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Masculine Defaults in Academic Science, Technology, Engineering, and Mathematics (STEM) Fields

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Ceci et al. (2023) provide a synthesis of research on the biases (or lack thereof) that women experience in tenure-track science, technology, engineering, and mathematics (STEM) academic fields. We expand on their analysis and suggest that in addition to differential treatment (e.g., women receiving lower teaching evaluation ratings than men), gender bias can take another form in *masculine defaults*. We argue that to achieve gender equity, we must identify and eliminate or balance many of the masculine defaults that pervade the culture of academic STEM fields. Below, we first define masculine defaults and distinguish them from differential treatment, discuss the need to examine masculine defaults, and consider how they are perpetuated within academic STEM fields. Next, we provide examples of masculine defaults prevalent in academic STEM fields across four levels of culture and how they may disadvantage women. Finally, we discuss recommendations for addressing masculine defaults in academic STEM fields.

Defining Masculine Defaults

Masculine defaults exist when stereotypically masculine characteristics, traits, or behaviors are rewarded and valued or viewed as the standard (Cheryan & Markus, 2020). Men are stereotypically considered more self-oriented, independent, and brilliant compared with women, who are stereotypically considered more other-oriented, interdependent, and warm (Eagly et al., 2000; Markus & Conner, 2014).[1] Consider an example of masculine defaults and their potential consequences: When the people in academic STEM fields have a masculine default of valuing brilliance, and view men as more likely to be brilliant than women (Bian et al., 2017), their biases may lead to more career growth opportunities and status for men compared with women.

Masculine defaults may be more insidious and difficult to detect compared with differential treatment because they are often more subtle and less questioned. For example, one form of differential treatment is when people nominate more men than women for awards or promotions. To remedy this differential treatment, some organizations encourage self-nominations for awards or promotions (Kang, 2014). However, from a masculine-defaults perspective, self-nominations can still disadvantage women, as promoting oneself is a stereotypically masculine behavior (Rudman, 1998).

Why Examine Masculine Defaults?

Many academic STEM fields still lack equal participation by women (National Science Foundation, 2021). First, there are areas within STEM where issues of differential treatment remain and women are disadvantaged relative to men (e.g., salary, teaching evaluations; Ceci et al., 2023). These inequalities still need to be addressed. Second, and relevant to the present Commentary, differential treatment is not the only form of bias that women in academic STEM fields face. Other forms of bias, including the existence and perpetuation of masculine defaults in academic STEM fields, can also disadvantage women.

There are three primary reasons why masculine defaults disadvantage women. First, many girls and women are typically not socialized to the same extent as boys and men to embody or express some stereotypically masculine characteristics (e.g., Crowley et al., 2001). As a result, when entering contexts with

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masculine defaults, women may experience lower belonging and interest and may believe that they will be less successful in those contexts (Bian, Leslie, Murphy, & Cimpian, 2018; Cheryan et al., 2009). Second, even when women's behaviors and characteristics align with masculine defaults, those behaviors may be overlooked. For example, when women and men entrepreneurs give identical funding pitches, investors are more likely to fund men than women (e.g., Brooks et al., 2014). Third, women may experience or perceive backlash for acting outside of their expected gender roles when they display characteristics that align with masculine defaults (Cheryan et al., 2020; M. J. Williams & Tiedens, 2016). For example, women who engage in more assertive negotiations for themselves—a stereotypically masculine behavior—are viewed more negatively than women who engage in assertive negotiations on behalf of others (Amanatullah & Morris, 2010). Although we highlight women's experiences, masculine defaults may also disadvantage other individuals who do not fit the stereotypical male gender role (e.g., nonbinary people; lesbian, gay, bisexual, transgender, queer, and plus individuals; some men). Moreover, like women, men may also experience lower work engagement and organizational identification in workplaces with high levels of masculine defaults (Berdahl et al., 2018; Koc et al., 2021).

If, as we suggest, masculine defaults that disadvantage women are present in academic STEM fields, why would Ceci et al. (2023) find no or minimal evidence of discrimination against women in several domains within academic STEM fields (e.g., faculty hiring, funding decisions)? First, even domains with no ostensible gender discrimination may still have gender disparities in outcomes as a result of masculine defaults. For example, women may not have a lower likelihood than men of being given a tenure-track offer once they are in the hiring pool, but masculine defaults, such as job ads that favor stereotypically masculine characteristics (e.g., competitiveness), may prevent women from entering these pools in the first place (Gaucher et al., 2011). Indeed, Ceci et al. (2023) offer evidence that women PhDs are less likely than men PhDs to apply for tenure-track positions, resulting in a lower proportion of women entering these positions. Second, many of the studies that Ceci et al. (2023) reviewed may have null effects because they controlled for effects of masculine defaults. For example, Ceci et al. (2023) found no gender bias or bias favoring women in grant funding. However, some studies controlled for productivity, operationalized as number of publications. Fewer women than men may amass a large number of publications because this process draws on characteristics associated with the male gender role (e.g., confidence, promoting one's own work). As a result, controlling for productivity may mask discrimination that results from criteria biased with masculine defaults. Third, effects of masculine defaults may build up over time. Encountering a series of masculine defaults across different domains may, over time, cause women to feel a lower sense of belonging and interest in academic STEM fields. Fourth, masculine defaults may also impact outcomes not addressed by Ceci et al. (2023), such as sense of belonging, retention, and entry. Masculine defaults may therefore cause gender disparities in academic STEM fields even when gender discrimination is not detected.

Masculine Defaults in Academic STEM Fields on Four Levels of Culture

We organize our review of masculine defaults in academic STEM fields in accordance with the four levels of culture present in the culture cycle—ideas, institutions, interactions, and individuals (Hamedani & Markus, 2019). These levels are mutually constitutive, such that each level shapes and is shaped by the other levels in a culture, an organization, or in this case, a set of academic fields (Cheryan & Markus, 2020; Hamedani & Markus, 2019; Markus & Conner, 2014; Markus & Kitayama, 2010).

The first cultural level describes the importance of ideas in establishing the foundation of the fields. The purpose of the academic fields, what the fields value, and what an effective member of the academic community looks like or does are all aspects shaped by the core ideas of these fields. These ideas may manifest in mission statements that underlie the fields' goals, narratives, and images (Cheryan & Markus, 2020). The second cultural level is institutions, or formal institutional policies that capture regulations of the academic fields (Hamedani & Markus, 2019), such as adding another year to faculty tenure clocks for the birth or adoption of a child (Antecol et al., 2018). The third level describes the interactions between individuals within academic fields and with the fields' norms, artifacts, and practices (Cheryan & Markus, 2020), such as rewarding self-promotion and individual accomplishment (Diekman et al., 2010). The interactions level reveals the location where most members interact with academic fields on a daily basis, and what happens at this level determines whether policies are followed or ignored (Cheryan & Markus, 2020; Hamedani & Markus, 2019). The final level of the culture cycle focuses on individual beliefs and behaviors, such as the belief that "brilliance" is needed to be successful in a person's field (Leslie et al., 2015). The potential for an academic field's ideas, policies, and interaction patterns to be resisted or implemented depends on individuals, whose

Table 1. Examples of Masculine Defaults in Academic STEM Fields on Multiple Levels of Culture

Cultural level	Examples
Ideas	Brilliance, defined by characteristics commonly associated with the male gender role and perceived as necessary for success (Leslie et al., 2015; Vial et al., 2022)
	Meritocracy beliefs (Castilla & Benard, 2010; Cech et al., 2016)
Institutions	Overlap of tenure-clock years with common childbearing and child-rearing years (Antecol et al., 2018)
	Valuing self-oriented over other-oriented work (O'Meara et al., 2018)
Interactions	Valuing independent over interdependent behaviors (Diekman et al., 2011; Markus & Conner, 2014)
	Rewarding self-promotion (Lerchenmueller et al., 2019)
Individuals	Individual beliefs that correspond to masculine defaults from the ideas level (e.g., that intelligence is fixed; Canning et al., 2022)

Note: STEM = science, technology, engineering, and mathematics.

beliefs and behaviors are essential to shaping the culture of the field (Cheryan & Markus, 2020).

Examples of Masculine Defaults in Academic STEM Fields

Masculine defaults and their negative consequences for women have been documented in many settings, such as male-dominated corporations (e.g., fostering a culture of intrusive interruptions; K. J. Anderson & Leaper, 1998) and schools (e.g., curricula that use masculine topics to teach science and engineering; Kerger et al., 2011). In this section, we provide examples of masculine defaults in academic STEM fields and how these masculine defaults can result in women's lower representation and success in these spaces. We consider two examples of masculine defaults on each of the four levels of culture: ideas, institutions, interactions, and individuals (see Table 1; Hamedani & Markus, 2019).

Ideas

Masculine defaults exist in many ideas endemic to academic STEM fields, including ideas about brilliance and merit. Academic STEM fields—especially those with the lowest representation of women faculty and faculty of color—tend to value brilliance. Academics in math, computer science, engineering, and physics are more likely than academics in education, psychology, and anthropology to believe that an innate brilliance is required to be successful in their discipline. The more brilliance is valued, the lower the representation of women and people of color in that discipline (Leslie et al., 2015). Environments that purport to value brilliance decrease women's sense of belonging compared with environments that purport to value hard work (Bian, Leslie, Murphy, & Cimpian, 2018; Vial et al., 2022). Moreover, people are less likely to recommend women for jobs that are perceived as requiring brilliance than for jobs not perceived as requiring brilliance (Bian, Leslie, & Cimpian, 2018). Why might academic environments that value brilliance cause these negative outcomes for women? The way brilliance is conceptualized—for example, independence, confidence, and competitiveness—is typically more associated with the male than female gender role. Brilliance is more strongly associated with White boys and men than White girls and women (Bian et al., 2017; Del Pinal et al., 2017; but not more associated with Black men than Black women; Jaxon et al., 2019). The value placed on brilliance in many academic STEM fields is a masculine default that may help explain the overrepresentation of White men in these fields.

Another masculine default on the ideas level in academic STEM fields is the widespread endorsement of the meritocratic schema, or a belief that inequality is primarily due to individual differences in abilities, experiences, and effort (Cech et al., 2016). A survey of 266 science and engineering faculty revealed that half of them use meritocratic schemas (in contrast to structural schemas, which primarily attribute differences in social outcomes to interactional and institutional processes; Cech et al., 2016). Faculty using meritocratic schemas are less likely than those using structural schemas to recognize department and professional cultures that may be difficult for women faculty, faculty of color, and lesbian, gay, and bisexual faculty (Cech et al., 2016). Beliefs in meritocracy predict greater bias against women (Castilla & Benard, 2010). Merit in academic STEM fields is typically indexed by qualities that are more associated with the male than female gender role, such as high intelligence, risk-taking, and promoting oneself. Prominent conceptualizations of merit may contribute to a culture that disadvantages women in academic STEM fields.

Institutions

Examples of masculine defaults on the institutional level include the overlap between the tenure years and common childbirth and child-rearing years, as well as the devaluing of other-oriented work (e.g., service, emotional labor) in hiring and promotion. In academic STEM departments (and other areas of academia), the common overlap between the tenure-track and child-rearing years is a masculine default. Behaviors that are more typical of men during these years, such as publishing more papers and having the freedom to pursue more professional opportunities, are rewarded with a greater likelihood of tenure. Motherhood explains most of the gap in productivity between women and men in publishing papers (see also Fox et al., 2011; Morgan et al., 2021). Before women have children, their rates of publishing are similar to men's. However, the number of papers published per year decreases for mothers immediately after childbirth, a decrease that is not observed for men or nonmothers (Morgan et al., 2021). Raising a family also contributes to professional life interruptions, such as curtailing travel and being overlooked for opportunities (Moors et al., 2022). These professional life interruptions predict lower career satisfaction and intention to stay in one's job among women but not men faculty (Moors et al., 2022).

Another masculine default on the institutional level in academic STEM fields is the devaluation of other-oriented work and the valuation of self-oriented work. Women tend to spend more time than men on other-oriented work, and men tend to spend more time than women on self-oriented work (O'Meara et al., 2018). Women faculty, especially women of color, are more likely than men faculty to contribute to the teaching, mentoring, and service aspects of their departments, whereas men spend more time on research (Bird et al., 2004; Link et al., 2008; Misra et al., 2012; Winslow, 2010). Valuing self-oriented over other-oriented work is more consistent with the male than female gender role (Eagly et al., 2000). Because teaching, mentoring, and service are devalued in academic STEM fields relative to research (Clark & Corcoran, 1986; Park, 1996), these inequities contribute to women's lower career advancement and greater dissatisfaction (Fox & Colatrella, 2006; Xu & Martin, 2011). Teaching, mentoring, and service also involve more emotional labor, or the need to control one's emotions and provoke emotions in others (Bellas, 1999). Women are often disadvantaged by the undervaluing of other-oriented work in academic STEM fields.

Interactions

Two examples of masculine defaults on the interactions level in academic STEM departments are norms and practices that favor independence and self-promotion. Academic STEM fields—like university cultures more broadly (Stephens et al., 2012)—value and reward independence. Women are more likely than men to endorse communal and interdependent goals (Diekman et al., 2010; Markus & Conner, 2014) and are often more collaborative in their approach to science (e.g., Murphy et al., 2020). However, academic STEM faculty are rewarded and evaluated for individual achievement in the form of publications, funding, and awards (Feist, 2016). Work in STEM is often collaborative, involving large teams and working with trainees, but these fields—especially the fields with the lowest representation of women—are not perceived as collaborative and are seen as more likely to fulfill goals related to independence (Diekman et al., 2011). Engineering and physical-sciences courses provide fewer opportunities to engage in collaboration on assignments than life-sciences courses (M. P. Joshi et al., 2022). Bulletin boards in engineering and physical-sciences academic buildings signal a lower sense of communal purpose than bulletin boards in life-sciences academic buildings (M. P. Joshi et al., 2022). Women feel more positivity toward STEM environments that are collaborative and involve helping other people than those that involve working independently (Diekman et al., 2011). Masculine defaults prioritizing independence contribute to women's lower representation in academic STEM fields.

Another example of a masculine default in academic STEM fields is the tendency to reward self-promotion. Academic articles in life-sciences and clinical research with a man first or last author are more likely than those with a woman first or last author to present their research in a positive light, using terms such as "novel," "unique," or "promising" to describe their work (Lerchenmueller et al., 2019). This self-promotion in articles is rewarded with an increased number of future citations (Lerchenmueller et al., 2019). Women are less likely than men to use broad language (P. D. Joshi et al., 2020), instead prioritizing concrete language in their grant proposals (Kolev et al., 2020). Reviewers are more likely to fund proposals that use broad language than those that use concrete language, even though broad language in proposals does not predict subsequent scientific output (Kolev et al., 2020). Valuing and rewarding self-promotion is another barrier that may constrain women's success in academic STEM fields.

Individuals

Masculine defaults on the ideas level get expressed in individual beliefs and behaviors. For example, an individual's belief that one needs to be brilliant to succeed in STEM constitutes a masculine default on the individual level (Cheryan & Markus, 2020). The more that teachers believe that success in math requires an innate ability, the lower the intrinsic motivation of their low-achieving students (Heyder et al., 2020). Another example of an individual-level masculine default is the belief that intelligence is fixed instead of malleable (Dweck, 1999). The more that STEM faculty believe that intelligence is fixed, the less belonging women students feel in their courses (Canning et al., 2022; see also Emerson & Murphy, 2015). Beliefs about brilliance and STEM intelligence are indexed by characteristics that are more strongly associated with the male gender role, such as risk-taking, promoting oneself, and asserting one's ideas. Individual beliefs and behaviors are another location of masculine defaults in academic STEM fields.

Questions for Future Research

Applying the theory of masculine defaults to academic STEM fields raises many interesting questions for future research. One important question is to investigate whether and where feminine defaults exist in academic STEM departments and their potential consequences. For example, science is a collaborative enterprise, and collaboration in academic science is, at times, rewarded and valued (e.g., teams produce more highly cited work than solo authors; Wuchty et al., 2007). In another example, conscientiousness, a trait that is more commonly observed in women than men (Mac Giolla & Kajonius, 2019; but see Weisberg et al., 2011), may predict more replicable findings (e.g., fewer errors and retractions). One consequence of making feminine defaults widely known is that the stereotypically masculine image of academic STEM fields may change and more women may enter and persist in STEM careers. However, an alternate possibility is that men will continue to have better outcomes even when feminine defaults are present. For example, men tend to get promoted more quickly and paid more in fields that may have feminine defaults as an outcome of being female-dominated (e.g., nursing; C. L. Williams, 1992). Researchers could also investigate whether these and other feminine defaults may have positive consequences for academic STEM fields beyond increasing equity, such as improving quality of work or increasing retention of students of all genders.

More work is also needed to uncover other masculine defaults in academic STEM departments. For example, on the ideas level, researchers could examine whether women and men tend to ask different research questions or use different methods and whether the type of work that women tend to do is less valued and rewarded (e.g., lower likelihood of funding or getting into top journals; see Hoppe et al., 2019, for a similar example with race). On the institutions level, how much a person's salary is shaped by a self-promotional process of seeking out other job offers could be investigated. On the interactions level, faculty meetings could be assessed for the extent to which interruption is common and rewarded with more speaking time, and the manuscript submission process could be investigated for how much asserting oneself in that process (e.g., appealing rejections) is rewarded. On the individual level, researchers could investigate faculty beliefs that overconfidence or risk-taking is a sign of competence in academic STEM fields (C. Anderson et al., 2012; Morgenroth et al., 2018).

Implications and Recommendations

In this final section, we offer some ideas for how to address masculine defaults and build more diverse and inclusive academic STEM disciplines.

Identifying masculine defaults

We encourage academics to raise awareness about the existence of masculine defaults generally and to spend time reflecting on default cultural features that might, either intentionally or inadvertently, advantage men over women. For example, is there a culture of interruption in lab gatherings or departmental meetings? Do job ads or other professional communications primarily signal values of independence in what it takes to be successful? How are ideas about brilliance and meritocracy reflected in discipline cultures? Are professional requirements structured such that working long hours and late nights are the default practice? Intentional efforts should be made to identify masculine defaults in ideas, institutional policies, interactions, and individuals.

Addressing masculine defaults

Once masculine defaults have been identified, the next step is to address them in a way that leads to more inclusive environments. This can be accomplished in one of two ways. In one approach, if the masculine default is not necessary, the biased cultural practice can be eliminated. For example, at Harvey Mudd College, the male-dominated computer-science department identified the favoring of students with previous programming experience as a masculine default because men are more likely than women to take programming courses prior to college (Nord et al., 2011). To address this masculine default, the department offered an introductory course for students without prior programming experience and initiated other cultural adjustments (e.g., trained instructors on how to minimize intimidating student interactions) to ensure that students who had prior experience were not valued more highly within the major. These adjustments gave students with and without previous programming experience the opportunity to be equally successful. As a result, the percentage of computer-science degrees awarded to women in Harvey Mudd's program increased from 10% to 55% in less than a decade (Staley, 2016; Taylor, 2013), revealing their strategy to be successful.

In another approach, rather than eliminating masculine defaults, cultural balancing can be achieved by adding feminine defaults. For example, in the University of Michigan's College of Engineering, applicants for top leadership positions were originally evaluated only by traditional markers of academic success, such as journal publications, conference invitations, and awards from academic societies, resulting in majority-men leadership. After identifying these masculine defaults, the college adjusted their criteria by evaluating candidates' visions for the future in terms of diversity, equity, and inclusion in addition to more traditional assessments. As the Dean of Engineering put it, "Being an accomplished engineer is still a requirement, but it is no longer sufficient. Our leaders also need to be able to see and articulate biases in the organization and propose ways to counter them" (Gallimore, 2019, para. 3). After the College of Engineering expanded the scope of valued traits in their leadership search process, half of its top leadership positions were filled by women (Gallimore, 2019).

A combination of these approaches may be appropriate at times. For example, a university might attempt to eliminate the masculine default of relying on wording that signals values of innate brilliance and independence by eliminating phrases such as "superstar" from hiring (Gaucher et al., 2011). At the same time, the university could signal the value of traits that are traditionally more strongly associated with women, such as collaboration. Eliminating and balancing can be used in combination to address masculine defaults.

Ongoing evaluation

Conducting ongoing empirical evaluation of initiatives is crucial to building more diverse and inclusive academic STEM fields. These evaluations should include identifying masculine defaults and demonstrating progress in addressing them. Caution needs to be exercised to ensure that attempts to address masculine defaults are effective and do not exacerbate disparities. For example, to alleviate the burden on mothers with young children during the tenure-track years, universities have established gender-neutral tenure-clock-stopping policies, in which faculty of all genders are given the opportunity to stop their tenure clock for 1 year following the birth or adoption of a child (Antecol et al., 2018). Some work found that women's tenure rates decreased and men's tenure rates increased when tenure-clock-stopping policies were implemented (Antecol et al., 2018; but see Morgan et al., 2021, who found no evidence that such policies are disadvantaging women). Men may have been using the extra time to be more productive rather than taking on an equal portion of child-rearing. Although the gender-neutral tenure-clock-stopping policy was adopted to give women the same opportunity to gain tenure as men, the policy may have further rewarded men and placed women at an even greater disadvantage. Evaluation should also include the consideration of identity intersections and the continual monitoring of areas in which progress has already been made in order to prevent regression.

Technical tools can help identify some masculine defaults. For example, software tools such as *Textio* analyze gendered language in job ads, which departments could use to examine the pool of applicants they receive before and after making adjustments to masculine defaults. Apps such as *Woman Interrupted* measure the frequency of interruptions, which departments could use to evaluate outcomes before, during, and after cultural shifts. Traditional tools such as surveys could be used to capture experiences and outcomes, as well as allow nomination of remaining masculine defaults. Tools can assist both with evaluation efforts and with identification of masculine defaults.

Conclusion

In this Commentary, we argue that masculine defaults must be identified and addressed in academic STEM fields in order to achieve gender equity. Masculine defaults may be a less noticeable form of gender bias than differential treatment, but they still often disadvantage women. Examples of masculine defaults in academic STEM fields can be found at the four levels of culture: ideas, institutions, interactions, and individuals. Recognizing and addressing masculine defaults are important steps to achieve gender equity in academic STEM fields.

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Note

1. Note that our discussion focuses on women and men, but gender is not binary (Morgenroth & Ryan, 2021) and includes other identities that need to be considered more deeply in future work on academic STEM fields.

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