Men are from Mars and women are from Venus: dyadic collaboration in the metaverse

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Abstract

Purpose – The gender composition of teams remains an important yet complex element in unlocking the success of collaboration and performance in the metaverse. In this study, the authors examined the collaborations of same- and mixed-gender dyads to investigate how gender composition influences perceptions of the dyadic collaboration process and outcomes at both the individual and team levels in the metaverse.

Design/methodology/approach – Drawing on expectation states theory and social role theory, the authors hypothesized differences between dyads of different gender compositions. A blocked design was utilized where 432 subjects were randomly assigned to teams of different gender compositions: 101 male dyads, 59 female dyads and 56 mixed-gender dyads. Survey responses were collected after the experiment.

Findings – Multilevel multigroup analyses reveal that at the team level, male dyads took on the we-impress manifestation to increase satisfaction with the team solution. In contrast, female and mixed-gender dyads adopted the we-work-hard-on-task philosophy to increase satisfaction with the team solution. At the individual level, impression management is the key factor associated with trust in same-gender dyads but not in mixed-gender dyads.

Originality/value – As one of the pioneering works on gender effects in the metaverse, our findings shed light on two fronts in virtual dyadic collaborations. First, the authors offer a theoretically grounded and gendered perspective by investigating male, female and mixed-gender dyads in the metaverse. Second, the study advances team-based theory and deepens the understanding of gender effects at both the individual and team levels (multilevel) in a virtual collaboration environment.

Keywords Gender, Effort, Collaboration, Impression management, Dyad, Virtual team, Virtual world, Trust, Satisfaction, Multilevel, Metaverse, Multigroup

Paper type Research paper

Introduction

In team collaborations, gender differences strongly influence team members' behaviors and task outcomes (Igbaria and Baroudi, 1995; Riedl *et al.*, 2010). People often form expectations and beliefs about their partners based on gender (Berger *et al.*, 1977). Additionally, the gender of team members can affect one's perceptions and performance in the team (Kenny and

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Garcia, 2012). Similarly, the influence of gender is present in virtual collaborations (Gefen and Ridings, 2005; Gefen and Straub, 1997; Hess *et al.*, 2005; Nah and Eschenbrenner, 2016; Weber *et al.*, 2009). As Gray (1992) pointed out in his book "Men are from Mars, Women are from Venus", a man's sense of self is defined by his ability to achieve results, and a woman's sense of self is defined through her feelings and relationships. The way a female feels about her female partner(s) is also different from the way she perceives her male partner(s), which can affect the collaboration process and outcomes (Gefen and Ridings, 2005; Hess *et al.*, 2005). Given that females and males are perceived to possess different degrees of computer self-efficacy (Gefen and Straub, 1997), different expectations and behaviors could arise during virtual collaborations in the metaverse.

The metaverse affords immense opportunities for team collaboration (Siau *et al.*, 2010). The term metaverse is often used interchangeably with virtual worlds. Some scholars refer to the metaverse as an interactive, immersive, and collaborative virtual world environment shared among users (Kim, 2021). Others define it as "an integrated network of 3D virtual worlds" (Dionisio *et al.*, 2013, p. 1). Hence, we use metaverse to refer generally to the virtual world environment. People socialize and work collaboratively in virtual worlds that are interactive, dynamic, and supported by rich environmental graphics (Animesh *et al.*, 2011; Nah *et al.*, 2010, 2011, 2017; Schiller *et al.*, 2014; Schultze and Orlikowski, 2010). It is, therefore, important to understand how gender influences team collaborations in the metaverse.

Most research undertaken on gender and team collaboration examined how gender and gender roles influence perceptions and behaviors at the team level. The literature has shown that gender differences have a strong influence on team behaviors and outcomes (Gefen and Straub, 1997; Igbaria and Baroudi, 1995; Riedl *et al.*, 2010), such as in group decision-making (Robert *et al.*, 2018). Some scholars focused on the gender identity of teams. The way females feel about their female partners is different from the way males perceive their male partners, which, in turn, affects perceptions of the collaboration process and outcomes (Gefen and Ridings, 2005; Hess *et al.*, 2005). Scholars found that the gender of one's interacting partner affects one's perceived role in a dyad (Athenstaedt *et al.*, 2004) and same-gender teams can outperform mixed-gender teams in performance and effectiveness of interaction (Astin, 1977; Lee and Bryk, 1986), performance ratings by team members, (Baugh and Graen, 1997), and the generation of novel and creative ideas (Klein and Dologite, 2000).

How do same- and mixed-gender groups affect team collaboration in the metaverse? Some research has examined gender roles in group use of technology for communication (Gefen and Ridings, 2005; Hess *et al.*, 2005; Nah and Eschenbrenner, 2016; Weber *et al.*, 2009), yet, to the best of our knowledge, no empirical study has investigated gender mix in team collaboration in the metaverse. Therefore, our research aims to understand how gender mix influences two important variables in team collaboration, satisfaction and trust, in the metaverse.

Theoretical foundation and background

The concept of gender has been well-developed and studied in the literature (Vanwesenbeeck, 2009). Two theories are relevant to the understanding and application of gender differences in this research - Expectation States Theory and Social Role Theory.

Expectation states theory

Expectation States Theory (EST) explains how expected competence forms the basis for status hierarchies in small groups (Berger *et al.*, 1977, 2014). The theory focuses on interpersonal behavior and expectations among team members (Berger *et al.*, 1974) with a

theoretical basis well-grounded in groups, teams, and dyads (Miles and Clenney, 2010). According to EST, expectations shape the characteristics of individuals and how they perform in groups. Every group has a status structure, which functions like a power or prestige structure, and higher status affords advantages and more opportunities to influence others (Correll and Ridgeway, 2006).

EST explains gender differences in the group or collaborative setting. EST posits that we anticipate the quality of people's task performances based on their status characteristics, i.e. attributes on which people differ (Berger *et al.*, 1977; Correll and Ridgeway, 2006). Like race and age, gender is one characteristic that shapes people's ability to participate, influence, and receive a positive evaluation from others in a group (or society) (Correll and Ridgeway, 2006; Wagner and Berger, 1997). Gender differences are social differences. Our society holds widely accepted cultural beliefs and general expectations about gender. For example, men are perceived as more competent and better at performing certain tasks than women (Miller and Halpern, 2014; Wagner and Berger, 1997). Gender stereotypes embody gender inequalities (Howcroft and Trauth, 2008), leading to hierarchies of gender status. For instance, men often speak more, and women are more often interrupted in a group setting (Craver, 2002; Ridgeway and Smith-Lovin, 1999). The higher perceived status of men leads to a higher expectation state than women (Luse *et al.*, 2022), who are perceived to have lower status and expectation states in a group setting.

Social role theory

Social Role Theory (SRT) (Eagly, 1987; Eagly and Kite, 1987) explains the cognitive and behavioral differences between individual females and males. The concept of *gender roles* refers to socially and culturally defined behaviors, emotions, activities, and attributes (Anselmi and Law, 1998). Most gender roles have normative expectations, and SRT explains gender differences in the context of normative roles. It posits that gender differences are the products of arbitrary socialization experiences. The expectancies of the social behavior of each gender are instrumental in developing gender stereotypes. Accordingly, men and women conform to these expectations, i.e. the stereotypes of their social roles. Men develop traits such as the inclination to be independent, assertive, and competent. Women develop traits that manifest communal or expressive behavior, entailing the tendency to be friendly, unselfish, and expressive (Eagly and Wood, 1991; Hyde, 2014). If a person's behavior is consistent with his/her prescribed social roles, he/she is generally viewed favorably. However, if a person's behavior violates what is considered acceptable for his/her gender, he/she is likely to be viewed negatively.

Research in the business domain has started to explore distributed collaborations in virtual teams, virtual communities, and the metaverse, where gender remains a complex topic in a virtual group setting. Team members' expectations, actions, and reactions often mirror gender stereotypes. Historically, men have dominated by leading tasks and focusing on action. Women are often viewed as playing a supportive role by caring for and supporting their team members, as well as perceiving emotions and feelings in the team (Awad and Ragowsky, 2008; Riedl *et al.*, 2010).

Trust and satisfaction in team collaboration

Trust has been explored in traditional and virtual work teams (Kim *et al.*, 2012; Larson and LaFasto, 1989; Mayer *et al.*, 1995; Schiller *et al.*, 2014). Trust refers to the willingness of a party to be vulnerable to the actions of another by reducing the need for control (Hill, 1990; Mayer *et al.*, 1995). Trust is established between two individuals; therefore, understanding the dyadic structure is important as it provides the basis for more complex social groupings (Lusher *et al.*, 2014). Trust is highly important for effective team processes (Kanawattanachai

and Yoo, 2002; Mennecke and Valacich, 1998) as the lack of trust is a primary reason for undermining effective teamwork (LaFasto, 2001; Larson and LaFasto, 1989). In the context of virtual collaboration, research shows that the impact of trust is of increasing significance as individuals are less familiar with others in their virtual team due to the geographic disparities of the team members (Schiller *et al.*, 2014). Overall, trust is shown to be an important dyadic construct, especially in a virtual environment, but how does impression management by team members affect trust in same- and mixed-gender teams in the metaverse? We could not find existing literature that has examined this relationship, and this is an important gap to be bridged.

In addition to trust, the characteristics of oneself and one's virtual team or community can affect perceptions of team performance and continued use of a virtual world (Kim *et al.*, 2012). For example, social identity theory and self-categorization theory suggest that the shared commonality of group members leads to increased collaboration (Hogg *et al.*, 1995), with the effectiveness of this collaboration leading to satisfaction (Driscoll, 1978; Gladstein, 1984). Satisfaction for those in homogeneous teams tends to be higher because of the similarity or affinity of members (Jarvenpaa and Leidner, 1999; Schiller *et al.*, 2014). Given the impact of group member commonality in homogeneous teams, satisfaction could be affected by the gender composition of dyadic teams. However, does impression management have an effect on team satisfaction with the solution, and if so, does this relationship differ between female-only teams, male-only teams, and mixed-gender teams? Does team effort have an impact on team satisfaction with the solution, and if so, does it differ across different team compositions? We did not find existing studies that have addressed these questions in the metaverse or virtual collaboration environment.

Impression management in team collaboration

Impression management refers to the process by which individuals attempt to control the formation of an impression of others toward themselves (Leary and Kowalski, 1990). Previous research has investigated the impact of impression management on dyadic relationships within the workplace, and findings have shown a significant effect of impression management on interpersonal outcomes (Harris *et al.*, 2007; Schiller *et al.*, 2014; Wayne and Green, 1993; Wayne and Liden, 1995). Impression management has also been explored in online contexts and shown to be an important driver of individual actions. In contrast, impression construction has been found to include difficult or impossible methods in an offline context (Chester and Bretherton, 2007). Hence, impression management within dyadic relationships may impact team collaboration, but how impression management affects team satisfaction with their solution in different gender compositions in the metaverse or virtual collaboration context has not been studied previously.

Team effort in collaboration

Team effort is the extent to which team members devote their resources (energy, attention, and time) to executing team tasks (Yeo and Neal, 2004). The effort is also important for relationship development that positively impacts the dyadic relationship (Liden *et al.*, 2016; Maslyn and Uhl-Bien, 2001). In a hedonic setting, success in collaborative gaming has been shown to mirror work settings in its reliance on the individual efforts of team members (Goh and Wasko, 2012). Cognitive effort during collaborative learning within virtual worlds is critical in fostering interaction in these environments (Kahai *et al.*, 2013). Overall, effort is an important ingredient when assessing dyadic interaction both in the real and virtual worlds, but the effect of impression management on trust in different gender compositions has not been studied in the virtual environment.

Our research examines the roles of gender in virtual collaborative task performance concerning trust, solution satisfaction, impression management, and effort in a virtual world. In the next section, we will develop the hypotheses by drawing on the above theoretical bases.

Hypothesis development

This research hypothesizes differences in impact among variables at both the team and individual levels. Multilevel analysis is used when the independence assumption is violated due to nested data (Peugh, 2010). In other words, we are interested in the differences across individuals (i.e. within specific groups) and the differences across the various group types – i.e. how team members view each other differently within specific groups and what differentiates these groups as a whole.

Impression management in same- and mixed-gender teams

EST posits that members of a group have a shared focus or goal. Naturally, a group is pressed to decide how it should act to deliver its best performance. Therefore, group members hold certain expectations of each member's contribution to an act, which are referred to as performance expectations (Berger *et al.*, 1974; Correll and Ridgeway, 2006). Some individuals are *perceived* to be able to make more valuable contributions toward the team's goal accomplishment. They are therefore *expected* to perform at a higher level (performance expectation state) than others. People also anticipate higher status members to make a relatively higher quality contribution to complete the team task (Berger *et al.*, 1992, 1998, 2014; Correll and Ridgeway, 2006).

How are some group members perceived to be more competent than others? We believe impression management plays a key role. Impression management, or self-presentation, is the control of self-image and the influence on how others perceive oneself (Goffman, 1959; Leary *et al.*, 1994; Rosenfeld *et al.*, 1995). In performing collaborative tasks, the social consequences of being perceived positively (such as being competent) can help members attain valued goals (Goffman, 1959; Schlenker, 1980). Favorable impressions can directly affect attitudinal and perceptual outcomes, such as satisfaction (Gardner and Martinko, 1988; Wayne and Liden, 1995). Team satisfaction has long been considered an important team-level outcome for collaborative task performance (Behfar *et al.*, 2016; Green and Taber, 1980; Marks *et al.*, 2001). It reflects the effectiveness of teamwork and is shaped by team members' reactions and experiences. A favorable impression helps to increase team rapport and support (Kacmar and Carlson, 1999) and encourages members to perform better, which increases satisfaction with the team solution. In contrast, when team members form unfavorable impressions of each other, a lack of optimism or excitement can arise, which hinders communication and results in lower satisfaction with the team solution (Nguyen *et al.*, 2008; Roberts, 2005).

According to EST, better impressions perceived by team members lead to higher performance expectations. The greater the performance expectation, the more likely a member will be given opportunities to "speak up and offer task suggestions, ... and to perform in the group" (Correll and Ridgeway, 2006, p. 31) and continue to influence other team members. Gender differences, not surprisingly, play a role in impression management. EST states that gender is a significant social characteristic, and it directly influences performance expectations. Men and women use different tactics and strategies to form impressions according to their gender role expectations. Based on SRT, men focus more on "controlling their environment and obtaining tangible outcomes such as task completion" (Eagly and Karau, 1991, p. 686). In male groups, it is important to exhibit competence and maintain control to progress toward task completion (Zeman and Shipman, 1998). Thus, men present

themselves more favorably on attributes related to competence and accomplishment (Leary *et al.*, 1986). In line with SRT, "A man's sense of self is defined through his ability to achieve results" (Gray, 1992), where it is critical for males to demonstrate competence to each other. We, therefore, label such an implicit and often unconscious process *we-impress*, which refers to the need to impress others by demonstrating competence and control.

EST specifically addresses task-oriented small groups. It posits that a task group's goal can pressure the members to give their best performance. "Given the opportunity to prove his potential, a man expresses his best self" (Gray, 1992, p. 44). As a team, males *impress*, wishing to be perceived by others as competent and strong. On social media sites, males share photos that accentuate their status (Tifferet and Vilnai-Yavetz, 2014). Males are expected to exhibit leadership behavior and assume leadership roles (competent impression), even in all-male groups (Fişek *et al.*, 1991). Based on SRT, men are expected to exhibit agentic behavior and compete for power and status in a group setting (Eagly *et al.*, 2000). Hence, in male groups, intense competition to demonstrate competence and status is expected.

SRT posits that gender social roles are ubiquitous, such that males and females tend to engage in their respective social roles of being agentic for males and communal for females (Eagly *et al.*, 2000). Due to societal norms and expectations, it is important for males to present the impression that they are competent to enhance their status (Eagly, 1987; Eagly and Kite, 1987); they focus on task accomplishment and utilize impression management to fulfill this role of demonstrating competence in accomplishing a task, On the other hand, females are expected to fulfill the societal norm of being communal to facilitate teamwork and the team collaboration process (Eagly, 1987; Eagly and Kite, 1987). Hence, females tend to channel their attention toward social-emotional support and group maintenance. Therefore, given that males manage their impression by focusing their energy, resources, and effort on controlling and demonstrating competence on the task as compared to females, male dyads will exhibit a higher correlation or association between impression management and satisfaction with the team solution. Given this, we propose the following hypothesis:

H1. At the team level, the association between impression management and satisfaction with the solution is greater in male dyads than in female or mixed-gender dyads.

Effort in same- and mixed-gender teams

Women, on the other hand, focus on group maintenance and building relationships when working together. Hence, based on SRT, groups with female members tend to contribute less to task accomplishment when compared to male-only groups due to balancing task and socioemotional needs in a team. Male-only groups, on the other hand, are more likely to focus heavily on task accomplishment. Thus, in female-only or mixed-gender groups, the task orientation focus may be lower than in male-only groups such that the greater the effort channeled toward the task by females, the higher the team's satisfaction with the solution.

Scholars observed that the gender composition of teams changes the association between effort and team satisfaction (Archer, 1990; Hamlyn-Harris *et al.*, 2006; Powell *et al.*, 2004; Scandura and Lankau, 1997). In virtual teams, women value providing rapport and support through actions to meet the needs of other members (Cramer, 2002; Nolen-Hoeksema and Jackson, 2001; Strough and Berg, 2000). In addition, women are more aware of and concerned about maintaining relationships among team members (Eagly and Kite, 1987). However, on the downside, their socioemotional emphasis may result in them downplaying their focus and attention on task accomplishment. Therefore, to compensate for this shortfall, women who adopt a *we-work-hard-on-task* conception, which refers to focusing effort on task accomplishment, will result in greater team satisfaction with the solution.

EST explains gender as a diffuse status characteristic. People expect women to be better than men at some tasks, such as nurturing and supporting their team in achieving the best

outcomes (Berger *et al.*, 2014; Wagner and Berger, 1997). However, it is equally important, if not more important, for female team members to contribute effort toward task accomplishment to increase team satisfaction with the solution. Since women tend to focus more on the socioemotional needs of their team and less on task accomplishment, their effort on task accomplishment is emphasized and valued at a much greater level than men. Thus, the effect of task effort on satisfaction with the solution is stronger in dyads involving females than in male dyads. We, therefore, propose the following hypothesis:

H2. At the team level, the association between effort and satisfaction with the solution is lower in male dyads than in female or mixed-gender dyads.

Impression management at the individual level in same- and mixed-gender teams

At the individual level, interpersonal trust is extremely important to the successful collaboration of virtual teams (Jarvenpaa *et al.*, 1998; Jarvenpaa and Leidner, 1999). Trust helps members manage uncertainty, ambiguity, and vulnerability (Dirks, 1999; LaFasto, 2001; Lipnack and Stamps, 1997). More importantly, trust helps to reinforce interdependence among virtual team members to accomplish team goals. It fosters positive relationships and team behaviors such as proactive action, optimistic team spirit, and dynamic leadership (Jarvenpaa *et al.*, 1998). In a team context, the interpersonal trusting relationship is developed based on the expectations of other team members' performance (Hill, 1990; Lewis and Weigert, 1985) and is connected to impression management. The central philosophy of impression management is that it drives individuals to act in a favorable, socially accepted way to present a better image in front of others (Wayne and Liden, 1995). When team members engage in socially accepted behaviors, a more positive impression is developed, leading to an increased liking among the team members and positive trust evaluations of the team (Nguyen *et al.*, 2008). In fact, trust itself is called "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau *et al.*, 1998, p. 395). The improved image evokes positive feelings in others, which in turn, leads to a higher level of trusting beliefs toward other team members (Dirks, 1999).

The gender of the interacting partner is an important determinant of the interpersonal effect developed in social groups (Athenstaedt *et al.*, 2004). Gender characteristics reflected in cognitive, affective, and motivational dimensions are more prominent in same-gender dyads than in mixed-gender dyads. When working with a same-gender partner, gender characteristics are more prominent and produce more gender-stereotyped behaviors than when working with an opposite-gender partner (Aries, 1996; Hess and Bourgeois, 2010; Kray and Thompson, 2004; Maccoby, 1990, 1998). According to SRT, women and men use different modes of communication and reveal different types of information depending on whether they are working with people of the same or opposite gender. For instance, when women work with women, they value socio-emotional cues in impression management and adjust their behaviors to their partners more than when they work with men (Deaux and Major, 1987). This intensifies the effect of socio-emotional behaviors on team collaboration that is, in turn, positively assessed by female partners. Similarly, in male-only teams, task-oriented cues dominate impression management, which positively affects trust because of their shared interest and norm of focusing on task accomplishment (Singh and Vinnicombe, 2001). Hence, when working with same-gender partners, members experience more cooperation and common ground due to their shared social role (Athenstaedt *et al.*, 2004; Van Vugt *et al.*, 2007). They also interact more effectively and achieve higher effectiveness (Baugh and Graen, 1997) than when working with mixed-gender partners (Astin, 1977; Lee and Bryk, 1986), particularly in novel and creative idea generation (Klein and Dologite, 2000).

Impression management plays a major role in trust building (Singleton and Vacca, 2007). When interacting with the same gender, members experience more shared understanding in their impression management practice (Deaux and Major, 1987) and hence, develop greater trusting beliefs toward each other (Singh and Vinnicombe, 2001). When individuals work with a partner of a different gender, their trusting beliefs would not be as sensitive to impression management as in same-gender dyads because of differential social roles and limited common understanding. When working in a mixed-gender group, SRT explains that males tend to take control and assert a leadership role (Sczesny and Kühnen, 2004), which can undermine the effectiveness of reciprocal impression maintenance on trust. On the other hand, same-gender groups possess a unique psychological closeness, common understanding, and stronger psychological ties among the members. Hence, impression management produces greater trusting beliefs in same-gender groups. Therefore, in a dyad setting, we propose the following hypothesis:

H3. At the individual level, impression management has a greater association with trust for individuals interacting with a same-gender partner than an opposite-gender partner.

Research method

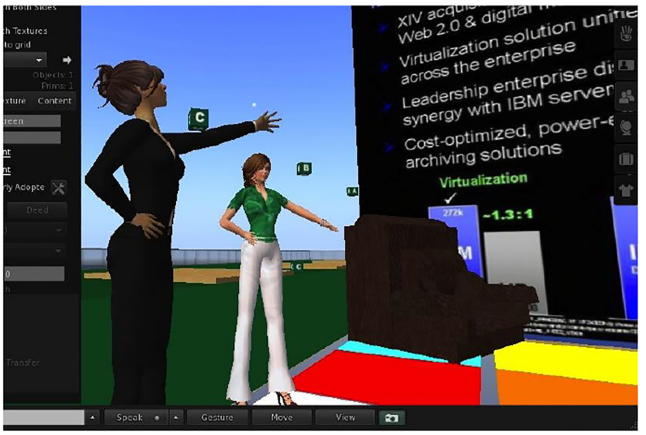
Experimental design

We chose dyads as our team setting because dyads are the most fundamental group form in everyday business communication. Every individual "participates in multiple dyadic relationships, and these relationships aggregate to form a complex social structure" (Ferrin *et al.*, 2006, p. 870). Further, 40% of all meeting time in organizations is spent in dyadic communication and collaboration (Panko, 1992), and most relationships are managed as dyads in virtual teams (Lurey, 1998).

Participants carried out a collaborative design task in the 3D virtual world, Second Life. Participants included graduate students enrolled in an MIS course. Each student was randomly paired with a partner with no prior working relationship. The participants met only in the virtual world and did not collaborate offline. Every participant created an avatar of the same gender. Each dyad was provided a 10-m by 10-m virtual workspace to illustrate an IT concept using 3D creative design. Participants were first guided through warm-up activities in the virtual world environment, including building basic prims and communication. Teams were given five weeks to complete the project. The completed team designs featured a variety of technical concepts such as server farms, green computing, VoIP, and disaster recovery. Figure 1 shows two female members working on their creative design. Participants completed both pre- and post-study surveys. The pre-study survey was used to gather covariate data to provide initial values unaffected by the study, while the post-study survey was used to measure the variables of interest. In all, 432 valid responses were received, including 101 male dyads, 59 female dyads, and 56 mixed-gender dyads. Table 1 shows the demographic statistics.

Measurement

The Appendix lists all the measurement items and their sources. To better tailor the measurement items for our context, we developed the measurement items for impression management and team trust by adapting existing instruments from the literature. Previous studies involving impression management often feature strategies used by individuals such as self-promotion, exemplification, and supplication (Bolino and Turnley, 1999) and hence, we developed four items for impression management (with one item being more encompassing and general) by adapting from their measures. Effort toward team collaboration was assessed using three items (effort, attention, and hard work) by adapting from Trent (1998).



Source(s): Authors' own creation/work

Figure 1.
Two members collaborating on a design

Age	Count	Percent	Education	Count	Percent	Second Life experience	Count	Percent	Years of Internet experience	
18–19	1	0.2	High School	12	2.8	None	398	92.1	Minimum	2
20–24	171	39.6	Bachelor's Degree	330	76.4	1 year	9	2.1	Maximum	21
25–29	131	30.3	Master's Degree	82	19	>1 year	9	2.1	Mean	11.65
30–34	56	13	Ph.D. Degree	7	1.6	Missing	16	3.7	Standard Deviation	3.2
>=35	73	16.9	Missing	1	0.2				Missing	1
Total	432	100.0	Total	432	100.0	Total	432	100.0	Total	432

Source(s): Authors' own creation/work

Table 1.
Demographic statistics

The trust measure was adapted from Jarvenpaa and Leidner (1999), and the satisfaction with team solution measure was adapted from Green and Taber (1980). Three control variables, propensity to trust, computer self-efficacy, and computer experience, were included in the analysis per previous research (Compeau and Higgins, 1995; Gerhard *et al.*, 2004; Jarvenpaa *et al.*, 1998, p. 57).

Common method bias was assessed using two techniques. First, we included one reverse-coded item in our measurement to reduce acquiescence problems (Lindell and Whitney, 2001). Reliability tests showed no sign of problematic issues. Second, we used Harman's one-factor test by entering all observed items into a principal component factor analysis and constraining them to a single factor. Results found no single unrotated factor accounted for the majority of the variance, with the single factor only accounting for 36.45% of the variance. Results from these tests demonstrated that common method bias was not an issue in our study.

Data analysis and results

Data were analyzed using multilevel and multigroup analysis. The multilevel analysis carried out the concurrent evaluation of team and individual differences; the multigroup

analysis evaluated different types of dyads – male-only dyads, female-only dyads, and mixed-gender dyads. Multilevel analysis helps to separate the variance in the dependent variable accounted for by individuals within a group and the common variance that impacts the dependent variable aggregated across everyone in the group (Snijders and Bosker, 1999). Most research uses either multilevel analysis (Akram *et al.*, 2022; Wang *et al.*, 2023; Zheng *et al.*, 2022) or multigroup analysis (Kwak *et al.*, 2021; Li *et al.*, 2022; Luse *et al.*, 2013; Shin *et al.*, 2022), but little research performs both. We believe our approach suits our specific research design and incorporates creative methodological solutions to solve complex research questions (Marsh and Hau, 2007).

Multilevel analysis adequately models the relevant unit of analysis for team-based research (Cronbach, 1976). It involves analyzing the variance components for the same construct at differing levels of analysis, whereas the team-level constructs are formed by statistical aggregations of individual-level responses to questions (Morin *et al.*, 2014). By modeling items at both levels, we prevent an ecological fallacy or the assumption that individual-level effects can be generalized to the team level (Robinson, 1950). While the team level may be the primary level of interest, these items must be estimated while controlling for individual-level differences on the same variable. Therefore, the multilevel analysis provides both a shared view at the team level and perceptions by individuals in those teams (Marsh *et al.*, 2012).

Multigroup analysis was used to further understand the differences between different teams (i.e. the shared, aggregated views formed by team members) as well as the views of individuals about their team when considering team types. Our research examines three different team types (all females, all males, and mixed gender). Multigroup analysis provides a robust test of the differences in effects between the different team types using equality-constrained testing. Given the multilevel nature of the data, multigroup analysis allows for an investigation of these differences at both the individual and team levels. At the *team* level, the gender composition of teams is expected to distinguish perceptions and outcomes across teams. At the *individual* level, multigroup analysis parses the within-team dynamics that function differently with a partner of the same or opposite gender.

To assess the structural and measurement models at both levels, we used covariance-based structural equation modeling (Blunch, 2012; Byrne, 2016) and a two-stage approach, which was used in prior studies (Dean *et al.*, 2006; Hess *et al.*, 2009; Son and Kim, 2008). First, we conducted a multilevel confirmatory factor analysis to verify the reliability and validity of the measurement model. Then, we used multilevel modeling with multigroup analysis to cross-validate the model and test the hypotheses.

Measurement model

Construct reliability and validity tests produced satisfactory results (see Tables 2 and 3). Past research has used a single measure of reliability for a construct across levels in a multilevel model (Raykov and Du Toit, 2005). More recent research suggests that single-level reliability estimates are not indicative of a scale's reliability, and instead, multilevel reliability should be assessed (Geldhof *et al.*, 2014). Both Cronbach's alpha coefficients and composite reliability estimates were above the recommended level of 0.70, indicating high reliability.

Validity assessment within a multilevel context is still somewhat novel. Recent research has suggested that the *primary* level of a multilevel construct may imply certain types of validity (Stapleton *et al.*, 2016). In our research, the constructs are traditionally individual-level constructs but show shared variance at the group level. Validity at the group level has been assessed using fit indices for the entire model (structural validity) and standardized loadings (indicator validity) (Stapleton *et al.*, 2016), and not Average Variance Extracted (AVE), which is suitable at the individual level.

Table 2. Inter-construct correlations, reliability, and validity tests

	Mean	S.D.	Composite reliability Alpha	Individual level	Group level	AVE	Correlations ImpMgmt	Effort	Trust	Satisfaction	CompExp	ComSelfEff	PropTrust
ImpMgmt	7.73	1.19	0.93	0.94	0.85	0.83	0.91						
Effort	8.11	1.00	0.91	0.92	0.89	0.80	0.71	0.89					
Trust	7.32	1.63	0.90	0.89	0.97	0.72	0.31	0.24	0.85				
Satisfaction	7.90	1.10	0.90	0.88	0.94	0.72	0.70	0.73	0.45	0.85			
CompExp	7.67	1.22	0.95	0.95	–	0.91	0.06	0.02	0.04	0.08	0.95		
ComSelfEff	6.70	1.10	0.88	0.88	–	0.71	−0.02	0.06	0.01	0.07	0.43	0.84	
PropTrust	5.01	1.62	0.87	0.87	–	0.70	0.11	0.20	0.11	0.17	0.00	0.09	0.83

Note(s):
S.D.: Standard deviation
Values of the square root of average variance extracted (AVE) are on the diagonal shaded in gray
ImpMgmt: Impression management
Effort: Effort toward task completion
Trust: Trust
Satisfaction: Satisfaction with team solution/outcome
CompExp: Computer Experience
ComSelfEff: Computer Self-efficacy
PropTrust: Propensity to Trust
Source(s): Authors' own creation/work

		Loading 1	Loading 2	Loading 3
GROUP	ImpMgmt	0.70	0.70	1.00
	Effort	0.68	0.90	0.98
	Trust	0.87	0.99	0.99
	Satisfaction	0.98	0.95	0.82
INDIVIDUAL	ImpMgmt	0.92	0.94	0.87
	Effort	0.81	0.94	0.93
	Trust	0.78	0.97	0.80
	Satisfaction	0.79	0.85	0.90
	CompExp	0.98	0.93	
	ComSelfEff	0.86	0.93	0.73
	PropTrust	0.79	0.85	0.87

Note(s):
ImpMgmt: Impression management
Effort: Effort toward task completion
Trust: Trust
Satisfaction: Satisfaction with team solution/outcome
CompExp: Computer Experience
ComSelfEff: Computer Self-efficacy
PropTrust: Propensity to Trust
Source(s): Authors' own creation/work

Table 3.
Multilevel confirmatory factor analysis standardized loadings

The structural validity of the multilevel construct was assessed using the fit indices of the multilevel CFA model. The model was found to fit the data well based on the fit indices ($\chi^2_{(258)} = 448.05$, $p < 0.001$, $CFI = 0.97$, $RMSEA = 0.041$, $SRMR_{within} = 0.047$, $SRMR_{between} = 0.102$), indicating adequate fit at both levels[1]. Table 3 shows each latent variable at each level of analysis along the left as well as each standardized loading of the observed items that were associated with each of these reflective constructs. As shown in Table 3, each construct loads high on its indicators (>0.6), indicating good indicator convergent validity. At the individual level, the AVE value for each latent construct was well above 0.5, indicating good convergent validity. The square roots of AVE values are all higher than their correlations with other constructs, indicating good discriminant validity (Chin, 1998; Gefen and Straub, 2005)[2]. Altogether, these analyses show good reliability and validity for our proposed model at both the individual and group levels.

Analysis and results

Multilevel modeling was used to test the research model, replacing pooled regression for analyzing dyadic data (Kenny *et al.*, 2006). The observed items were averaged for each respective construct to obtain a single-factor score (Comrey and Lee, 2013). Summed factor scores provide three advantages, including the easier interpretation and comparison across factors when the number of items differs across factors (DiStefano *et al.*, 2009), a good approximation of the true factors (DiStefano *et al.*, 2009; Skrondal and Laake, 2001), and alleviation of issues with model complexity (Geldhof *et al.*, 2014).

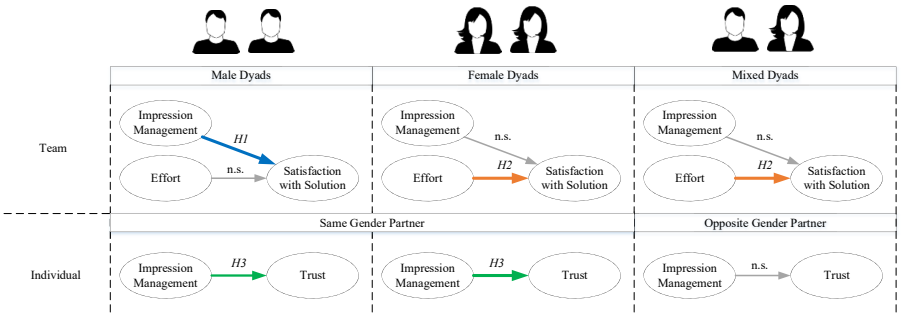
Before performing multigroup analyses in multilevel models, we assessed the need for multilevel modeling by evaluating whether group differences are apparent in the data. We ran a null multilevel model by including only the dependent variables of trust and solution satisfaction. For this model, we nested team members within teams but did not group the teams by team type (i.e. multilevel null model but no multigroup). As expected, the model was found to have a very poor fit on all measures ($\chi^2_{(2)} = 173.17$, $p < 0.001$, $CFI = 0.00$, $RMSEA = 0.45$, $SRMR_{within} = 0.244$, $SRMR_{between} = 0.574$), demanding the need for including

predictor variables at both levels. We found a significant amount of variance unexplained at both the team level ($\tau_{11\_Trust} = 0.83, p = 0.002$; $\tau_{11\_SatSol} = 0.28, p = 0.008$) and the individual level ($\sigma^2_{Trust} = 1.87$, $p < 0.001$; $\sigma^2_{SatSol} = 0.93$, $p < 0.001$) for both dependent variables, indicating that both individual and group-level predictors are needed. The intraclass correlation values were found to be well above the cutoff value of 0.1 (Muthen, 1997), indicating high unexplained variance, with both trust ($\rho = 0.33$) and solution satisfaction ($\rho = 0.27$) accounting for 33 and 27% of their variance across the different gender composition teams. These results demonstrate the need to use a multilevel analysis to include predictors at both the individual and team levels.

Next, we ran the multilevel model with all hypothesized predictor variables and all teams (i.e. multilevel model but no multigroup). A robust maximum likelihood (MLR) estimator was used to accommodate the non-independence of observations and the non-normality of variables (Muthén and Muthén, 1998–2015). The model was found to fit the data well on all fit measures at both levels ($\chi^2_{(0)} = 0.76$, $p < 0.001$, $CFI = 1.00$, $RMSEA = 0.000$, $SRMR_{within} = 0.008$, $SRMR_{between} = 0.006$). No significant amount of variance was found unexplained at the team level for either trust ($\tau_{11\_Trust} = 0.03$, $p = 0.93$) or solution satisfaction ($\tau_{11\_SatSol} = 0.04$, $p = 0.72$). The result indicates that adding the predictor variables of impression management and effort reduced the team-level variation by 96% for trust and 86% for solution satisfaction, supporting the addition of these predictors. While a significant amount of variance was found at the individual level for both trust ($\sigma^2_{Trust} = 1.65$, $p < 0.001$) and solution satisfaction ($\sigma^2_{SatSol} = 0.46$, $p < 0.001$), adding the predictor variables reduced the individual-level variation by 12% for trust and by 50% for solution satisfaction. The explained variance was found to be good at both the individual ($R^2_{Trust} = 0.11$, $R^2_{SolSat} = 0.48$) and team ($R^2_{Trust} = 0.96$, $R^2_{SolSat} = 0.89$) levels. The excellent fit measures, the reduction in unexplained variance, and the explained variance at both levels provide credence to the proposed research model.

To better understand the individual and team-level differences in the model, we ran a multilevel multigroup model with individuals nested within teams. We examined three team types (male-male, female-female, and mixed-gender). The model fits well at both levels and across team types ($\chi^2_{(0)} = 3.39$, $p < 0.001$, $CFI = 0.99$, $RMSEA = 0.000$, $SRMR_{within} = 0.02$, $SRMR_{between} = 0.01$). In addition, we found noticeable differences in the paths between impression management and the outcome variables for dyads of different gender mixes at both the individual and team levels. We ran an equality-constrained model to test the significance of the differences between groups (Hair *et al.*, 2006). The results show differences at the team level in impression management's impact on solution satisfaction and effort's impact on solution satisfaction. At the individual level, we found differences in the impact of impression management on trust. To test these proposed model differences, each of these five relationships was restricted to be equal across the three groups for the equality-constrained model. Using an adjusted chi-squared difference test for use with MLR estimation (Satorra, 2000), we compared the restricted model to the unrestricted model and found a significant chi-squared statistic ($\Delta\chi^2_{(10)} = 24.44$, $p = 0.006$).

Figure 2 illustrates the results. At the team level, impression management has a significant relationship with solution satisfaction in male dyads only (blue link) ($\beta = 0.78$, $p = 0.03$), supporting H1. Effort has a significant relationship with solution satisfaction in female dyads (orange link) ($\beta = 0.79$, $p = 0.003$) and mixed dyads (orange link) ($\beta = 2.03$, $p = 0.02$) but not in male dyads ($\beta = 0.30$, $p = 0.57$), supporting H2. Additionally, at the individual level, a significant, positive association is found between trust and impression management for those individuals in female dyads ($\beta = 0.43$, $p < 0.001$) and male dyads ($\beta = 0.32$, $p = 0.01$) (green links) but not in mixed-gender dyads ($\beta = 0.24$, $p = 0.15$), supporting H3. We included co-location as a covariate to account for its potential effects on the outcome variables, but they are not insignificant.



Source(s): Authors' own creation/work

Figure 2.
Multilevel multigroup model results

Discussion

This study aims to understand the role of gender in same- and mixed-gender teams at both the team and individual levels in a metaverse, or more specifically, a virtual world environment. Overall, our findings suggest that male, female, and mixed-gender dyads function differently. At the ***team*** level, impression management has a significant association with team solution satisfaction for male dyads only. Conversely, effort in task performance has a significant influence on team solution satisfaction for female and mixed dyads but is absent in male dyads. Hence, impression plays an important role for male dyads (*we-impress*), while effort directed toward the task is of primary importance for female and mixed-gender dyads (*we-work-hard-on-task*) in achieving team solution satisfaction.

Our findings at the team level are supported by EST and SRT. Berger and his colleagues demonstrated that socially significant characteristics such as gender could influence performance expectations in a collaborative context (Berger *et al.*, 1977, 2014). Recent applications of EST and SRT have advanced our understanding of gender research, specifically with studies showing that females need to do more in a collaborative context to prove their credibility to gain opportunities (Ridgeway, 2011). Our study provides support for EST and additional insights into the differences between male and female teams, in agreement with SRT and other prior studies on team collaboration (Gefen and Straub, 1997). Our findings also present novel discoveries. Our results demonstrate the important role that gender plays in a collaboration context, particularly concerning the interplay of impression, effort, and collaboration outcomes. We empirically demonstrate how gender effects and gender compositions operate at the team level.

At the ***individual*** level, team members develop trust differently depending on the gender of the collaborative partner. Impression management has a greater association with trust for individuals interacting with a same-gender partner than with an opposite-gender partner. For individuals working with a same-gender partner, there is a significant positive relationship between impression management and trust; however, such association is not observed for individuals working with an opposite-gender partner. The results show that the same-gender trusting-belief factor manifests at the individual level in collaboration. Trust is interpersonal between two individuals. In this context, trust is built upon the impression perceived toward the same-gender partner. Males trust their male partner when the partner is perceived as competent through perceived impression. Females trust their female partner when the partner exhibits communal impressions in the collaboration. We call this effect *same-gender-impress-to-trust*. Interestingly, when a man is working with a woman, impression management does not contribute to mutual trust at the individual level.

These findings at the individual level are consistent with prior research examining gender roles in collaborative contexts. Empirical studies found that self-presentation (impression) influences social interaction for gender-related behavior and self-interpretations (Deaux and Major, 1987). For instance, same-gender decision-making groups manage impressions by following a conforming societal norm and adjusting behavior to their partners to create a sense of belonging, inclusion, and trust (Deaux and LaFrance, 1998). In same-gender groups, a favorable impression is especially well perceived by the partner (Athenstaedt *et al.*, 2004). Members of same-gender dyads endeavor to maintain a good impression to achieve harmony in collaboration (Singleton and Vacca, 2007). When showing gender-stereotypical behavior, a partner may adjust his/her self-image to become more socially desirable and trustworthy (Vanwesenbeeck, 2009).

Theoretical contributions

Our theoretical contributions are threefold. First, we offer a theoretically grounded and gendered perspective on both the individual and team levels of team collaboration in a virtual environment. In doing so, we are filling an important gap in the study of gender in teamwork. Available research in this area has focused primarily on how gender social roles affect team outcomes (Riedl *et al.*, 2010; Vanwesenbeeck, 2009) but lacks team-level empirical exploration and assessment in the metaverse (Peck *et al.*, 2021). We illuminate the effects of gender at the team level. Male teams manage impressions (we-impress) and female teams focus on task effort (we-work-hard-on-task) to achieve satisfactory team goals. We also demonstrate that there is much more to understand at the omni-level. At the individual level, we identified a *same-gender-impress-to-trust* effect. Regardless of whether one is a male or female, people trust their same-gender partner better when impression management is practiced.

Second, our study advances team theory at the dyadic level. Gender shapes social experience and expectations (Maccoby, 1998). Most existing research addresses medium to large social groups, with scant research studying dyads. Researchers have called for more rigorous theoretical development and adoption of critical epistemology on gender studies in information systems (Howcroft and Trauth, 2008). The composition of a dyad in an immersive, virtual collaboration context is a subject in need of more theoretical development. Taking inspiration from EST and SRT, our theoretical model deepens the understanding of gender effects in a virtual environment at both the dyadic and individual levels.

The third contribution extends the perception "Men Are from Mars and Women Are from Venus" (Gray, 1992) when studying gendered relationships. Contemporary research has focused on men and women fulfilling traditional gender stereotypes in teamwork. When men and women work with same or different gender partners, women's expectations are radically different from those of men (Athenstaedt *et al.*, 2004). Despite decades of gender research, few studies distinguished same-gender and gender-diverse groups on communication (Athenstaedt *et al.*, 2004) and knowledge sharing (Robert *et al.*, 2018). Our study adds to this stream by contrasting same-gender and mixed-gender groups. Our close examination of this subject on multiple levels reveals insights that were not observed previously. It is also fascinating to discover that men take on the *we-impress* manifestation to sculpt their team and that team outcome satisfaction can increase when female and mixed-gender teams adopt the *we-work-hard-on-task* philosophy.

Implications for practice

Today, the metaverse is attracting companies, consumers, and marketers as the new technological evolution (Hazan *et al.*, 2022; Kim, 2021). Virtual worlds offer rich, collaborative potential (Srivastava and Chandra, 2018), and virtual teams have become a pervasive form of collaboration in the broad context of the metaverse. Our study discovered first-of-its-kind

insights that carry wide implications for business practice. First and foremost, when building and growing virtual teams, businesses should focus on educating and training *individuals* to build and maintain a professional, competent self-image. When establishing a new team, trust building is the key. An effective way to achieve team trust is to pair people with a same-gender partner and assign them a low-stake task to help them develop a professional impression through the initial collaboration, which helps establish interpersonal trust. The "*impress-to-trust*" effect works particularly well for same-gender teams. Trust building could be more challenging in mixed-gender teams as it is beyond managing impressions.

To manage *teams* and achieve team satisfaction, practices need to develop plans accordingly and consider the gender composition of virtual teams. We should be mindful of the professional image of male-dominated teams, not individually but as a team. For female-dominated teams, we need to recognize the value of effort and channel it efficiently at the team level. Training and practice should highlight how all teams function as a unit and how to manage expectations with each other properly. To facilitate successful collaborations in virtual teams, managers and leaders need to acknowledge that gender plays a critical role in teamwork, recognize gender differences, and take steps to address them at both the team and individual levels.

Limitations and future research

Some limitations exist in our study. First, the nature of the collaborative task was creative design. Some may consider creativity a special skill more closely associated with women (Beyer and Haller, 2006), so a creative, aesthetic design task may favor women unintentionally. In future research, tasks of a different nature, such as confined (structured) tasks, should be developed to address this limitation. For example, it would also be helpful to assess such gender effects in the metaverse in an educational setting (Eschenbrenner *et al.*, 2008; Kahai *et al.*, 2023). Second, we conducted our research in Second Life and did not compare it with the face-to-face setting, as was done in other studies (e.g. Chen *et al.*, 2012). Although Second Life is a popular immersive virtual environment, many other types of the metaverse, such as mixed reality and augmented reality environments, have also distinct characteristics. Future research could test the generalizability of our findings and expand our research to other types of metaverse and settings.

Notes

1. While the between level SRMR value is right at the cutoff of 0.1, the following multilevel structural model shows evidence of good group-level fit.
2. While two of the correlations are above 0.7, simulation research has suggested that as long as discriminant validity is apparent and correlations are below 0.8, the power of the statistical tests is not affected (Finch, 2005; Finch and French, 2013).

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Appendix
Measurement Items

Construct	Items and source
Impression Management	
Imp1-WorkHard	I worked hard to make a good impression on my teammate
Imp2-ActGood	I acted in a way that I hoped would give my teammate a good impression of me
Imp3-BestImpression	When working on the task, I tried to put my best foot forward
Imp4-GoodPartner	I wanted my teammate to think I was a good partner
Effort	
Efft1-Tried	I tried hard to do a good job on this project
Efft2-Attn	I paid attention to this project
Efft3-Work	I worked hard on this project
Trust	Jarvenpaa and Leidner (1999)
Trust1-Confidence	We have confidence in one another in my team
Trust2-Considerate	We were usually considerate of one another's feelings in my team
Trust3-Rely	I could rely on the partner with whom I worked
Trust4-TeamSpirit	My group has no "team spirit" [reverse coded]
Satisfaction with Team Solution/ Outcome	Green and Taber (1980)
Sat1-Committed	To what extent do you feel committed to your team's solution?
Sat2-Quality	How satisfied or dissatisfied are you with the quality of your team's solution?
Sat3-Inputs	To what extent does the final solution reflect your inputs?
Propensity to Trust	Jarvenpaa *et al.* (1998)
PropTrust1-Experiences	Most people are honest in describing their experiences and abilities
PropTrust2-Limits	Most people tell the truth about the limits of their knowledge
PropTrust3-Personal	Most people answer personal questions honestly
Computer Self-Efficacy	Compeau and Higgins (1995)
CompSelfEf1-NoOne	I am able to complete the job even if there is no one around to tell me what to do as I go
CompSelfEf2-NeverUsed	I am able to complete the job even if I have never used a package like it before
CompSelfEf3-Seen	I am able to complete the job if I have seen someone else using it before trying it myself
CompSelfEf4-Helped*	I am able to complete the job if someone else has helped me get started
CompSelfEf5-BuiltIn*	I am able to complete the job if I have just the built-in help facility for assistance
Computer Experience	Compeau and Higgins (1995)
ComExp1-Computer	Rate each item using 1: Not at All, 3: Little Experienced, 5: Fairly
ComExp2-Internet	Experienced; 7: Experienced; 9: Extremely Experienced
ComExp3-Online chat*	
ComExp4-CompGaming*	
ComExp5-3D viwo*	

*Item dropped

Note(s): (1 for strongly disagree/not at all, and 9 for strongly agree/to a great extent)
Source(s): Authors' own creation/work except noted with publication source

Table A1.
All questions were answered on a 9-point Likert scale