears in *Doctor Who*, and one that is likely to affect not only women in science, but also gender minorities and men whose appearance or behavior does not conform to stereotypically masculine expectations. It seems to be consistent wherever scientifically incompetent characters appear, and it does not contradict the quantitative finding that *Doctor Who* is generally supportive of individual women in science. We must therefore amend our assessment of the hegemonic ideology present in the show: it recognizes the need to redress social inequality, but retains and reproduces many aspects of the masculinist culture that arguably underpin that inequality. Women and men are encouraged to participate in science and compete for success, but only if they play by, accept, and commit to, masculinist rules.

Limitations and Future Research Directions

Three limitations of our study are apparent. One is its focus on a single television program, *Doctor Who*. However, this long-playing program is diverse in its contributing cast and crew and the texts that influenced its content so that our study does sample a range of perspectives. Nonetheless, future scholars might test the robustness of our conclusions using texts from other genres and mediums. Second, some of the within-decades quantitative comparisons of credibility traits are based on small sample sizes. Although our statistical tests used legitimate methods, our small samples within time period nonetheless bring into question the strength of some conclusions. Finally, only one character examined in the qualitative analysis appeared in the new series; most were drawn from the period 1965–1980 when *Doctor Who* was most rich in earnestly scientific themes (Orthia 2010). This raises the question of the extent to which more recent texts incorporate discourses that police the masculinist commitments of science. This is something future scholars would do well to address.

Our study also suggests that research into gender and science needs to move beyond examination of a female–male dichotomy. Methodologically, there is a problem with making assumptions about fictional characters' gender, as discussed. A fruitful avenue of future research may investigate LGBTIQ viewer perceptions of characters' gender, and the extent to which their interpretations differ from a binary assumption. Beyond that, the qualitative analysis of our study identified the presence of gender non-conforming scientists: camp male scientists, uncompromisingly feminist scientists, a male scientist who privileges his sexual relationship with a powerful senior woman above his career (a trait more typical of female scientist characters, Flicker 2003), as well as

apparently gay, lesbian or bisexual scientist characters. The initial findings of our study suggest that, despite these methodological limitations, some level of gender-variant appearance and behavior in characters who appear male is unfortunately used as a marker of scientific incompetence. However, the presence of such diverse manifestations of gender in scientific roles warrants further study, including the capacity of more positive characters to role-model scientific careers for gender non-conforming and LGBTIQ viewers.

Practice Implications

The results suggest that professionals committed to encouraging more gender-inclusive practices in science work should look to subtle discourses about the masculine culture of science as well as other impediments to women's participation. Cultural factors play a critical role in girls' decisions about pursuing careers in science (Long et al. 2010; Miller et al. 2006), and here we have shown that overt opposition to sexism can still be accompanied by more covert associations between scientific culture and masculine values.

Conclusions

Our study has shown that, at least in the culture that created *Doctor Who*, the hegemonic ideology regarding women's participation in scientific work has shifted since the 1960s. When *Doctor Who* began, it marginalized women as a group (through low numbers) while allowing exceptional individuals to shine (through equal credibility in characterization). That appears to have shifted to an ideology that accepts the aspirational ideal of workplace equality for women in science and the growing reality of women's participation in scientific activity, but with a continuing underlying expectation that everyone will conform to the existing endorsed masculine culture of science.

This conclusion resonates with real-world experience of gender discrimination in science in the West. Even if workplace discrimination on the basis of gender is officially condemned, unconscious cultural biases continue to disadvantage women, and presumably less masculine men, in the sciences (Moss-Racusin et al. 2012; Sheltzer and Smith 2014; and see Merrick 2012 for a discussion of the better position of women in science in Asia, Latin America and Eastern Europe). One such bias is underlying masculinist commitments (Bevan and Learmonth 2012). Indeed, Thornton (2013) argues that academic areas in which the number of women has recently increased are seen by male academics as becoming feminized, leading to defensive moves to maintain a masculinist culture in the form of men's flight from them or a hardened hierarchy that keeps women at the bottom.

We used a mixed methods approach in the present study to show how this complex state of affairs is reflected in and

reinforced by popular fiction. Ours is the first known study of gender and scientists in popular fiction to do so. It has demonstrated that in future studies of scientist characters, scholars should be cautious of assuming all is well if demographic patterns appear to be free from gender bias—but cultural expectations are not.

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