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Team implicit coordination based on transactive memory systems

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Received 17 March 2020
Revised 8 July 2020
Accepted 13 July 2020

Abstract

Purpose – This study aims to examine how daily communication and transactive memory systems (TMSs) promote implicit team coordination, meaning when team members cooperate smoothly without engaging in explicit communication, in organizations. In TMSs, members share knowledge of who-knows-what with one another.

Design/methodology/approach – A survey was conducted with 216 teams consisting of 1,545 people in three organizations. The relationships among daily communication, TMSs and implicit coordination in the survey data and in team performance were analyzed using multi-level structural equation modeling.

Findings – Results confirmed a significant influence process model in which "daily communication → TMS → implicit coordination → team performance" at the team level. Therefore, as hypothesized, implicit coordination is positively related to team performance and daily communication has a positive relationship with implicit coordination through mediation by TMSs.

Originality/value – This study demonstrated the evidence of the relation between implicit coordination, TMS, team performance in organizational settings by using multi-level structural equation modeling.

Keywords Teamwork, Team performance, Team processes, Transactive memory systems, Implicit coordination

Paper type Research paper

Introduction

In recent years, with the increasing complexity of social environments, many organizations have realized the difficulty of solving complex problems through individuals alone, emphasizing the importance of teamwork. Understanding the psychological processes of teamwork that lead to high performance is becoming increasingly critical. This study aimed to determine how daily communication and transactive memory systems (TMSs) interact to promote implicit team coordination, which, in turn, promotes higher team performance in organizational settings.

This work was supported by JSPS KAKENHI Grant Numbers 19H01749.

Team Performance Management: An International Journal
Vol. 26 No. 7/8, 2020
pp. 375-390
Emerald Publishing Limited
1352-7592
DOI 10.1108/TPM-03-2020-0024

Implicit coordination in organizational teams

Coordination refers to core teamwork processes and it is defined as "orchestrating the sequence and timing of interdependent actions" in the team (Marks *et al.*, 2001). Coordination among members is required when teams work on tasks; however, coordinating appropriately and achieving high performance is not easy for a group. Social psychological studies have shown that, even for simple additive tasks, group outcomes are lower than the sum of the potential powers of the groups' individual members (Latané *et al.*, 1979). One reason for this is poor coordination among group members that is process loss (Steiner, 1972) or coordination decrement (Fiore *et al.*, 2003). In other words, appropriate coordination among members is an essential factor for high team performance. Meta analytic studies have shown that coordination is one of the core dimensions of teamwork behaviors (Rousseau *et al.*, 2006).

Past research on team coordination has mainly studied explicit coordination between members that is planning, task assignments, helping and communication (Kraut and Streeter, 1995; Malone and Crowston, 1994; Sims and Salas, 2007). Although explicit coordination is still a core factor of teamwork, the importance of implicit coordination in teamwork has been noted in recent years. Implicit coordination is defined as team members coordinating by predicting one another's intent without engaging in linguistic or behavioral communication (Rico *et al.*, 2008; Wittenbaum *et al.*, 1996). Examples of implicit coordination include passing a basketball to a team member without looking at him or her and voluntarily helping others at work without being requested to do so.

A critical reason implicit coordination is effective is because a more efficient, cost-saving team process can be achieved by avoiding repeated requests (Kolbe *et al.*, 2011; Rico *et al.*, 2008). Of course, communication in teamwork is important; however, communication costs much time and effort. If smooth coordination can be conducted without taking the time and effort needed for overt communication, efficiency will improve, resulting in higher team performance. For example, Entin and Serfaty (1999) experimentally demonstrated that teams using implicit coordination scored higher when time pressure increased the need for high efficiency than when time pressure was not used. Thus, process loss (Steiner, 1972) can be avoided if teams can develop implicit coordination.

The effects of implicit coordination have mainly been shown in experimental studies in the laboratory (Aggarwal *et al.*, 2019; Akiho *et al.*, 2018; Butchibabu *et al.*, 2016; Entin and Serfaty, 1999; Wittenbaum *et al.*, 1996). However, the same is true for the organizational situation in a company's workplace. Even when working on a team toward a common goal, team members do not always interact with each other or engage in explicitly coordinated team activities. To improve team effectiveness, implicit coordination is useful because it enables team members to collaborate and cooperate smoothly even when direct communication is not possible. So, while the effectiveness of implicit coordination seems evident, to the best of our knowledge, the relationship between implicit coordination and team-level performance in an organizational field has not yet been shown. Thus, first, we will show that implicit coordination has a positive effect on team performance in an organizational setting:

H1. Implicit coordination is positively related to team performance.

This study hypothesized that the bases of implicit coordination are communication and team cognition. Implicit coordination is "coordination without communication," but it is *not* "coordination that makes communication unnecessary." Instead, implicit coordination is possible because the team communicates on a daily basis and establishes accurate team cognition that allows for smooth implicit coordination without timely communication.

Akiho *et al.* (2018) demonstrated that prior communication facilitates team performance based on timely implicit coordination. They conducted an experiment wherein two members participated by repeatedly coordinating tasks without verbal communication. The experiment showed that communication during the repeated tasks enhanced team performance with regard to implicit coordinating tasks. The results implied that daily communication about tasks increases team performance in coordination tasks when timely communication is not possible during a task.

In the current study, we hypothesized that the antecedent of implicit coordination in an organization is daily communication. In addition, team cognition, particularly the TMS, mediates the process. From the perspective of communication and team cognition, the purpose of this study is to investigate a basis for implementing implicit coordination. First, we discussed the hypothesis that team cognition would promote implicit coordination. Further, in the next section, we discuss the possibility of communication as a basis for team cognition and implicit coordination.

Implicit coordination promoted by transactive memory systems

We focus on TMS as a factor to achieve high implicit coordination. A TMS is defined as a common understanding of "who-knows-what" among team members (Wegner, 1987; Lewis, 2003; Lewis and Herndon, 2011; Ren and Argote, 2011). The TMS emerges from a compilation process of each team members' distinct expertize, which combines in a complementary fashion such as a jigsaw puzzle, to form team cognition (DeChurch and Mesmer-Magnus, 2010). A team that has a TMS can effectively conduct help-seeking/help-providing, workload adjustment and role-sharing so that its members can coordinate in a complementary manner.

One characteristic of a TMS is that diverse and highly specialized knowledge is distributed within the team. Lewis and Herndon (2011) noted three core functions of a TMS, namely, differentiated expert knowledge; transactive encoding, storage and retrieval throughout the team; and the dynamic nature of a TMSs' function. Critically, expert knowledge itself is not equally distributed among team members; sometimes, expertize is concentrated in several people. Moreover, more important is that the team understands the meta knowledge of who-knows-what correctly (Mell *et al.*, 2014; Grossman *et al.*, 2017). The expert knowledge effectively stored in the team can be used by every team member with meta knowledge, and the TMS becomes effective when every team member can accurately use the expert knowledge unevenly distributed among team members.

In today's complicated work environment, it is difficult and inefficient for only one person to perform all the work; teamwork, characterized by team members complementing one another's strengths and weaknesses, is essential. Previous studies have examined TMSs mainly through laboratory experiments (Liang *et al.*, 1995) and field surveys (Akgün *et al.*, 2005). Both approaches have shown a positive relationship between TMS and team performance (Lewis, 2003). Results of meta-analysis studies demonstrated that the compilation aspect of team cognition, including TMSs, has a stronger relationship with team performance than the composition aspect of cognition (DeChurch and Mesmer-Magnus, 2010).

Past research has pointed to team cognition as an antecedent of implicit coordination; shared mental models or team mental models as composition aspects have been often examined (Fisher *et al.*, 2012; Rico *et al.*, 2008). On the other hand, the role of the compilation aspect of team cognition, including TMSs, in implicit coordination has rarely been investigated. One of the few available studies shows the interactive effect of TMS and implicit coordination on team adaptive behavior in emergency teams (Marques-Quinteiro *et al.*, 2013). The positive relationship between TMS and implicit coordination can also be found in business organizational teams, on which this study focuses.

Understanding team coordination from the perspective of a shared mental model is limited (Gorman *et al.*, 2010). Studies of the shared mental model have demonstrated the importance of team members having common knowledge about tasks; however, for example, in a surgical team, is it necessary for surgeons, anesthesiologists and nurses to share all the same knowledge? Rather, effectiveness can be promoted by team members with differentiated and specialized knowledge and skills that they share with each other. Considered from a specialization perspective, it is vital to build a TMS as a compilation aspect of team cognition. A TMS also plays an important role in implicit coordination. Rico *et al.* (2008) suggested that anticipation is one of two basic processes required for implicit coordination. TMS promotes anticipation: even if team members do not directly communicate about tasks, actions, demands and the like, if team members can anticipate the tasks, actions or demands that will be needed, team collaboration is implicitly facilitated. Building a TMS, that is sharing "who-knows-what," promotes anticipation of others' demands or actions. For precise anticipation to succeed, that team members know one another well is key. Thus, spontaneous and smooth helping and cooperation can be facilitated if members are aware of others' expertize.

Suppose, for example, a team shared the information that one member is good at making sales to foreigners because of his or her foreign language skills. Based on the teams' shared cognition of his or her expertize, the team will be able to achieve better performance by allocating customer responsibilities to this member when foreigners visit the store. Moreover, if team members also share awareness of areas in which a member has low expertize, other team members can offer support voluntarily rather than waiting for the rest of the team to request help. With such a TMS structure, appropriate role-sharing, help-seeking and help-provision would occur implicitly, without requiring time to communicate. Thus, we predicted that TMS will have a positive relationship with implicit coordination:

H2. TMS is positively related to implicit coordination.

Daily communication as the basis of transactive memory system

As an antecedent to building a TMS in a team, we focused on daily communication. Daily communication was defined in this study as communication in daily situations, including both informal communication – greetings and chats – and formal communication about the task. Daily communication can deepen interpersonal relationships in teams and allows members to share interpersonal information both formally and informally.

Communication is the basis of teamwork. A study on business teams (Nawata *et al.*, 2015) demonstrated that team collaboration, including coordinative behavior, is based on communication. However, it is still unclear what results from daily communication in detailed interpersonal team processes. This study hypothesized that daily communication would facilitate implicit coordination through a TMS.

Informal information such as information related to members' characteristics, special skills, work progress and family conditions, as well as information difficult to share in formal communication settings such as conferences or meetings, is naturally shared across the team through daily communication. For example, daily communication about what a member was studying abroad in China when he/she was a college student can build a TMS on Chinese expertize within the team. This will contribute to smooth coordinative behavior within the team in a situation that involves Chinese customers. In related research, He *et al.*

(2007) demonstrated that team familiarity – whether team members know each other well – positively affects awareness of expertize location and a shared understanding of tasks.

The positive relationship between daily communication and implicit coordination may seem contradictory. Implicit coordination is coordinative behavior without communication, whereas daily communication is overt communication. However, to be able to implement effective team collaboration that uses implicit coordination, it is necessary for the team to already possess a shared cognition that includes a TMS, which is created by conducting communication thoroughly in daily situations. Fiore *et al.* (2003) noted the importance of the process of understanding member roles and competencies and interacting during mission pre-brief sessions to conduct effective implicit coordination in team processes. In other words, in emergencies or high-pressure situations, to smoothly perform implicit coordination without requiring communication, it is necessary that shared team cognition such as a TMS is built by engaging in explicit communication in everyday situations:

H3. Daily communication is positively related to TMS.

Integration of *H2* and *H3* shows the team-level process of "daily communication → TMS → implicit coordination." This is interpreted as a mediating effect in which daily communication promotes implicit coordination by constructing a TMS:

H4. TMS will mediate the relationship between daily communication and implicit coordination.

Hypothesis of the entire implicit coordination process

The above hypotheses (i.e. *H1–H4*) posit that the following team-level process exists: daily communication → TMS → implicit coordination → team performance (Figure 1).

In this study, a team-level process was examined using multi-level structural equation modeling (ML-SEM, Preacher *et al.*, 2010). A study that deals with only two variables can only reveal causality or correlations between those two variables. In SEM, it is possible to examine multiple stages of a process such as X → Y → Z. Teamwork researchers have drawn abstract theoretical models of the overall process of teamwork (Dickinson and Mcintyre, 1997; Hackman, 1987; Ilgen *et al.*, 2005); however, past empirical studies of teamwork often investigated the relationship between only two or only a small number of variables and the overall process of influence was rarely tested directly. Therefore, it is vital not only to confirm the relationship between two or three variables but also to show the relationship between multiple variables in the entire process.

This study tested the whole process using ML-SEM, which can examine team-level and individual-level processes independently. This made it possible to understand the overall team-level process of influence targeted in this research. The hypothesized process was examined for teams in organizations. Moreover, to show the importance of implicit

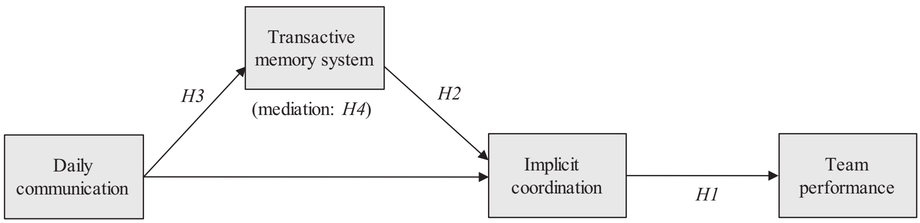


Figure 1. Hypotheses regarding team-level influence processes in this study

coordination, additional analyzes comparing the effects of implicit coordination and collaboration were conducted.

Method

This study conducted research using three companies in Japan. Employees answered questionnaires that measured variables related to teamwork. Two companies provided team performance indicators. Methodological features of this research included the following: to collect data from more than 200 teams; to conduct a statistically valid analysis using ML-SEM to understand the overall team-level process; and to use team performance indicators, which were provided by the two companies, to minimize self-rating bias.

Participants

Company A is a major construction company in Japan. They undertake civil engineering and construction projects such as dams, tunnels, bridges. A total of 611 members on 77 teams were analyzed, with each construction site serving as a team unit. The average team size was 7.93 (SD = 5.33, range = 2–32). Company B manufactures and sells beverages. For sales employees, sales offices were used as team units. A total of 174 members on 21 teams were analyzed. The average team size was 8.30 (SD = 2.47, range = 4–13). Finally, Company C is a general logistics company. "Departments" or "divisions" such as the finance department were categorized as teams. A total of 760 people on 118 teams were analyzed. The average team size was 6.44 (SD = 3.71, range = 2–16). These companies are management consulting clients of the third author.

As part of the work of one of the authors' management consulting practices, we asked employees of each client company to respond to an online survey system. This survey is a self-assessment questionnaire for teamwork and leadership provided by our research group as part of our management consulting services. By accumulating data on a large number of teams, it is possible to measure each teams' level of teamwork. Each team members responded to the survey from January to March 2014. Except for a team that had only one respondent, 216 teams (N = 1,545 members; 1,329 men, 86%) were analyzed. Participants' mean age was 39.50 years (SD = 10.67, range = 18–69 years). The average team size was 7.15 (SD = 4.34, range = 2–32), and the number of respondents in the team was used.

Measures

Three variables – daily communication, TMS and implicit coordination – were self-rated. Items used and the factor analysis results are shown in Table 1. Self-rated items included the phrase "this team" for aggregation at the group level. All items were rated on a five-point Likert-scale ranging from 1 (disagree at all) to 5 (strongly agree). Intra-team average scores were used in the team-level analysis. All questionnaire items were originally written in Japanese. The items were translated into English for this paper.

Daily communication. Three items from Nawata *et al.* (2015) were used. The average of all three items was used as an indicator of daily communication. The items are "this team communicates freely during daily work;" "this team frequently engages in informal communication and greetings;" and "on this team, members are not afraid to ask others if they do not understand something." The Cronbach's alpha coefficients re 0.77 at the individual level and 0.85 at the team level.

Transactive memory system. Based on previous studies of TMSs (Lewis, 2003) and discussion by the authors, two social psychologists and one management consultant, four items were devised to measure TMSs. The average of all four items was used as an indicator of TMS. The four items are "this team has a common understanding regarding what we

Table 1. Factor analysis of the items at the individual and team levels

Items	Individual level F1	F2	F3	h^2	Team level F1	F2	F3	h^2
F1. Transactive memory system (individual $\alpha = 0.79$, team $\alpha = 0.84$)								
This team has a common understanding regarding what we should ask to whom	0.74	0.07	−0.06	0.56	0.75	−0.04	0.13	0.67
This team knows who has what expert knowledge about certain tasks	0.68	−0.03	−0.03	0.46	0.81	−0.07	−0.12	0.45
This team understands who is assigned what precise tasks	0.67	0.01	0.03	0.45	0.61	0.11	0.13	0.63
When problems occur, this team knows who works how	0.53	0.06	0.19	0.32	0.54	0.31	−0.01	0.62
F2. Daily communication (individual $\alpha = 0.77$, team $\alpha = 0.85$)								
This team communicates freely in daily work	−0.02	0.81	0.03	0.66	−0.17	−0.01	1.11	0.98
This team frequently conducts informal communication and greetings	−0.01	0.70	0.03	0.49	0.23	0.08	0.51	0.58
In this team, members are not afraid to ask others if they do not understand something	0.27	0.49	−0.04	0.32	0.35	−0.03	0.49	0.58
F3. Implicit coordination (individual $\alpha = 0.69$, team $\alpha = 0.85$)								
This team works well together and has good chemistry	−0.10	−0.01	0.84	0.71	−0.14	0.97	−0.03	0.73
Team members can communicate successfully with abbreviated explanations	0.06	0.07	0.53	0.29	0.09	0.68	0.05	0.62
This team implicitly understands what each person should do and deals with problems	0.25	0.00	0.44	0.25	0.27	0.43	0.06	0.49
Correlation between factors	F1	F2	F3		F1	F2	F3	
F1								
F2	0.76				0.73			
F3	0.67	0.63			0.75	0.63		

Notes: Intra-team average score was used in the team-level analysis. All questionnaire items were originally written in Japanese should ask to whom," "this team knows who has what expert knowledge about certain tasks," "this team understands who is assigned, which precise tasks" and "when problems occur, this team knows who works how." The Cronbach's alpha coefficients were 0.79 at the individual level and 0.84 at the team level.

Implicit coordination. Based on previous studies of implicit coordination (Fisher *et al.*, 2012) and discussion by the authors, two social psychologists and one management consultant, four items were devised to measure implicit coordination. The average of all three items was used as an indicator of implicit coordination. The three items are "this team works well together and has good chemistry," "team members can communicate successfully with abbreviated explanations" and "this team implicitly understands what each person should do and manages problems." The Cronbach's alpha coefficients were 0.69 at the individual level and 0.85 at the team level.

Team performance (internal performance rating in Company A). This was an index that applied to the 77 teams in Company A. The company assessed outcomes using a five-stage rating (1–5) of six aspects, namely, construction technology, quality, profit and loss, process, safety and environment. The Cronbach's alpha coefficient was 0.70. The average score of the six items was used as a team performance index. The data from Companies B and C were missing values.

Team performance (target achievement rate in Company B). We were provided with actual sales scores and predicted sales score for 18 out of 21 teams in Company B. We calculated the ratio of actual versus predicted sales for each store and used it as the target achievement rate for the team performance indicator. The data from Companies A and C were missing values.

Team size. The indicator was operationalized as the number of participants on the team because almost all members answered the survey.

Statistical analyzes

Data were analyzed using Mplus ver. 7 (Muthén and Muthén,1998-2012) for the ML-SEM. The other descriptive statistics, intra-class correlation (ICC) coefficients and correlation coefficients were calculated using HAD ver. 15.2 (Shimizu, 2016).

Results

Factor analysis in self-rating scales

In this analysis, the three variables of daily communication, TMS and implicit coordination were evaluated by self-rating. To check the discriminatory validity of these items, we first conducted an exploratory factor analysis. For the individual level (individual $N = 1{,}545$) and the within-group mean level (team $N = 216$), we similarly conducted a factor analysis, extracting three factors and applying promax rotation. As a result, a three-factor structure was obtained, as shown in Table 1. The items included in each of these three factors were exactly as we had originally created them. The factor structure was the same in the individual level and in the within-group mean level. It was confirmed that the three self-rated variables were discriminant factors.

Descriptive statistics based on intra-team average score

Table 2 shows the descriptive statistics calculated based on the average score of team members within the team. The ICC coefficients of the three self-rated variables were all 0.1 or over and significant. This showed that individuals on the same team had similarities and that using multi-level analysis is necessary when considering team-level effects.

Table 2. Descriptive statistics at the team level

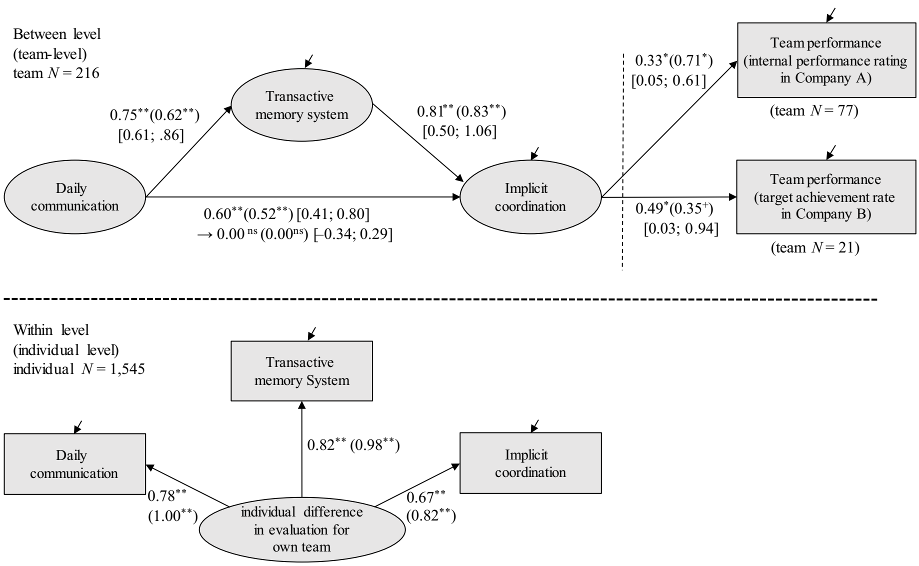
Variables		N_{team}	*Mean*	*SD*	*ICC*	1	2	3	4a	4b
1.	Daily communication	216	3.73	0.42	0.13**					
2.	Transactive memory systems	216	3.78	0.37	0.11**	0.71**				
3.	Implicit coordination	216	3.17	0.41	0.12**	0.61**	0.70**			
4.	Team performance									
	4a. Internal performance rating	77	4.02	0.50	–	0.19^{+}	0.24*	0.26*		
	4b. Target achievement rate	18	1.04	0.16	–	0.28	0.23	0.17	–	
5.	Team size	216	7.15	4.35	–	–0.09	–0.17*	–0.18**	–0.18	0.20

Notes: Analysis was based on the average intra-term score. $^{**}p < 0.01$, $^{*}p < 0.05$, $+p < 0.10$

Team-level process by multi-level structural equation modeling

The process was modeled at the team level (between-level) and individual level (within-level). This method of modeling of team-level and individual-level influences followed Nawata *et al.* (2015). At the team level, based on the hypothesis, a model was devised assuming the following path: daily communication → TMS → implicit coordination → team performance. In the present analysis, team size was controlled. Additionally, the variance at the individual level was interpreted to be individual differences in cognition of the team they belonged to among team members. When team members evaluated the team they belonged to, some members evaluated it positively and others evaluated it negatively. In ML-SEM, the effect at the individual level can be interpreted as individual intra-team differences regarding how team members see their own team. Therefore, at the individual level, the path was modeled from the latent variable – individual differences in evaluation of ones' own team – to all observed variables. In addition, the full-information maximum likelihood method was used for the missing data of Companies B and C in "team performance in Company A" and that from Companies A and C in "team performance in Company B." Furthermore, ICC at the organizational level was calculated; however, it was low (< 0.04). Therefore, it was determined that a three-level SEM was unnecessary.

The results of the analysis showed that the goodness-of-fit of the model was adequate ($\chi^2 = 1.476$, $df = 5$, $p = 0.92$; comparative fit index [CFI] = 1.000; root mean square error of approximation [RMSEA] = 0.000; standardized root mean residual [SRMR] = 0.000 [within-level] and 0.036 [between-level]). Figure 2 shows the process of the entire model and presents



Notes: The values associated with each path are standardized coefficients, and values in parentheses are nonstandardized coefficients, and the values in the between-level in brackets represent 95% confidence intervals. **$p < 0.01$, *$p < 0.05$, $^{+}p < 0.10$. Fit indices are the following: $\chi^2 = 1.476$, $df = 5$, $p = 0.92$; RMSEA = 0.000; SRMR = 0.000 (within-level), 0.036 (between-level). The team size was added in the analysis as a variable of between-level, and the effect was controlled, but it was omitted from the figure

Figure 2.
Influence process enhancing team performance in an organizational team

standardized and unstandardized parameter estimates. As hypothesized, all the paths from daily communication → TMS → implicit coordination → team performance at the team level were significant.

In addition, to examine the mediating effect, a test based on Baron and Kenny (1986) was conducted. The direct path from daily communication to implicit coordination in the model excluding TMS had a significant positive effect ($\beta = 0.60$, $p < 0.01$). However, when TMS was entered simultaneously into the model, the effect of daily communication on implicit coordination became non-significant ($\beta = 0.00$, $p = 0.99$). In other words, the effect from daily communication to implicit coordination was completely mediated by TMS. In sum, all four hypotheses were supported.

Comparison of goodness-of-fit for the causal process

This study examined the causal process between the four variables and confirmed the validity using the above analysis. This is the order of influence theoretically assumed in this research, and processes following another order can be assumed. The most appropriate method is the mediation analysis of multiple step models; X → M1 → M2 → Y (Hayes *et al.*, 2010). However, the variables in this study were highly correlated, and this caused multi-collinearity. Thus, different ordered models were compared. Because team performance is an outcome variable, it is the last in the causal order. For this reason, ML-SEM was conducted for all six patterns in which the team performance was always placed last, and the order among three variables replaced by other self-ratings was modeled. Then, the goodness-of-fit of each model was calculated.

The results are summarized in Table 3. In all indices of χ^2, comparative fit index, RMSEA, AIC, SRMR (within) and SRMR (between), the fit of the hypothesized process was the best compared with other orders of influence. Thus, it was confirmed that the causal process presented by this research is highly relevant. However, it should be noted that the fit index of the process 3 → 2 → 1 → 4 was also high and the difference between 3 → 2 → 1 → 4 and the hypothesized model was not significant. The goodness-of-fit of the hypothetical process in Table 3 is slightly different from that shown in Figure 2 because the model in Figure 2 includes the direct path of "1 (daily communication) → 3 (implicit coordination)."

Discussion

This study aimed to examine how daily communication and TMSs promote implicit team coordination, resulting in high team performance. We conducted a survey with 216 teams to investigate the process of daily communication → TMS → implicit coordination → team performance at the team level. Our hypothesized team process was tested using ML-SEM.

Tested processes	χ^2	CFI	RMSEA	AIC	BIC	SRMR (within)	SRMR (between)
1 → 2 → 3 → 4a,4b (Hypothesis)	1.397 ($p = 0.97$)	1.000	0.000	8,448.608	8,582.178	0.000	0.036
1 → 3 → 2 → 4a,4b	16.582 ($p = 0.01$)	0.994	0.034	8,456.280	8,589.850	0.006	0.046
2 → 1 → 3 → 4a,4b	31.220 ($p < 0.01$)	0.987	0.052	8,463.232	8,596.802	0.005	0.073
2 → 3 → 1 → 4a,4b	18.573 ($p < 0.01$)	0.993	0.037	8,457.863	8,591.432	0.006	0.061
3 → 1 → 2 → 4a,4b	41.595 ($p < 0.01$)	0.987	0.052	8,462.862	8,596.432	0.005	0.064
3 → 2 → 1 → 4a,4b	2.905 ($p = 0.82$)	1.000	0.000	8,449.673	8,583.242	0.001	0.046

Notes: 1 = daily communication, 2 = transactive memory system, 3 = implicit coordination, 4a = team performance in Company A, 4b = team performance in Company B. Team size was controlled

Table 3. Comparison of fit index for the causal process

The results demonstrate that implicit coordination is positively related to team performance. Moreover, the results suggest that daily communication and TMS are the basis of implicit coordination.

Implicit coordination based on the transactive memory system and daily communication

A positive relationship between implicit coordination and team performance at the team level was revealed; it was empirically demonstrated through a study of Japanese companies that teams with implicit coordination perform effectively. In addition, the analysis showed that daily communication promoted the TMS and that implicit coordination can result from the enhancement of the TMS on daily communication.

First, the TMS was a key predictor of implicit coordination. TMSs refer to the sharing of members' expertize regarding who-knows-what. By sharing expertize, it is possible to smoothly perform role-sharing and help each other such that the members oversee specialized tasks based on their own expertize, without explicit communication. In addition, TMSs include the sharing of non-expertize. If information on a member who is weak in a certain task is shared by building a TMS, voluntary backup behavior can be performed implicitly and quickly by others. Implicit coordination can be promoted in teams that share knowledge of who-knows-what.

Furthermore, the results of this study imply the possibility that daily communication is the basis of TMS. Daily communication is not just wasteful talk; a variety of functions are conducted through informally conducted daily communication. For example, daily communication functions as a place for interpersonal information-sharing. Moreover, the function of daily communication overlaps with that of dialogue in the organization. Dialogue is a mode of communication that emphasizes mutual understanding and peoples' individuality and enhances creativity in a team as a learning organization (Senge, 2006). Daily communication can function as an excellent "dialogue" when done properly.

In this study, team size was included as a control variable. The larger the team size, the worse the team process and performance. Previous group research has also demonstrated that team performance decreased when the team size was too large (Hackman and Vidmar, 1970; Steiner, 1972; Wheelan, 2009; Stewart, 2006). One of the biggest reasons is process loss. In larger groups, team members cannot monitor others' work and cannot support each other carefully. Thus, it is thought that building a TMS and using implicit coordination as part of higher-level teamwork is more difficult as the team size increases.

Limitations and future directions

Causality should only be inferred carefully. The hypothesized model was judged as the most appropriate based on the model fitness revealed from the ML-SEM. However, there are two points to keep in mind. First, because a one-time cross-sectional survey was used, it is difficult to show strict causality. An experiment using longitudinal data is, thus, required. Second, the study investigated the causality by comparing models in various orders. Although the hypothesis model was shown to be the most suitable and reasonable, it should be noted that the process of "implicit coordination → TMS → daily communication → team performance" is also highly adaptable, and the difference from the fitness of the hypothesis model was non-significant. Further investigation of causality is necessary. Moreover, team influences may be bi-directional. For example, cohesiveness has been shown to enhance team performance while team performance increases cohesiveness (Mullen and Copper, 1994). Similarly, while communication and TMS may improve team performance, conversely, team performance may promote communication and TMSs. This should be considered in future studies.

This research showed the relationship between TMSs and several variables. While important findings have been obtained, sharing team cognition includes many aspects such as shared mental models or sharing situation awareness and a TMS. The mutual relationship between these different aspects was not sufficiently determined in this research. The shared mental model as composition and the TMS as compilation are two core aspects of team cognition (DeChurch and Mesmer-Magnus, 2010). It is necessary to investigate the differences and mutual relationships between these two types of team cognitions.

Next, it should also be noted that the measurement of teamwork variables used questionnaire self-ratings. To measure TMSs, participants answered regarding the extent to which their team shared who-knows-what. This was a subjective rating. It is necessary to measure TMSs in a more objective way. Cognition of "who-knows-what" is subjective; however, the extent to which this subjectivity is consistent among the team members should be quantified. For example, we can understand the level of expertize-sharing by the extent to which the mutual evaluation of expertize about task and jobs among each member matches (Austin, 2003). In future research, it is necessary to examine TMSs using objective ratings of how similar or how accurate knowledge of who-knows-what is.

Moreover, concerning the objective measurement of implicit coordination, research should use a labyrinth experiment like Akiho *et al.* (2018), in which coordination without communication is required. However, implicit coordination in the organizational context is difficult to measure objectively because coordinative behavior is by nature "implicit." Therefore, rather than aiming at objective measurements in an organizational setting, more precise scale development could prove useful, even though it is based on subjective ratings.

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