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A collective action approach to improving attitudes and self-efficacy towards gender equality among male STEM academics

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Abstract

Despite the implementation of equality interventions within higher education, progress towards gender parity in science, technology, engineering, and mathematics (STEM) remains slow. Male educators often exhibit poorer engagement with diversity initiatives, potentially contributing to persisting gender disparities in STEM given men's longstanding dominance in these programs. Two experiments investigate how equality interventions should be designed to maximize support from male educators. Experiment 1 ($N=72$; $M_{age}=39.72$, $SD_{age}=12.33$) used virtual reality to manipulate 2 factors among male academics: (1) exposure to gender inequality and (2) virtually taking the perspective of a female scientist. Using self-report and behavioral measures, viewing an empirical presentation outlining the prevalence of gender issues in STEM yielded the greatest support for equality initiatives following successful perspective-taking. Experiment 2 ($N=120$; $M_{\text{age}}=32.48$, $SD_{\text{age}}=10.36$) varied two additional factors among male academics: (1) evidence-based methods to reduce gender biases in STEM (i.e., promoting self-efficacy) and (2) blaming male academics for gender inequalities. Promoting self-efficacy and blaming men for disparities led to greater confidence in male academics' ability to address gender inequalities in their field. Notably, higher self-efficacy accounted for greater support for equality initiatives and internal motives to engage with diversity programs. Findings provide an empirical framework and high-tech training tools for promoting engagement with diversity initiatives among male educators, informing development of interventions within higher education to improve student and faculty experiences in STEM.

Keywords Gender · Diversity · STEM · Intervention · Virtual reality

After significant investments in gender equality initiatives over many years (e.g., Athena SWAN in UK and Ireland, SAGE in Australia, SEA Change in the US), enrollment and hiring of women within higher education have slowly increased (Badura et al., 2018; Carey et al., 2020; Ceci & Williams, 2015). However, closing the gender gap in fields with severe disparities (e.g., science, technology, engineering, and mathematics; STEM) may take over

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a century to achieve (Holman et al., 2018). One reason for this slow progress is ineffective equality initiatives within STEM, which are often met with negative attitudes among educators, fostering backlash against groups they are designed to help (Ovseiko et al., 2017, Tzanakou et al., 2019). Notably, negative attitudes are more prominent among men who make up the majority of STEM educators (Caffrey et al., 2016; Ovseiko et al., 2017), perpetuating culture that negatively affects women's academic performance and success (Legault et al., 2011). Yet, there is currently a gap in our understanding concerning how interventions uniquely impact academics, since they differ from the general and student population due to their scientific training, level of education, and role within academia. Given men may disengage from equality initiatives, the goal of the present research is to inform development of intervention techniques to improve engagement among male STEM academics using relevant psychological theory (e.g., the social identity model of collective action).

Theoretical rationale

STEM academics benefit from scientific education and technological advances due to the nature of their research. Thus, present work investigates how to use these skills to improve the effectiveness of perspective-taking interventions, an established method to reduce bias towards women in STEM (Crone & Kallen, 2022). Across two experiments, the social identity model of collective action (van Zomeren et al., 2008, 2018) was used to determine how to best incorporate perspective-taking within equality initiatives. This model outlines three factors which promote equality-focused action (e.g., engagement with initiatives, allyship): (1) emphasizing perceptions of injustice, (2) highlighting men's social identity, and (3) promoting self-efficacy or confidence in enacting social change (van Zomeren et al., 2008). While equality initiatives often target these factors, how they affect perspective-taking among male academics is unclear.

Experiment 1 replicates prior work examining how perspective-taking in virtual reality can promote equality-focused action (Crone & Kallen, 2022; van Loon et al., 2018). However, men may underestimate the amount of problematic sexism in STEM (De Souza & Schmader, 2022). Thus, Experiment 1 manipulates salience of gender issues via detailing the negative experiences faced by women in STEM prior to taking the perspective of a female scientist (i.e., emphasizing perceptions of injustice). Relatedly, initiatives often frame disparities as the fault of men which may promote guilt among male educators (i.e., via highlighting men's social identity; Dobbin et al., 2015; Moss-Racusin, 2014). Interventions may also provide educators with practical methods to address inequalities to promote self-efficacy (i.e., confidence one's actions will enact change; Combs & Luthans, 2007). Thus, Experiment 2 examines how perspective-taking interacts with these factors (i.e., promoting guilt and self-efficacy) to foster support for equality initiatives.

Experiment 1

Perspective-taking often requires participants to imagine themselves as a member of a stigmatized group to promote understanding of their experiences and feelings (i.e., fostering empathy; Decety & Cowell, 2014; White, 1997). Thus, effective perspective-taking may provide deeper understanding of women's experiences in STEM, motivating male academics to engage in altruistic behaviors to address gender issues within academia (Dovidio et al., 2004;

Vescio et al., 2003). Relevant to STEM, virtual reality is used as a robust method to facilitate perspective-taking via altering participants' avatars. For example, White participants may view themselves as a Black avatar to reduce racist attitudes (Groom et al., 2009) or young participants may see elderly avatars to diminish ageist attitudes (Oh et al., 2016). Relevant to gender inequities, men who view themselves as a female avatar are less likely to exhibit biases during hiring exercises (Crone & Kallen, 2022). Notably, use of virtual reality to facilitate perspective-taking is more effective than traditional paradigms (e.g., writing from the perspective of an individual), lasting up to 8 weeks after an intervention (Herrera et al., 2018).

Perceived injustices in STEM

One caveat of perspective-taking is the assumption that male educators can accurately imagine the lived experiences of women in STEM. Despite men explicitly supporting women's advancement in STEM, they are unlikely to engage in equality-focused action due to inaccurate perceptions of gender disparities (De Souza & Schmader, 2022). For example, lack of male allies and low number of men leading equality initiatives may foster assumptions that these disparities are no longer an issue within academia (De Souza & Schmader, 2022). These misperceptions of gender disparities often coincide with lack of awareness of the consequences women experience as minorities in STEM (Becker & Swim, 2011; Martínez et al., 2010). Importantly, these patterns of ignorance are not unique to STEM, with White Americans underestimating the consequences and severity of racial inequities in the United States (Callaghan et al., 2021; Kraus et al., 2017).

According to the social identity model of collective action, male educators may be more likely to address gender disparities when they accurately perceive these injustices (van Zomeren et al., 2008). Thus, ignorance of these inequalities may limit men's ability to take the perspective of a female scientist, subsequently hindering equality-focused action. Yet, presentations which provide evidence of women's experiences as a minority in STEM may offer greater insight when taking the perspective of a female scientist (Callaghan et al., 2021). For example, this data-driven presentation may refute claims there are differences in brain anatomy between sexes (Allen et al., 1991), as recent research suggests these differences are due to spurious factors such as body size rather than sex (Luders et al., 2014). Further, published gender differences in performance are typically marginal (Hyde, 2014), with up to 85% of studies demonstrating small effects (Zell et al., 2015). Thus, gender disparities might be perpetuated through negative gender stereotypes, given that greater endorsement of these stereotypes within a country predicts larger gender inequalities within those respective STEM fields (Nosek et al., 2009). Notably, inaccurate gender stereotypes lead to poorer evaluations of women's publications (Knobloch-Westerwick et al., 2013), teaching (Morgan et al., 2016), and recommendation letters (Schmader et al., 2007), in addition to negatively affecting employability (Moss-Racusin et al., 2012). Women's knowledge of stereotypes may also worsen math performance (Spencer et al., 1999) and negatively impact physiology (Murphy et al., 2007; Vick et al., 2008). Yet, recent investigations into stereotype threat indicate effects might be smaller than initially reported, suggesting issues with publication bias and limitations of laboratory methods (Zigerell, 2017). Notwithstanding potential issues, using the above evidence to outline the consequences of gender disparities can promote support for equality initiatives among students (Zawadzki et al., 2012), suggesting this approach may also benefit male academics prior to perspective-taking.

Present study

It was expected male academics taking the perspective of a female scientist would exhibit greater support for equality initiatives. Similarly, men who learned about the pervasiveness of inequalities were predicted to report greater support for initiatives due to enhanced perception of injustices (van Zomeren et al., 2008). Moreover, enhanced perception of injustices was expected to boost the effectiveness of perspective-taking in promoting support for interventions. Self-report (explicit) and behavioral (implicit) measures were used to assess support for initiatives.

Method

Participants

Related studies using virtual perspective-taking included samples ranging from 20–84 participants (Chang et al., 2019; Hamilton-Giachritsis et al., 2018; Oh et al., 2016; Schutte & Stilinović, 2017; Starr et al., 2019). Thus, 72 participants were recruited, which a sensitivity power analysis (GPower 3.1; Faul et al., 2009) indicated 80% power to detect significant effects given a moderate to large effect size ($\eta^2 = 0.10$). To be eligible to participate, participants were required to be a male faculty member (e.g., lecturer, professor), postdoctoral researcher, or PhD student within STEM. Recruiting across career stages ensures diverse representation of expertise in STEM, addressing a gap in the literature which tends to focus on undergraduates (Yadav et al., 2020). The inclusion of participants from varying career levels may also provide insight into the challenges of implementing initiatives across the professional spectrum, informing development of tailored intervention approaches based on men's academic position and experience in STEM.

Participants ($M_{age} = 39.72$, $SD_{age} = 12.33$) were male academics from engineering (55.6%), physics or astronomy (16.7%), computer science (15.3%), and other STEM fields (e.g., chemistry, mathematics, information systems; 12.4%) and were recruited from a UK university to participate in a study described as investigating virtual emulation of research conferences (i.e., participants blind to the purpose of the study). Participants identified as White (80.6%), Asian (13.9%), or another race (5.5%; see supplemental Table S1 for breakdown of demographics; https://osf.io/8p7y9/). Permanent faculty (51.4%), postdoctoral researchers (25%), and PhD students (23.6%) were randomly assigned to one condition in a 2 (Presentation: gender issues, neutral) × 2 (Perspective-taking: male, female avatar) between-subjects design.

Procedure and measures

After providing consent, participants had electrodes attached to the middle and ring fingers of their non-dominant hand to assess electrodermal activity (data not presented here). Participants then wore a virtual reality headset (Vive Pro; HTC; Fig. 1a) to view a computer-generated environment developed in Unity 2017.1.5f1 (Unity Technologies). The first virtual space was a conference room, consisting of a projector screen, podium, and mirror (Fig. 1b).

Fig. 1 Virtual reality experience. Participant wearing headset (**a**) and their point of view during (**b**) presentation, (**c**) perspective-taking, and (**d**) conference reception

Virtual environment

Participants first explored the room for two minutes to become accustomed to moving in virtual reality. Next, participants watched a four-minute presentation delivered by a male presenter, containing evidence-based information about the consequences of gender inequality in science as described in the introduction to this experiment (e.g., biological differences, cultural stereotypes, performance detriments) or a neutral presentation about the host city of a conference, similar to previous research (Pietri et al., 2017; see supplemental materials for presentation slides). A male presenter was chosen as men respond more positively to gender issues when presented by male sources (Hardacre & Subašic, 2018).

Participants then walked towards a mirror and were instructed to view themselves for 2 min. Depending on the experimental condition, participants saw themselves as a male or female avatar matched on characteristics such as hair and skin color (Fig. 1c). Participants were told, "imagine a day in the life of this woman [man], looking at the world through their eyes and walking through the world in their shoes" (Oh et al., 2016). Participants then explored a room which rendered a reception of a research conference for two minutes (Fig. 1d), after being told, "imagine how you would feel in this environment as the woman [man] you currently are." Participants assigned to the gender issues presentation were told, "with your knowledge of the negative effects of gender disparities, take note of the number of male and female attendees," which was designed to reflect male–female ratios in many STEM fields (5:1).

Explicit measures

Following the virtual reality experience, participants completed a manipulation check assessing the perspective-taking experience using 9-items (e.g., "It was easy for me to take the perspective of the avatar I was given;" $\alpha = 0.77$). Participants also reported their support for gender equality initiatives and demographics. Explicit support for equality initiatives was assessed using 5-items adapted from Dover et al., (2016; e.g., “I would like to work for a University with a gender equality initiative”; $\alpha = 0.80$). Explicit support was also assessed using a 3-item scale adapted from Danbold and Huo (2017; e.g., “I think an equality initiative would be a poor use of resources.”). However, due to this scale’s poorer reliability ($\alpha = 0.69$), results focus on the scale adapted from Dover et al. (2016). All items were rated from 1 (*Strongly disagree*) to 5 (*Strongly agree*).

Implicit measures

Implicit attitudes were measured with a single-category Implicit Association Test (IAT) using Inquisit software (Millisecond; Seattle, WA), associating equality initiatives with positive versus negative affective words (Karpinski & Steinman, 2006). In one set of critical trials, participants sorted initiatives with positively valanced words, and in another set of trials initiatives were sorted with negatively valanced words (see table S2 in supplemental materials). Whether positive versus negative pairings were presented first was counterbalanced and reaction time-based *D* scores were calculated using the IAT scoring algorithm outlined in Greenwald et al. (2003), such that positive scores indicated positive associations with equality initiatives and negative scores suggested stronger negative associations with equality initiatives. Since participants may not have been familiar with initiatives categorized during the task, they were provided with a list of stimuli and asked to familiarize themselves with the initiatives, in addition to being provided with practice trials which asked participants to categorize initiatives. Approval was received from the university’s ethics committee. Data, materials, and supplemental tables (e.g., scale items, factor loadings) can be found at https://osf.io/8p7y9/.

Results

Descriptive statistics for variables used in Experiment 1 are displayed in Table 1. Chi-squared tests indicated equal distribution of academic positions (e.g., PhD students, post-doctoral researchers, faculty) across presentation, $\chi^2(2) = 0.78$, $p = 0.679$, $\phi = 0.104$, and perspective-taking conditions, $\chi^2(2) = 0.76$, $p = 0.686$, $\phi = 0.102$. Levene’s test indicated homogeneity of variances across conditions for explicit, $F(3,68) = 0.56$, $p = 0.641$, and implicit support for initiatives, $F(3,68) = 0.14$, $p = 0.938$, in addition to the manipulation check, $F(3,68) = 0.68$, $p = 0.568$.

Manipulation check

A one-sample *t*-test indicated scores for the manipulation check ($M = 3.50$, $SD = 0.53$) were significantly above the scale midpoint across conditions, $t(71) = 8.01$, $p < 0.001$, indicating a medium effect ($d = 0.53$), suggesting participants effectively took the perspective of their avatar. A 2 (Presentation: gender issues, neutral) × 2 (Perspective-taking: male, female avatar) ANOVA indicated effectiveness did not differ among conditions or their interaction, all ps > 0.161.

Explicit measure of support

A 2 (Presentation) × 2 (Perspective-taking) ANOVA indicated a moderate effect on explicit support, suggesting presentation of gender issues elicited greater self-reported intentions

Table 1 Summary of descriptive statistics for experiment 1

Variable	1	2	3
Entire sample ($N=72$)			
1. Age	39.72(12.33)		
2. Explicit support	.014	4.18(0.65)	
3. Implicit support	-.087	.358**	0.06(0.21)
PhD students ($N=17$)			
1. Age	27.41(8.37)		
2. Explicit support	-.022	4.18(0.64)	
3. Implicit support	-.240	.423	0.12(0.23)
Postdoctoral researchers ($N=18$)			
1. Age	39.28(10.20)		
2. Explicit support	.095	4.23(0.68)	
3. Implicit support	.397	.451	0.02(0.22)
Faculty ($N=37$)			
1. Age	45.59(10.61)		
2. Explicit support	.014	4.16(0.66)	
3. Implicit support	-.106	.299	0.05(0.20)

M(*SD*) reported on the diagonal of the correlation matrix. $^{**}p<.01$

to engage with equality initiatives compared to neutral presentations, $F(1,68)=6.29$, $p=0.015$, $\eta_p^2=0.085$. No main effect emerged between male versus female avatars for explicit support, $F(1,68)=2.25$, $p=0.138$, $\eta_p^2=0.032$. Presentation significantly interacted with perspective-taking, $F(1,68)=4.25$, $p=0.043$, $\eta_p^2=0.059$. Female avatars moderately increased explicit support after viewing the gender issues presentation compared to male avatars, $F(1,68)=6.72$, $p=0.012$, $\eta_p^2=0.091$ (Fig. 2a). No differences emerged between avatar conditions after neutral presentations, $F(1,68)=0.15$, $p=0.700$, $\eta_p^2=0.002$. Race, age, and academic position did not interact with conditions to affect self-reported intentions to engage with equality initiatives, all ps >0.359.

Implicit measure of support

Similarly, a 2 (Presentation) × 2 (Perspective-taking) ANOVA indicated a large effect for implicit support, with the gender issues presentation eliciting more positive associations with initiatives compared to the neutral presentation, $F(1,68)=11.87$, $p=0.001$, $\eta_p^2=0.149$. No main effects emerged between male versus female avatars, $F(1,68)=2.19$, $p=0.143$, $\eta_p^2=0.031$. Yet, presentation significantly interacted with perspective-taking to affect levels of implicit support, $F(1,68)=4.10$, $p=0.047$. $\eta_p^2=0.057$. Female avatars moderately increased positive associations with initiatives compared to male avatars after viewing the gender issues presentation, $F(1,68)=6.51$, $p=0.013$, $\eta_p^2=0.090$, (Fig. 2b). No differences in implicit associations emerged between avatar conditions after neutral presentations, $F(1,68)=0.14$, $p=0.710$, $\eta_p^2=0.002$. Race, age, and academic position did not interact with conditions to affect implicit support, all ps >0.463.

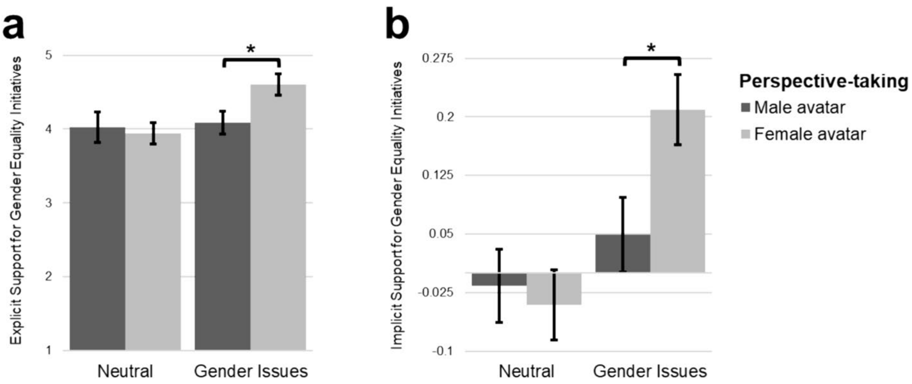


Fig. 2 Effects of conditions on initiative support (Experiment 1). Explicit (**a**) and implicit (**b**) support for gender equality initiatives as a function of presentation and perspective-taking conditions. Error bars represent standard error. *$p < .05$

Discussion

Using virtual reality, findings demonstrate how perspective-taking effectively promotes support for gender equality initiatives among male educators, extending research which has used perspective-taking to reduce biases towards stigmatized groups among students (Crone & Kallen, 2022; Groom et al., 2009; Oh et al., 2016). Unlike prior research, perspective-taking alone did not promote support for equality initiatives. Instead, taking the perspective of a female scientist only increased support following a presentation outlining the consequences of gender disparities. This suggests male educators may not have extensive understanding of women's lived experiences as a minority in STEM, limiting their ability to engage with perspective-taking. Ignorance of social injustices is common among majority group members (Becker & Swim, 2011; Callaghan et al., 2021; De Souza & Schmader, 2022; Kraus et al., 2017; Martínez et al., 2010) and may contribute to lack of collective action to address gender inequalities among male STEM academics. Thus, making gender disparities salient among male educators may provide the necessary context to facilitate taking the perspective of a female scientist to increase support for equality initiatives.

Interestingly, the data-driven presentation alone was sufficient in promoting support for initiatives. This effect is consistent with work demonstrating how evidence-based interventions increase awareness of disparities and promote positive perceptions of equality (Callaghan et al., 2021). Findings also support longstanding theory which suggests emphasizing the perception of injustices may promote actions to address inequalities (van Zomeren et al., 2008, 2018). Thus, the presentation may have alleviated potential ignorance among male academics, highlighting the prevalence of problematic sexism and stereotypes in STEM to promote equality-focused action.

Experiment 2

While enhancing perceptions of injustice increased the efficacy of perspective-taking among male STEM academics, the effectiveness of this approach may be further bolstered via targeting men's social identity and self-efficacy (van Zomeren et al., 2008, 2018). Even if men are aware of inequalities in STEM, they may not engage with initiatives due to perceptions that gender disparities are too difficult or substantive to address (van Zomeren et al., 2008). Yet, these misperceptions may be alleviated when gender disparities are saliently attributed to men's social identity (e.g., promoting guilt) and when men are confident their actions will enact social change (i.e., self-efficacy; van Zomeren et al., 2008). While promotion of guilt and self-efficacy are often components of diversity initiatives, whether they influence support for interventions after taking the perspective of a female scientist remains untested.

Social identity and guilt

Individuals are more likely to engage in equality-focused action when injustices are relevant to their social identity (van Zomeren et al., 2008, 2018). Equality initiatives often frame inequalities as the responsibility of intervention targets, such as male educators being personally accountable for gender disparities in STEM (Dobbin et al., 2015; Moss-Racusin, 2014). Thus, linking gender inequalities to men's social identity may promote support for equality initiatives by fostering guilt (i.e., feeling responsible for disparities caused by one's social group; Doosje et al., 1998; Ferguson & Branscombe, 2014). Yet, assigning blame may also create backlash against initiatives due to threatening men's status or success in STEM. For example, men feel threatened when their privilege is highlighted or attributed to social inequities (Lowery et al., 2007; Phillips & Lowery, 2020). Unfortunately, feelings of threat often promote deflection of responsibility for these disparities to avoid negative feelings associated with guilt (Danbold & Huo, 2017; Leach et al., 2006; McGarty et al., 2005). Thus, male STEM academics might attribute gender inequalities to external factors outside their control (e.g., organizational policy) or assume inequities are due to intrinsic factors (e.g., biological differences; Rothschild et al., 2012).

However, acknowledgement of privilege and the promotion of guilt can promote support for policies which address social inequalities (Leach et al., 2006; Lowery et al., 2007). Notably, this behavioral change fostered by guilt is often due to internalized, altruistic motivations rather than external or defensive motivations (Gausel et al., 2016). Thus, facilitating guilt through highlighting men's social identity and involvement in the creation of gender disparities may be effective in promoting equality-focused action. However, promoting guilt alone may not be sufficient in increasing support for gender equality initiatives. For example, if men do not feel confident in their abilities to improve disparities (i.e., low self-efficacy), they may not engage with initiatives since they believe their actions will not contribute to effective social change to reach gender parity (Legault et al., 2011; van Zomeren et al., 2008).

Self-efficacy

Self-efficacy is one's confidence to complete a task and is an essential mechanism in reducing drug use (Foster et al., 2014), improving academic performance (Honicke & Broadbent, 2016), and adopting healthier diets (Prestwich et al., 2014). Relevant to improving inequalities in STEM, equality self-efficacy is the belief one's actions will make a positive impact on diversity issues (Combs & Luthans, 2007). Educators often report low equality self-efficacy, such as having less motivation to help stigmatized students (Geerlings et al., 2018). Self-efficacy is an established precursor of attitude change, thought to precede long-term changes in habitual behaviors (Combs & Luthans, 2007; Maddux, 2009). Supporting the potential importance of equality self-efficacy, successful equality initiatives are often mediated by self-efficacy, with the effects on confidence lasting up to a year after the initial intervention (Combs & Luthans, 2007).

Educators' self-efficacy may be improved by repeatedly engaging in equality-focused actions (real or imagined) or observing colleagues exhibiting these actions. Relevant to brief interventions, verbal messages of strategies to address inequalities may similarly promote self-efficacy (Maddux, 2009). Thus, training which provides methods to reduce gender disparities should boost confidence to address equality issues (Carnes et al., 2012; Zawadzki et al., 2012). As in Experiment 1, imagining counter-stereotypical representatives of male-dominated careers (i.e., female scientists) can reduce bias (Blair et al., 2001; Burns et al., 2017) and simply raising awareness about biases has long-term impacts on prejudice (Devine et al., 2012). During hiring processes, biases can be limited by using structured interviews; emphasizing the qualifications and achievements of an applicant to minimize the influence of gender (Alonso et al., 2017; Ceci & Williams, 2015). Diversifying the curriculum and using examples of female scientists through coursework, media, or textbooks can also allow educators to form stronger associations between women and science to reduce bias (Good et al., 2010; Steinke, 2005).

Providing these methods to address biases may be effective in promoting self-efficacy among male educators due to reducing the effort required to engage in equality-focused action. When self-efficacy is low, individuals assume behavior change is difficult and often default to habitual behaviors (Maddux, 2009). Yet, when confidence is promoted via providing methods to enact change, new behaviors persevere due to requiring less effort to maintain. Importantly, self-efficacy promotes spontaneity of actions (George & Jones, 1997), knowledge sharing (Hsu et al., 2007), commitment to change (Herold et al., 2007), and autonomy (Cupertino et al., 2011) which encapsulate internal motivations. Thus, promoting self-efficacy and internal motives may lead to greater support for initiatives.

Present study

It was expected blaming male educators for STEM gender disparities would elicit greater support and internal motivations to engage with equality initiatives compared to when both men and women were attributed as responsible for disparities (i.e., reducing feelings of blame). It was also expected providing methods to address inequalities would elicit higher initiative support and internal motivations. Lastly, men blamed for disparities were expected to report highest levels of support and internal motivations when also provided with methods to address inequalities. Since self-efficacy is an established mechanism of behavioral change, men's confidence in addressing gender issues was expected to mediate support and internal motives to engage with initiatives.

Method

Participants

Sample size was determined using rationale described in Experiment 1; however, due to expected attrition from the online format, the study oversampled and recruited 120 participants which a sensitivity power analysis (GPower 3.1; Faul et al., 2009) indicated 80% power to detect significant effects given a moderate effect size ($\eta^2 = 0.08$). Participants were required to be a male faculty member (e.g., lecturer, professor), postdoctoral researcher, or PhD student in STEM who did not participate in Experiment 1. Participants ($M_{age} = 32.48$, $SD_{age} = 10.36$) were male academics from physics or astronomy (42.5%), engineering (21.7%), mathematics (15.8%), chemistry (10.8%), computer science (4.2%), and other fields (e.g., information systems; 5.0%) and were recruited from 3 UK Universities to participate in a study investigating the online emulation of research conferences. Participants identified as White (79.2%), Asian (16.7%), or another race (4.1%; see supplemental Table S5 for breakdown of demographics; https://osf.io/8p7y9/). Faculty (25.0%), postdoctoral researchers (25.8%), and PhD students (49.2%) were assigned to one condition in a 2 (Blame for gender disparities: male blame, reduced blame) × 2 (Methods to address bias: provided, not provided) between-subjects design.

Procedure and measures

Due to implementation of COVID restrictions which occurred during data collection, Experiment 2 used an online intervention. Interested participants were given a link to the study hosted by Qualtrics (Provo, UT). After providing consent, participants were asked to watch a 6-min video containing information about gender issues in STEM as in Experiment 1. However, presentations were manipulated to link gender disparities to men's social identity (i.e., assigning blame) versus stating no unique social group is at fault for disparities (i.e., reduced blame). In the blame condition, evidence was presented suggesting men perpetuate the existence of stereotypes to justify their dominance in STEM fields. In the reduced blame condition, participants were told both men and women endorse gender stereotypes and that not one social group is responsible for gender inequalities in STEM. This approach to assigning blame is consistent with prior work that manipulated guilt and shame via intergroup (e.g., men) versus human-level categorizations (e.g., both men and women; Wohl & Branscombe, 2005). Presentations also included information to foster self-efficacy (i.e., stereotypes are malleable, tools to address biases) versus diminish self-efficacy (i.e., stereotypes are unchanging, no effective methods to reduce bias; see supplemental materials for presentations). Regardless of condition, all participants then took the perspective of a female scientist by viewing a 2-min video which started with a 30-s static image of a female professional and stated via recorded audio:

> "You will now watch footage from a research conference. Using the information from the previous presentation, imagine how it would feel being this woman while attending a research conference in your academic field, looking at the world through their eyes and walking through the world in their shoes. For example, think about how it would make you feel as a woman to walk into a room full of men."

Participants then watched 90-s of real-life footage of professionals interacting at male-dominated research conferences, similar to prior perspective-taking paradigms (Todd et al., 2011). Participants then wrote for 5-min from the perspective of a female scientist, writing a narrative about a typical day as a woman in STEM (adapted from Galinsky & Moskowitz, 2000; Ku et al., 2010). Prior to writing the essay, participants read the following prompt:

> "Using the information from the presentation and reflecting on the video you just watched, imagine the day in the life of the woman from the previous video attending a research conference in your academic field, looking at the world through their eyes and walking through the world in their shoes. Please write for the next 5 minutes

about how you would imagine this experience and how it would make you feel. As a reminder, your responses are anonymous. Once 5 minutes has passed, you will be able to continue to the rest of the study."

Explicit measures

Participants then self-reported support and internal motivations to engage with initiatives, in addition to equality self-efficacy. Explicit support was assessed using a 5-item scale adapted from Dover et al., 2016 as described in Experiment 1 ($\alpha = 0.79$). Internal motivations were adapted from Plant and Devine (1998) with additional items being created and validated in Farrell et al. (2021). Five items assessed internal motives to engage with initiatives (e.g., "Gender equality initiatives are a good use of my personal time." $\alpha = 0.87$). Self-efficacy was assessed using 10-items adapted from previous work (Chemers et al., 2001; Pietri et al., 2017). Example items included, "I believe that I can help address gender bias in my professional field," and, "The presented information provided opportunities for me to strengthen my ability to address gender bias in my professional field." ($\alpha = 0.87$). All items were rated from 1 (*Strongly disagree*) to 5 (*Strongly agree*). Approval was received from the university's ethics committee. Due to shifting data collection online and issues with software compatibility (i.e., Inquisit), no implicit measure of initiative support was assessed in Experiment 2. Data, materials, and supplemental tables (e.g., scale items, factor loadings) can be found at https://osf.io/8p7y9/.

Results

Descriptive statistics are displayed in Table 2. Participants from each university were equally distributed across blame, $\chi^2(3) = 2.53$, $p = 0.470$, $\phi = 0.145$, and self-efficacy conditions, $\chi^2(3) = 5.26$, $p = 0.154$, $\phi = 0.209$. Similarly, academic positions were also equally distributed across blame, $\chi^2(2) = 2.13$, $p = 0.345$, $\phi = 0.133$, and self-efficacy conditions, $\chi^2(2) = 5.61$, $p = 0.060$, $\phi = 0.216$. Levene's test indicated homogeneity of variances for support, $F(3,116) = 0.17$, $p = 0.914$, internal motives, $F(3,116) = 0.96$, $p = 0.414$, and self-efficacy, $F(3,116) = 0.47$, $p = 0.702$.

Explicit measure of support

A 2 (Blame for gender disparities: male blame, reduced blame) $\times$ 2 (Methods to address bias: provided, not provided) between-subjects ANOVA was used to test the primary hypotheses. No main effects emerged for blame, $F(1,116) = 1.71$, $p = 0.193$, $\eta_p^2 = 0.015$, or methods to address bias for explicit support, $F(1,116) = 0.01$, $p = 0.956$, $\eta_p^2 < 0.001$. No significant interaction between conditions emerged, $F(1,116) = 0.08$, $p = 0.781$, $\eta_p^2 = 0.001$.

Explicit measure of internal motivations

No main effects emerged for blame, $F(1,116) = 1.35$, $p = 0.247$, $\eta_p^2 = 0.012$, or methods to address bias for internal motivations, $F(1,116) = 0.06$, $p = 0.805$, $\eta_p^2 = 0.001$. No interaction among factors was observed, $F(1,116) = 0.02$, $p = 0.881$, $\eta_p^2 < 0.001$.

Table 2 Summary of descriptive statistics for experiment 2

Variable	1	2	3	4
Entire sample ($N=120$)				
1. Age	32.48(10.36)			
2. Explicit support	.087	3.88(0.81)		
3. Internal motivations	.122	.817***	3.83(0.87)	
4. Equality self-efficacy	-.035	.506***	.463***	3.44(0.79)
PhD students ($N=59$)				
1. Age	25.47(3.06)			
2. Explicit support	.191	3.86(0.24)		
3. Internal motivations	-.048	.809***	3.77(0.95)	
4. Equality self-efficacy	.080	.545***	.449***	3.55(0.78)
Postdoctoral researchers ($N=31$)				
1. Age	33.77(6.39)			
2. Explicit support	-.320	3.92(0.73)		
3. Internal motivations	.022	.805***	3.88(0.76)	
4. Equality self-efficacy	-.033	.403*	.439*	3.42(0.77)
Faculty ($N=30$)				
1. Age	44.93(10.83)			
2. Explicit support	.374*	3.85(0.90)		
3. Internal motivations	.346	.861***	3.88(0.84)	
4. Equality self-efficacy	.312	.546**	.584***	3.24(0.83)

$M(SD)$ reported on the diagonal of the correlation matrix. *$p<.05$, **$p<.01$, ***$p<.001$

Explicit measure of equality self-efficacy

Assigning blame, $F(1,116)=3.31$, $p=0.072$, $\eta_p^2=0.028$, and providing methods to address biases, $F(1,116)=1.16$, $p=0.282$, $\eta_p^2=0.010$, had no main effects on self-efficacy. However, the interaction between factors significantly affected self-efficacy, $F(1,116)=4.86$, $p=0.029$, $\eta_p^2=0.040$. Blaming men for gender inequalities had a small effect, $F(1,116)=5.32$, $p=0.023$, $\eta_p^2=0.044$, with male educators given methods to reduce bias reporting greater self-efficacy ($M=3.79$, $SD=0.70$) compared to those not provided any methods ($M=3.33$, $SD=0.71$). No differences between conditions emerged when no unique social group was responsible for gender disparities, $F(1,116)=0.64$, $p=0.425$, $\eta_p^2=0.005$ (see Fig. 3). Race, age, academic position, and university did not interact with conditions to affect support, internal motives, or self-efficacy, all $ps>0.343$.

Self-efficacy as a mechanism for support

Self-efficacy was tested as a mechanism for support and internal motivations to engage with initiatives using the PROCESS macro for SPSS (model 8; Hayes, 2012). Self-efficacy was specified as a mediator between the interaction among conditions and dependent variables. Self-efficacy significantly predicted initiative support, $b=0.22$, $\beta=0.53$, $p=0.007$. Results indicated a moderated-mediation effect for self-efficacy on support, $b=0.19$,

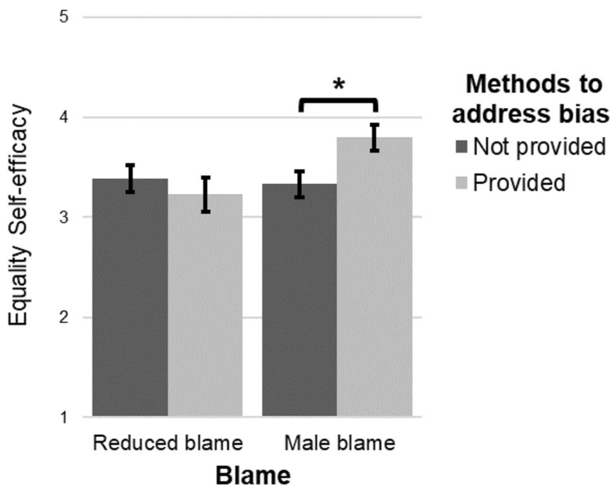
β=0.42, SE=0.11, 95% CI [0.01, 0.43]. Self-efficacy accounted for the relation between blame conditions and support, but only among those given methods to address gender bias, b=0.14, β=0.38, SE=0.08, 95% CI [0.02, 0.32], and not among those who did not receive these methods, b=-0.05, β=-0.03, SE=0.07, 95% CI [-0.19, 0.10] (see Table S6 in supplemental materials for detailed analysis).

Equality self-efficacy also predicted internal motivations to engage with initiatives, b=0.52, β=0.48, p<0.001. Results indicated a moderated-mediation effect for equality self-efficacy on internal motives, b=0.33, β=0.37 SE=0.16, 95% CI [0.02, 0.66]. Self-efficacy accounted for the relation between blame conditions and internal motives, but only among male academics given methods to address gender biases in STEM, b=0.30, β=0.34, SE=0.12, 95% CI [0.09, 0.54], and not when these methods were withheld, b=-0.03, β=-0.03, SE=0.10, 95% CI [-0.25, 0.16] (see Table S7 in supplemental materials for detailed analysis).

Discussion

These findings initially suggest attributing gender disparities in STEM to men's social identity, in addition to providing methods to address inequalities, may not influence support or motivations to engage with initiatives. While there are several reasons for these inconclusive results, a major limitation was the decision to include these factors alongside the most effective intervention established in Experiment 1. Since emphasizing perceived injustices in STEM prior to perspective-taking promoted greater support as established in Experiment 1, this may have left little variance for additional manipulations to influence. This assumption is partly confirmed by average responses for initiative support being above the mid-point of the scale in Experiment 2, suggesting participants may have been similarly supportive of initiatives regardless of condition. However, the promotion of guilt and self-efficacy are known to reduce prejudiced attitudes and behaviors (Carnes et al., 2012; Leach et al., 2006; Zawadzki et al., 2012). Further, while blaming men for inequalities is thought to promote backlash (Dobbin et al., 2015; Legault et al., 2011; Moss-Racusin, 2014), no

Fig. 3 Effects of conditions on equality self-efficacy (Experiment 2). Equality self-efficacy as a function of blame for gender disparities and methods to address bias. Error bars represent standard error. *p<.05



reductions in support emerged after blaming men for gender disparities in STEM. Thus, assigning blame for these inequalities may not promote disengagement from interventions, particularly when provided with tools to address biases.

While the combination of blame and methods to reduce biases increased levels of self-efficacy, neither factor alone affected confidence. These findings support theory suggesting guilt may only be effective in promoting collective action when individuals are confident behaviors will facilitate positive change (van Zomeren et al., 2008, 2018). Thus, men given methods to address biases may feel more confident in confronting gender issues, but only when disparities are made relevant to their social identity (i.e., via assigning blame). While manipulations did not directly impact initiative support or motivations, it is important to note the influence of self-efficacy on these outcomes. Notably, equality self-efficacy indirectly accounted for greater support and motivations, suggesting men's confidence may be a necessary antecedent for viable progress towards gender parity in higher education. This mechanistic interpretation is consistent with prevailing evidence establishing self-efficacy as a precursor for behavior change (Foster et al., 2014; Honicke & Broadbent, 2016; Prestwich et al., 2014).

General discussion

Across two experiments, the use of virtual reality and online tools provides evidence for effective methods to improve support for equality initiatives and promote self-efficacy, important factors which may contribute towards improving STEM gender disparities (Holman et al., 2018). Guided by the social identity model of collective action (van Zomeren et al., 2008), highlighting perceived injustices in STEM uniquely fostered support for equality initiatives, particularly when men also took the perspective of a female scientist. Experiment 1 developed immersive tools for male academics via the use of virtual reality, while Experiment 2 built upon this intervention by targeting additional factors thought to promote equality-focused action (i.e., social identity, self-efficacy; van Zomeren et al., 2008, 2018). As suggested by the social identity model of collective action, attributing men's social identity to gender disparities (via assigning blame) and providing methods to address bias yielded greater confidence in confronting gender issues in STEM which accounted for increased support and internal motivations to engage with initiatives, suggesting self-efficacy may play an essential role in changing attitudes towards equality within academia.

Importantly, the present research examined these factors among a pertinent group, male academics and educators. Since men make up a large percentage of STEM programs, it is vital to understand what factors promote support for equality initiatives among this population. Despite the presence of interventions within academia, vast disparities are still present in STEM (Holman et al., 2018). Thus, novel approaches to achieve gender parity are needed to improve engagement and effectiveness of interventions, since current initiatives elicit indifferent or negative attitudes from male faculty (Caffrey et al., 2016; Ovseiko et al., 2017). Yet, our results suggest men may already endorse ambivalent or positive attitudes towards equality initiatives, as many participants scored above the midpoint on measures of support regardless of manipulations. However, despite privately supporting gender equality, men are unlikely to engage in equality-focused action due to misperceptions of problematic sexism and assumptions their colleagues may not endorse pro-equality attitudes (De Souza & Schmader, 2022; van Zomeren et al., 2008). Thus, initiatives may not succeed without clear and outward support from the majority of educators. This assumption is consistent with work suggesting gender parity may only be achieved when entire organizations are motivated to address inequalities and support is consistent across intergroup boundaries (i.e., both men and women; Sherf et al., 2017). These findings provide tools and guidance to mobilize faculty more effectively, particularly targeting men who may perceive initiatives unfavorably which limits advancement towards gender parity (Caffrey et al., 2016; Ovseiko et al., 2017).

Limitations and future directions

Notably, the use of self-report measures to assess support for equality initiatives may limit the validity of findings due to social desirability (e.g., failing to capture true intentions of academics). While we also use behavioral measures to capture implicit associations with equality initiatives which tend to be less affected by social desirability (Greenwald et al., 2009), future work may longitudinally monitor engagement with university initiatives after participating. Yet, implicit measures were not collected in Experiment 2. Thus, results from the second iteration of the intervention may be limited by social desirability. Further, while virtual reality is common in facilitating perspective-taking (Herrera et al., 2018; Ventura et al., 2020), limitations include the depth of immersion felt by participants (Herrera et al., 2018) and whether the exercise promoted empathy. While manipulation checks indicated virtual reality facilitated perspective-taking, we did not assess empathy to minimize demand characteristics. Traditional paradigms outside of virtual reality were also not used to compare as prior work has done (Oh et al., 2016). However, traditional perspective-taking used in Experiment 2 (i.e., writing narrative essay) suggested this approach may have been effective in facilitating perspective-taking as a female scientist.

While the manipulation of blame in Experiment 2 was consistent with prior work which fostered guilt via attributing blame using interpersonal versus human-level categorizations (Wohl & Branscombe, 2005), other work has manipulated guilt by alleviating blame via promoting lack of control over the situation (e.g., no one is responsible for disparities; Rothschild et al., 2012). Thus, future work may consider how completely alleviating blame for inequalities may impact support and internal motivations to take part in initiatives. Further, while gender inequalities in STEM were explicitly linked to men's social identity via assigning blame, levels of guilt were not assessed to avoid demand characteristics. Promotion of self-efficacy was also brief compared to prior work (e.g., Carnes et al., 2012; Zawadzki et al., 2012), as participants were only given a list of tools to reduce bias. Yet, findings suggest brief discussion of tools promoted confidence in addressing gender biases among male educators. Relatedly, while this manipulation was meant to foster self-efficacy, it may have affected learning mindsets. For instance, instructing participants stereotypes are static and difficult to change may have promoted fixed mindsets (i.e., associated with poorer behavior change) whereas instructing men that stereotypes are malleable may have promoted growth mindsets which often facilitate behavior change (Duchi et al., 2020; Wohl et al., 2015). Thus, future interventions may benefit from promoting dynamic over fixed mindsets.

Samples only contained STEM academics, since this population is relevant for the development of gender equality initiatives due to their majority status in these fields. Thus, findings may not generalize to fields or professions which do not have the expertise to evaluate the scientific evidence used in the manipulations. Female academics were also not recruited for these experiments, who may also hold negative attitudes towards equality initiatives due to fears their achievements may be attributed to interventions and positive discrimination (Ovseiko et al., 2017). Future research might include minority group members to determine if perspective-taking is effective across genders. For example, women taking the perspective of a successful female scientist may reduce the consequences of being a minority in STEM (Starr et al., 2019), while highlighting injustices and promoting self-efficacy promote equality attitudes and leadership among women (Becker & Swim, 2011; Carnes et al., 2012). Similarly, whether manipulations differ by source is unclear as information was always presented by a man in the present studies, since men are more likely to engage in equality-focused action when messages come from male sources (Hardacre & Subašic, 2018). Thus, whether men respond negatively to information when presented by female sources, and how these presentations may differentially impact women, should be addressed in future research. Lastly, experiments do not address racial disparities or intersectionality (e.g., female racial minorities) which are more severe than gender inequalities and further reduce student and faculty advancement in STEM (e.g., Charleston et al., 2014).

Notably, the present findings are informed by male academics recruited from a diverse range of career stages (e.g., PhD students, postdoctoral researchers, lecturers, and professors). However, our interventions may have differentially impacted participants based on their current academic position and experience in STEM. For instance, PhD students may not feel responsible for inequalities due to having little power to facilitate change needed to achieve gender equality. Postdoctoral researchers or staff on temporary or part-time contracts may also not feel motivated to engage with interventions if they are only employed temporarily. While interventions tested in these experiments were unaffected by academic position, other sociodemographic factors might impact engagement which were not assessed. For example, seniority within faculty positions may provide insight into potential resistance towards gender parity, given senior academics may contribute to poorer experiences among women students and faculty (O'Connell & McKinnon, 2021). Unfortunately, faculty seniority was not assessed in the present experiments to minimize identification of participants. However, analyses were unaffected by age which tends to capture similar career traits as seniority among STEM academics (Hall & Mansfield, 1975). Further, while part-time employees were not excluded from the studies, all participants reported full-time employment at their university. Thus, future work may examine whether interventions may differentially impact support for equality initiatives among academics in early versus late career stages, in addition to understanding motivations among part-time versus full-time academics.

Practical implications and conclusions

The current research deepens our understanding of how to best facilitate support for equality programs through perspective-taking, promoting awareness of inequalities and self-efficacy, and creating a sense of responsibility through promotion of guilt. Interventions should provide data-driven presentations outlining prevalence and consequences of gender inequalities in STEM, in addition to methods educators may use to address these disparities in the classroom and during hiring decisions, as this evidence can reduce ignorance and promote their confidence in improving inequalities (Callaghan et al., 2021; De Souza & Schmader, 2022; van Zomeren et al., 2008). This evidence may also provide greater context of the lived experiences of women in STEM, leading to more immersive perspective-taking among male educators. Importantly, using virtual reality to deliver interventions may provide greater immersion compared to the traditional paradigms (Herrera et al., 2018). However, as demonstrated in Experiment 2, these interventions might be scalable through utilizing online formats if virtual reality is unfeasible.

Results demonstrate how perspective-taking as a female scientist can promote support for equality initiatives, particularly when educators accurately perceive the severity of disparities in STEM. Support for initiatives may further be promoted through overtly blaming men for gender inequalities, in addition to providing male educators with practical solutions to address diversity issues. These findings are guided by the social identity model of collective action (van Zomeren et al., 2008, 2018), suggesting equality-focused action is unlikely to occur until individuals are made aware of injustices, in addition for injustices to be highly relevant to one's social identity and for individuals to feel confident in addressing disparities. The techniques discussed not only offer a recipe for creating effective interventions for educators but also provide a foundation for high-tech training tools to be widely used by equality initiatives within higher education.

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Declarations

Conflict of interest The authors have no conflicts of interests or competing interests to declare.

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Current Themes of Research

Recent work from the authors informs understanding of gender disparities within STEM fields, such as the role of stereotypes and discrimination, in addition to development of interventions to improve engagement with equality initiatives within higher education to achieve gender parity.

Relevant Publications

Jones, A., Turner, R. N., & Latu, I. M. (2022). Resistance towards increasing gender diversity in masculine domains: The role of intergroup threat. *Group Processes & Intergroup Relations*, *25*(3), 24-53.

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