Chapter 12
Who Knows What and Who is Reliable: Transactive Memory System in Multiactivity Task Environment

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Abstract In this research, we examine that how TMS works in a multiactivity task environment. We propose that the development of TMS, an ongoing feed forward and feedback process to improve the group performance, depends on the establishment and confirmation of credibility in group members' transactive memory. Using the computer simulation, we determine the effects of multiactivity task attributes on group task performance through establishing a TMS model. The virtual experimental results indicate that interdependence, dynamics, implicitness, and the interaction of these three attributes are negatively related to group task performance in different degrees.

Keywords Transactive memory system · Multiactivity task · Group performance · Agent-based simulation · Group learning

12.1 Introduction

Researches on transactive memory systems provide lots of compelling evidences to the fact that group cognition, which can be reflected by the transactive memory system (TMS), influences collective performance [18]. As been widely revealed, TMS is a group-level collective system for encoding, storing, and retrieving information that is distributed across group members [25]. Usually, in groups with a well-developed TMS, members specialize in different knowledge and have a common cognition about the knowledge possessed by each member. Thus, TMS is often

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considered as “a shared understanding of who knows what”. Based on members’ clear understanding of the specialized expertise that each member possesses, group performance might be improved through TMS because it can provide quick and coordinated accesses to group members to get a greater amount of high-quality and task-relevant knowledge [14].

Most of the published TMS studies were conducted in laboratory using newly formed ad-hoc groups for the special purpose of studying TMS [15]. These groups were generally asked to complete a single task (e.g. assembling radios) and were disbanded when the task was complete. These studies revealed that the groups trained collectively performed better than other groups trained individually and that the relationship between training and performance was mediated by the existence of a TMS [3]. In addition, based on the measurement scales developed by Lewis [13] and Austin [3], some field studies were published recently [6, 29]. However, it is regrettable that these field studies paid more attention to the antecedents and consequences of TMS and were rarely concerned with the dynamic task demands from organizational workgroups [2, 17]. On the whole, most of the previous studies were conducted in a simple and static task environment.

In fact, workgroups in organizations might encounter a large variety of group tasks. Many organizational workgroups engage in tasks characterized by dynamic complexity, and are performing activities that cannot fall clearly into the same type. Meanwhile, the tasks which involve a set of coordinated activities are time-bound, with specific start and completion dates, and proceed in a series of phases that can form a complete project life cycle together. Thus, the main purpose of this paper is to extend the TMS research into the multiactivity task environment in consideration of the attributes of interdependence, dynamics, and implicitness.

We begin our discussion by presenting a general framework which reveals the relationships among multiactivity task attributes, TMS, and group task performance. This framework provides the conceptual foundations for this study and describes the elements and the logic of the simulation model. We then outline the model specification and parameters before reporting the results and analysis of the model runs. Finally, we conclude several suggestions for future research in discussion section.

12.2 A Theoretical Framework

12.2.1 TMS in Multiactivity Task Environment

We advocate that the usefulness of a TMS depends not only on a shared understanding of who knows what but also on the degree to which group members know who is more reliable to do what. Thus, we deem that TMS development depends on the establishment and confirmation of the credibility. In the following sections, we analyze how the characteristics of TMS relate to the credibility and affect group task performance in multitask activities (See Fig. 12.1).

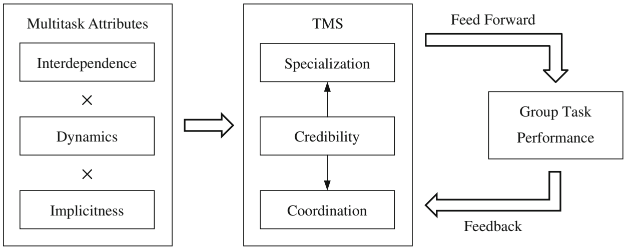

Fig. 12.1 The theoretical model of the relationships among multiactivity tasks attributes, transactive memory system, and group task performance

Credibility Updating. Brandon and Hollingshead [5] argue that the development of TMS involves a cycle of construction and evaluation of the hypotheses regarding other team members' knowledge, abilities, and credibility. On the one hand, it takes time and effort to discern who is good at what. On the other hand, the accurate expertise perceptions at one period may be obsolete at another period because of the dynamic task environment. Thus, group members will keep modifying their perceptions of others' expertise over time from crude perceptions based on the surface characteristics to more accurate conceptions of group members' expertise. As group members begin to perform tasks and start receiving performance feedback, they accurately gain a better understanding of each other's expertise and keep adjusting their existing credibility.

Knowledge Refining. Compared with the perception adjustment toward others during the transactive memory updating process, knowledge refining is more concerned with self-reflection. Social learning theory suggests that feedback achieved through learning by doing and vicarious learning acts as a powerful reinforcing mechanism of behaviors. Performance feedback, especially the negative performance feedback, may evoke group members' reassessment on the accuracy of their own expertise. Therefore, the credibility is an important moderator between diagnostic performance feedback and expertise modification.

Expertise Coordination. Because of the fact that organizational workgroups sometimes are partially specialized and group members' expertise is to some extent overlapped, it is common that there are more than one member-expertise associations ready to be accessed when a member who is responsible for some subtask needs external memory aids. One reason is that many group members bring their versatility to the group at its inception. Another is that group members can learn from others during the previous task processing.

The overlapped knowledge in a group poses a challenge to coordination. To ensure the completion of a subtask, the responsible member will choose the most trusted expert who possesses that special knowledge. In other words, a group matches a person with the special expertise according to the credible knowledge of the responsible member's transactive memory. The coordination based on trust is conducive to accomplish the group task. On the one hand, the providers expect that any knowledge they share will be accepted by the receivers without questions about their competence. On the other hand, the receivers know that the providers will provide them with the accurate, reliable, and complete knowledge. Trust should therefore enhance team members' uses of each other's expertise to store and retrieve knowledge and thus strengthen the influence of the location dimension of transactive memory on performance [22].

In summary, we believe that the feed forward and feedback between TMS and group performance is mediated by the establishment and confirmation of credibility in group members' transactive memory. Group members choose the most reliable partners to work together so as to achieve good performance. Based on performance feedback, group members update their existing credibility and refine the expertise knowledge for the coming subtasks.

12.2.2 Multiactivity Task Attributes

Because the group task determines the specialization demands and coordination processes, recently published TMS studies repeatedly stressed the task attributes in TMS research [4, 5, 9, 14, 28]. Compared with the simple and static tasks that are engaged by the groups in TMS laboratory studies, multiactivity tasks are more often engaged by organizational workgroups in actual situations. The dynamic complexity is one of the major characteristics for all multitask activities, and thus the group processes and the demands for the knowledge and skill change throughout the life cycle of the group's work [14, 21]. In order to well perform the multitask activities, a group with TMS will develop task representations that include how the task can be broken down into component parts and who should perform a subtask to achieve the overall goal [13]. We recognize that each subtask has three typical features: interdependence, dynamics, and implicitness.

Interdependence. Interdependence refers to the extent to which group members need knowledge, skills, and support from other group members. The knowledge must be acquired from other group members through the retrieval and coordination processes to effectively complete the subtask. Previous studies mostly investigated task interdependence from the cognition point of view. For instance, Zhang and Hempel [28] manifested that task interdependence perceived by team members is positively related to the team's TMS. Yuan and Fulk [27] demonstrated that task interdependence is positively related to individual expertise exchange. In this research, we focus on the interdependence that arises from different kinds of knowledge in a specific subtask, particularly on how variations in degree of knowledge from different expertise interdependence influence TMS and subtask performance.

In a simple and static task environment, the interdependence is a fundamental driving force. Group members are more likely to develop a TMS when group tasks are interdependent than when tasks are independent. But in a complex and dynamic task environment, group performance will dramatically decrease as tasks become more interdependent. When interdependence is in a low level, task representation is so clear that group members can easily recognize how many kinds of expertise are needed and find the most reliable partners to accomplish subtasks. Meanwhile, group members can distinguish that which expertise leads to the negative performance. Based on this, both TMS updating and knowledge refining proceed smoothly. In this way, more accurate TMS and expertise can facilitate the improvement of group performance. However, when interdependence is in a high level, group members must have an access to a large body of knowledge and combine each other's distributed expertise to carry out the tasks. Any inaccurate expertise can cause groups' failure to update the TMS and refine their knowledge. Therefore, as interdependence increases, group members will try harder and harder to understand each other's skills and coordinate their knowledge and expertise so that they are able to complete the tasks.

Hypothesis 1 Interdependence of a multiactivity task is negatively related to task performance.

Dynamics. Dynamics refers to the changing frequency of task demands. A dynamic and shifting environment creates commensurate group task demands that members have to resolve through a coordinated process that combines their cognitive, affective, and behavioral resources. However, the environment change is hard to predict, which means knowledge valid at one time can easily become counterproductive at another time without any symptoms. Besides, the environment change is not obvious, which means that it can be discovered only after making some mistakes. Essentially, group adaptation to the changing demands is mainly a process of collaboration and interaction among individuals, which is the base for learning from the mistake. If dynamics is in a low level, based on TMS, group members can reflect on their performance and its consequences, discover the cause and effect relationships, and identify the weaknesses and strengths in their own efforts. But if dynamics is in a high level, the obsolete knowledge retrieved from TMS cannot be used to solve the unexpected problems effectively. Besides, the limited cognitive resources are consumed during TMS updating and knowledge refining processes. Therefore, the more the group task demands dynamic, the worse the task performance achieved through TMS.

Hypothesis 2 Dynamics of a multiactivity task is negatively related to task performance.

Implicitness. Implicitness refers to the implicit part of expertise knowledge to accomplish group tasks. As pointed by previous studies, tacit knowledge is the knowledge that is difficult to be transferred to another person by the means of writing it down or verbalizing it. By anticipating what others in the group are likely to do, members can adapt their own behavior to facilitate the group's task completion without explicit discussion of who should do what [24]. The existence of tacit knowledge in multi-activity tasks is due to two reasons: first, the dynamics decreases the chance to code implicit knowledge into explicit knowledge because of group members' lack of cognitive resources; second, since each individual concentrates on his or her own expertise area, which increases the obstacles to transfer knowledge; third, the implicit coordination characteristic of TMS prevents changing the implicit knowledge into explicit knowledge.

Although the evidence from Lewis et al. [15] suggests that TMS can facilitate the transformation of prior knowledge to different tasks, they do not distinguish which kind of knowledge is learned and transferred. We advocate that the knowledge and experience, especially the explicit part, gained from a special area expert in one task can be stored in group member's memory and transferred to accomplish other tasks. If the percentage of tacit knowledge is low, group members are more likely to gain additional knowledge from an unfamiliar expertise area during the coordination of previous tasks. The result is that group members can partially reduce the dependence on the expert in that area when they meet a task that needs this part of knowledge next time. As more tasks can be finished by groups during the limited time, therefore group performance increases. When the percentage of tacit knowledge is high, group members are less likely to acquire new expertise knowledge. Thus, high implicitness is not conducive to the improvement of group performance.

Hypothesis 3 Implicitness of a multiactivity task is negatively related to task performance.

In addition to the main effects proposed in Hypotheses 1–3, we propose that interdependence, dynamics, and implicitness may interact with each other to influence the group task performance. It means that group will achieve the lowest performance if the engaged task has all three attributes at the same time.

Hypothesis 4 The interaction of interdependence, dynamics, and implicitness is negatively related to task performance.

12.3 The Simulation Model

12.3.1 Simulation Setting

Group Size. There are m individuals in a group. Because TMS effectiveness is contingent upon group size, the group size in our simulation model is determined by real organizational workgroup size. Devine and Clayton [7] report that the average size of new product development teams in the United States is 11 members. The Saratoga Institute's 2001 benchmarking study found that the average span of control of supervisors in U.S. companies ranged from four employees per manager (for information services) to 16 employees for healthcare organizations. Thus, we fix group size to 10 individuals during the simulation ($m = 10$).

Knowledge Representation. We use the framework of reality and beliefs to simulate TMS evolution. Reality represents the correct knowledge to accomplish multiactivity tasks. It is modeled as an n-dimensional vector with each element randomly assigned a value of 1 or -1 with equal probability. Each element of reality represents a piece of knowledge. The greater is n, the greater is the complexity of the group task.

The reality is equally divided into s areas of expertise. Adapted from Miller et al. [19] paper, each area of expertise contains explicit dimensions and tacit dimensions, and the portion of tacit dimensions in every area of expertise is represented by p. In our model, reality is fixed to contain 100 pieces of knowledge ($n = 100$), which corresponds to 10 areas of expertise respectively ($s = 10$). That means each area of expertise consists of 10 pieces of knowledge, and the number of tacit pieces of knowledge equals to 10 times p. Thus, p is an indicator for the implicitness attribute of multiactivity task.

Because organizational workgroups usually consist of members who join with knowledge and experience in particular areas, group members are randomly assigned one or two areas of expertise at the beginning of our simulation. The number of areas of expertise depends on the extent of group expertise diversity. Expertise diversity refers to differences in the knowledge and skill domains in which members of a group are specialized as a result of their work experience and education. In our model, expertise diversity can range from 1 when each individual possesses unique expertise to 2 when the group can be divided into two subgroups with equivalent function. We fix expertise diversity to 1.5 in simulation. Thus, the total number of areas of expertise in a group is 15, which is calculated by the product of expertise types and expertise diversity ($10 \times 1.5 = 15$). Then the 15 areas of expertise are randomly assigned to 10 individuals, and we make sure every individual corresponds to at least one area of expertise.

Each individual holds beliefs about the corresponding elements of reality at each period. Each dimension of beliefs has a value of 1, 0, or -1. A value of 0 reflects the absence of knowledge about a particular dimension of reality, whereas 1 and -1 indicate commitments to particular knowledge. At the beginning of the simulation, all the expertise dimensions of agent beliefs are consistent with reality, and the other dimensions are equal to 0.

Task Setting. In the model, we assume a group task in each period and that can be broken down to a set of subtasks. We adapt the classic *NK* model to generate subtasks. The *NK* model is named for the two parameters that are used to randomly generate problem spaces. It was originally developed by evolutionary biologist Kauffman to model epistasis, the genetic analog to synergies among human activities. Levinthal [12] firstly introduce *NK* model to organizational research. From then on, it has been widely used in the studies of organization management. In our model, n is interpreted as the number of potential pieces of knowledge needed to accomplish each subtask, and k is the typical amount of synergies among pieces of knowledge. In other words, the performance of any given subtask depends on the presence of k pieces of knowledge belonging to different areas of expertise respectively. The subtask can be accomplished only when all the k pieces of knowledge correctly reflect the corresponding dimensions of reality. Thus, k is used as a proxy for the interdependence attribute of multiactivity task.

Dynamics. Dynamics is episodic in our model. We perturb r proportion of dimensions in every expertise of reality (from 1 to -1, or from -1 to 1) at every d period. We fix r to 0.1 in our model. Thus, d is used as the only indicator to reflect the dynamics attribute of multiactivity task.

12.3.2 Interaction Process

Expertise Coordination. For each period, the group encounters n subtasks. The group coordinates these subtasks according to their performance, from most to least value. We assume that each subtask corresponds to a key expertise. Any subtask is assigned to a responsible agent who has the key expertise. Because organizational work groups engage a lot of activities that are time-bound, if the agent who possesses the key expertise cannot be found, group immediately gives up this subtask and starts to coordinate the next.

We assume all the agents can accurately and uniformly break subtasks down to different pieces of knowledge, which is a kind of shared knowledge in our model. To perform subtasks, agents may not possess all the necessary knowledge, so they need to search for the persons who have these pieces of knowledge in the group according to their transactive memory. We assume that even if agents have the required knowledge through previous individual learning, they can still choose to improve their skills or gain more knowledge by seeking help from experts of relevant areas. Only when TMS does not exist or they cannot find a suitable expert in TMS, do agents then estimate whether they themselves have the required knowledge. If responsible agents possess the required knowledge, they take this part of the subtask by themselves; otherwise they randomly choose an agent from available agents so as to know more people's expertise. If TMS exists and they can get more than one suitable expert, agents will choose the most reliable expert according to credibility. In this way, group members are assigned to subtasks based on their transactive memory of who knows what and who is more reliable to do what. Because we simulate the tasks involved complex knowledge and skills, group members need to indeed participate and not only just provide some simple information. Hence, we assume each individual can only work for one subtask in a period of time.

Credibility Updating. Credibility is gained by accumulation in the simulation model. We use an index to represent credibility. At the beginning, all the credibility in TMS is set to 0. If a subtask is successfully finished, all the individuals who participated are assigned plus 1 for each other's expertise in their transactive memory. If a subtask is failed, the value of credibility remains unchanged.

Existing Knowledge Refining. Individuals only refine knowledge when they get negative feedback. In the model, refining means inversing the value of knowledge dimension (from 1 to -1, or from -1 to 1). The likelihood of individuals refining their knowledge depends on knowledge refining probability. For any individual, we measure the probability for refining the knowledge dimension as follows:

$$\text{knowledge refining probability} = \frac{1}{a}\prod_{i=1}^{I}\frac{c_i}{Mc}, \tag{12.1}$$

where c_i takes on each element in the set of credibility index, respectively corresponding to which expertise of whom is used to perform the subtask. Mc represents the maximum credibility value in the individual's transactive memory in that period of time. Besides, a serves as a tunable parameter which changes according to the number of element in the set.

New Knowledge Learning. Individuals only learn from partners' expertise when get the positive performance feedback. Because of the nature of multiactivity task, we assume individuals can only learn explicit dimensions of expertise with probability e, and tacit dimensions cannot be learned in the simulation. In the model, e is fixed to 0.5.

12.3.3 Outcomes Measures

The groups go through 200 task periods. The second 100 task periods have exactly the same setting as the first 100 task periods, except that agents start to refine their knowledge based on the credibility developed during the first 100 task periods. At the end of each task period, performance is recorded by adding all the successful subtasks' performance value. All of performance collected at the end of each task period is averaged based upon 1,000 runs of the simulation model. Group task performance is the average of the 200 performance values.

12.4 Simulation Results

We constructed our simulation models using MATLAB 7.8. We use the model to run a series of simulations that examine the impact of multiactivity task attributes on group task performance through TMS. First, two interdependence conditions are simulated: low and high. Under low interdependence, each subtask consists of two kinds of knowledge respectively belonged to two different types of expertise ($k = 2$). Under high interdependence, each subtask consists of three kinds of knowledge ($k = 3$), which makes the coordination become more complex. Second, two dynamics conditions are simulated: low and high. Under low dynamic condition, the interval of reality change is 20 periods ($d = 20$). That means some dimensions of expertise in reality change at every 20 period. Under high dynamic condition, the interval of reality change is 10 periods ($d = 10$). Task dynamics increase as the decreasing of interval period number. Last, we design two implicitness conditions. Under low implicitness condition, the proportion of tacit dimension in every expertise is 0.2 ($p = 0.2$). Whereas, under low implicitness condition, the proportion of tacit dimension in every expertise is 0.8 ($p = 0.8$). Under such condition, it is hard to transfer knowledge from one person to another. Therefore, each of these three predictor variables was manipulated into a high and a low condition resulting in a $2 \times 2 \times 2$ complete factorial experimental design. We conducted all hypotheses tests using analysis of variance (ANOVA).

A three-way ANOVA (see Table 12.1) reveals a significant main effect for interdependence, $F(1{,}792) = 132{,}074.94$; $p < 0.001$, a significant main effect

Table 12.1 ANOVA summary

Source	*df*	*SS*	*MS*	*F*
Interdependence	1	554.15	554.15	132074.94***
Dynamics	1	1.16	1.16	277.43***
Implicitness	1	325.44	325.44	77564.02***
Interdependence × dynamics	1	0.04	0.04	9.45***
Interdependence × implicitness	1	3.99	3.99	951.63***
Dynamics × implicitness	1	0.63	0.63	150.79***
Interdependence × dynamics × implicitness	1	0.02	0.02	5.81***
Error	792	3.32	0.00	
Total	799	888.77		

Note $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

for dynamics, $F(1,792) = 277.43$; $p < 0.001$, and a significant main effect for implicitness, $F(1,792) = 77564.02$; $p < 0.001$. These results provide support for Hypothesis 1–3. Also, Table 12.1 reveals a significant interaction effect between interdependence and dynamics, $F(1,792) = 9.45$; $p < 0.01$, a significant interaction effect between interdependence and implicitness, $F(1, 792) = 951.63$; $p < 0.001$, and a significant interaction effect between dynamics and implicitness, $F(1,792) = 150.79$; $p < 0.05$. Last, as predicted in Hypothesis 4, the analysis revealed a significant three-way interaction between interdependence, dynamics, and implicitness, $F(1,792) = 5.81$; $p < 0.05$.

To more easily see the form of the interaction, we use two graphs to present conditions under which the multiactivity task attributes have effects on group task performance. As shown in Fig. 12.2, all three attributes, interdependence dynamics, and implicitness, have detrimental influence on group task performance in different degrees. The group undertaken low interdependence, low dynamics, and low implicitness tasks obtain the highest performance (4.80). In contrast, groups suffer the most in a high interdependence, high dynamics, and high implicitness task environment (1.77).

12.5 Discussion

This paper highlights the credibility of a TMS. Although there is a clear understanding in the literatures of psychology and management that TMS can influence collective performance by sharing cognitive labor, we advocate that the credibility accumulated from previous performance feedback is the core of a TMS in a multiactivity task environment. Based on this function mechanism, we develop an agent-based simulation model to examine the influence of multiactivity task attributes on group task performance through the TMS. The virtual experimental results show that interdependence, dynamics, implicitness, and the interaction of these three attributes are all negatively related to group task performance.

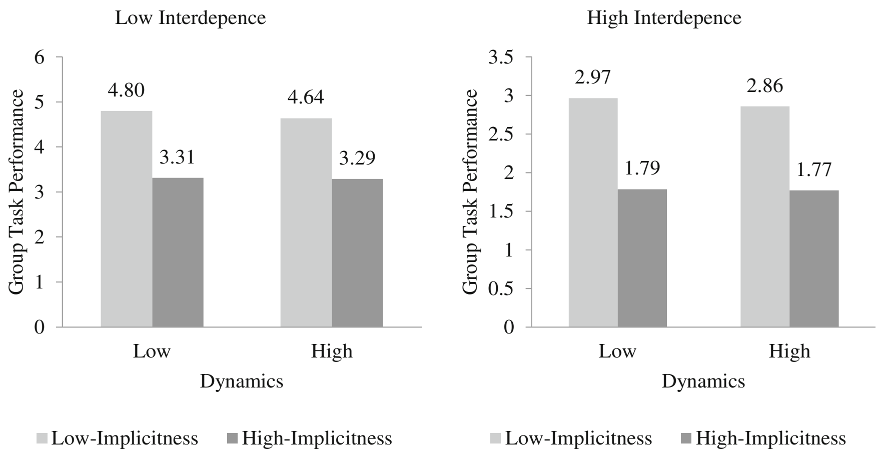

Fig. 12.2 Three-way interaction of interdependence, dynamics, and implicitness

Previous studies mainly regarded TMS as a coordination mechanism of information. The information in a TMS has several characteristics: first, the information sharing does not cause any loss to the information providers; second, the information can be used by receivers without any transformation cost; third, the accuracy of information is easy to discern. Thus, the most important part of TMS development is to build a shared understanding of who knows what. Group members can get the information to finish subtasks as long as they find the right person. However, the multiactivity tasks that organizational workgroups engage in usually need to be accomplished by complex expertise. It is impossible to transfer some professional knowledge from one person to another in a limited time. In order to accomplish group task, experts from different areas often work together, which means that individual members serve as knowledge repositories [1]. In this process, the expertise is the exclusive resource that individuals utilize to fulfill the tasks by co-operating with others. Group members share with other parties the burden of loss or benefit of gain. Therefore, group members will cooperate with their most reliable persons.

Usually, group tasks determine what domains of knowledge are relevant. Group members first recognize which pieces of knowledge belong to which expertise. Then they determine that whom they should cooperate with according to the credibility of each person's expertise in their transacitve memory. Meanwhile, the credibility serves as a practical guide to other important group processes like knowledge refining. Thus, the first contribution of this paper is that we propose the effectiveness of a TMS in multiactivity task environment depends on the establishment and confirmation of credibility. Group member not only need to know who knows what but also to know who is more reliable to do what.

However, TMS is not useful for all types of tasks performed by workgroups in knowledge-based organizations. For a team that does not require diverse expertise or knowledge to do their work, it may not be necessary to develop a TMS [14].

Categorizing tasks allows us to systematically analyze the role of task type and to pinpoint more precisely how learning works when groups work on certain type of task [11]. Although the multiactivity task has been repeatedly stressed from theory to practice [14, 16, 21], the task attributes that matter most remain under theorized. Therefore, we focus our analysis on the attributes of multiactivity task. First, we view interdependence from the nature of task instead of the perception of group members which was widely used in previous studies. Second, we use dynamics to reflect the ever changing nature of the task demands caused by the change of broader organizational systems or performance environments. Third, as far as we know, this is the first study distinguishing the tacit and explicit knowledge in TMS research. Thus, our second contribution lies in summarizing the interdependence, dynamics, and implicitness attributes of multiactivity task, and demonstrates that the main effects and three-way interaction are all negatively related to group task performance.

This study makes the third contribution by developing a new agent-based simulation model to reflect the dynamic evolution process of TMS. Ren et al. [23] developed a multi-agent system named ORGMEM to investigate the effects of TMS on performance dependent on the organizational context and on team size. The most glaring weakness of their model is that all the simulated agents, resources, and tasks begin with a particular design, which greatly limits the stability and repetition of their model. In addition, Palazzolo and Serb [20] developed a simulation model to study the effects of initial knowledge, initial accuracy of expertise recognition, and network size on the development of a TM system as mediated through communication. They developed the simulation model by Blanche, which was a software package designed to create and execute computational models of network behavior. Although it is relatively easy to do simulation based on the mature software, the generality of those models is low. Our model overcomes above-mentioned shortcomings. It can clearly reflect how TMSs develop and evolve over time. This model can be used to investigate a complex set of factors that might affect the TMS evolution processes.

However, our study suffers from several limitations. First, because some scholars put forward that the TMS is an important component of group learning [8], and group learning processes are distributed across organizational members in a well-developed TMS [1], group learning should be another important indicator of group performance. Thus, task performance and group learning are not conflicting but complementary. On the one hand, some change in the group's range of potential behavior constitutes an evidence of group learning, but it is not manifested in external performance [26]. On the other hand, many factors that influence group learning (e.g. turnover) are also likely to impact group performance via mechanisms other than learning [10]. We deem that these two group performance indicators can reflect how task attributes affect group performance through TMS in a multiactivity task environment more completely. Second, we only consider the knowledge learning and TMS sharing in the model. During the interaction with others, group members can not only learn expertise knowledge but also develop the credibility of each person's expertise in their transacitve memory. Thus, the question that how the sharing of transactive memory affects group performance should be answered in future studies.

Third, more detailed indicators should be developed to measure TMS in the model. We only analyze the mediation effect of TMS between multiactivity task attributes and group task performance in theory. More specific mechanism should be investigated in future studies. Last, although the computer simulation method has high level internal validity, the results developed from our model still need to be further tested studies conducted in laboratory or field settings.

In conclusion, our paper provides an optimistic answer on how a TMS works in a multiactivity task environment. We propose that the development of TMS, an ongoing feed forward and feedback process to improve group performance, largely depends on the establishment and confirmation of credibility in group members' transactive memory. Our results suggest that all three attributes of multiactivity tasks (interdependence, dynamics, and implicitness) have negatively influences on group task performance in different degrees. In order to overcome the detrimental influence, managers should not only promote group members share understanding of who knows what, but also provide opportunities for gaining understanding of who is reliable to do what.

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