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The Role of Gender in Team Collaboration and Performance

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Given that women continue to be underrepresented in STEM (Science, Technology, Engineering and Math) and that scientific innovations are increasingly produced by team collaborations, we reviewed the existing literature regarding the effects of gender diversity on team processes and performance. Recent evidence strongly suggests that team collaboration is greatly improved by the presence of women in the group, and this effect is primarily explained by benefits to group processes. The evidence concerning the effect of gender diversity on team performance is more equivocal and contingent upon a variety of contextual factors. In light of the importance of collaboration in science, promoting the role of women in the field can have positive practical consequences for science and technology.

KEYWORDS Collective intelligence, Team work, Women in science, Gender diversity of teams, Team performance

Introduction

Women continue to be underrepresented in STEM (Science, Technology, Engineering and Math) on multiple levels, ranging from undergraduate and graduate enrolment to positions in industry and at universities (National Science Foundation 2009). Though some progress has been made to close this gender gap in the past few decades with women's enrollment increasing in Bachelor's and Master's degree programmes, the gap persists, especially in managerial and other top-level positions in both corporations and academe. A variety of reasons have been given for this gender gap, including bias and discrimination, a lack of role models, differential access to social networks, and issues related to work-life balance and family responsibilities (Blackwell *et al.* 2009; Blickenstaff 2005; Fox 1991; Kyvik and Teigen 1996; Sonnert *et al.* 2007). In light of these potential causes, governments and universities conduct

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mentoring and career development programmes for women specifically aimed at closing this gap (Blickenstaff 2005; Cronin and Roger 1999). Thus, the causes and proposed solutions are primarily framed on the individual level, i.e. in terms of the way individual women confront these issues (Corley 2005). However, scientific work is not conducted in isolation, and scholars have also pointed out the necessity of institutional solutions for closing the gender gap (Corley 2005).

We maintain that, between the individual and institutional levels, there is another level that plays a crucial role in scientific work — teams. Indeed, a recent review of decades of scientific articles and patent applications has revealed that our most important scientific innovations are increasingly produced by collaborating teams (Wuchty *et al.* 2007). Moreover, recent evidence strongly suggests that group collaboration is greatly improved by the presence of women in the group (Woolley *et al.* 2010). Taken together, these recent findings imply that promoting the role of women in STEM can have positive consequences for scientific productivity by enhancing the quality of collaboration taking place in teams. Thus, in order to both promote more successful collaborations as well as improve our understanding of the persistent gender gap in science, it is important to examine the effect of gender diversity on team collaborations. With these aims in mind, we review the existing evidence regarding the effects of gender diversity on team processes and performance.

Effects of gender diversity on team process and performance

Does gender diversity matter for team processes and performance? This question has been the subject of numerous empirical studies, meta-analyses and literature reviews (e.g. Baugh and Graen 1997; Bowers *et al.* 2000; Chatman and O'Reilly 2004; Ely and Thomas 2001; Jackson *et al.* 2003; Joshi and Roh 2009; Mannix and Neale 2005; Myaskovsky *et al.* 2005; Pelled 1996; Stewart 2006; Webber and Donahue 2001). Overall, existing research suggests that gender diversity can have a positive effect on group process, while its effect on performance is fairly equivocal and dependent to some degree upon the context of the work.

In terms of group process, recent evidence strongly suggests that group collaboration, as indexed by collective intelligence, is greatly improved by the presence of women in the group (Woolley *et al.* 2010). The collective intelligence of a system resides in the connections among the units and their patterns of behaviour (Losada and Heaphy 2004). Collectively intelligent patterns of behaviour are responsive to the accomplishment of desired outcomes, rather than the mindless enactment of prescribed processes or routines. This is akin to the 'heedful interrelating' discussed by Weick and Roberts (1993) as supportive of the development of collective mind. 'Heedful performance is not the same thing as habitual performance. In habitual action, each performance is a replica of its predecessor, whereas in heedful performance, each action is modified by its predecessor' (Weick and Roberts 1993, 362). Thus, collective intelligence is evident in the consistency of the outcome quality a collective produces across domains, as a result of the

responsiveness of members to one another and to the shifting performance contingencies in dynamic situations.

Woolley *et al.* (2010) found that the proportion of women in a group is strongly related to the group's measured collective intelligence. Upon further examination, they found that the effects were explained in part by the higher levels of social sensitivity exhibited by women, based on their greater ability to read nonverbal cues and make accurate inferences about what others are feeling or thinking. Groups with more women also exhibited greater equality in conversational turn-taking, further enabling the group members to be responsive to one another and to make the best use of the knowledge and skills of members.

The findings of Woolley *et al.* (2010) are consistent with related research on the effects of gender diversity on group process. In a study of group performance in a business simulation, Fenwick and Neal (2001) found that groups with equal numbers of men and women and/or groups with a greater number of women than men performed better than homogeneous groups on a management simulation task, and this effect was explained by more effective collaborative group processes and cooperative norms. Likewise, a study by Jehn and Bezrukova reported in Kochan *et al.* (2003) found that gender diversity increased constructive group processes. In some cases, however, the effects of gender diversity on group process also depend to some extent on context. For example, in a study of a Fortune 500 firm in the information processing industry by Joshi and Jackson, also reported in Kochan *et al.* (2003), the authors initially found no effects for team-level gender diversity on team cooperation. However, when they included regional location of the teams in the analysis, they found a positive relationship between team gender diversity and team cooperation within regions that were diverse in terms of gender. Thus, contextual effects also play a role in the effects of gender diversity on team processes.

These findings concerning the effect of gender diversity on group process are also consistent with past work examining the effect of gender on interpersonal communication in groups (Carli 2010). For example, in a meta-analysis comparing men and women in terms of task and interpersonal styles, Eagly and Johnson (1990) found that women were significantly more interpersonally oriented than men. Men's style was more autocratic than women's, i.e. involved giving orders, whereas women's style was more democratic than men's, i.e. focused on participation. In addition, when comparing all-female versus all-male groups, all-female groups demonstrate more egalitarian behaviours, such as equal amounts of communication among group members and shared leadership (Berdahl and Anderson 2005; Schmid-Mast 2001). Finally, in conversation, men display more social dominance-related behaviour while speaking than women, such as chin thrusts, gesturing, and direct eye contact, while women engage in more smiling whether they are speaking or listening (Dovidio *et al.* 1988).

These different interpersonal styles may help to explain the positive effect of gender diversity on team processes and collaboration, since greater gender heterogeneity increases the likelihood of participation among team members. Research on gender and influence in groups has shown that men's and

women's level of influence is most equal in gender-balanced groups, further reinforcing the relationship between heterogeneous gender composition of groups and improved group process (Carli 2001; Craig and Sherif 1986; Taps and Martin 1990). In addition, in an experimental study in which solo versus majority status was manipulated (groups with two women and one man and vice versa), solo women were less talkative than women in the majority whereas the opposite was true for men (Myaskovsky *et al.* 2005). Similarly, gender diversity also appears to have a positive effect on the psychological experience of group members, with members of heterogeneous groups reporting greater feelings of efficacy about their tasks (Lee and Farh 2004) and better morale (Jehn *et al.* 1999) than members of homogeneous groups. In sum, gender diversity benefits group processes in a variety of ways, and these benefits appear to stem from gender differences in attitudes and behaviours during group interactions.

In evaluating group performance, the effects of gender diversity become slightly more complex. The results of several meta-analyses have shown either no effects or slightly negative effects for gender heterogeneity of team members on team performance, which is typically measured in terms of both objective performance indicators, such as financial outcomes, as well as subjective ratings of team effectiveness by team members and/or supervisors (Bowers *et al.* 2000; Jackson *et al.* 2003; Stewart 2006; Webber and Donahue 2001). Other research has shown that the effect of gender diversity on team performance depends upon a variety of moderators, such as task difficulty (Bowers *et al.* 2000), type of team (Stewart 2006), the presence and activation of social divisions or 'faultlines' within the team (Lau and Murnighan 1998; Pearsall *et al.* 2008), and the other types of demographic diversity present in the team (Pelled *et al.* 1999).

However, some scholars maintain that the preponderance of equivocal findings does not mean that the effects of gender diversity are non-existent, but rather that the effects should be investigated in light of organizational context (Joshi and Roh 2009; Kochan *et al.* 2003). They argue that, since empirical work on diversity in teams grew out of self-categorization theory (Tajfel 1981), which concerns the ways in which the salience of differences among team members can lead to certain attitudes and behaviours, contextual factors become paramount for understanding the influence of diversity. In other words, in male-dominated professions, where women are likely to be in the significant minority, initially gender diversity is likely to have more negative effects, given that gender stereotypes are more salient due to the increased categorization of underrepresented women (Kanter 1977). In contrast, in gender-balanced professions, negative stereotyping and categorization by gender are less likely to occur and thus gender diversity should be less problematic. This point is especially relevant to understanding the role of gender diversity in STEM, given that most STEM professions tend to be male-dominated.

Indeed, research shows that in occupations dominated by males, such as teams of engineers, gender diversity has strong, negative effects on team performance, whereas in gender-balanced occupations, gender diversity has significantly positive effects on team performance both in terms of objective

(e.g. financial outcomes, product quality) and subjective (e.g. self-rating, supervisor rating) measures (Joshi and Roh 2009). These findings are consistent with the work of Allmendinger and Hackman (1995) on the integration of women into symphony orchestras. The integration of women into male-dominated orchestras led to declines in member satisfaction and social functioning when the proportion of women was below 50%, but as the proportion increased, those trends flattened or reversed (Allmendinger and Hackman 1995). This suggests that integrating women into traditionally male-dominated fields may be difficult initially, but should get better as their representation approaches parity with men. These effects should accrue as greater participation of women in a setting allows for negative stereotypes to fade and for their expertise and contributions to be more accurately recognized. For example, in examining scientific collaboration more directly, Joshi (2010) found no effects for gender composition of teams on productivity and innovation, but found that when women's influence in the group was misaligned with their expertise (i.e. they had more expertise than others attributed to them), the productivity of the team was negatively affected.

Implications for scientific teams

Overall, the findings from the literature concerning the effect of gender diversity on team performance suggest benefits for team process but mixed results for team outcomes. Despite the somewhat equivocal nature of the literature, two consistent themes emerge — the importance of context in moderating the effects of gender diversity on performance and the generally positive effects of gender diversity on group processes. Both of these themes are extremely relevant to scientific work and should also be taken into consideration in light of the persistent gender gap in STEM.

Given that gender diversity is more likely to have a negative effect on performance in male-dominated versus gender-balanced industries (Joshi and Roh 2009), the lack of gender balance in scientific teams may be detrimental to scientific innovation. Furthermore, the aforementioned research implies that gender-balanced teams lead to the best outcomes for group process in terms of men and women having equal influence (Carli 2001; Craig and Sherif 1986; Taps and Martin 1990), participating at an equivalent rate (Myaskovsky *et al.* 2005) and being satisfied with their group collaboration experiences overall (Jehn *et al.* 1999). Thus, having a few 'token' women on scientific teams does not appear to be sufficient in order to improve performance, and, based on past research could even have detrimental social consequence in the short term (Allmendinger and Hackman 1995). In addition, scientific research is conducted within teams of individuals with varying levels of expertise, in varying career phases, and with a variety of demographic differences such as gender, age, ethnicity and national origin. As Joshi (2010) demonstrated, in this context, the effect of gender on performance may interact with other dimensions of diversity such as expertise and status within the team, leading the expertise of women to be underutilized, to the team's detriment. In sum, the underrepresentation of women in STEM not only means that scientific teams may be missing out on female talent, but it also means that the women

who are members of STEM teams may not be participating to their fullest if they are a significant numerical minority or solo members of teams.

Furthermore, the positive effects of gender diversity on group processes are extremely relevant to scientific teams, since scientific discoveries are increasingly the products of team collaboration (Wuchty *et al.* 2007). As Woolley *et al.* (2010) showed, enhanced interaction and communication in teams with greater numbers of women, as well as egalitarian rather than autocratic norms, improve group processes, which, in turn, facilitate increased collective intelligence. Collective intelligence is not correlated with the intelligence of individual group members but rather with the quality of the social interaction processes within the group, which are correlated with the proportion of females in the group. Given the degree to which collective intelligence predicts performance on innovative tasks as demonstrated by Woolley *et al.* (2010), it is critical to higher levels of performance in the scientific domain.

Conclusion

Gender diversity in STEM is often advocated for social and political reasons. To be sure, enabling equal access to and participation in STEM fields is a worthy social goal in and of itself. However, based on the evidence regarding the effects of gender balance in teams, gender diversity can also enhance group processes, which are increasingly important as collaboration becomes a centrepiece in the production of science. The enhancement of group processes and higher levels of collective intelligence can, in turn, lead to greater innovation and scientific discovery. Thus, the findings reviewed here imply that, when evaluating the gender gap in STEM, it is not enough to simply examine the number of women in a particular institution or role. In order to reap the rewards of gender diversity, it would be most beneficial to ensure that women are represented in collaborative scientific teams at parity to men. Thus, the current focus by universities and industry on individual women's career paths as a way to increase the number of professional women in STEM is laudable. However, in order to be truly effective, the role that women play in scientific teams should also be taken into consideration and promoted in order to yield the substantial benefits of increased gender diversity.

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