Antecedents of Transactive Memory Systems in Virtual Teams – The Role of Communication, Culture, and Team Size

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Abstract

One success factor of teams and organizations is an effectively managed knowledge management system (KMS). However, these systems are even hard to develop in regular face-to-face conditions. Virtual teams as a form of geographically dispersed work arrangement offer significant opportunities for companies and organizations around the globe. But besides the advantages of those teams they pose additional challenges to the leadership and the team itself in order to achieve their goals. The question is: can virtual teams develop an effective knowledge management system? And if so, what are important drivers? In this study we are driven by the question how communication affects the building of a knowledge management system, more specifically of a transactive memory system (TMS) as a subset of KMS, in virtual teams. The paper shows how important the perceived richness and experience of the communication media used is and how the team size of a virtual team as well as the culture of the team members influence the relationship between communication and the knowledge management.

1. Introduction

One construct especially relevant for understanding team knowledge processes is a transactive memory system (TMS). Wegner [52] observed that members of groups tend to rely on one another to obtain, process, and communicate information from distinct knowledge domains. He termed this system of cognitive interdependence a TMS. According to transactive memory theory, group members divide the cognitive labor for their tasks, with members specializing in different domains. Compared to traditional views of KMS, the TMS also has the expertise location as an important dimension. However, a TMS is less technology supported which means that the knowledge is not saved in data management systems. The knowledge in the TMS is rather owned by the different members at the same time being supported by communication technology. With regard to the resource-based view, creation, adoption and coordination of knowledge is important to gain competitive advantage, but it is impeded in virtual collaboration due to the dispersion in time and space [49, 7]. The use of virtual teams provides organizations access to a much greater pool of information than in traditional face-to-face working structures. But compared to traditional teams their challenge lies especially in the access, the sharing and the capitalization of the team knowledge [6] caused by the fact that virtual team members predominantly interact via electronic information and communication technologies (ICT). The large amount of ICT communication in virtual teams can cause both information overloads and communication intrusions like increasing interruptions of work by communications [31]. Other problems for the functioning of virtual teams can arise from a lack of contextual information, from technical problems and from the fact that information is often not evenly dispersed between distant team members. However TMS can help to ameliorate the disadvantages of virtuality as it can reduce the extent of unevenly distributed information and develop shared understandings as well as facilitate efficient knowledge sharing. For these reasons and the fact that virtual teams usually have demanding time constraints, which may put the members of the team under a heavy pressure, TMS helps to save time and effort. The presented difficulties demonstrate that working in
virtual teams demands special competencies both from its members and leaders. Guidance is needed especially on the following points: How organizations can boost the TMS development, how to use evolved TMS structures in virtual teams and the impact of communication on the development of TMS. We draw on several streams of research to formulate our hypotheses regarding the development and the influence of TMS on performance in virtual teams. The study aims to shed light on the following questions: First, how do perceived communication richness and perceived communication experience influence the building of a TMS? Second, does a TMS in a virtual context influence team performance? Third, do culture and team size as context factors moderate the relationship of perceived communication richness and perceived communication experience on TMS? Presently to the best of our knowledge, these relationships have not been studied regarding virtual teams in the context of a Massively Multiplayer Online Game (MMOG). In addition to contributing to the literature on virtual teams, our research also contributes to the literature on antecedents of TMS in virtual teams.

2. Theoretical Foundations and Hypotheses

2.1 Perceived Communication Richness and Transactive Memory

Since virtual team members predominantly interact via ICT there is a wide scope to investigate the differences how communication channels differ in their influence. Perceived media richness in this study examines objective media richness as it draws on the Media-Richness-Theory [9]. In line with e.g. the Reduced-social-Cues-Approach [32] and the Media-Synchronicity-Theory [12], the Media-Richness-Theory refers to technical media richness. The present study investigates the influence of communication richness on three behavioral dimensions of a TMS, namely recognition of (TMS expertise), trust in (TMS trust) and coordination (TMS coordination) of specialized knowledge among virtual team members.

TMS expertise as first dimension is “the awareness of knowledge specialization among team members” [22: 785]. Due to the fact that virtual teamwork is often limited to a short period especially TMS expertise is difficult to develop. Furthermore, virtual teams often face a high turnover as specialists are called in on an ad hoc-basis according to upcoming requirements. The changes in the availability and distribution of expertise that come along with this alternating team composition can impede specialization and thus disrupt the TMS [40]. Perceived communication richness may support virtual team members in faster figuring out expertise partners for given tasks by allowing communication partners to give timely feedback [4]. Therefore, we hypothesize the following:

\[ H_1: \text{Communication richness in a virtual team is positively related to TMS expertise.} \]

Besides expertise, trust plays an important role in virtual teams because people only rarely meet face-to-face while being highly interdependent. Virtual team members have to trust in the knowledge of the other team members and in their competencies to complete the task in their name, furthermore team they have to be willing to share their own knowledge [22]. According to Curral [8] trust can be seen as the “individual’s behavioral reliance on another person under a condition of risk” [8: 151]. This condition of risk is higher in virtual teams because the members have mostly not met each other in person and are switching teams often. Therefore members fear their peers could steal or destroy their resources and keep their knowledge a secret [8]. These conditions of high interpersonal risk negatively influence their will to collaborate with others, which is detrimental for knowledge sharing [47]. The establishment of trust is impeded in virtual teams but nonetheless essential for cooperation. Since perceived communication richness allows communication partner to adjust messages to the partners’ own personal requirements, to communicate partners’ personal requirements, to communicate partners’ personal cues (such as emotional tone, attitude), and to use a rich and varied language it may foster the implementation of TMS trust among virtual team members. Therefore, we hypothesize the following:

\[ H_2: \text{Communication richness in a virtual team is positively related to TMS trust.} \]

Finally the last TMS dimension, coordination, as “the management of knowledge and skill dependencies” is more difficult when working conditions complicate the exchange of information like in the case of virtual teams [14]. The members of virtual teams often face different contexts, which impede the development of shared understandings and complicate the coordination of knowledge [22]. Cramton [7] stated that relative differences in speed of access to information (e.g. caused by different time zones) among team members and speed of transmission of information could cause some problems for coordination. The chance of timely feedback and the usage a rich and varied language facilitated by perceived communication richness [4] may assist the TMS coordination process in virtual teams. Therefore, we hypothesize the following:

\[ H_3: \text{Communication richness in a virtual team is positively related to TMS coordination.} \]
2.2. Perceived Communication Experience and Transactive Memory

Apart from the theories of objective media choice, there are several theories regarding subjective characteristics as the experience in the usage of communication media and the positive attitude of a user towards a communication media. This includes the Technology Acceptance Model [10], Channel-Expansion-Theory [4], and the Effects-of-Experience-on-Media-Appropriateness-Approach [33]. The present study uses the Channel-Expansion-Theory as it considers media richness as subjective user evaluation, which is based on different forms of experience. As with perceived communication richness we investigate the influence of perceived communication richness on all three behavioral dimensions of a TMS.

TMS expertise as first dimension requires to fast figure out expertise partners. People have to make their own knowledge accessible, and they have to share information about who is well versed in which knowledge domains. Experience with different communication media has been shown to positively influence the usage of the media [4]. This reasoning may support TMS expertise. We therefore hypothesize:

\( H_2: \) Communication experience in a virtual team is positively related to TMS expertise.

As TMS trust is an important in virtual teams because people interact virtually while being highly interdependent, perceived communication experience may help team members to use communication media in a way they feel comfortable and competent when they communicate with other team members [4]. This is especially important in an early stage of trust building, when team members get to know each other. It limits the risk not to collaborate with others, which is detrimental for knowledge sharing [47]. Therefore, we hypothesize the following:

\( H_3: \) Communication experience in a virtual team is positively related to TMS trust.

Finally the last TMS dimension, coordination may also benefit from perceived media experience as virtual team members might be better able to manage knowledge and skill dependencies. The more experience an individual has in the usage of communication media the more aware the individual will be about its features and fields of application [33]. Therefore, we hypothesize the following:

\( H_4: \) Communication experience in a virtual team is positively related to TMS coordination.

2.3. Transactive Memory and Performance

Prior research supports the positive relationship between TMS and team performance in traditional teams [2, 55]. This effect is caused by different benefits arising from TMS. TMS enhances the communication between group members sustaining the cohesion of the team and facilitating identification and usage of the appropriate knowledge [2]. Furthermore it fosters team members' knowledge contributions and task performance in complex task environments [15, 40, 29]. Following Liang et al. TMS has a stronger positive impact on group performance than on group development, social identity or cohesion of a group [36]. Several researchers recently supported these findings. They found a positive relationship between TMS and group performance [39, 2, 55]. However, there is only limited empirical research on the development of TMS in virtual teams [29]. Rosen, Furst, and Blackburn [46] identified the failure to develop an effective TMS to be one of the most common barriers in the success of virtual teams. Therefore, we hypothesize the following:

\( H_5: \) Transactive memory in a virtual team is positively related to performance.

2.4. Culture

Although ICT has facilitated information exchange across distances, cultural influences represent one of the biggest challenges in communication processes since “people from different national origins have different perceptions of, and preferences for, communication technologies” [21: 75]. The present study investigates the dimensions of cultural individualism and collectivism as it is the most often used dimension in computer-mediated communication research due to its implications on communication patterns as it strongly influences an individual’s personality, its values and self-construal [19]. Collectivistic cultures are mostly favoring context communication considering not only the content of the message but also the context in which the actual information is embedded. In order to interpret such a message correctly the communication partner needs to be able to read social cues (e.g. gestures, voice changes). Regarding communication richness, a rich communication medium should possess the capability to provide parallel channels such as language, tone, gestures and facial expressions, but should also allow giving feedback and therefore reflect different emotions and moods. Leonard et al. [34] suggest that collectivists are more reluctant to use leaner communication media (e.g. email) due to the lack of exactly contextual cues. Furthermore, Erez and Earley [13] state that high context cultures do not only prefer richer but also synchronous communication media (e.g. synchronous instant messaging), because it enables a more frequent information exchange and a faster formation of personal relationships. Considering
collectivistic cultures to prefer richer communication media, we hypothesize the following:  

$H_8$: Culture of a virtual team moderates the relationship between communication richness and all three dimensions of TMS such that the positive impact of communication richness on TMS will be stronger for collectivistic teams than for individualistic teams.  

Regarding communication experience, an individual that has sufficiently experience in a certain communication medium based on a frequent use of this medium may be able to transfer richer information. As collectivistic cultures are mostly favoring context communication, they may be more open and accustomed to the usage of different kinds of communication media in general. Kayan et al. [30] e.g. show that high context cultures like Asian nations prefer synchronous instant messaging whereas low context cultures (e.g. North America) were found to use instant messaging semi or asynchronously because they see no need for instant feedback. It provides for example the possibility of multi-party chats, which is indeed used more frequently by collectivist than individualistic nations as they prefer making group decisions rather than individual decision making [20]. Another feature is the use of emoticons which are highly popular in high context cultures to make a conversation via instant messenger more personal and reduce ambiguity [30]. Therefore, we hypothesize the following:  

$H_9$: Culture of a virtual team moderates the relationship between communication experience and all three dimensions of TMS (expertise, trust, coordination) such that the positive impact of communication experience on TMS expertise will be stronger for collectivistic teams than for individualistic teams.  

2.5. Team Size  

Prior research on team size and ICT is inconclusive. There is evidence that the use of ICT can overcome the problems noted with larger face-to-face problem solving groups where ideas can be blocked. So in virtual teams in contrast to face-to-face teams, more ideas have been recorded as the size of the group grows (e.g. [16]). Taking a closer look at the usage of rich communication media smaller groups seem to adjust better, while larger roups feel overburdened by rich media [37]. Furthermore Riopelle et al. [45] found larger teams to have more difficulties in communicating than smaller teams using audio conferencing. Especially benefits of synchronous communication media (considered as rich communication media) is limited by the size of the team. Coordination problems with synchronous communication in virtual teams arise as the number of team members increases [51]. We therefore hypothesize the following:  

$H_{10}$: Team size of a virtual team moderates the relationship between communication richness and all three dimensions of TMS such that the positive impact of communication richness on TMS will be stronger for small teams.  

With an increasing team size the frequency of communication between individual virtual team members decreases [50]. In large teams people have no time and opportunity to communicate with all team members. However, virtual teams may be able to draw upon a larger network for sources of knowledge due to their expected greater informational diversity [17]. As a result, the size of a team drives diversity in knowledge and ability to innovate [27, 48]. We expect that larger teams already possess a great access to their knowledge and have a greater pool of different expertise. However, we believe that smaller teams benefit more from perceived communication experience due to their few members. E.g. Anderson [1] found that even an increase from two to three members in both face-to-face and video conference interactions, raised the communicative effort required to realize task success. Therefore, we hypothesize the following:  

$H_{11}$: Team size of a virtual team moderates the relationship between communication experience and all three dimensions of TMS (expertise, trust, coordination) such that the positive impact of communication experience on TMS expertise will be stronger for small teams.  

![Figure 1. The research model](image)  

3. Method  

3.1 The Online Game Context  

Researchers have recently begun to understand the potential of virtual worlds as research environments [5]
for the study of organizational phenomena by tremendously increasing the number of subjects, overbearing socio-cultural boundaries and collecting standardized data of social and economic interactions [3]. Participants come from a much broader background than just students; research shows that online gamers defy common stereotypes [53]. The generalizability of results from experiments with student samples has been challenged for a long time [41, 44]. Moreover, MMOGs tend to be highly engaging and psychologically meaningful to participants. Often the relationship between players is compared to the relationship between co-workers in their real job [54]. Roles within teams are self-allocated based on knowledge and experience rather than arbitrary assignment by the experimenter [29, 28]. Further, the tasks fulfilled within these teams are highly complex [29]. Thus, online games are blurring the boundaries between work and play very rapidly and the activities in such games are increasingly similar to the work performed in business corporations [54]. Most games have an objective performance measure built into the game, substituting flawed perceptual performance measures and avoiding possible common method variance [38]. Another major advantage is that MMOGs are played throughout the world enabling researchers to conduct true international and cross-cultural studies at very low costs. Research shows that most players are older than was previously thought [18, 54]. Yet, systematic and representative research has remained elusive and rare [53]. And even though researchers admit that online games are not a perfect analogue to all aspects of organizations in the offline world (due to eventual disguise of offline identities and sometimes lower stakes), online games do open a window into the future of real-world business leadership and offer a “sneak preview of tomorrows business world” [43]. The data for this study was derived from a popular browser based MMOG called Travian. The game itself is a real-time strategy game (RTS). Players start out as chieftains of their own villages and seek to gain natural resources, build armies and expand their realms. The game is timed to last approximately one year, at which one entity being deemed the winner based on the fastest completion of a certain building called “wonder of the world”. The game is played with up to 25,000 users on one server, using scarce resources, and only one actor or team can win. Actors soon find themselves in a social dilemma [11] which is typical for the social dilemmas present in any organization that coordinates labor parts. The actors have to cooperate with other actors to protect their territory to successfully expand their realm. In the race to dominate, actors form teams of up to 60 members under a leading chieftain. Teamwork, diplomacy and negotiation skills play a crucial role in this context leading to complex team structures and interactions between and among teams.

3.2 Sample and Procedure

In our approach, we use data taken directly from the computer servers and enhance it with a questionnaire which is distributed to subscribed players in virtual teams. Specifically, we obtained the data from two sources: a survey sent to the team members and archival data from the log-files of the game server. To estimate the relevant population for our research we employed several sampling criteria. First, we used game servers that were running for around 200 days. This way we ensured that teams had been established and team membership was stable. Second, we restricted the sample to players who were part of a team, and excluded those playing alone or who had any leadership function. This led to a relevant population of 89,720. As 27,092 of these players playing in 4,417 teams answered the survey has an initial response rate of 30.2%. We excluded the players with leadership function and those under 18 years which resulted in a sample size of 13,726 resulting in a final response rate of 15.3%. Additionally we focused on players who were over 18 years of age. Using these criteria, we identified 2,780 teams with 7,982 members from 21 countries, namely Argentina, Australia, Brazil, Chile, Germany, Finland, Hungary, Indonesia, Italy, Iran, Israel, Japan, Netherlands, Poland, Portugal, Russia, Slovenia, Spain, Turkey, UK, and USA. All questions were translated to the language of the country the survey was posted. The average age of the surveyed players was 29, ranging from 18 to 69 years and 19% of the sample was female. The average team size was 34 players.

3.3 Measures

Dependent Variables. The data on TMS was obtained from the team members’ survey. The items were adapted from Lewis [35] and adjusted to the context. The items were rated on a five-point Likert-type scale with anchors of “strongly disagree” and “strongly agree”. The measures for the three dimensions showed acceptable reliabilities with Cronbach’s $\alpha = .83$ (coordination), Cronbach’s $\alpha = .80$ (trust) and $\alpha = .74$ (expertise location) respectively. The data on team performance was obtained directly from the log-files of the game server. The game has an in game scoring system for all players (which is used to measure the player’s performance). This system cannot be altered by the players themselves only by improving their performance. These scores were used as performance measure in this study.
Independent Variables. The data on communication experience (e.g. “I am very experienced using electronic forms of communication”) and perceived communication richness (e.g. “The communication technology used in my alliance allows me to give and receive timely feedback”) was obtained from the members’ survey. The three items for communication experience and three items for perceived communication richness were derived from Carlson & Zmud [4]. Instead of focusing the questions on email use we focused on electronic communication (instant messaging, email, forum, voice, and video). The items were rated on a seven-point Likert-type scale with anchors of “strongly disagree” and “strongly agree”. The measures showed very good reliabilities with Cronbach’s $\alpha = .91$ and $\alpha = .89$ respectively. Data on group size was obtained directly from the log-files of the game. The data on culture was obtained from the team member survey. The four items for individualism-collectivism were adapted from the GLOBE study [25]. Items were rated on a seven-point Likert-type scale with anchors of “strongly disagree” and “strongly agree”. The measure showed acceptable Cronbach’s $\alpha = .65$.

Control Variables. Data on gender and age was obtained from the team member survey.

4. Results

Players play in teams, and teams can be groups within countries. Thus, the players’ perception may be affected by grouping effects both at the team and the country level and therefore may not be independent of each other. The hypotheses involve predictors measured at three levels of analysis, the individual, the team, and the societal level. These nested data structures call for hierarchical linear models (HLM) rather than ordinary least square (OLS) analysis [26, 42]. HLM allows to measure different variables on the levels they reside. Team size is a variable that resides at the group level of analysis. In our study we were interested in the collectivism characteristic on the societal level. Therefore these variables were aggregated to the adequate levels to get exact influences of all predictors. A shortcoming in research on groups and organizations in general is the tendency to adopt a single-level view of the phenomenon. Our approach answers the call to incorporate multiple levels into research on individuals and groups [23]. This approach has both theoretical and practical advantages. A cross-level view offers greater precision in prediction and explanation by identifying contextual factors that qualify relationships. All predictors were standardized prior to hypotheses testing [24]. Table 1 shows means, standard deviations and correlations for study variables.

### Table 1. Means, standard deviations and correlations for study variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2 (country) 1</td>
<td>4.50</td>
<td>.21</td>
<td></td>
<td></td>
<td></td>
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<td>Level 2 (group) 1</td>
<td>33.54</td>
<td>19.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1 (individual) 1</td>
<td>29.28</td>
<td>.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.82</td>
<td>.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country Experience</td>
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<td>1.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country Richness</td>
<td>4.83</td>
<td>1.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TMS Trust</td>
<td>3.60</td>
<td>.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>TMS Expertise</td>
<td>3.40</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMS Coordination</td>
<td>3.49</td>
<td>.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*p < .05

* Hypotheses 8 and 9, regarding the moderating influence of societal collectivism on the relationship between perceived richness and communication experience on the TMS dimensions could only partially be supported. The hypothesized moderating effect of culture could only be supported for the relationship between perceived richness and expertise location ($\gamma = .03$, $t = -1.88$, p < .01). Hypotheses 10 and 11, which predicted a moderating role of team size on the relationship between communication richness on TMS as well as the relationship between communication experience on TMS could only be supported for
communication richness. The influence of communication experience on the TMS was not moderated by team size. The relationship between perceived richness and the TMS dimensions was supported. Team size of a virtual team moderated the influence of perceived richness on all dimensions of the TMS (γ = -0.05, t = -4.34, p < .001 for coordination / γ = -0.05, t = -4.60, p < .001 for trust / γ = -0.04, t = -3.40, p < .001 for expertise location).

To interpret the results of the moderation hypotheses, we estimated the simple slopes for the relationships 1 s.d. above and below the mean of team size and culture. The slopes plotted in Figure 2, 3, 4, and 5 illustrate the hypothesized relationships. Estimating effects from a lower level on a dependent variable on a higher level is not possible. Therefore, in order to analyze the effect of TMS on team performance (hypothesis 7) we had to aggregate the individual level variables to the group level and run a separate HLM. The expected positive relationship between TMS and team performance could be supported by the data (γ = 370, t = 10.94, p < .001) (see table 3).

Table 2. 3-level HLM results for TMS dimensions

<table>
<thead>
<tr>
<th></th>
<th>TMS Coordination</th>
<th>TMS Trust</th>
<th>TMS Expertise Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Level 3 (country)</td>
<td>Intercept</td>
<td>3.49 (1.01)</td>
<td>3.50 (1.01)</td>
</tr>
<tr>
<td></td>
<td>Culture</td>
<td>0.02 (0.02)</td>
<td>0.02 (0.02)</td>
</tr>
<tr>
<td>Level 2 (group)</td>
<td>Team size</td>
<td>0.10 (0.10)</td>
<td>0.10 (0.10)</td>
</tr>
<tr>
<td>Level 1 (individual)</td>
<td>Age</td>
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<td>-0.04 (0.01)</td>
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<tr>
<td></td>
<td>Gender</td>
<td>0.00 (0.01)</td>
<td>0.00 (0.01)</td>
</tr>
<tr>
<td></td>
<td>Comm. Experience</td>
<td>0.01 (0.01)</td>
<td>0.01 (0.01)</td>
</tr>
<tr>
<td></td>
<td>Comm. Richness</td>
<td>-0.39 (0.02)</td>
<td>-0.39 (0.02)</td>
</tr>
<tr>
<td></td>
<td>Comm. Experience*Culture</td>
<td>0.00 (0.01)</td>
<td>0.00 (0.01)</td>
</tr>
<tr>
<td></td>
<td>Comm. Richness*Culture</td>
<td>0.00 (0.01)</td>
<td>0.00 (0.01)</td>
</tr>
<tr>
<td></td>
<td>Comm. Experience*Team size</td>
<td>0.05 (0.01)</td>
<td>0.05 (0.01)</td>
</tr>
<tr>
<td></td>
<td>Comm. Richness*Team size</td>
<td>-0.31 (0.01)</td>
<td>-0.31 (0.01)</td>
</tr>
</tbody>
</table>

N (Level 1) = 7962; N (Level 2) = 2700; N (Level 3) = 21

Note: Standardized parameter estimates are reported in the body of the table, with standard errors reported in parentheses;
*p < .05, **p < .01, ****p < .001

Figure 2. Simple slopes for the interaction of culture and comm. richness

Figure 4. Simple slopes for the interaction of team size and comm. richness

Figure 3. Simple slopes for the interaction of team size and comm. richness

Figure 5. Simple slopes for the interaction of team size and comm. richness
Table 3. 3-level HLM results for team performance

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level 2 (country) Intercept</th>
<th>Level 1 (group) Age</th>
<th>Gender</th>
<th>TMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>252.33 (154)</td>
<td>160.14 (31) ****</td>
<td>123.07 (30) ****</td>
<td>370.17 (34) ****</td>
</tr>
</tbody>
</table>

N (Level 1) = 2780; N (Level 2) = 21

5. Discussion

The results of this study highlight the importance of communication for the building of a TMS in virtual teams. Perceived richness of the communication media as well as experience with electronic communication positively influenced all dimensions of the TMS. While perceived richness positively influences all three dimensions, communication experience only significantly influences expertise location. This result is interesting but not that surprising. The better followers are using the communication media they have available the easier the usage of all media in order to get the knowledge about the different expertise areas of their team members. Interestingly the experience did not influence the coordination. This is surprising since one would expect that the efficient usage of the channels would also help players to coordinate more efficiently. The search for the expertise of team members seems to require more knowledge about the communication media due to the high communication work that is necessary for the location. We expected culture to moderate the relationship of communication on TMS. We believed since communication is highly culture contingent that the influences would vary across cultures. Interestingly culture only moderated the influence of perceived richness on expertise location. Individualistic oriented cultures profited more from perceived richness than did collectivists. Even if the effect is pretty small it is exactly contradictory to our hypothesis. One explanation could be that collectivistic teams already share more knowledge with each other due to their cultural orientation. It could explain that individualistic cultures benefit more from richer communication since they don’t have the level of group understanding as collectivists do. This way they benefit more from higher perceived richness even though both cultures benefit from it. We further expected team size to moderate the influence of communication on the TMS. Interestingly, team size did moderate the influence of perceived communication richness on TMS on all three dimensions. However, team size did not moderate the influence of communication experience on TMS. As predicted the positive effect of higher richness on TMS was stronger for smaller teams. Smaller teams seem to benefit stronger since member are more easily reached. In larger teams, even though richness positively influences TMS, the positive effect is not as high as for small teams. In larger teams, members need more than richness or can benefit from the richness less due to their more diverse knowledge and higher complexity. Finally, the TMS positively influenced the performance of the virtual team. This result highlights the importance of a working knowledge management system in virtual teams and shows that if established, the knowledge management has a strong positive effect on the effectiveness of virtual teams. This study draws attention the importance of communication in building a TMS in a virtual team. Managerial implication though should be the advice to foster communication richness and pay attention to the culture as well as the team size of their teams.

6. Limitations and future research

A few limitations are worth noting. First, we employed a correlational design, which limits our ability to draw causal conclusions. However, this limitation is offset by the use of multiple sources of data and the temporal separation of survey data and performance data, which both mitigate self-report bias and reverse causality. In contrast to teams in actual work settings, this study was conducted in the context of a game, which may limit the extent to which the findings can be generalized. However, like many MMOGs, this particular game is highly engaging and requires many of the team-related skills and behaviors needed in virtual teams at work. Moreover, there are few technical and expertise barriers to playing the game, so the population is likely to be similar to the general population of computer literate adults who would be engaged in virtual teams at work. Future research may build upon the results of this study in a number of ways. For example, we examined teams that were homogeneous in terms of culture, which provides important insight into transferring virtual team practices across cultures. Future research could test the model using heterogeneous teams. Future research might also look at the TMS using a longitudinal approach. It is assumed that a TMS develops over time. Future research could look at
several stages in the formation and the alternating role of communication.

7. References