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We're All in This (Game) Together: Transactive Memory Systems, Social Presence, and Team Structure in Multiplayer Online Battle Arenas

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Abstract

This study applies theories of computer-mediated communication and human-computer interaction to the study of transactive memory systems (TMS; how small groups coordinate expertise, for which communication is the central mechanism) in video game teams. A large-scale survey (N = 18,627) of players from the small group video game *League of Legends* (LoL) combined with server-side data provided by Riot Games (the creators of LoL) was conducted to look at the relationship between TMS and win/loss outcome as well as the role of team size and past team member acquaintanceship on the formation of TMS, using social presence as a mediator. Results found that TMS was highly predictive of the likelihood of a team winning a game, and that while past team member acquaintanceship predicted TMS, team size did not. Furthermore, only two dimensions of social presence, copresence and perceived comprehension, were related to TMS. These two dimensions fully mediated the relationship between past team member acquaintanceship and TMS.

Keywords

online games, transactive memory systems, social presence, *League of Legends*

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Video games are a ubiquitous medium. According to the Entertainment Software Association (ESA; 2015), in the United States, the average household owns at least one dedicated game console, PC, or smartphone. Similarly, video game play stretches across all segments of the population, with approximately 44% of all game players being female and 44% of all game players being 36 years of age or older. Part of the reason why games are popular is because the there are many types of games ranging from virtual worlds to casual games to children's spaces to serious games (Williams & Kahn, 2013).

In addition to their importance in popular culture, video games provide a fertile ground for social science research. Games and virtual worlds can serve as "petri dishes" for the study of human behavior (Castronova & Falk, 2009; Williams, 2010). It is possible that parallels exist between real-world behavior and behavior in virtual worlds; with the right methodology, virtual worlds can provide better experimental control and less expensive ways to test theories of human behavior than would a face-to-face lab experiment. The validity of an experiment requires the researcher to *hope* that everything is held constant at across participants. On the other hand, an experiment in a virtual world can *ensure* everything (other than individual differences in participants) is held constant by programming the world such that the only difference between conditions is the experimental manipulation.

Furthermore, many video games (especially online games) require players to create an account that a player must sign into every time. Therefore, player statistics (and sometimes second-by-second player actions) are stored somewhere on a server (Williams, Contractor, Poole, Srivastava, & Cai, 2011). These server logs, assuming researchers are able to gain access, provide objective, unobtrusive measures of player behavior (as opposed to requiring human coders, which is often necessary when lab experiments are videotaped). This provides researchers with the advantage of not having to rely on self-report data, which are often imperfect (Kahn, Ratan, & Williams, 2014; Webb, Campbell, Schwartz, & Sechrest, 2000). Why ask players what they do while playing a game when you have precise data that say what they actually do in the game?

Games are a very social medium, so they provide fertile group for studying small group processes. The ESA (2015) reports that 56% of the most frequent game players play games with others. For many individuals, interacting and socializing with others is reported to be one of the most appealing aspects of playing video games (Griffiths, Davies, & Chappell, 2004; Kahn et al., 2015; Sherry, Lucas, Greenberg, & Lachlan, 2006). Given the fact that playing games is often such a social experience, they have the potential to answer many questions of interest to group communication researchers (Wirth, Feldberg, Schouten, van den Hooff, & Williams, 2012). Given the methodological promise of video games, not only can questions be asked about virtual groups, questions about real-world groups can also be tested in these environments.

The present study uses a field study of video game players (including both survey and server measures) to examine a phenomenon of interest to group communication scholars known as a transactive memory system (TMS). A TMS is "the shared division of cognitive labor with respect to the encoding, storage, retrieval, and the communication of information from different knowledge domains, which often develops in groups and can lead to greater efficiency and effectiveness" (Brandon & Hollingshead, 2004, p. 633). Multiplayer video games fall into an understudied category of group tasks known as contest tasks, which have a unique metric of "effectiveness" known as group outcome. Furthermore, this study examines the role of a phenomenon known as social presence to better understand how a TMS may develop in virtual teams.

TMS

The idea of a TMS was first proposed by Wegner (1987) almost 30 years ago. Since then, the study of TMS has been of great interests to scholars in communication, social psychology, and organizational science—especially in recent years. Lewis and Herndon (2011) found 198 articles published between 2000 and 2010 with the keyword "transactive memory," with 77% of these articles published after 2005. TMS has been studied in dyadic (e.g., Hollingshead, 1998, 2000, 2001; Hollingshead & Fraidin, 2003; Wegner, 1987), small group (e.g., Jackson & Moreland, 2009; Lewis, Belliveau, Herndon, & Keller, 2007; Lewis, Lange, & Gillis, 2005; Liang, Moreland, & Argote, 1995; Moreland, 1999; Moreland & Myaskovsky, 2000), and organizational (e.g., Austin, 2003; Lewis, 2003, 2004; Yuan, Fulk, & Monge, 2007; Yuan, Fulk, Monge, & Contractor, 2010) contexts.

The central component of a TMS is the TMS structure (Lewis & Herndon, 2011; Wegner, 1987). The TMS structure is a group's shared mental model of the expertise of group members. It is sometimes referred to as "a shared understanding of who knows what" (Brandon & Hollingshead, 2004; Lewis & Herndon, 2011). Individuals may learn the expertise of partners/teammates through close interpersonal relationships (Hollingshead, 1998; Wegner, 1987), prior experience working together (Liang et al., 1995; Moreland, 1999; Moreland & Myaskovsky, 2000), explicit feedback about the strengths of team members (Hollingshead, 2000; Moreland & Myaskovsky, 2000), or even based on societal stereotypes (Hollingshead & Fraidin, 2003). The group shared mental model will only form when group members are cognitively interdependent on one another (Hollingshead, 2001; Wegner, 1987). By having a shared mental model, individuals in a group can both explicitly and implicitly create a division of labor best suited to both the unique and shared expertise of the group members.

Brandon and Hollingshead (2004) noted that TMS "will be most effective when knowledge assignments are based on group members' actual abilities, when all group members have similar representations of the system, and when members fulfill expectations" (p. 639). Thus, the quality of the shared mental model depends on three things: accuracy, sharedness, and validation. Group members must have an accurate mental representation of the expertise of their teammates. Otherwise, tasks may be delegated incorrectly. Group members must share a similar mental model. Otherwise, different team members' strategies for dividing labor may differ. Finally, group members must validate the expectations of their group mates. Otherwise, it may lead to individuals incorrectly modifying their mental model.

Communication (both verbal and nonverbal) is one of the central mechanism by which the TMS mental model can initially develop. Once the mental model is developed, communication also serves as the mechanism by which cognitive labor can be divided and coordinated (Hollingshead, 1998; Hollingshead & Brandon, 2003; Hollingshead, Brandon, Yoon, & Gupta, 2011; Yuan et al., 2007; Yuan et al., 2010). There is a strong association between the amount of communication within a group and the strength of a TMS (Jackson & Moreland, 2009; Kanawattanachai & Yoo, 2007; Lewis, 2004; Yoo & Kanawattanachai, 2001; Yuan et al., 2007; Yuan et al., 2010).

There are three latent indicators of an established TMS: specialization, credibility, and coordination (Lewis, 2003). If group members do not have specialized knowledge or abilities, labor might as well be divided up at random. If group members do not trust one another's knowledge or abilities, individuals may not want to delegate tasks to somebody who claims expertise in an area. Finally, even if there are specialization and credibility, if there is no mechanism to coordinate the knowledge and abilities, this specialization is of little use.

TMS in Video Game Teams

Given the elements of specialization, credibility, and coordination, multiplayer online games provide an excellent test bed for the study in the area of TMS. In fact, one study (Richter & Lechner, 2009) looked at the formation of TMS in zero-acquaintance *World of Warcraft* teams. However, it simply looked at the communication transcripts of five teams and subjectively judged whether TMS communication processes occurred. It concluded that some of the five teams seemed to have a TMS, and the teams that did have TMS included both teams that communicated solely by voice and teams that communicated solely by text.

Despite the importance of social motives for video game players and the fact that games provide a fertile methodological ground for group communication scholarship, research on video game teams is an understudied area by communication researchers. Peña and Hancock (2006) posited two reasons for this. First, video game scholars tend to come out of the media processing and effects tradition. This tradition has a tendency to look at the individual as the unit of analysis. Second, group scholars have a tendency to focus on instrumental and task-oriented communication, seeing relational and socioemotional communication as secondary processes (Keyton, 2000; Rice & Love, 1987). And because the recreational nature of video games makes relational and socioemotional communication the dominant forms of communication during game play, group researchers tend to show little interest in the subject. Yet, relational and socioemotional communication are integral components of all human interactions, and video games provide a space where these interactions are prevalent (Peña & Hancock, 2006).

However, not only does studying group processes in video games add to the minimal research on mediated communication in socioemotional and recreational contexts, it also fills an overlooked deficiency in group research: groups engaging in what are known as "contest" tasks. After surveying and synthesizing the literature on types of tasks groups engage in, McGrath (1984) proposed a typology of tasks groups engage in, one of which is known as a "Type 7. Contest task,"[1] defined as "tasks for which the unit of focus, the group, is in competition with an opponent, an enemy, and performance results will be interpreted in terms of a winner and a loser, with pay-offs in those terms as well" (p. 65). These tasks have no intragroup conflict or mixed-motive relationships with other groups; these tasks involve groups "conquering" other groups. He gave such examples as wars, winner-take-all conflicts, and competitive sports, but such a definition would extend to contemporary multiplayer games.

Unlike other task types, contest tasks have two metrics have to be considered: performance and outcome (McGrath, 1984). While performance—how well a team does during the course of a task—can be measured in different ways, is on a continuum, and is relevant to multiple tasks types, outcome is unique to contest tasks. Outcome is binary: A group either wins or loses. A strong performance does not guarantee a win, and a weak performance does not guarantee a loss. An athletic team can score many points but still lose a game, and an army can incur many casualties but still win a battle.

When he first proposed the typology of task types almost 30 years ago, McGrath (1984) noted about Type 7 tasks that "such tasks are very heavily represented in the workaday world and, against that baserate, are quite underrepresented in research on groups" and "performance tasks of this type . . . constitute a large part of the time and energies of a large number of actual groups. Considering that, the amount of attention given to such performance in small group research is quite limited" (pp. 65, 115). This is still very true today. Despite the prevalence of contest tasks in the real world, in an informal analysis conducted for the purposes of this article, only four of the 92 articles published in *Small Group Research* (the preeminent journal on the subject) between 2010 and 2012 dealt with any form of team engaged in a Type 7 task.[2]

As McGrath notes, Type 7 tasks are central to many real-world groups. These tasks are the primary tasks of sports teams and military units. They are a component in parliamentary groups in which opponents must debate and will ultimately pass or fail to pass a law or win over public opinion. In order to land clients, companies must outbid their competitors. Even a family arguing over where they should go on vacation may involve a Type 7 tasks. Thus, while Type 7 tasks have received minimal research, they are an area of study ripe for investigation.

Some Type 7 tasks such as a sports competition or military battles are very fast-paced and require diverse expertise: Sports teams have positions, and military groups have subunits. With such speed, there may not be much time to decide what to do next, so it is important for team members to be able to recognize the expertise of others and have a mechanism to coordinate said expertise. This leads to the importance of looking at the role of TMS in Type 7 tasks.

Only two known studies looked at TMS in video game teams. The first (Richter & Lechner, 2009), as already mentioned, had little generalizability given that it was a descriptive, qualitative study with a very small sample size. The second (Riedl, Gallenkamp, Picot, & Welpe, 2012), involved a video game, *Travian*, which involved mixed-motive tasks[3] as opposed to purely competitive tasks; thus, it would not necessarily have been classified by McGrath (1984) as a Type 7: Contest/battle task.

A popular new genre of video game, the multiplayer online battle arena (MOBA), would be a classic example of a contest/battle task: Ad hoc teams compete against other ad hoc teams in fast-paced, head-to-head combat. Currently, the most popular video game in the world is a MOBA: *League of Legends* (LoL). LoL has an active player based of over 67 million players as of January 2014 (Riot Games, 2014, January 28).

MOBAs are a hybrid of the massively multiplayer online game (MMO) and real-time strategy (RTS) genres; they center around two small teams competing against one another. MOBAs may in fact be especially appropriate to study group process given that research has shown that many MMO players play predominantly on their own (Ducheneaut, Yee, Nickell, & Moore, 2006). The primary distinguishing feature of a MOBA as compared with MMOs like *World of Warcraft* or *Travian*[4] is that a MOBA is a nonpersistent world. This means that whereas in a persistent world, one logs off and logs back on to where he or she left off, in a nonpersistent world, once a game has been completed (either a team wins or loses), a new game begins. When one logs off and logs back on, he or she starts a new game (although identity and friends lists are persistent). On the other hand, many MOBAs resemble many MMOs in that both genres involve characters and stories that would be considered of the fantasy genre. In addition, both MOBAs and MMOs have players assume the identity of an avatar.

Team Outcome

While increased team performance is often associated with increased levels of TMS, due to the lack of studies of TMS in contest tasks, no study has systematically examined its relationship with team outcomes. Richter and Lechner (2009) found that some of the observed *World of Warcraft* teams developed a TMS during the course of a one-time activity, but TMS was measured using subjective observer judgments. Riedl et al. (2012) found that TMS developed in the RTS *Travian*, but this was a yearlong, mixed-motive task. When teams engaged in battle, the winner was determined not by avatar combat but by which team had statistical advantages going into a battle. This is very different from the fast-paced, psychomotor battle of a MOBA.

Riedl et al. (2012) did find that TMS was predictive of performance in *Travian*. However, in terms of examining team outcome, in this particular game, only one team per server could be declared the winner (after a year), thus giving Riedl et al. a sample size of one for this particular metric. McGrath (1984) noted that in the context of contest/battle tasks, task performance and task outcome, while related, are not the same thing. However, given that performance and outcome are related, the following hypothesis will be tested:

> **Hypothesis 1 (H1):** In a MOBA, the greater the TMS, the greater the likelihood of a team having a winning outcome.

Team Composition

Self-Selective Team Formation

Much of the early research on TMS in small groups focused on the effect of different ways of training group members (Liang et al., 1995; Moreland, 1999; Moreland & Myaskovsky, 2000). This research found that group members who trained together had greater TMS and performed better than group members who had trained individually or with a different set of group members. Research has suggested that teams composed solely of people who train together had greater performance than those where only a subset of a team trained together (Lewis et al., 2007). Other TMS research has found that prior familiarity with team members is positively related to TMS development (Akgün, Byrne, Keskin, Lynn, & Imamoglu, 2005; Lewis, 2004), although this has not always been demonstrated to be true (Jackson & Moreland, 2009). In some MOBAs, players can choose to play with specific teammates or they can be randomly assigned to a team (or have a subset of teammates self-selected and a subset randomly assigned). In order to play with specific people, one must have prior familiarity, which is positively related to TMS, but at the same time, if teams only partially trained together, only a partial TMS will be developed. Thus, it is hypothesized as follows:

> **Hypothesis 2 (H2):** In a MOBA, there is a positive relationship between the percentage of team members who self-selected their formation (as opposed to players randomly assigned team members) and TMS.

Team Size

Among the most frequently asked questions in small group research is, "what is the ideal team size?" (Moreland, Levine, & Wingert, 1996). The answer to this question is "it depends." In the case of TMS research, some research suggests a positive relationship between team size and TMS, and other research suggests a negative relationship. Jackson and Moreland (2009) found that smaller student project teams developed a stronger TMS than larger projects teams. They suggested this was because smaller teams were able to communicate with one another better. Similarly, because research has shown that social loafing and an overall decrease in productivity are more likely to occur as group size increases (Steiner, 1972). Hollingshead et al. (2011) suggested that increasing group size will lead to individual members to act in such a way that does not actually reflect their full abilities, thus leading to problems with the validation necessary for a TMS. In the case of online games, Xiong, Poole, Williams, and Ahmad (2009) found that in the MMO, *EverQuest II* (EQII), group size had a negative total effect on group performance, while not specifically addressing TMS. In another computer-mediated communication (CMC) context, Lowry, Roberts, Romano, Cheney, and Hightower (2006) found three-person CMC teams had better communication than six-person CMC teams, and effective communication is essential to the development of a TMS (Hollingshead & Brandon, 2003; Hollingshead et al., 2011; Jackson & Moreland, 2009).

On the other hand, some aspects of increased group size suggest a stronger TMS in the context of video game teams. Xiong et al. (2009) found that in EQII, larger groups had a greater aggregated expertise, which is a key element of a developed TMS (Lewis & Herndon, 2011; Wegner, 1987). Riedl et al. (2012) had hypothesized that team size would moderate the relationship between communication patterns and TMS such that these relationships would be stronger in smaller teams, but instead found the opposite (albeit with a negligible effect size). Given the conflicting research, it is asked the following:

Research Question 1 (RQ1): Does team size affect the strength of a TMS in a MOBA team?

Social Presence

Lewis and Herndon (2011) noted that when Wegner (1987) first proposed the concept of transactive memory, TMS was composed of both knowledge *structure* and knowledge-relevant transactive *processes*. Yet, they go on to note that most TMS research focuses on the structure and not the process. The bulk of the research looks at the cognitive antecedents and outcomes of TMS, but not cognitive processes. For this reason, even longitudinal research fails to examine the dynamic nature of TMS development. In the case of video game teams, there is an additional component to cognitive processes not found in most other TMS research: Interaction is often mediated through virtual social actors (avatars and agents). One construct coming from the mediated communication literature that addresses such psychological processes is that of social presence. Not only should this psychological variable be explored in the context of TMS given the focus on TMS structure over process, but it may also serve as an explanation of why team formation and team size may affect TMS in mediated contexts.

Lee (2004a) defined social presence as "a psychological state in which virtual (para-authentic or artificial) social actors are experienced as actual social actors in a sensory or non-sensory way" (p. 45). Biocca and colleagues (Biocca, Harms, & Burgoon, 2003; Biocca, Harms, & Gregg, 2001; Harms & Biocca, 2004) further explicated social presence as consisting of three parts: copresence, psychological involvement, and behavioral engagement. Copresence is

> the degree to which the observer believes he/she is not alone and secluded, their level of peripheral or focal awareness of the other, and their sense of the degree to which the other is peripherally or focally aware of them. (Harms & Biocca, 2004, p. 247)

Psychological involvement is "the degree to which the observer allocates focal attention to the other, empathically senses or responds to the emotional states of the other, and believes that he/she has insight into the intentions, motivation, and thoughts of the other" (Biocca et al., 2001, p. 2). A key element to psychological involvement is the ability for an individual to feel like he or she is communicating clearly to and is correctly comprehended by the virtual social actor, and that the individual feels like he or she is correctly comprehending the virtual social actor's communications. Behavioral engagement is "the degree to which the observer believes his/her actions are interdependent, connected to, or responsive to the other and the perceived responsiveness of the other to the observer's actions" (Biocca et al., 2001, p. 2).

It should be noted that this is a more contemporary definition of social presence and slightly different from the original definition (Short, Williams, & Christie, 1976), which was in the context of comparing different telecommunication media with each other and with face-to-face interaction. The original definition referred to "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationship" (Short et al., 1976, p. 65). Whereas the original Short et al.'s definition was concerned only with the interpersonal aspect of mediated telecommunication, the Lee (2004a) conceptualization of social presence comes from a research community that concerns itself with cognition, affect, and behavior in virtual environments (such as virtual reality, virtual world, and video games). Cognition has always been the central component of TMS research; recent TMS research has suggested affect plays an important role in the establishment of TMS (Neff, Fulk, & Yuan, 2014). While the conceptualization of social presence this study is using does assume that media that afford more communication cues should exhibit greater levels of social presence (like the original conceptualization), the medium is one of many possible variables that can affect feelings of social presence.

The dimensions of social presence are very related to antecedents of TMS. Copresence would be a necessary condition: Teammates must be mutually aware of one another if they are to learn each other's expertise and coordinate their actions based on individual expertise. More generally, copresence is a defining feature of a small group even in face-to-face contexts (McGrath, 1984). For psychological involvement, it is necessary to devote attention to one's teammates in order to either establish expertise or determine characteristics of each other that will allow for using stereotypes, as they too can be used (albeit not always correctly) to establish expertise (Hollingshead & Fraidin, 2003). Given that communication is essential to the development of TMS (Hollingshead, 1998; Hollingshead & Brandon, 2003; Hollingshead et al., 2011; Yuan et al., 2010), it is necessary for players to properly comprehend their teammates' communications and intentions. They must mutually understand each other in order to engage in transactive processes that allow for the creation of a shared, accurate, and validated group mental model. For behavioral engagement, if cognitive interdependence is a necessary condition for a purely cognitive task (Brandon & Hollingshead, 2004; Hollingshead, 2001), behavioral interdependence should be necessary for a behavioral task such as video game play. In addition, Neff et al. (2014) found that the homegeneity of affect on the team had an indirect effect on the development of the development of TMS, and thus affective interdependence should also predict TMS. Thus, it is hypothesized as follows:

> **Hypothesis 3 (H3):** In a MOBA, there will be a positive relationship between social presence and TMS.

Lee (2004b) proposed that social presence is a result of individuals being able to attribute a theory of mind to virtual social actors. Social presence occurs when individuals are able to simulate the mental states of avatars and agents. It would follow then, if a game player already knows his or her teammates in advance, it would be easier to simulate their mental states. Examples coming from video games and the more general area of presence research would support such a view. Players exhibit greater levels of presence and engagement when they are simply told they are playing against a human opponent as opposed to a computer opponent (Lim & Reeves, 2010; Ravaja et al., 2006; Weibel, Wissmath, Habegger, Steiner, & Groner, 2008). This is true not only for self-reported measures of presence but also for psychophysiological responses previously shown to correlate with feelings of presence (such as increased skin conductance indicating attentional processes). For example, Ravaja et al. (2006) found similar results, but more importantly found that players showed increased self-reported and physiological measures of presence when that human was a friend than when the human was a stranger. Having a preestablished relationship with coplayers created greater feelings of presence than when playing with strangers. Taking Lee's theory of mind explanation and the presence research on knowing one's coplayers, it is hypothesized as follows:

> **Hypothesis 4 (H4):** In a MOBA, there is a positive relationship between the percentage of team members who self-selected their formation (as opposed to players randomly assigned team members) and social presence.

One could reason that as team size increases, it should become more difficult to be aware all of one's teammates at the same time and allocate attention to any individual. At the same time, if motivation loss increases as team size increases (Steiner, 1972), one's teammates may be doing fewer things individually to be aware of and to allocate attention to. Thus, increasing team size should lead to a decrease in copresence and attentional allocation (a component of psychological involvement). Similarly, miscommunications are more likely to occur as team size increases (Hollingshead et al., 2011; Moreland et al., 1996), decreasing a player's ability to gain insight into the intentions, motivations, and thoughts of teammates (another component of psychological involvement). Finally, if production loss increases as team size increases, individual teammates may be less likely to respond to the actions of a player and the player may be less likely to respond to the actions of his or her teammates with an increase in team size. This would indicate a decrease in behavioral engagement.

On the other hand, Lee and Nass (2004) found that when one heard a series of persuasive statements in computer-synthesized voices, they felt greater levels of social presence and were influenced more when different statements came from different voices as compared to when the statements came from a single voice. The logic was, the more voices one heard, the more virtual social actors one psychologically experienced, and therefore the greater level of social presence. Thus, it is asked the following:

Research Question 2 (RQ2): Does team size affect the level of social presence players experience in a MOBA team?

The rationale for establishing H3 and H4, and asking RQ2 is that social presence has been shown to mediate the relationship between variables in human-computer interaction and computer-mediated communication. Many studies of avatar-mediated communication and human-machine communication that concern the replication of findings from face-to-face research have found social presence as a mediating variable. Examples include similarity attraction in voice interfaces (Lee & Nass, 2005) and human-robot interaction (Lee, Peng, Jin, & Yan, 2006), the multiple source effect in computer-synthesized speech (Lee & Nass, 2004), and perceptions of robots as developing creatures (Lee et al., 2006). Social presence has also been shown to mediate effects in contexts such as persuasive agents (Jin, 2011; Skalski & Tamborini, 2007), and parasocial interaction with avatars (Jin, 2010). It should be noted that in these studies, social presence was conceptualized and operationalized unidimensionally.

This reason why social presence often serves as a mediator is explained in Lee's (2004b) theory of mind explanation of social presence: When one can simulate the mental state of a virtual social actor, he or she will respond and behave in the way he or she would with an actual social actor. In the present study, self-selecting teammates should increase the likelihood that players will know their teammates, and therefore should be more accurate and valid in simulating the mental state of their teammates. When players have the ability to accurately and validly simulate the mental states of their teammates, it should make it easier for a team to form an accurate and valid TMS shared mental model. Thus, it is hypothesized as follows:

Hypothesis 5a (H5a): In a MOBA, social presence will mediate the relationship between the percentage of team members who self-selected their formation (as opposed to players randomly assigned team members) and TMS.

Similarly, if a relationship exists between team size and social presence and between team size and TMS, it would be because team size makes it either easier or more challenging for a player to simulate the mental state of teammates, thereby leading to either a more or less accurate and valid TMS shared mental model. Thus, it is hypothesized as follows:

Hypothesis 5b (H5b): In a MOBA, social presence will mediate the relationship between the percentage of team size and TMS (assuming one exists).

A full diagram of the hypotheses and research questions can be found in Figure 1.

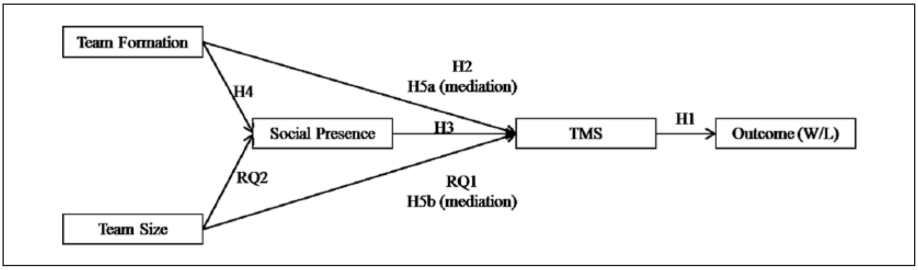

Figure 1. Hypotheses and research questions.
Note. TMS = transactive memory system; W/L = win/loss.

Method

The current study focuses on the game LoL, a MOBA. LoL was chosen for two reasons. First, since the fall of 2012 and as of March 2015, it is the most popular video game in the world (Raptr, 2015, April 20; Riot Games, 2012). Second, its operator, Riot Games, Inc., agreed to assist the research team in both providing server-side behavioral data and soliciting a random sample of its user base to participate in the survey described below.

In LoL, players take on the role of summoners. For every individual "match," summoners select one "champion" to control. Based on the performance of the champions in matches, players earn "influence points" (IP). IP allow players to purchase in-game items and more powerful champions for future matches. The structure of a match involves two teams of champions competing against each other, and the match ends when one team wins by destroying their opponents' "nexus" (essentially, the home base). LoL and the MOBA genre, in general, is a "nonpersistent world." Unlike an MMO, where a player usually logs into a game and returns to the spot he or she left off (or at least resumes the same character), in LoL, once a match is over, a player can choose any champion he or she wants and play with any team he or she wants in the next match.

There are a three general types of LoL matches: player versus player (PvP; a team of human players vs. another team of the same size of human players),[5] co-op versus AI (a team of human players vs. a team of the same size of computerized "bots"), and custom games (where teams could vary in size and contain humans and "bots" together). PvP though is by far the most prevalent type of game play.

In PvP games, players can choose to play on a three-member team against another three-member team (3v3) or a five-member team against another five-member team (5v5). In PvP games, the tasks in a 3v3 game and a 5v5 game are the same in the sense that the goal is to destroy the enemy's nexus. However, the "maps" on which the games are played differ slightly to reflect the fact that three players can cover less terrain than five players can.

In PvP games, players can choose to play an "arranged match," where they choose their teammates, or a "solo match," where they are randomly assigned teammates by the game.[6] Opposing teams are matched by the game, trying to balance the skill levels of the two teams. Together, this provides a framework for testing the specified hypotheses and research questions.

Participants and Procedure

Using a simple-random sample of all LoL accounts that had played at least one match in the preceding month, Riot Games invited 113,579 players to participate in a web-based survey about their experiences with LoL. Selected players received the invitation via email and would click on a link to be directed to the survey, which was hosted by the researchers. In compensation, players would have their earned IP doubled for the next four LoL matches that they won. In 1 week, 25,996 (22.9%) of the emails were opened, and 22,521 complete responses were collected. After eliminating duplicate responses, responses coming from invalid links (likely noninvitees), and responses completed "too fast" (pretesting indicated 12 minutes would be a reasonable minimum completion time given the survey length), 18,627 valid responses were collected. This was a response rate of 16.4% of all emails sent and 71.7% of all emails opened.

In addition, for the purpose of this study, players were eliminated (as determined by server-side data) if their last match was not an official PvP match (as the survey measures would ask a player about their last match and the server data only provided information about the last match and career statistics). Furthermore, players were also asked if they used multiple accounts, and if so, whether or not they received the survey invite from their main account. If the player responded that he or she had received the survey from an alternate account, the response was not included in the present study. The reason for this is that players' alternate (or "smurf") accounts may not reflect their level of experience or playing style, and thus the server data associated with the survey data may threaten internal validity. After filtering out those that did not meet these two inclusion criteria, the final sample size was 16,499.

Measures

Server-side measures

Team outcome. Riot provided the information as to whether or not a player won his or her last PvP match.

Team formation. Team self-selection was operationalized as the percentage of teammates a player prearranged to play with. This was calculated by taking server-side measures of how many other players were prearranged to be on a person's team in his or her last game played (a number ranging from 0 to 2 for 3v3 games and a number ranging from 0 to 4 for 5v5 games) and dividing this by three or five (depending on whether the game was 3v3 or 5v5). Because of the sheer size of LoL's player base, it is highly unlikely that two players have ever played together before if it was not prearranged.

Team size. Server-side data identified whether a player's last game played was a 3v3 game or a 5v5 game.

Controls. For the purpose of analyzing predictors of the likelihood a team wins a match, two server-side measures were collected: number of PvP matches played and career PvP winning percentage. Because the number of PvP matches played ranged anywhere from one to 1,749, with a mean of 333.56 and standard deviation of 241.88, this number was divided by 100 in order to better interpret odds ratios.

Survey measures

TMS. TMS was measured using nine questions adapted from Lewis (2003) pertaining to the three dimensions of TMS: specialization, credibility, and coordination. Together, the nine questions were aggregated into a single measure (M = 3.40, SD = 0.82, Cronbach's α = .87). While this measure is normally a team-level aggregation of individual members' responses, this study only had survey measures from one member of a team. It was not possible to survey all team members, as the random sample was of individuals and not teams). However, Lewis's validation found a high r_{wg} (a measure of within-group agreement), suggesting that an individual measure would be relatively consistent with a team aggregated measure.

Social presence. Social presence was measured using five items from Biocca and Harms's (2002) Networked Minds Social Presence Inventory v. 1.2, which is generally consistent with the dimensions of social presence they had explicated previously (Biocca et al., 2003). Players were asked to think about the last game they had played and to what extent they agreed or disagreed with a set of statements, each of which corresponded to one of the five subscales from the inventory: Copresence (M = 2.68, SD = 1.25), Perceived Attentional Engagement (M = 4.08, SD = 0.86), Perceived Emotional Contagion (M = 3.26, SD = 1.17), Perceived Comprehension (M = 3.66, SD = 1.10), and Perceived Behavioral Interdependence (M = 3.95, SD = 0.98). Asking multiple questions from each subscale would have been preferred for purposes of reliability, but survey space was limited because it was being used for multiple studies conducted by other researchers. The specific questions for social presence were selected based on high factor loadings in previous studies (Biocca et al., 2001; Harms & Biocca, 2004) and high face validity and clarity as determined by 17 video game scholars.

Copresence was measured with the item, "I often felt as if my teammates and I were in the same physical space." Perceived attentional engagement was measure with the item, "I paid close attention to my teammates." Perceived emotional contagion was measured with the item, "I was sometimes influenced by my teammates moods." Perceived comprehension was measured with the item, "I was able to communicate my intentions clearly to my teammates." Perceived behavioral interdependence was measured with the item, "My actions were often dependent on my teammates' actions."

Data Analysis Procedures

With a sample size as large as the present study, the statistical power provided was likely to produce highly significant statistics for most tests conducted, regardless of the substantive meaning. Therefore, standardized measures were used to determine whether the significant effects were meaningfully significant. In order to consider a hypothesis supported, the statistical analysis needed to not only be statistically significant but also needed to meet the minimum criteria of a small effect size.

Cohen (1988) provided the following indexes and values for measuring effect size in social science research: d indicates small, medium, and large effect sizes at values of 0.20, 0.50, and 0.80 (respectively) for t tests, and r indicates small, medium, and large effect sizes at values of .10, .30, and .50 (respectively) for correlation.

Results

Common Method Variance

Before analyzing data, in order to test for common method variance, a Harman's one-factor test (Podsakoff & Organ, 1986) was conducted. This test loads all survey items onto a single, unrotated factor using exploratory factor analysis, and if this single factor accounts for less than 50% of the total variance, common method variance should not be a major concern of the researcher. For the survey measures of TMS and social presence, only 32.87% of the variance was accounted for by the single factor.

The Harman one-factor test is not without its criticisms (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). While not meeting the 50% threshold, some of the variance of the single factor may be common method variance, nor does the Harman one-factor test partial out any common method variance. In addition, the more measurements there are, the less likely a single factor will account for 50% of the variance. An alternate procedure suggested by Lindell and Whitney (2001) is to either include a "marker variable" that should be theoretically unrelated to at least one variable of interest and assume that any correlation between the marker variable the unrelated variable is the common method variance, which can then be partialled out. Alternatively, the lowest positive correlation in the correlation matrix of all measurements taken during the survey administration can be used in lieu of the marker variable. In the case of the survey administration, there was a correlation of $r = .001$ between two variables unrelated to this study. Between the results of the Harman one-factor test and the Lindell and Whitney technique, common method variance was ruled out.

Unit of Analysis Bias

Despite the fact that Lewis's (2003) measure of TMS has been demonstrated to have high interrater reliability, the fact that measures taken from the individuals are being used to represent the group is a methodical limitation. To determine whether individual characteristics might bias individual responses, the association between TMS and social presence was examined for a variety of demographic factors. No meaningfully significant differences were found for gender and TMS (d = 0.13), copresence (d = 0.11), attentional engagement (*ns*), emotional contagion (d = 0.05), comprehension (*ns*), or behavioral interdependence (*ns*). No meaningfully significant associations were found for age and TMS ($r = -.05$), copresence ($r = -.04$), attentional engagement (*ns*), emotional contagion (*ns*), comprehension ($r = -.04$), or behavioral interdependence ($r = .04$). No meaningfully significant differences were found for race and TMS ($\eta^2 = .002$), copresence ($\eta^2 = .007$), attentional engagement ($\eta^2 = .002$), emotional contagion ($\eta^2 = .002$), comprehension ($\eta^2 = .001$), or behavioral interdependence ($\eta^2 = .003$). No meaningfully significant differences were found for educational attainment and TMS ($\eta^2 = .001$), copresence ($\eta^2 = .002$), attentional engagement ($\eta^2 = .001$), emotional contagion ($\eta^2 = .001$), comprehension ($\eta^2 < .001$), or behavioral interdependence ($\eta^2 = .003$). No meaningfully significant associations were found for household income and TMS ($r = .008$), copresence ($r = -.04$), attentional engagement ($r = .05$), emotional contagion ($r = -.03$), comprehension ($r = .04$), or behavioral interdependence ($r = .04$).

Data Analysis

To test H1, that there would be a positive relationship between TMS and the outcome of a match, a hierarchical binary logistic regression was conducted, where a losing outcome was coded as 0 and a winning outcome was coded as 1. The number of PvP matches played and career PvP winning percentage were entered into the regression before entering TMS. The odds ratios and model fit can be found in Table 1. After controlling for career PvP experience and winning percentage, it was found that for every one-unit increase on the 5-point TMS scale, a team was 2.23 times more likely to win a match. TMS accounted for anywhere from 7% to 12% of the variance in whether or not a team wins a match (depending on the R^2 statistic used). Thus, H1 was supported.

To test H2, that the percentage of self-selected teammates would be positively related to TMS, a bivariate correlation was conducted. Results indicated a small-to-medium size relationship between familiarity and TMS, $r(15766) = .19$, $p < .001$, 95% bias-corrected and accelerated (BCa) confidence interval (CI) = [0.173, 0.201]. Thus, H2 was supported.

To answer RQ1, as to whether three-person teams or five-person teams would have greater levels of transactive memory, an independent-samples t test was conducted. While TMS in three-person teams (M = 3.56, SD = 0.83) was significantly different from five-person teams (M = 3.39, SD = 0.82), $t(15147) = 7.91$, $p < .001$, 95% BCa CI for mean difference = [0.125, 0.209], the effect size, d = 0.13, did not meet Cohen's threshold for a small effect. Thus, in response to RQ1, it is concluded that there is no meaningful difference in TMS for three-person teams as opposed to five-person teams.

To test H3, that social presence would be positively related to TMS, a simultaneous multiple regression was conducted with the five dimensions of social presence as

Table 1. Odds Ratios and Fit of the Model Predicting Whether or Not a LoL Team Wins a Match.

	Odds ratio and CI	
	Step 1	Step 2
Total career PvP matches played (divided by 100)	1.05 [1.034, 1.066]	1.05 [1.038, 1.074]
Career PvP win percentage (multiplied by 100)	1.05 [1.043, 1.055]	1.05 [1.047, 1.069]
TMS		2.23 [2.119, 2.349]
Model R^2	$R^2_L = .02$	$R^2_L = .09$
	$R^2_{CS} = .03$	$R^2_{CS} = .11$
	$R^2_N = .03$	$R^2_N = .15$
	$\chi^2(2) = 333.44$	$\chi^2(3) = 1{,}525.71$
ΔR^2		$\Delta R^2_L = .07$
		$\Delta R^2_{CS} = .08$
		$\Delta R^2_N = .12$
		$\Delta\chi^2(1) = 1{,}192.27$

Note. All odds ratios and χ^2 have $p < .001$. All confidence intervals are 95% BCa on 1,000 bootstrap samples. LoL = *League of Legends*; CI = confidence interval; PvP = player versus player; TMS = transactive memory system; BCa = bias-corrected and accelerated.

individual predictors. The full model was found to be significant with a large effect size, adjusted $R^2 = .31$, $F(5, 15143) = 1{,}360.95$, $p = .001$. However, only copresence ($b = 0.19$, 95% BCa CI = [0.183, 0.204], $\beta = .29$, $p = .001$, $r = .31$) and comprehension ($b = 0.26$, 95% BCa CI = [0.242, 0.268], $\beta = .34$, $p = .001$, $r = .35$) met any of Cohen's thresholds for effect sizes (in these cases, medium effect sizes). The remaining three dimensions of attentional engagement ($b = 0.06$, 95% BCa CI = [0.039, 0.072], $\beta = .06$, $p = .001$, $r = .06$), emotional contagion ($b = -0.01$, 95% BCa CI = [−0.023, −0.003], $\beta = -.02$, $p = .014$, $r = -.02$), and behavioral interdependence ($b = 0.07$, 95% BCa CI = [0.054, 0.080], $\beta = .08$, $p = .001$, $r = .09$) did not meet Cohen's threshold for a small effect size. Thus, H3 was partially supported.

To test H4, that the percentage of teammates self-selected would be positively related to social presence, bivariate correlations were conducted for each of the individual dimensions of social presence. An intercorrelation matrix of TMS and the individual dimensions can be found in Table 2. Results indicate a small-to-medium size relationship between self-selection and copresence and a small-to-medium size relationship between self-selection and message understanding. The remaining three dimensions of social presence did not meet Cohen's threshold for a small effect. Thus, H4 was partially supported.

Table 2. Means, Standard Deviations, and Intercorrelations of Team Formation, Dimensions of Social Presence, and TMS.

	M	*SD*	1	2	3	4	5	6	7
1. Team formation (percentage self-selected)	0.30 [0.297, 0.308]	0.35	—						
2. Copresence	2.68 [2.659, 2.697]	1.25	.19[a] [.171, .203]	—					
3. Attentional engagement	4.07 [4.062, 4.089]	0.86	.05 [.034, .066]	.15[a] [.137, .171]	—				
4. Emotional contagion	3.27 [3.247, 3.286]	1.17	.10 [.080, .111]	.23[a] [.216, .251]	.12[a] [.099, .133]	—			
5. Comprehension	3.66 [3.636, 3.676]	1.10	.18[a] [.164, .196]	.34[b] [.310, .350]	.30[a] [.282, .316]	.11[a] [.091, .127]	—		
6. Behavioral interdependence	3.95 [3.937, 3.968]	0.97	.06 [.043, .072]	.11[a] [.092, .130]	.33[b] [.316, .352]	.18[a] [.159, .195]	.19[a] [.171, .207]	—	
7. TMS	3.40 [3.390, 3.418]	0.82	.19[a] [.173, .201]	.42[b] [.406, .435]	.23[a] [.213, .244]	.11[a] [.088, .123]	.47[b] [.453, .482]	.19[a] [.171, .206]	—

Note. All correlations have $p < .001$. All confidence intervals are 95% BCa on bootstrap 1,000 samples. TMS = transactive memory system; BCa = bias-corrected and accelerated.

[a]Meets Cohen's threshold for a small effect.

[b]Meets Cohen's threshold for a medium effect.

To answer RQ2, as to whether three-person teams or five-person teams would have greater levels of social presence, a series of independent-samples *t* tests were conducted for each of the five dimensions of social presence. Statistics for each *t* test can be found in Table 3. None of the mean differences had a *d* that met Cohen's threshold for a small effect size. Thus, in response to RQ2, it is concluded that there are no differences in social presence for three-person teams as opposed to five-person teams.

To test H5a, that social presence would mediate the relationship between team formation and TMS, Model 4[7] of the PROCESS custom dialog for SPSS was used (Hayes, 2013).[8] The five dimensions of social presence were entered in simultaneously as mediators with team familiarity as the predictor and TMS as the outcome. Preacher and Kelley (2011) noted that there are no interpretable measures of indirect effects when measures come from arbitrary units (e.g., latent scales as opposed to observable measurements). They proposed an analogue to R^2 called κ^2, but this only measures indirect effects in simple single mediator models. Thus, in testing the mediation hypothesis of H5a, to determine whether to consider a hypothesis supported, an *r* was calculated for *t* tests (for coefficients) and *z* scores (for Sobel tests) when PROCESS did not explicitly provide *r*.

Results of PROCESS's mediation analysis can be found in Table 4. While there are small indirect effects of self-selection on TMS through copresence and comprehension, there are negligible indirect effects through attentional engagement, emotional contagion, and behavioral interdependence. In addition, the direct effect of familiarity on TMS did not meet Cohen's criteria for a small effect size (as judged by the *r* for the *z* score of the Sobel test), indicating total mediation. Thus, H5a was partially supported. Because no relationship was found between group size and either TMS or social presence, H5b was not tested, as two of the conditions of mediation are that the predictor has a relationship with the outcome as well as the mediator (Baron & Kenny, 1986). A final diagram of the results can be found in Figure 2.

After data analysis was complete, it was suggested to the researcher that one explanation for the relationship between team formation and TMS was that teams that self-selected would be more likely to use voice chat, which might improve TMS. While no data existed on the mode of communication used in the previous match, players had also been asked about how frequently they used three different modes of communication (for the purposes of a different study): in-game text chat, voice chat, and face-to-face (in the same room) communication. However, none of the three modes of communication had a bivariate correlation with TMS that reached Cohen's threshold for a small effect: for text chat: $r(15493) = .04$, $p < .001$, 95% BCa CI = [0.023, 0.056]; for voice chat: $r(15493) = .09$, $p < .001$, 95% BCa CI = [0.073, 0.102]; and for face-to-face communication: $r(15493) = .09$, $p < .001$, 95% BCa CI = [0.075, 0.108].

Discussion

This study established that TMS could develop in MOBA teams, and that in a contest/battle task, such as a MOBA, TMS predicts outcome. In fact, it strongly predicts outcome: With an odds ratio of 2.23 (after controlling for player experience and prior win

Table 3. Means, Standard Deviations, and Differences in Social Presence Based on Team Size.

	Three-person team		Five-person team					
	M	*SD*	*M*	*SD*	*t*	*df*	*d*	CI for mean differences
Copresence	2.86	1.30	2.65	1.24	6.51	15147	0.11	[0.146, 0.277]
Attentional engagement	4.10	0.88	4.07	0.86	1.35	2103.52	0.06	[−0.016, 0.074]
Emotional contagion	3.29	1.18	3.26	1.17	0.88	15147	0.01	[−0.032, 0.087]
Comprehension	3.76	1.11	3.64	1.10	4.14	15147	0.07	[0.064, 0.169]
Behavioral interdependence	3.89	1.01	3.96	0.96	−2.63	2089.98	0.12	[−0.119, −.017]

Note. All *t* tests have $p < .001$. All CIs are 95% BCa on 1,000 bootstrap samples. CI = confidence interval; BCa = bias-corrected and accelerated.

Table 4. Tests for Social Presence as a Mediator Between Team Formation and Transactive Memory Systems.

	X → M		M → Y		Indirect effect							
M	*a*	*r*	*b*	r_t	*ab*	CI	ab_{cs}	P_M	R_M	*z*	r_z	κ^2
Copresence	0.66	.19[a]	0.19	.30[b]	0.12	[0.110, 0.136]	0.05	0.28	0.75	20.00	.16[a]	.08
Attentional engagement	0.12	.05	0.06	.06	0.007	[0.004, 0.010]	0.003	0.02	0.04	4.88	.04	.01
Emotional contagion	0.32	.10	−0.02	−.03	−0.005	[−0.008, −0.002]	−0.002	−0.01	−0.03	−3.00	−.02	<.01
Comprehension	0.56	.18[a]	0.25	.34[b]	0.14	[0.125, 0.152]	0.06	0.32	0.85	20.02	.16[a]	.08
Behavioral interdependence	0.16	.06	0.07	.09	0.01	[0.008, 0.014]	0.005	0.02	0.06	5.98	.05	.01
Total indirect effect					0.27	[0.253, 0.295]	0.12	0.63	1.66			
Total effect: $b = 0.44$, $r = .19$[a]												
Direct effect: $b = 0.16$, $r_t = .08$.												

Note. κ^2 is calculated for a simple mediation model, as it is not calculable for multiple mediator models. X = team formation (percentage self-selected). Y = TMS. All tests have $p < .01$. All confidence intervals are 95% BCa on 1,000 bootstrap samples. CI = confidence interval; TMS = transactive memory system; BCa = bias-corrected and accelerated.

[a]Meets Cohen's threshold for a small effect size.

[b]Meets threshold for a medium effect size.

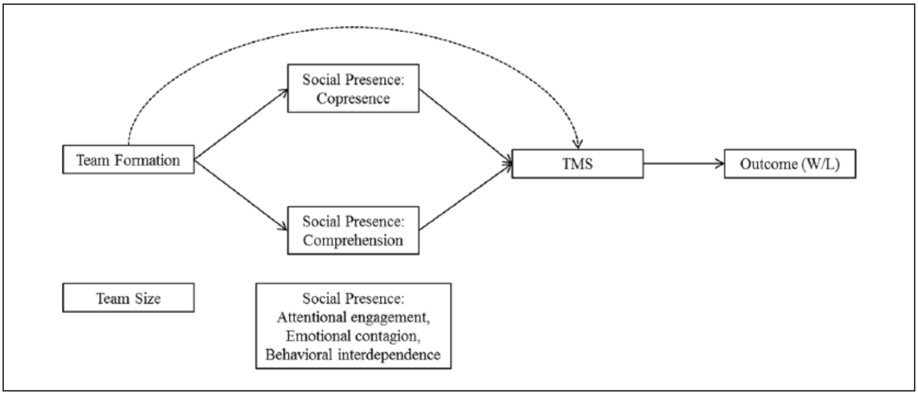

Figure 2. Final model.
Note. TMS = transactive memory system; W/L = win/loss.

percentage), a team that would rate the highest on the 5-point TMS scale would be almost 5 times as likely to win compared to a team that rated at the midpoint, and 25 times as likely to win compared with a team that rated at the lowest point.

This shows that the existence of a TMS can lead to immediate positive outcomes in a fast-paced contest task. This is important because contest tasks have been understudied in relation to their frequency of occurring in the real world. Furthermore, of the little research that has looked at TMS and contest tasks, this is the first to explore the outcome measure of effectiveness as opposed to performance. If this were to map onto real-world groups engaged in contest/battle tasks, this would be analogous to a military unit with a developed TMS not only being more likely to inflict maximum damage on and take minimum damage from an opposing force but also be much more likely to win the battle. It should be noted that LoL attempts to match teams based on similar prior performance in the game, so the results would suggest that a more developed TMS greatly increases the likelihood a team will win even if teams are evenly matched. Thus, finding ways to strengthen TMS in teams engaged in contests/battles is of utmost importance.

It was hypothesized that team formation would predict TMS and that this relationship would be mediated by social presence. As predicted, the percentage of team members who self-selected their formation (as opposed to randomly assigned team members) was positively related TMS. For social presence, which was originally hypothesized unidimensionally but due to measurement issues was addressed multidimensionally, only the dimensions of copresence and perceived comprehension mediated the relationship between team formation and TMS. These two dimensions completely mediated the relationship to the extent that a direct effect remained but of negligible effect size. The other three dimensions of social presence, attentional engagement, emotional contagion, and behavioral interdependence, had no relationship with team formation or TMS. It should not be surprising that perceived comprehension was quite strong in its association with TMS, as effective communication is at the heart of the transactive processes of a TMS.

These results suggest that finding mechanisms to increase feelings of copresence among team members and facilitate team members being able to clearly communicating their intentions to other team members can increase TMS in virtual teams. If virtual systems have affordances that promote copresence and message comprehension, teams will be able to work more effectively with each other online. Designers should focus on increasing these dimensions of social presence as opposed to designing affordances that allow teams to focus attention on one another or promote affective expression. It is interesting though that behavioral interdependence had no relationship with TMS, as cognitive interdependence is an antecedent to TMS developing in the first place.

In regard to the question of the relationship between team size, TMS, and social presence, there were no differences in TMS or social presence between 3v3 teams and 5v5 teams. In addition to the possibility that indeed no relationship exists, there are three possible explanations. First, there may not be sufficient differences between three-person and five-person teams (although Lowry et al., 2006, found differences in communication quality between three- and six-person teams, both via face-to-face communication and CMC). Second, in the case of LoL, because both 3v3 and 5v5 involved evenly matched teams as well as different game maps (albeit similar and with the same goal), the tasks were sufficiently different that they were an inappropriate comparison. Finally, group size may have indirect effects on social presence and TMS, but the indirect effects cancel each other out. Indeed, Xiong et al. (2009) found that group size had indirect effects on team performance, but because some of the effects were positive and some were negative, the total effect was negligible in size.

Limitations

A major limitation of the study was that while the survey measures described teams, the survey used measures taken from individuals as a proxy for their teams (as Riot selected individuals for participation and provided server data for the individuals' last game played before taking, not receiving, the survey). While the measures used have been shown to have strong interrater agreement, variance may have been gained or lost due to the use of individuals instead of the aggregation of individuals. There is no way to know for certain as to whether one member's response represented the whole team. The high level of statistical power due to the large sample size and the lack of demographic differences on the measures alleviates some of the concerns about individual biases in the data, but they do not make up for the fact that by using individuals to represent a group is equivalent to a 20% to 33% response rate for a team (depending on team size).

Another possible response bias was one of a "halo effect" (Thorndike, 1920). Individuals who won a match may have indicated higher levels of TMS and social presence as a result of winning a match, as opposed to higher levels of TMS and social presence actually contributing to winning a match. However, in light of the fact that not all dimensions of social presence were associated with TMS, this would indicate a halo effect was unlikely to have occurred (otherwise, all dimensions would have been associated).

There were a handful of other limitations for this study. As previously mentioned, the differences between 3v3 and 5v5 matches may have either not differed enough (in the sense that three-person teams may be too similar to notice an effect) or differed too much (in the sense that the tasks were too different to compare the two). These constraints were a result of PvP games being limited to 3v3 and 5v5 (it would be possible for a researcher to vary team size anywhere from one to five players, but this would have to be set up manually and then the field study aspect of the present research would have been lost).

Another limitation is that while measures of individual game play experience were controlled for, there was no server-side measure of how experienced a team was playing together. All that was known was how many teammates knew each other. It is possible that at some point, there may be a ceiling for the level of TMS and/or social presence that can develop among teammates. Furthermore, as TMS and social presence develop, the relationship between these two constructs may change over time. It is possible that some dimensions of social presence could be related to TMS early in a group's life cycle but diminish as a group has a more developed TMS.

Finally, even Cohen (1988) conceded that using his thresholds for effect sizes is almost as arbitrary as null hypothesis significance testing. However, some criteria were needed to determine whether hypotheses should be supported. Bootstrapping showed that on many occasions, when an effect size did not meet Cohen's criteria, the 95% BCa confidence interval did include 0, which is another way to conclude that the null hypothesis is a better explanation than the alternative hypothesis. However, in some cases, the negligible effect sizes did not include 0 in the 95% BCa confidence interval, which would suggest an effect truly did exist (however small it may be).

Future Research

In light of the limitations brought about by the cross-sectional nature of the server-side and survey data along with the use of the individual level measures as proxies for group level measures, future research will benefit from a longitudinal study that administers questionnaires to all members of a game team. By taking repeated measures, it would be possible to see how the relationship between TMS and social presence may change over time, and by having these measures from an entire team would not only increase reliability and validity but could also provide additional insight. Kozlowski (2012) recommended using intergroup agreement as a moderating variable when examining group processes. In light of the fact that a well-developed TMS involves a shared mental model, one would expect that groups with higher intergroup agreement in their self-reports would have stronger relationships between the variable of interest.

The post hoc analysis that found that there was no relationship between preferred communication channel and TMS prompts further investigation. According to social information processing theory (SIP; Walther, 1992), established computer-mediated groups will have developed communication patterns similar to those of face-to-face groups and have found ways to compensate for nonverbal cues. However, the theory posits that zero-acquaintance computer-mediated groups will initially suffer from the lack of nonverbal cues as compared to a face-to-face group and only over time will this difference diminishes. Williams, Caplan, and Xiong (2007) pointed out that in video games, the appropriate comparison is voice chat compared with text chat instead of face-to-face compared with computer-mediated. In light of the fact the present study found no differences in communication channel preference, further analysis in this area in relation to SIP may be in order. Because most of the players in the present study were quite experienced, the researchers intend to study the differences between voice chat and text chat in zero-acquaintance, zero-experience teams.

Conclusion

As McGrath (1984) noted when he proposed his typology of tasks, contest tasks needed further study in light of how often groups engage in them relative to the size of the body of research. A major reason for proposing the typology in the first place was that he believed researchers should not assume that findings about one type of task would necessarily apply to other types of tasks. Indeed, contest tasks have the unique property of having two metrics to evaluate the group on performance and outcome. While much research had studied the relationship between TMS and performance, as this is a metric of most other types of tasks, the present study examined the outcome metric that is unique to contest tasks.

Because of the small body of research on contest tasks, it is hard to know to what extent the lack of support for hypotheses was a result of task type. In addition to advancing the body of research on TMS in computer-mediated contexts, the present study serves as an example as to why more theorizing about contest tasks is necessary. A more robust body of literature on contest tasks, be they related to video game teams, sports teams, or military units, will better contextualize the present study. Furthermore, it provides support for the suggestion by Lewis and Herndon (2011) that task type is an important variable to be studied in theorizing about TMS.

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Notes

1. Sometimes, McGrath also used the terminology of “Contests/battles” or “Contests/battles/competitive tasks” to describe Type 7 tasks.

2. This count includes any article that focuses solely on a Type 7 task (either empirically or theoretically), surveys at least one group that primarily focuses on Type 7 tasks, or has at least one experimental condition where a group engages in a Type 7 task. Simulations (e.g., computerized simulations of military exercises) of Type 7 tasks were also included.
3. *Travian* begins with players initially working individually. Along the way, players can form and break alliances. While members of an alliance were interdependent, players chose their alliances based on self-interest.
4. Travian is also hybrid of a massively multiplayer online game (MMO) and real-time strategy (RTS) as well, but like an MMO, it is a persistent world and player resources and not real-time combat determine the winners of battles (e.g., the alliance with the most soldiers, weapons, and so on, would win a battle).
5. PvP is an abbreviation for player versus player.
6. The term *random* is used loosely, as the game does match players of similar career performance.
7. Model 4 tests for up to 10 mediators running in parallel and operates based on the ideas outlined by Preacher and Hayes (2004, 2008).
8. Structural equation modeling could not be used because only having a single item for each dimension of social presence would result in a model being underidentified.

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