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The Catalyst Effect: The Impact of Transactive Memory System Structure on Team Performance

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THE CATALYST EFFECT: THE IMPACT OF TRANSACTIVE MEMORY SYSTEM STRUCTURE ON TEAM PERFORMANCE

ABSTRACT

Research on transactive memory systems (TMSs) implicitly assumes that metaknowledge (i.e., the "knowledge of who knows what") is uniformly distributed among team members. Relaxing this assumption results in a more realistic notion of team cognition in which the distribution of metaknowledge can take different forms. Demonstrating the importance of this conceptual shift, we compare teams in which metaknowledge is concentrated within one central member (a centralized TMS structure) with teams in which metaknowledge is distributed evenly among the members (a decentralized TMS structure). We predicted that centralized metaknowledge can give teams a performance advantage over decentralized metaknowledge, because centralized metaknowledge can allow the central member to function as a catalyst for information exchange and integration. We proposed this catalyst effect to be contingent on the extent to which the distribution of task information among members poses high coordination demands to effectively integrate members' knowledge. In a laboratory team decision making experiment (N = 112) we found the predicted interaction effect between TMS structure and the distribution of task information. Furthermore, the experiment supported our hypotheses about the mediating role of the transactive retrieval process and the ensuing team information elaboration.

Keywords:
transactive memory; distributed information; group decision making, team cognition, shared cognition, information elaboration

The increasing complexity of tasks and decision issues faced by today's organizations has motivated the use of teams at all hierarchical levels. Engaging teams rather than individuals with complex tasks can be beneficial because it enlarges the pool of knowledge resources to draw from (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). Yet, teams consistently fall short of making full use of this potential, failing to effectively share and integrate distributed knowledge. This realization has given rise to a burgeoning stream of research addressing collective information processing in teams (Hinsz, Tindale, & Vollrath, 1997; Mesmer-Magnus & DeChurch, 2009; van Knippenberg, De Dreu, & Homan, 2004). One stream of research that has particularly shaped our understanding of the role of team cognition for knowledge utilization and integration is research on *transactive memory systems* (TMS, Wegner, 1986). TMS theory suggests that teams develop a division of cognitive labor with regard to learning, retrieving, and sharing knowledge (Hollingshead, 2001). In a TMS, team members are argued to develop specialized knowledge stocks and shared *metaknowledge* – knowledge of who knows what. This metaknowledge in combination with the distributed expertise forms the *TMS structure*. Alongside this structural aspect, members develop a set of communication processes to collectively use the distributed knowledge. Originally describing the implicit division of cognitive labor in intimate couples (Wegner, Giuliano, & Hertel, 1985), the notion of TMSs has since been elaborated and widely applied to understanding information processing in teams and organizations (Austin, 2003; Lewis, 2003; Liang, Moreland, & Argote, 1995; Peltokorpi, 2011). TMSs have been found to be positively related to a range of desirable team level outcomes such as performance, learning, and creativity (e.g., Akgün, Byrne, Keskin, Lynn, & Imamoglu, 2005; Austin, 2003; Gino, Argote, Miron-Spektor, & Todorova, 2010; Liang et al., 1995; Zhang, Hempel, Han, & Tjosvold, 2007).

This line of research has provided consistent evidence for the importance of TMSs for team processes and outcomes, but it is characterized by an important blind spot in that it ignores the role of the distribution of metaknowledge among team members. The definitional emphasis on *sharedness* of metaknowledge, that is, the similarity of perceptions of the distribution of expertise among team members (Brandon & Hollingshead, 2004), seems to build on the implicit assumption that metaknowledge is uniformly distributed in a team – meaning that team members do not differ in the extent to which they have knowledge of who knows what. This implicit assumption has largely constrained TMS research to the investigation of the implications of different average levels of metaknowledge in the team. As a case in point, experimental research has mainly compared the extremes of no member having any metaknowledge and all members having complete metaknowledge (Stasser, Stewart, & Wittenbaum, 1995; Stewart & Stasser, 1995). Field research has allowed deviations from these extreme points, but has not deviated from a focus on team average metaknowledge only (e.g., Austin, 2003).

However, metaknowledge is an individual resource derived from partly idiosyncratic sources (e.g., Cross, Borgatti, & Parker, 2001) and a fully shared and complete understanding of the expertise distribution within the team seems to be an advanced state of a TMS (Brandon & Hollingshead, 2004). Thus, partially distributed metaknowledge may be the rule rather than the exception. It is thus somewhat striking that we do not know anything about how the distribution of metaknowledge in a team affects team process and performance – TMS research has turned a blind eye to what arguably is an important aspect of metaknowledge.

The primary aim and contribution of the present study is to address this neglected role of metaknowledge distribution. In doing so, we introduce the concept of *TMS centralization*, which captures the disparity of metaknowledge levels within the team. We contrast a *centralized TMS structure*, which is a situation in which one or a few central team members possess a high level of metaknowledge while the rest of the team members have a low level of metaknowledge, with a *decentralized TMS structure*, which is a situation in which all members have a similar level of metaknowledge. We argue that in a centralized TMS structure central members can play a role of process catalysts stimulating important team processes. In particular, they can encourage and model *transactive retrieval*, i.e. communication aimed at retrieving specific information from other team members (Wegner, 1995), which, in turn, can enhance *information elaboration*, i.e. the exchange, discussion, and integration of task-relevant information (van Knippenberg et al., 2004) Through this effect on team information processing, a centralized TMS structure ultimately can improve *team performance*, i.e. the extent to which a team accomplishes its goals or mission (Bell, 2007), on tasks that demand information exchange and integration such as team decision making, complex problem-solving, or creative tasks. We furthermore examine how the distribution of task knowledge among team members moderates this process. We suggest that the catalyst effect of TMS centralization is stronger the more the knowledge distribution requires coordination of expertise for the team to effectively integrate team members' knowledge.

In addition to contributing to a better understanding of TMSs in revealing how and under what conditions member differences in metaknowledge can impact team process and outcomes, our study makes at least two further contributions. First, we present a conceptualization of TMS structure that is a powerful source of new questions in TMS research. By acknowledging that metaknowledge can differ among team members and by putting the spotlight on the implications of these differences, our study opens up new avenues for research on different levels of analysis which can greatly advance our understanding of information processing and knowledge integration in teams. Second, our study has implications for team cognition research more broadly. Our conclusion that not only the degree but also the configuration of metaknowledge in a team is relevant may also hold for other aspects of team cognition such as task representations, attitudes, or preferences (Salas & Fiore, 2004).

THEORETICAL BACKGROUND AND HYPOTHESES

A transactive memory system is an emergent property of a team that is conceptualized in terms of two components. The structural component consists of individual knowledge, while the process component is a set of communication processes among individuals that coordinate learning, retrieval, and application of knowledge (Wegner et al., 1985; Wegner, 1986). *Transactive memory,* or metaknowledge, forms a basic constituent of TMSs. Metaknowledge describes a person's understanding of what knowledge other individuals possess; it is individual cognition reflecting awareness of the expertise of different team members (Ren & Argote, 2011).

The prevailing view on TMS structure strongly emphasizes sharedness of metaknowledge among team members. For instance, Lewis and Herndon (2011: 1256) define TMS structure as "a knowledge representation of members' unique and shared knowledge (including members' shared understanding of who knows what)". An implicit assumption entailed in this definitional emphasis on shared metaknowledge is that metaknowledge is uniformly distributed among team members. This emphasis on sharedness of metaknowledge is reflected in the field's use of average team scores as for example established in Lewis' (2003) and Austin's (2003) measures of TMSs as well as in experimental designs comparing teams where no member has any metaknowledge with teams where each member has complete metaknowledge (Stasser et al., 1995; Stasser, 2000; van Ginkel & van Knippenberg, 2009).

We do not argue with the important insights derived from this research on team level differences in metaknowledge. However, we do contend that the emphasis on team level metaknowledge has resulted in an important blind spot in TMS research. TMS theory is inherently a multilevel theory with team level cognition, i.e. a TMS, arising from the compilation of individual level cognition, i.e. metaknowledge (Lewis & Herndon, 2011; Yuan, Fulk, Monge, & Contractor, 2010). The fact that individual cognition – metaknowledge – lies at the core of TMS implies that there may be differences in metaknowledge between team members; metaknowledge can be shared, but it need not be. The fact that distributions of team cognition need not be uniform is recognized in other areas of team cognition research (e.g., cross-understanding, i.e. the understanding of others' mental models, Huber & Lewis, 2010), but TMS research has generally ignored the possibility that metaknowledge can take different distributions in a team. We argue that TMS research can take important steps forward by analyzing the potential influence of member differences in metaknowledge.

Metaknowledge can vary among members of a team for several reasons. As a team forms, some members might already be familiar with each other, have shared experiences, or have knowledge about each other from other sources. These factors have been shown to affect the building of metaknowledge (Akgün et al., 2005; He, Butler, & King, 2007; Liang et al., 1995; Yuan et al., 2010), and may thus result in differences in metaknowledge within the team. Over time, asymmetries in metaknowledge can arise through subgroup interdependence and communication (Brandon & Hollingshead, 2004; Lewis, 2004), or through individual access to metaknowledge via other sources, such as external communication, gossip, or research (Cross et al., 2001). Finally, team members may differ in the metaknowledge they are able or motivated to extract in the course of team interaction.

Although the optimal state of a TMS is a complete and shared understanding of available knowledge resources in the team (Brandon & Hollingshead, 2004), this ideal state is likely to be the exception rather than the rule. First, in the process of TMS development, metaknowledge converges, i.e. becomes shared, at a rather late stage (Brandon & Hollingshead, 2004). Second, teams experience turnover which has a disruptive effect on TMSs (Lewis, Belliveau, Herndon, & Keller, 2007; Moreland, 1999). Third, transactive memory can decay with time or become obsolete as team members' knowledge changes (Ren & Argote, 2011). In short, average metaknowledge levels that differ from the extremes of none or full are not uncommon and at these intermediate average levels non-uniform metaknowledge distributions are likely. Ignoring the distribution characteristics of metaknowledge thus implies considerably limiting the scope of our understanding of transactive memory and its implications for team process and performance. Therefore, we conceptualize the structural component of a TMS as capturing members' individual expertise alongside their mental representations of expertise location in the team, and highlight that this conceptualization implies that such individual cognition need not be shared.

In a shorthand rendition of Brandon and Hollingshead's (2004) notion of task-person-expertise unit, we consider a *metaknowledge unit*, i.e. a cognition linking a person with an area of expertise (e.g., "Paul knows about marketing"), to be the elementary unit of TMS structure. A person's *level of metaknowledge* corresponds to the number of metaknowledge units this person holds. Members of a team can differ with respect to their levels of metaknowledge. An important dimension of TMS structure arising from these differences is its *centralization*. TMS centralization describes the disparity of the number of metaknowledge units held by each team member or, in other words, the relative concentration of metaknowledge within the team (Harrison & Klein, 2007). In a team with a highly centralized TMS structure one or few members hold many units of metaknowledge while most members hold few. In decentralized TMS structure, on the other hand, every member holds roughly the same amount of metaknowledge. Figure 1, panels a and b, illustrates this distinction.

Insert Figure 1 about here

TMS Centralization and Team Performance: The Catalyst Effect

As illustrated in Figure 1 (panels a and b), at the same team average metaknowledge level, a striking difference between a team with a decentralized TMS structure and a team with a centralized TMS structure is the maximum level of metaknowledge of an individual member. Whereas in a team with a decentralized TMS structure each member has approximately the same number of metaknowledge units that corresponds to the team average, a centralized TMS structure is defined by at least one member holding an above average number of metaknowledge units – a *central* member in terms of metaknowledge. In other words, comparing two teams with a similar average level of metaknowledge but a different degree of TMS centralization, the central member(s) of a team with a centralized TMS will have a higher level of metaknowledge than any member of a team with a decentralized TMS. In the following, we argue that such central members are likely to show behaviors that will stimulate the exchange and integration of task information in the team. In performance contexts where TMSs are deemed relevant – tasks with clear information exchange and integration demands such as decision making with distributed information – this should result in higher team performance.

Individuals with a high level of metaknowledge are more likely to engage in behaviors that stimulate team information processing because they are more likely to recognize the importance of information exchange to team performance (van Ginkel & van Knippenberg, 2009). The more metaknowledge a person has, the more complete that person’s understanding of the knowledge accessible to the team and the distributed nature of this knowledge is. As van Ginkel and van

Knippenberg argued and showed, realizing that different team members have unique expertise leads individuals to the understanding that the team can benefit from exchanging and discussing this information. As a result, they approach the team task from this perspective and more actively pursue information exchange. Relating these insights to the fact that, given a certain level of team average metaknowledge, a central member in a team with a centralized TMS structure has more metaknowledge than any member of a team with a decentralized TMS structure, we can expect central team members in teams with a centralized TMS structure to more actively pursue the exchange of information than any member of a team with a decentralized TMS structure.

Such behavior in pursuit of information is known as transactive retrieval. Transactive retrieval is one of the transactive processes – interactions that coordinate a team's encoding, storage and retrieval of information relevant to the team task (Wegner et al., 1985; Wegner, 1986). It refers to communication behaviors aimed at accessing specific information held by other team members, for instance by asking questions that invoke labels referring to a specified knowledge domain (Hollingshead, 1998; Wegner, 1995).

Team members observing transactive retrieval in a fellow member are likely to follow this example. Seeing a member taking the lead in transactive retrieval may signal that such behavior is appropriate and safe to members who may otherwise be hesitant to reveal own lack of knowledge and encourage them to ask for information, too (Edmondson, 1999; van Ginkel & van Knippenberg, 2008). In addition, observing a member successfully retrieving wanted information can inspire other members to show the same behavior in order to find information that is missing from their perspectives (Bandura, 1965). Moreover, transactive retrieval questions can help other members to develop their own metaknowledge by communicating the asker's metaknowledge. For example, the question "Peter, what is our financial situation with regard to this issue?"

reveals that the asker thinks that Peter has financial information and deems such information important to the task. As a result, other team members observing this communication may also be more likely to ask Peter for financial information.

For teams with distributed information, transactive retrieval is important as it stimulates information elaboration, i.e., the exchange, discussion, and integration of task-relevant information (van Knippenberg et al., 2004). First, in contrast to more general questions about others' opinions and preferences seeking subjective judgments, transactive retrieval questions aim to elicit specific, relatively objective task information. Thus, they make information available for team discussion and collective judgment. Second, members engaging in transactive retrieval are consciously seeking information unknown to themselves, which makes it likely that they will indeed consider and process the obtained information and integrate it with what they already know. This process of information elaboration, in turn, has been consistently shown to be a key driver of the performance of teams with distributed information and diversity of perspectives (Hoever, van Knippenberg, van Ginkel, & Barkema, 2012; Homan et al., 2008; Kearney, Gebert, & Voelpel, 2009; van Ginkel & van Knippenberg, 2008).

To sum up, we propose that teams with a more centralized TMS structure engage in more transactive retrieval, because the central members in such teams can fulfill a catalyst role in setting off transactive retrieval in the whole team by taking the lead in this behavior. We expect the higher levels of transactive retrieval in teams with a more centralized TMS structure to result in more information elaboration, which in turn results in better team performance.

The Moderating Role of the Distribution of Interdependent Task Information

TMS centralization can enhance transactive retrieval and thus information elaboration and team performance for teams with distributed information and perspectives. However, not all tasks are equally conducive to this catalyst effect. Rather, this catalyst effect should be contingent on the extent to which the task at hand poses demands for *expertise coordination*, i.e. team interactions to manage knowledge dependencies (Faraj & Sproull, 2000). Such demands rise, e.g., with task novelty, complexity, or the manner in which needed knowledge is distributed. In this study, we focus on the role of the distribution of task information. We argue that the distribution of task information can take different forms that put greater or lesser demands on expertise coordination. As a result, in some information distributions the catalyst effect of TMS centralization becomes more pronounced and more critical to team performance than in others. That is, we investigate the interacting effects of the distribution of two kinds of information on team performance: task information (i.e., knowledge that is directly relevant to the task at hand) and metaknowledge (i.e., knowledge about the distribution of task information).

One aspect of task information that has important consequences for the coordination demands of a task is its *interdependence*. Information items are interdependent whenever the meaning of one statement is dependent on other statements (Pennington & Hastie, 1993). For example, knowledge about an upcoming change in legislation such as a change in safety requirements for production facilities can be highly meaningful for a team involved in strategic planning. However, it only acquires its full meaning when related to knowledge about, e.g., design features of the currently available facilities. Together, these pieces of information allow judging whether and how the upcoming changes affect the current plan of action.

Interdependent information can be distributed in a team in different manners that vary in the extent to which interdependent information is known by one individual or rather distributed over individuals (Fraidin, 2004). Figure 1 captures two illustrative cases. In a *connected distribution* (panel c), each team member possesses a complete (and different) set of independent information. In other words, each member holds items of information whose meanings are dependent on other items of information that are known to that same member. An example of such a connected distribution is a team of different industry specialists or product champions, every one of them knowledgeable about all relevant aspects of his or her product area. On the other hand, in a *disconnected distribution* (panel d), a set of interdependent information is distributed over different team members. That is, each member holds items of information whose meanings are dependent on other items of information that are known to other members but not to that same member. An example of such a distribution is a team of functional specialists, each knowledgeable of a specific class of aspects regarding different products.

The distribution of interdependent information has important consequences. As suggested by the very definition of interdependence of information, members possessing a more complete set of interdependent information are in a better position to understand the meaning of these pieces of information and judge their relevance to the task. Thus, as demonstrated by Fraidin (2004), a connected distribution helps team members to recognize the implications and the importance of their knowledge for the task. As a result, they may be more likely to share and discuss relevant information with the team or even to integrate interdependent information on their own and present the team with an accurate conclusion without necessarily discussing the constituting information. In a disconnected distribution, on the other hand, individual members are less able to accurately judge the meaning and relevance of their knowledge for the team task. Thus, they may be less likely to share potentially relevant information unprompted – while at the same time, the disconnected distribution requires information to be explicitly shared with the team in order to be integrated with interdependent information held by others. Thus, in a disconnected distribution establishing the right connections among interdependent pieces of information becomes a team task that raises additional coordination demands and decision quality is critically dependent on how well the team achieves this coordination.

As a consequence of this increased coordination demand, a disconnected distribution of interdependent information is more conducive to the catalyst effect of TMS structure centralization on team performance. When team members are less likely to share relevant information unprompted, the role central members in a centralized TMS structure can have in driving transactive retrieval and, consequently, information elaboration will be highly important. In a task with a connected distribution of interdependent information, on the other hand, TMS centralization is less likely to play a role as members can easily recognize, share or individually combine relevant information unprompted and therefore rely less on transactive retrieval.

To sum up our conceptual analysis, we argue that TMS structure impacts the quality of team decision making such that, in a task with a disconnected distribution of interdependent task information, teams with a centralized TMS structure outperform teams with a decentralized TMS structure. We do not expect this effect in a task with a connected distribution of interdependent task information. We furthermore argue that this interaction is mediated by a rise in transactive retrieval and, as a consequence, information elaboration. We tested the following hypotheses:

Hypothesis 1: Teams with a centralized TMS structure perform better than teams with a decentralized TMS structure when there is a disconnected distribution of interdependent task information, but not when there is a connected distribution of interdependent task information.

Hypothesis 2: The interaction effect of TMS structure and the distribution of interdependent task information on team performance is sequentially mediated by (a) transactive retrieval and (b) information elaboration.

To test these hypotheses we conducted a laboratory experiment in which teams performed a decision making task that required the exchange and integration of distributed information – a prototypical setting for the effects of metaknowledge to unfold (Stasser et al., 1995; van Ginkel & van Knippenberg, 2009). We manipulated the connected versus disconnected distribution of interdependent task information and the centralized versus decentralized nature of the TMS structure. We opted for this experimental method because it allowed us to draw conclusions about causality and enabled us to use audio-video recordings of the team discussions rather than self-reports for an unobtrusive and reliable measure of the team processes (Weingart, 1997).

METHODS

Experimental Design

The experiment had a 2 (TMS structure: centralized/ decentralized) by 2 (distribution of interdependent task information: connected/ disconnected) design. Three-person groups engaged in a “hidden profile” task, i.e. a decision making task in which the information required to find the optimal solution is distributed among individuals (Stasser & Titus, 1985). Because no experimental task in prior literature met all our requirements to simultaneously manipulate TMS structure and distribution of interdependent information, we developed a new task for this study, modeling it on tasks used in earlier studies. In the task, participants acted as business consultant teams evaluating the profitability of product innovations. During a pilot phase we ensured that the optimal solution could be found with the complete information set and fine-tuned the task difficulty to produce sufficient variation in performance among the teams within our sample population of students of business and economics.

Participants

372 students at a Dutch university (190 males, 182 females, mean age 20.6, SD = 2.5)

volunteered to participate in the study for extra course credit (36%) or a monetary compensation of 10 euro (64%). The majority of the volunteers (93%) were students in the business and economics departments. Because we could not completely control the sampling procedure, a small part of the participants were following non-business related majors and therefore were outside of the population the task was designed for and piloted on. We tolerated groups that included one such participant (21 groups), but excluded groups in which participants with a non-business related major constituted the majority[1]. Furthermore, we dropped three groups in which participants explicitly indicated that their level of English was too low to understand the instructions and two further groups due to procedural errors. The final sample consisted of 112 groups, with between 26 and 29 groups per condition.

Experimental Task[2]

In order to be able to meaningfully manipulate information distribution and metaknowledge distribution, we developed a new task based on several requirements. First, information items that were critical to the task solution were designed to be interdependent, i.e. to acquire the specific meaning and relevance for the task solution only once combined. Second, the critical items of information were designed to lend themselves to a labeling that allowed a cross-classification into two sets of information categories that make intuitive sense to the participants – products and functions. Third, the task was made up for teams of at least three persons.

The task requires the participants to assess the profitability of food product innovations. Participants are asked to take the role of a team of consultants and to make recommendations to

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[1] Additional analyses showed that our conclusions were not affected by including either the choice of reward or the presence of one non-business related major.

[2] Complete task materials are available from the corresponding author at request.

two independent clients. These recommendations consist of a ranking of five product ideas in terms of profits for a given time period for each of the clients. Twenty-five critical items of information describe each of the two choice sets, each item providing information from one of five functional categories with regard to one of the products (see Table 1).

Insert Table 1 about here

Functional information within every product alternative was created to be interdependent in a similar way as in Fraidin's (2004) study. For example, information from the research and development department reveals parts of the formula of a product while the legal department informs about a law change which limits the use of a certain substance. On their own both pieces of information are insufficient and seemingly irrelevant for the task solution, but combined they reveal that the particular product will shortly be banned. To accurately assess the profitability of any of the five products, information from all five functional categories needs to be integrated.

Each of the team members received the same background information about the clients, a short description of the product alternatives (see Appendix A1 for a sample) and five pieces of additional information about the product alternatives which were irrelevant for the task solution. Each product was described as being designed for a particular target group, the target groups being the same across both choice sets. Furthermore, each member received one or two sets of the critical information items which were uniquely assigned to them. Text length was kept similar among the different members. As is customary practice in research in distributed information (e.g., Gruenfeld, Mannix, Williams, & Neale, 1996), all of the team members were told that the information the members received could differ.

Experimental Manipulations

Distribution of interdependent task information. To manipulate the distribution of interdependent task information we split up the critical information items among team members in different manners. In the *connected distribution* condition information was split up according to the products (target groups) the items described (see Appendix A2), i.e. by columns of Table 1. Thus, each of the three team members received all the information required to accurately judge the profitability of one or two of the five products - interdependent information was located “in one head” (Fraidin, 2004). In the *disconnected distribution* condition information was split up according to the functional categories (see Appendix A3), i.e. by rows of Table 1. Thus, every group member received a part of the critical information for every product. Here, interdependent information was located “in different heads”.

TMS structure. TMS structure was manipulated by means of written instructions (van Ginkel & van Knippenberg, 2009). Metaknowledge, i.e. information about which member of the team held extra information about which functional category or product group (e.g., “market research” in the disconnected distribution or “products designed for young adults” in the connected distribution, see Table 1 for all labels), was presented in writing and on a sketch showing a map of the table the participants were seated at. In total, all teams received an equal number of metaknowledge units, namely five relations between information category and person with extra information on it. However, teams differed with regard to the distribution of the metaknowledge units. In the *centralized TMS structure* one person received all five units of metaknowledge while the other two members did not receive any metaknowledge. In the *decentralized TMS structure* every team member received one or two units of metaknowledge. In both conditions all five existing units of metaknowledge were disclosed to the team.

Procedure

On arrival, each team was orally introduced to the task. Teams were given information on the full procedure, including the time frames for reading and discussing. Furthermore, they were told that the teams with the best solutions had a chance to win a prize of 150 euro to be split evenly among team members. The participants then had up to 25 minutes to individually read the task materials which consisted of a general introduction, information on the clients and products, and the metaknowledge presentation for those participants who received any based on the design.

Next, the teams continued with the discussion phase. They were allowed to keep and review the information booklets during the discussion but not to show them to each other. They had fifteen minutes to make decisions on both choice sets. Teams that had not finished by the time the fifteen minutes elapsed were asked to finish as quickly as possible. Discussion time in the final sample varied between 11.2 and 18 minutes with an average of 15.2 minutes.

After finishing the task, participants filled in individual questionnaires, were debriefed, received their credits or payment and were dismissed.

Measures

Performance. Team performance scores reflected the quality of the team's decisions and were based on the similarity of their solutions to the objectively correct solution. For each choice set, one objectively correct ranking order of the five product alternatives existed. To assess team performance, we calculated the deviation of the rank a team gave to each product alternative within the choice sets from their optimal rank positions. We summed these ten deviation scores into an overall score that ranged from 0 to 24. For ease of interpretation, we subtracted this value from 24 which yielded a performance score with higher values indicating better performance.

We used audio-video recordings of the team discussions to assess the team process. One rater, blind to the experimental conditions, coded transactive retrieval and information elaboration for all 112 teams. A second independent rater provided overlapping ratings for 24 of the 112 teams in order to determine the inter-rater reliability of the coding scheme (see Homan, van Knippenberg, van Kleef, & De Dreu, 2007; Ten Velden, Beersma, & De Dreu, 2010 for a similar procedure). We used intraclass correlations (ICC) to assess inter-rater reliability, ICC1 referring to the reliability of a single rater and ICC2 referring to the reliability of the averaged rating (Bliese, 2000; LeBreton & Senter, 2007; Shrout & Fleiss, 1979).

Transactive retrieval. Transactive retrieval (ICC1 = .74, ICC2 = .85) was operationalized in line with its original descriptions (Hollingshead, 1998; Wegner, 1995) as communication acts aimed at searching for information pertaining to a specified knowledge domain within the other team members. Information search was recognized as transactive retrieval when questions invoked labels of the product category or the functional category (e.g., "*Do you know anything about the iced tea*?" or "*Are there any legal issues with this?"*) or when askers tried to elicit specific information complementary to their own (e.g., "*Market research says that we will sell out this product if the price is not higher than three euro. Do you know the price?").* In contrast, questions asking for a contribution to the discussion without referring to a specified knowledge domain as well as questions aiming to elicit statements of preferences were not coded as transactive retrieval. Team scores were based on the frequency of transactive retrieval acts.

Information elaboration. Information elaboration (ICC1 = .93, ICC2 = .97) was operationalized on the basis of a rating scheme successfully employed in previous research (Homan et al., 2007; Kooij-de Bode, van Knippenberg, & van Ginkel, 2008; van Ginkel & van Knippenberg, 2008, 2009). Each item of information but for the distractor items received an elaboration score from 0 to 5. To receive a score higher than 0 an item must be mentioned during the discussion. Thus, if a member silently drew a conclusion based on his or her information and only shared the conclusion without recounting the constituting information items, these items received a score of 0. A score of 1 was given when a member mentioned an item. A score of 2 was given when a mentioned item was acknowledged by at least one of the other team members (e.g., by nodding or saying "*OK*"), or when the item was mentioned in response to a question but was not further discussed after that. A score of 3 was given when a mentioned item was clearly responded to by asking a clarifying question about it (e.g., "*Is that the sales prediction for one or for two years?")*. A score of 4 was given when a conclusion was drawn from the item without explicitly integrating it with other information (e.g., "*This definitely brings the product down!").* A score of 5 was given when an item was combined with another piece of information (e.g., *"So far we had a profit of 250 000 but with these extra costs we're down to 200 000."*). Items that were integrated by different people ("*You say x but I know y, hence z*.") as well as items that were integrated by one and the same person ("*I know x, but I also know y, hence z*.") received the same high elaboration score of 5.[3] Each item received the highest elaboration score observed during the discussion phase. The item scores were summed over the fifty items to give a total information elaboration score that theoretically could range between 0 and 250.

[3] We also coded elaboration according to an alternative conceptualization, deeming an item strongly elaborated only if a different person executed the integration. The measures were highly correlated (r = .93) and analyses conducted with either measure resulted in identical conclusions.

RESULTS

The Effect of TMS Structure and Distribution of Interdependent Task Information on Team Performance

Table 2 presents the descriptive statistics for the observed variables and partial correlations among them after controlling for the influence of the experimental manipulations. Hypothesis 1 predicted an interaction effect between the two experimentally manipulated factors of TMS structure and the distribution of interdependent task information on team performance.

Insert Table 2 and Figure 2 about here

We tested this hypothesis in a 2 x 2 analysis of variance. In line with Fraidin's (2004) results, we found a significant main effect of the distribution of interdependent information on team performance, $F(1,108) = 9.95$, $p < .01$, $\eta^2 = .08$. On average, teams in the connected distribution condition performed significantly better ($M = 12.85$) than teams in the disconnected distribution condition ($M = 9.81$)[4]. Furthermore, consistent with our hypothesis, while we found no main effect of TMS structure, $F(1,108) = .13$, *ns*, we found a significant interaction between the distribution of interdependent task information and TMS structure, $F(1,108) = 4.48$, $p < .05$,

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[4] As anticipated, participants in the connected distribution condition more often presented a conclusion about a product after individually integrating their interdependent information, which resulted in lower team information elaboration scores in the connected distribution condition, $F(1,108) = 44.98$, $p < .01$, $\eta^2 = .29$; with more integrated conclusions shared by individual members, there was less need for the team to accomplish such integration in team discussion.

$\eta^2 = .04$. We used planned contrasts to test whether within the more demanding disconnected information distribution condition teams with a centralized metaknowledge structure indeed outperformed teams with a decentralized metaknowledge structure as we predicted. The contrast analysis confirmed a performance difference in the expected direction, $t(108) = 1.76$, $p < 0.05$, one-tailed, $\eta^2 = .03$. In contrast, teams working on a task with a connected distribution of interdependent information did not differ in their performance as a function of their initial metaknowledge structure, $t(108) = 1.23$, *ns*. Figure 2 illustrates the interaction.

The Mediating Roles of Transactive Retrieval and Information Elaboration

Hypothesis 2 posed that the interaction effect between TMS structure and the distribution of interdependent information is sequentially mediated by transactive retrieval and information elaboration. To test this prediction we relied upon recent models for mediated moderation and serial mediation (Edwards & Lambert, 2007; Muller, Judd, & Yzerbyt, 2005; Preacher, Rucker, & Hayes, 2007). In our analysis, we followed the procedure for serial multiple mediation suggested by Hayes (2013). As we were interested in the indirect effect of the interaction between TMS structure and the distribution of interdependent task information, we employed the interaction term as independent variable, and entered the contrast-coded variables denoting the experimental conditions as covariates into each regression (Preacher & Hayes, 2008).

In the first step of the analysis, we derived path coefficients for our model through a series of regressions (see Figure 3 and Table 3). Regressing team performance on the experimental conditions and their interaction (model 1) reproduces the total effect model discussed earlier. Regressing transactive retrieval on the experimental conditions and their interaction (model 2) yielded the path coefficients for the first stage of the mediation model. In line with our reasoning, we found a significant effect of TMS structure and the interaction term. Within the disconnected distribution conditions, teams with a centralized TMS structure showed more transactive retrieval acts than teams with a decentralized TMS structure ($F(1, 55) = 6.49$, $p < .05$, $\eta^2 = .11$). In contrast, transactive retrieval was virtually the same over both TMS structure conditions within the connected distribution conditions ($F(1, 53) = .05$, *ns*). Regressing information elaboration on the conditions, their interaction, and transactive retrieval (model 3) yielded the path coefficients for the second stage of the mediation model. We found that transactive retrieval significantly predicted information elaboration. Finally, regressing team performance on the full series of predictors (model 4) yielded the path coefficients for the last stage of the mediation model. In this model, information elaboration significantly predicted team performance while neither the interaction term nor transactive retrieval showed any residual effects.

Insert Table 3 and Figure 3 about here

In the second step of the analysis, we tested the indirect effect of the interaction term via transactive retrieval and information elaboration. The indirect effect consists of the product of the paths from the interaction term to transactive retrieval, from transactive retrieval to information elaboration, and from information elaboration to performance. We used a bootstrapping procedure to test the magnitude of the indirect effect in order to avoid shortcomings of the classical causal step approach and the parametrical Sobel test (Baron & Kenny, 1986; Edwards & Lambert, 2007; Hayes, 2009). In this procedure, 5000 random samples are drawn with replacement from the original sample and the indirect effect of interest is calculated from each bootstrap sample, thus yielding a sampling distribution which can be used to construct a confidence interval (Preacher et al., 2007). In support of Hypothesis 2, the estimate of the indirect effect was positive and significant, the bias-corrected confidence interval not including zero (b = 0.15, 95% CI [.03; .37]).

DISCUSSION

We investigated an important issue that TMS research has hitherto overlooked – the effects of member differences in metaknowledge (i.e., knowledge of who knows what) on information elaboration and team performance. Our findings show that a more centralized TMS structure (i.e., greater disparity of metaknowledge within the team) can result in more information elaboration and higher performance than a more decentralized TMS structure. As our results show, the condition for this catalyst effect to occur is that interdependent task information is distributed in a disconnected manner – a condition that is often present in teams of functional specialists. Such a disconnected distribution of information makes sharing of interdependent information more critical to performance - yet it renders the relevance of individual items of information less obvious to members holding them. In this situation, members that are central in the TMS structure can play a catalyst role by spurring transactive retrieval and information elaboration in the team - which benefits team performance.

Theoretical Implications and Contributions

Our study makes several contributions to TMS theory and research, the most important of which is to step away from the traditional focus on team average levels of metaknowledge only and to put the spotlight on the distribution of metaknowledge within the team. Integrating the notion of metaknowledge distribution into analyses of TMSs is valuable for several reasons. First and most straightforward, as we empirically showed, metaknowledge distribution is a performance-relevant characteristic of a team's TMS structure. Teams that do not differ in the average metaknowledge of their members can differ in information elaboration and performance as a function of the distribution of metaknowledge within the team. In short, complementing the dominant focus on average metaknowledge with a focus on metaknowledge distribution is necessary for a full understanding of TMSs.

Second, paying attention to metaknowledge distribution can be highly informative in the study of TMS development. Brandon and Hollingshead (2004) describe *convergence*, "where all members have similar representations of the transactive memory system that accurately reflect relative knowledge in the group and have been validated by members" as the theoretical ideal state of a TMS. TMS centralization could be an important predictor of the success and speed at which a TMS will develop toward this ideal state. As we showed, the initial distribution of metaknowledge can affect the extent to which a team engages in transactive retrieval and information elaboration. Such interactions, in turn, can allow metaknowledge to diffuse within the team as members learn metaknowledge in addition task information to in the course of such communication (Brandon & Hollingshead, 2004; van Knippenberg, van Ginkel, & Homan, 2013; Wegner et al., 1985). We therefore expect that to the extent that TMS centralization stimulates transactive retrieval and information elaboration, teams with a centralized TMS structure will experience a faster rise in average metaknowledge and metaknowledge sharedness. We note, however, that a likely boundary condition for this is the extent to which communication is "accessible" to all team members even when they do not directly take part in the specific exchange, e.g. takes place in face-to-face meetings of the complete team like in our experimental setup or in electronic spaces accessible to all members. This boundary condition may also apply to the catalyst effect more generally and is a subject for future research.

Third, recognizing that metaknowledge need not be shared within a team allows treating TMSs as a true multilevel phenomenon. This may also invite a methodological shift from the predominantly used team average scores to a network perspective (Lewis & Herndon, 2011; Peltokorpi, 2008). Using this view, the TMS structure can be represented as a network in which people and their expertise are nodes and awareness of each other's expertise are ties (Borgatti & Cross, 2003). Such a conceptualization of TMS structure allows considering its antecedents and outcomes at individual, dyadic, and team levels. For instance, while we showed that a centralized TMS structure can benefit team performance, other questions about the consequences of such a structure for the individual team members depending on their own position in this network or about the consequences of such a structure for dyadic relationships open up.

Beyond contributing to the study of TMSs, our study invites scholars to consider the application of a distribution perspective on the broader field of team cognition. The main focus of this field is – as exemplified by TMS theory – on *shared* cognition (Cannon-Bowers & Salas, 2001; Hinsz et al., 1997; Tindale & Kameda, 2000). As argued by this stream of literature, the *degree* of sharedness of cognitive elements such as attitudes and preferences, task knowledge, and knowledge about each other is a key aspect to understand team information processing. Our study suggests that, in addition to that, more carefully examining the configurations formed by these cognitive elements can be valuable. Examples of such an approach to team cognition are still few (e.g., Huber & Lewis, 2010; Kameda, Ohtsubo, & Takezawa, 1997), but we believe that a focus on the distribution of team cognition can open the view on many interesting questions. For instance, it allows investigating the repercussions of specific patterns of *un*shared cognition as, for example, caused by turnover.

Practical Implications

Knowledge has become a crucial resource in an organization's portfolio (Grant, 1996). The increasing demand for the integration of diverse, highly specialized knowledge makes teamwork indispensable. TMSs play a key role in helping teams to capitalize on their knowledge resources as they allow members to specialize and gain extensive knowledge in their areas of expertise while granting them access to their coworkers' complementary knowledge (Wegner, 1986).

The present study suggests that metaknowledge may in itself be an area of expertise worth specializing in. In a context where the range of expertise domains is large, the number of actors is high, team membership is fluctuating, and knowledge is dynamic, developing accurate metaknowledge and keeping it up to date is costly. An attempt to foster complete and shared metaknowledge in a team operating in such a context requires a very high effort. A half-hearted attempt, on the other hand, might result in a waste, creating incomplete representations of the team's knowledge pool in the individuals' minds. Instead, our findings imply that it might be fruitful to focus the resources dedicated to raise metaknowledge upon a selected group of individuals who will function as information hubs and process catalysts. Indeed, some organizations seem to have such an intuition and assign central actors to manage expertise recognition (Garner, 2006: 334). Our study contributes to a theoretical and empirical grounding for such measures and furthermore suggests that they may be particularly important for teams whose members are specialists in different functional or disciplinary domains such as cross-functional teams in business organizations or inter-disciplinary research teams in academia.

Limitations and Future Research

We aimed to provide causal empirical evidence for our theoretical claim that the centralization of the TMS structure represents a performance-relevant dimension. We chose the experimental method in order to maximize internal validity and to closely observe the process mediating between cause and outcome. The random assignment of groups to conditions and of members to roles averts concerns about endogeneity and self-selection, as we can ascertain that the initial TMS structure is not caused by individual preferences or abilities or by team history. Such an experimental set-up may raise concerns with external validity, however. In this respect, previous research generally shows that findings in laboratory and field studies tend to converge (Anderson, Lindsay, & Bushman, 1999; Dipboye, 1990). For instance, both lab and field studies consistently found positive relationships between TMS and team performance (e.g., Austin, 2003; Moreland, 1999; Stasser, 2000) and between information elaboration and team performance (Homan et al., 2007; Kearney & Gebert, 2009; van Ginkel & van Knippenberg, 2008). Two recent meta-analyses further support convergence between effects found in field and experimental research on teamwork processes (LePine, Piccolo, Jackson, Mathieu, & Saul, 2008) and team cognition (DeChurch & Mesmer-Magnus, 2010). These findings provide reasonable grounds to expect that our results would generalize to field settings. Even so, future research extending the investigation of the effect of different TMS structures to field settings would be highly valuable.

In designing such field research, questions of measurement and aggregation may need to be addressed from a new perspective. As suggested above, we believe that taking a network approach (Borgatti & Cross, 2003) is a promising way to capture metaknowledge structures within teams more fully. With regard to aggregation of metaknowledge to the team level, our findings imply that a disjunctive aggregation capturing the metaknowledge level of the "best" member (LePine, Hollenbeck, Ilgen, & Hedlund, 1997) may be more appropriate than an additive aggregation generally used in TMS research. Again, the extent to which communication is accessible to all team members may be an important factor to consider when making decisions about the appropriate form of aggregation.

Our manipulation of metaknowledge followed previous research in using written instructions (Stasser et al., 1995; van Ginkel & van Knippenberg, 2009). However, the specific requirement of our study to create different metaknowledge distributions might have led to a potential side effect: While in both TMS structure conditions the total amount of metaknowledge assigned to the teams was identical, in the centralized condition only one rather than three group members received metaknowledge. Thus, in the decentralized groups all three members were made aware that information would differ among group members twice – in the general instructions and in the manipulation. In the centralized groups, on the other hand, only one member was told this twice. If anything, this might have made it more likely that in the decentralized groups the issue of information distribution would be breached and elaborated on during discussion (Stasser & Titus, 1985), which presumably would render information elaboration more likely (van Ginkel & van Knippenberg, 2008, 2009). To the extent that such an influence would obtain, it would make it harder rather than easier to find the hypothesized catalyst effect, making the present study a rather conservative test of our claim.

Our study focuses on TMS centralization as one important dimension of TMS structure. Yet, this is not to mean that this is the only dimension of interest. For instance, metaknowledge *sharedness*, i.e. the proportion of metaknowledge that members hold in common, assumed as a given in prior conceptualizations of TMSs, is another dimension on which teams can vary. In our study, we held sharedness constant in order to isolate the effects of metaknowledge centralization unconfounded with other factors. However, sharedness of cognitions could be an important moderator of the effects of team cognition (van Knippenberg et al., 2013).

We also held the average level of metaknowledge constant in order to compare the pure effects of metaknowledge distribution. While this is an important first step in the investigation of non-uniform metaknowledge distributions, future research might examine the average level as a possible boundary condition for the effect of TMS centralization. As we argue above, the advantage of centralization is driven by the central member having an above-average level of metaknowledge and, hence, a higher level of metaknowledge than any member of a decentralized team with a comparable average metaknowledge. Consequently, our expectation is that metaknowledge centralization will be most impactful at intermediate team average levels of metaknowledge. At very low levels the total amount of available metaknowledge might be so low that even complete centralization would not result in a sizeable behavioral impact on the central member. At very high levels, on the other hand, the central member's advantage above the already high team average would only be marginal.

We limited this study to the investigation of TMS structure effects on the team level under cooperative conditions. But, clearly, non-uniform metaknowledge distributions open the stage for future exploration on many interesting questions with regard to cross-level interactions. A central position in a team with a centralized TMS makes individuals occupying it critical for team performance as the potential for exploiting the benefits of possessing transactive memory resides almost exclusively with them (see Huber & Lewis, 2010 for a similar argument on cognitive centrality with regard to cross-understanding). Thus, individual factors that influence the central members' communication and information processing, e.g. personality characteristics such as extraversion, their cognitive ability or their individual social or epistemic motivation (De Dreu, Nijstad, & van Knippenberg, 2008) may become predictive for the performance of the whole team. Furthermore, it is important to investigate the role of goals and incentives. Team tasks may hold competitive elements (Wittenbaum, Hollingshead, & Botero, 2004), and this may incentivize strategic or even manipulative use of information (Steinel, Utz, & Koning, 2010; Toma & Butera, 2009). A metaknowledge advantage relative to the team provides opportunity to do so and members may try to hoard metaknowledge in order to keep this advantage.

The overlap of the position in the TMS structure with other roles in the team presents a further interesting avenue for future research. For instance, it is likely that a central position in the TMS structure and a formal leadership role often co-occur. However, there are scenarios in which this may not be the case – for example when a leadership role is absent, when a leader lacks skill or the intention to develop metaknowledge or when other team members are more tenured in the team than a freshly appointed leader. In a recent paper, Soda and Zaheer (2012) showed that the extent to which an individual's formal authority relationships overlap with his or her informal advice relationships impacts his or her productivity. It may well be that extent to which the formal leadership role overlaps with de facto centrality in the TMS structure affects team processes and outcomes in a similar way.

Finally, our study investigated the effect of the TMS structure in very small teams. This was sufficient to show a catalyst effect, but there is ample reason to expect that this effect will be more accentuated in larger teams. As the number of members grows, the distribution of the task information becomes more complex and its integration requires more coordination – while at the same time the team size holds back communication processes needed to acquire metaknowledge about the team (Palazzolo, Serb, She, Su, & Contractor, 2006). Hence, having at least one member who has a clear overview over the available information and can direct communication in the right direction becomes even more valuable. Future work could further explore this relationship as well as other boundary conditions to generalize or qualify our findings.

CONCLUSION

TMSs allow teams to capitalize on the diversity of the knowledge held by their members by supporting coordination and integration of knowledge. This study extends the understanding of

TMSs by shedding light on the structural component of the construct and relating it with characteristics of the task. Whereas the present analysis provides several specific insights and contributions to theory and practice, its main argument is simple: TMS structure matters. After being neglected in TMS theory for a long time, a closer look at TMS structure from a metaknowledge distribution perspective may prove rewarding and open up a multitude of new questions on multiple levels of analysis which will advance our understanding of team cognition and team work.

APPENDIX

A1. General Description of the Product Alternatives for Client "Teasies" (Softdrink Manufacturer)

"Electric Grape", a grape-flavored energy drink. Its target market is *young adults*. Teasies' formula is less sweet than competitors' energy drinks but gives the same energy kick.

"Acqua di Roma", an exclusive flavored mineral water with a simple formula and a big name. It is targeted at rather well-off, *fashion-conscious adults.*

"BioBerry", a berry-flavored lemonade made from all-organic ingredients. Its target market is *quality-driven adults*. "BioBerry" is a drink to enjoy and to make a "green" statement.

"Vitfit", a sports drink low on calories and with an extra portion of vitamins. It is targeted at the group of *health-conscious adults*.

"Teasies' Lemon Iced Tea", THE original iced tea in the characteristic small bottles. Its target market is *kids and their parents* wishing to give their children the same memories they love.

A2. Sample Information Set for "Acqua di Roma" as Occurring in Connected Distributions of Interdependent Task Information

The R&D department developed a very simple and cheap formula for Acqua di Roma: mineral water with a hint of fruit syrup. For 10 million bottles it only needs to process 25 000 liters of syrup.

The financial department expects to sell 50 million of bottles of Acqua di Roma over 2 years and to make 1.5 Euro profit per bottle.

There is a legal conflict about the formula for Acqua di Roma because it is very similar to another product. To start production, Teasies has to settle this conflict. This would cause additional legal costs of 5 million Euro on top of the forecast.

Because the contracts with the syrup suppliers are limited, Teasies' will only be able to source 100 000 liters of syrup for the production of Acqua di Roma in 2 years.

Market research shows that the target group likes Acqua di Roma more than Teasies' management thought. Sales could be even 25% higher than initially expected.

A3. Sample Information Set for "Production Processes" as Occurring in Disconnected Distributions of Interdependent Task Information

The production of Electric Grape is very easy and Teasies can use their existing plants for this.

The organic ingredients needed for the production of BioBerry are very expensive and raise the selling price. At 3 Euro per bottle, it will be the most expensive lemonade on the market.

A safety inspection in Teasies' old brewing plant has revealed some problems. If Teasies absolutely wants to stick to the traditional brewing method for Teasies' Lemon Iced Tea, it has to reconstruct it which would cost additional 15 million Euro on top of the forecast.

Because the contracts with the syrup suppliers are limited, Teasies' will only be able to source 100 000 liter of syrup for the production of Acqua di Roma in 2 years.

Some production space that is suitable for Vitfit has unexpectedly freed up. This would save Teasies 10 million Euro of rent costs they had calculated for Vitfit's production.

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TABLE 1

Overview over the Structure of Information Items in the Experimental Task

Functional category	Product targeted at…				
	Young adults (P1)	Fashion-conscious adults (P2)	Quality-driven adults (P3)	Health-conscious adults (P4)	Kids and their parents (P5)
Research & development (RD)	P1, RD	P2, RD	P3, RD	P4, RD	P5, RD
Financial forecasts (FF)	P1, FF	P2, FF	P3, FF	P4, FF	P5, FF
Legal information (LI)	P1, LI	P2, LI	P3, LI	P4, LI	P5, LI
Production processes (PP)	P1, PP	P2, PP	P3, PP	P4, PP	P5, PP
Market research (MR)	P1, MR	P2, MR	P3, MR	P4, MR	P5, MR

Note. Each cell represents one item of critical information, stemming from one functional department and referring to one product. Items referring to the same product are interdependent among each other.

TABLE 2

Descriptive Statistics and Correlations among the Observed Variables

		Descriptive statistics: *M* (*SD*)					Correlations[a]		
		Full sample	Connected distribution		Disconnected distribution				
			Centralized TMS	Decentralized TMS	Centralized TMS	Decentralized TMS	1	2	3
1	Transactive retrieval	6.17 (3.89)	5.86 (2.17)	5.69 (3.22)	8.11 (4.86)	5.03 (4.23)	-		
2	Information elaboration	101.83 (39.52)	64.24 (18.94)	73.00 (22.61)	117.64 (42.54)	108.55 (46.69)	.46**	-	
3	Performance	11.27 (5.34)	12.00 (5.21)	13.69 (5.05)	11.00 (4.94)	8.62 (5.13)	.25**	.38**	-

a. The reported correlations are partial correlations, controlling for the effect of the experimental conditions and their interaction.

** $p < .01$

TABLE 3

Regression Results for Serial Mediated Moderation Model

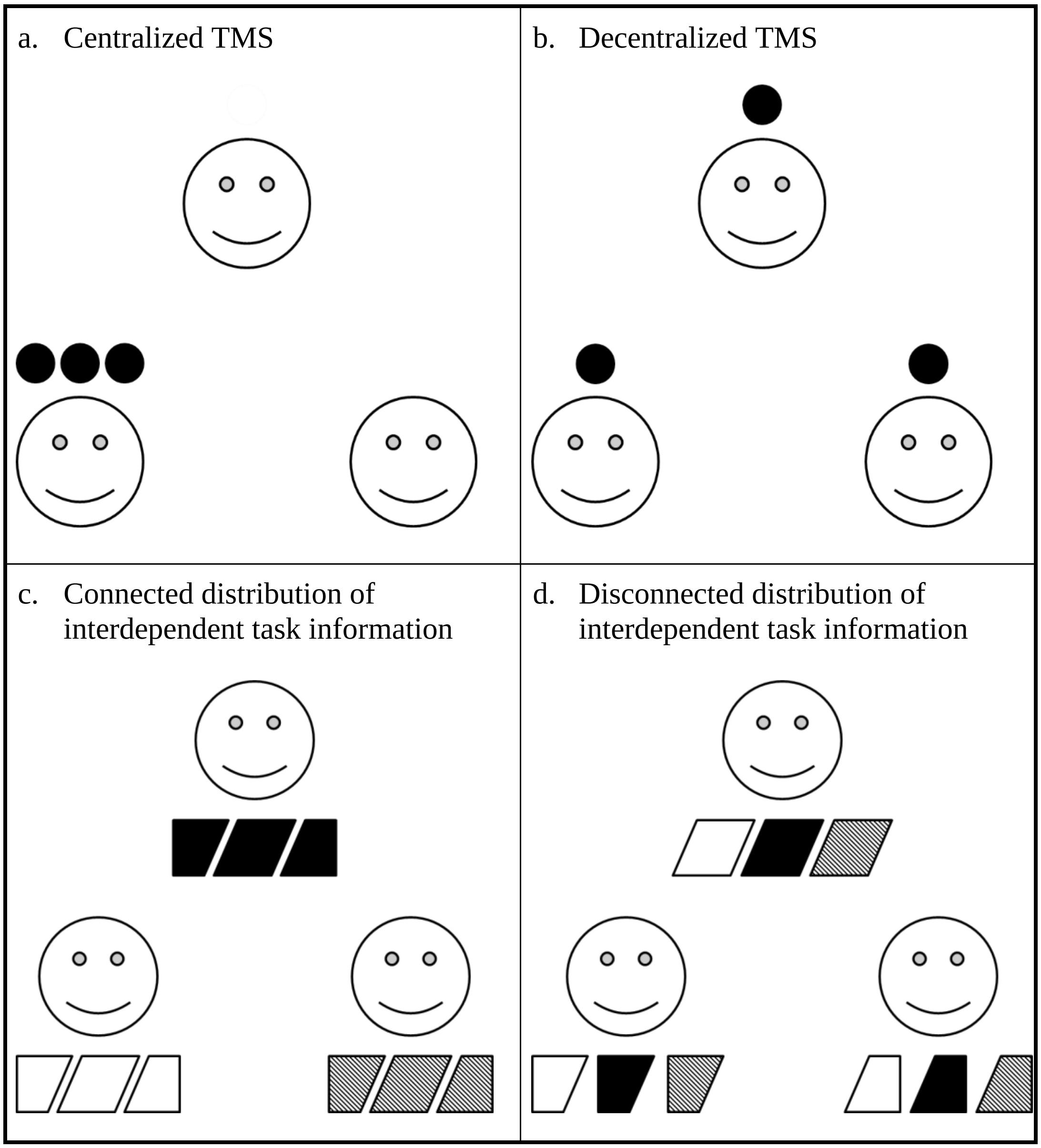
Predictor	***b***	***SE***	***β***	***t***	***R^2***
Model 1: Performance (total effect model)					.12**
TMS structure (1=centralized)	.17	.48	.03	.36	
Information distribution (1=disconnected)	-1.52	.48	-.29	-3.16**	
TMS structure x Information distribution	1.02	.48	.19	2.12*	
Model 2: Transactive retrieval					.09*
TMS structure (1=centralized)	.81	.36	.21	2.28*	
Information distribution (1=disconnected)	.40	.36	.10	1.11	
TMS structure x Information distribution	.73	.36	.19	2.04*	
Model 3: Information elaboration					.29***
TMS structure (1=centralized)	-4.33	3.27	-.11	-1.32	
Information distribution (1=disconnected)	10.18	3.22	.26	3.17**	
TMS structure x Information distribution	1.60	3.26	.04	.49	
Transactive retrieval	4.56	.86	.45	5.28***	
Model 4: Performance					.25***
TMS structure (1=centralized)	.09	.46	.02	.19	
Information distribution (1=disconnected)	-2.11	.47	-.40	-4.47***	
TMS structure x Information distribution	.70	.46	.13	1.53	
Transactive retrieval	.14	.14	.10	1.02	
Information elaboration	.04	.01	.33	3.29***	

Note. Information distribution refers to the distribution of interdependent information. TMS structure and information distribution are contrast coded variables: 1 = centralized TMS structure; disconnected information distribution.

* $p < .05$. ** $p < .01$. *** $p < .001$

FIGURE 1

Examples of Different Degrees of TMS Centralization and Different Distributions of Interdependent Task Information



Note. Circles represent metaknowledge. Quadrangles represent different items of task information. Task information of the same color is interdependent.

FIGURE 2

Interaction of TMS Structure and Distribution of Interdependent Task Information on Team Performance

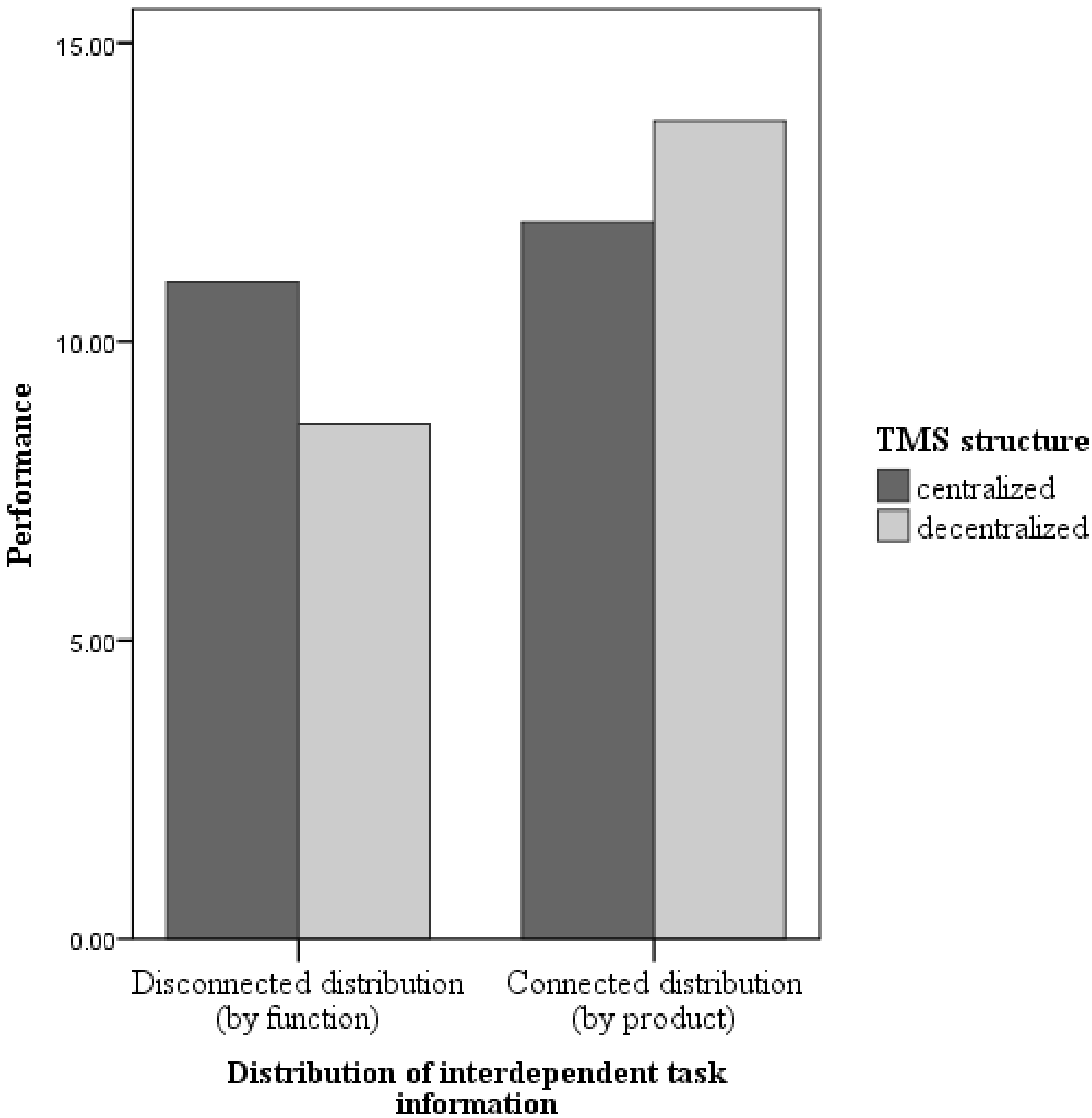
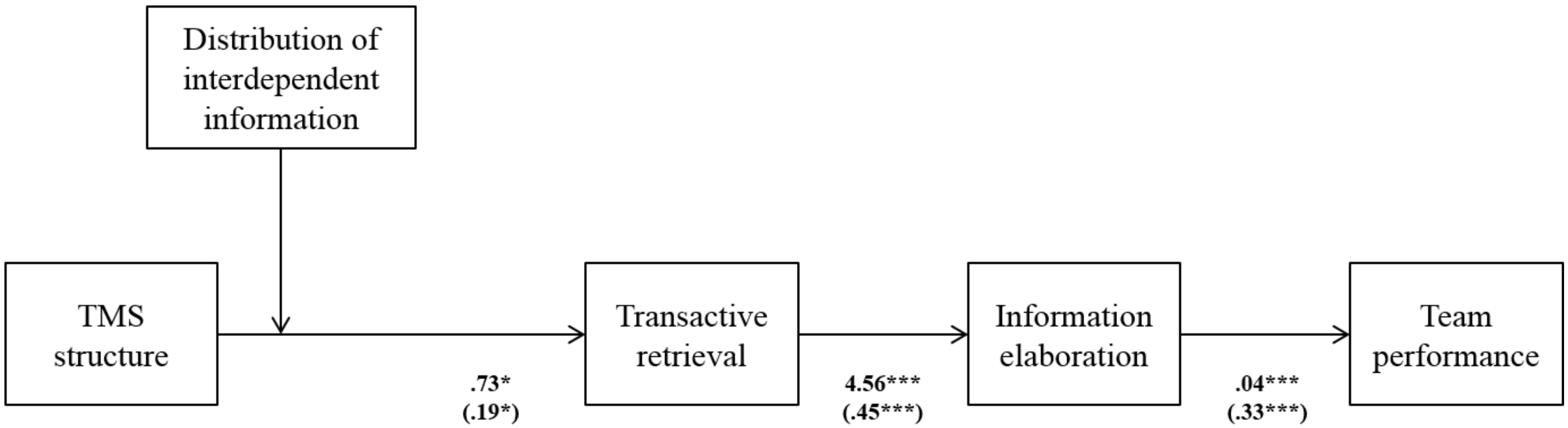


FIGURE 3

Results of the Mediated Moderation Model



Note. Path estimates are unstandardized regression coefficients, standardized regression coefficients are in parentheses.

* $p < .05$

** $p < .01$

*** $p < .001$

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