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■論文

A transactive memory perspective of group learning

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Abstract

An increasing reliance on groups in organizations has made group learning a popular topic in the domain of organizational behavior. While shedding light on a range of factors influencing group learning processes, the literature on this topic is subject to conceptual ambiguities and inconsistent definitions. I draw on transactive memory theory (Wegner, 1986) to discuss learning processes in groups through three interrelated information processing phases of encoding, storage, and retrieval.

Keywords: group learning; information processing; transactive memory

Introduction

Group learning has gained increasing interest among scholars due to the growing reliance on groups in organizations and changing and uncertain organizational environments (Edmondson, 1999). The literature on group learning has become rich and multidimensional, ranging from output-orientated effectiveness to learning process models (see Edmondson, Dillon, & Roloff, 2007; Mohammed & Dumville, 2001 for reviews). While this steam of literature has provided important information on various processes contributing to group learning and outcomes, scholars have argued that definitions of the used learning construct have varied considerably and that there are still persistent conceptual gaps and ambiguities (e..g., Edmondson et al., 2007; Mohammed & Dumville, 2001; Wilson, Goodman, & Cronin, 2007).

This paper by providing a transactive memory (TM) theory-based (Wegner, 1986, 1995) description of group learning contributes to the literature in three ways. First, a description of group learning through the information-processing phases of encoding, storage, and retrieval is beneficial because group-level models have paid little attention to these learning processes (Wilson et al., 2007). In particular, the group learning literature neglects the storage phase that enables groups to retain learned information. Second, TM theory provides a conceptual frame for a multilevel (individual and group) account of group learning in which shared awareness of expertise enables individual group members to specialize and contribute to group learning. The multilevel approach is beneficial because group-level frameworks focus predominately on shared mental models not discussing whether the learning of a few, the majority, or all group members constitutes group learning (Mohammed & Dumville, 2001). A distinction between the literature on group learning and TM is important because these two bodies of literature have progressed parallel with little cross-fertilization.

Information Processing Perspective

Information processing refers to a sequence of operations within the human mind that takes in information, transforms it, and then produces some sort of output (Hinsz, Tindale, & Vollrath, 1997). A generic information processing model suggests that an individual in the attention phase perceives information in a particular context. He or she evaluates, interprets, and transforms the information during the encoding phase that prepares it during the storage phase in his or her memory (Hinsz et al. 1997). The stored information can be retrieved from memory when needed. An individual enacts a response based on the retrieved information that constitutes individual performance. Individuals receive feedback on the validity of their responses that becomes integrated with the information stored in memory. These information-processing phases have been used to describe individual learning (Ellis & Bell, 2005, Hinsz et al., 1997), referring to a "relatively permanent change in knowledge or skill produced by experience" (Weiss, 1990: 172).

These information-processing phases have been extended to the group level to describe group learning. Like individuals, information processing allows groups to take in information, transform it, and produce an output (Hinsz et al., 1997). Although group learning also occurs through these information processing phases, individual and group learning are not identical (Ellis & Bell, 2005; Kozlowski & Ilgen, 2006). Kozlowski and Ilgen (2006) noted that group learning is based on individual learning, but when conceptualized as more than a pooling of individual-level knowledge, it can be distinguished as a group-level property that includes the collective knowledge pool, potential synergies among group members, and unique individual contributions. Thus, group learning occurs between and within the minds of group members. Ellis and Bell (2005) argued that group-level accounts should include each group member's ability to acquire knowledge and skill, and their ability to collectively share that information with their group members. These information processing principles are emphasized in TM theory.

Transactive Memory Theory

TM theory states that individuals in ongoing relationships form a shared cognitive system for encoding, storing, and retrieving information from different cognitive domains through repeated interpersonal interactions (Wegner 1986). Like intimate couples, group members divide responsibilities for specific information domains and rely on each other as external cognitive aids. The objective for groups to form a cognitive division of labor is to process information efficiently to meet their collective goals. The cognitive division of labor in TM theory consists of two interrelated components: (1) internal memory (what individual group members know personally), and (2) external memory (what individual group members collectively know about the knowledge of other members of their group or can be located and retrieved from other external storage devices). While TM exists in the mind of an individual, a transactive memory system (TMS) exists between or among individuals as a function of their individual transactive memories (Peltokorpi, 2008; Peltokorpi & Hood, 2019).

A TMS is formed and functions as an organized knowledge body in memory that exists at the collective level. Development of a TMS starts at the individual level when individuals learn something about the domain of expertise of other group members. During the encoding phase, individuals can make expert inferences through stereotypes, written communication, explicit expertise indications (e.g., diplomas), roles, and information received from third parties (e.g., friends). Knowing that a person gained specific information, had access to it for a long period of time, or accessed it recently, can also serve as a basis for expert inferences. In work groups, expertise areas are often assigned explicitly (Wegner, 1986). Wegner, Giuliano, and Hertel (1985) proposed that expertise evaluations through indirect sources can be subject to error and exaggeration, and those interpersonal interactions are the most accurate identify domain experts. Through self-disclosure and repeated social interactions, a more accurate shared awareness of expertise is formed in groups. A shared awareness of expertise is developed as people learn who knows what.

A TMS can be formed because all group members take or accept responsibility for the encoding, storage, and retrieval of information related to their expertise areas. The acceptance and shared expertise recognition allow members to support each other's expertise by directing new information to the domain experts. Depending on specialization and group size, similar information items might be stored simultaneously by one, two, or several members (Wegner, 1986). The transactive retrieval phase occurs when at least two group members work together to retrieve uniquely held task information (one/more members seeking information and one/ more members providing it). Individuals can retrieve the needed information by identifying a domain expert via the appropriate location of information or relying on other group members for retrieval cues. During the retrieval phase, shared expertise awareness allows groups to take advantage of the information stored on their members.

Groups with interdependent members and complex tasks form differentiated TMSs in which members hold different information items and all members know domain experts in their group (Wegner et al., 1985). For differentiated TMS to function efficiently, specialized knowledge held by different group members should be credible and well-coordinated (Liang, Moreland, & Argote, 1995). Specialization refers to the memory differentiation in the group, credibility to beliefs about the reliability of other group members' expert information, and coordination to members' ability to work together efficiently. By specializing in one area, the cognitive load of each member is reduced, increasing the pool of information across domains for the group as a whole (Hollingshead, 1998). Part of a group's coordination in terms of the ability to work together effectively depends on members' shared awareness of who has what knowledge and how that knowledge fits together (Lewis, 2004).

Group Learning – Process Perspective

Group learning is defined in terms of group processes and outcomes (Mohammed & Dumville, 2001). I focus here on the group process perspective due to its similarity with TM theory (Kozlowski & Ilgen, 2006; Mohammed & Dumville, 2001). Group learning processes are described in numerous ways such as task mastery, process improvement, experimenting expanded understanding, discussing mistakes and failures, and innovation (Edmondson et al., 2007). Edmondson (1999: 353) described group learning as "an ongoing process of reflection and action, characterized by asking questions, seeking feedback, experimenting, reflecting on results, and discussing errors." Group learning is also described as the extent to which group members seek opportunities to develop new knowledge, welcome challenging assignments, are willing to take risks on new ideas, and work on tasks that require skills and knowledge (Bunderson & Sutcliffe, 2002). Common in descriptions of group learning processes is that various factors hinder or facilitate knowledge sharing and combination in groups.

Group learning processes consist of multiple, interdependent events because solutions for prevailing task challenges need to be searched for, chosen, and implemented (Gibson & Vermeulen, 2003). This notion has led scholars to describe learning as a cycle of interrelated activities in which group learning is to some degree a function of individual learning (Crossan, Lane, & White, 1999; Edmondson, 2002). For example, Crossan et al. (1999) proposed that intuition, insight, and innovative ideas occur at the individual level, but these ideas are then shared and interpreted within the group wherein a common meaning is developed. Scholars have also argued that conceptualizations of learning at the group level need to include each member's ability to individually acquire knowledge and skill, and their ability to collectively share that information with other group members (Ellis, Hollenbeck, Ilgen, Porter, West, & Moon, 2003). In group contexts, people learn not just from their own direct experience, but also the experience of other members.

Group learning models further draw on the information processing perspective. For example, Ellis and Bell (2005) argued that group-level conditions of capacity, collaboration, and commonality enable group learning. These three conditions are important because they support collective information-processing activities. Capacity consists of cognitive resources the members bring to the group processes. Collaboration refers to the sharing of information, critical discussion, and insight within the group; commonalty to a common frame of reference or language within the group that enables members to understand and replicate the learning of others within the group. As group members interact with one another, knowledge and skills gathered by one member can be transferred to his or her groupmates, which can influence the efficiency and effectiveness of the group's collective learning process. This suggests that the learning construct at the group level needs to include each member's ability to individually acquire knowledge and skills and their ability to share that information with other group members.

Synthesis

While having similarities, the group learning and TMS literature have progressed with little cross-fertilization, and it has remained unclear to which extent these bodies of literature are conceptually related. Although both TMS and group learning scholars describe cognitive processes in groups, Lewis, Lange, and Gills (2005) suggested that the literature on TMS focuses more on differentiated learning processes at the individual and group level – group members through repeated interactions and shared experience form a shared awareness of expertise that allows individual members to specialize and develop task-relevant expertise, which facilitates group learning. At the group level, information is distributed across individual members that act as nodes that collectively form a cognitive network or TMS system (Wegner, 1995).

In contrast, the group learning literature places emphasis on the overlapping definition of knowledge sharing, arguing that knowledge reflects how the group functions together and the communicative processes that are held in common by all group members (Mohammed & Dumville, 2001). Shared cognition is thus emphasized at the expense of individual expertise. Thompson and Fine (1999) argued that the word 'shared' in 'shared cognition' to which both TMS and group learning process descriptions can be classified to have three meanings. It can mean "divided into portions" relating to dividing up responsibility for different information domains. The differentiation aspect in TM theory is captured by members' specialization in differentiated but complementary information domains. Second, shared can mean "held in common" including overlapping cognitive representations of task and role requirements. A shared awareness of expertise captures this dimension in TM theory. Third, it can mean the "notion of consensus or acceptance" in perceiving things and tasks from another member's perspective. Neither TM theory nor group process perspectives have stressed this possibility. Although a separation between shared and differentiated cognition is outlined in TM theory, group process scholars have not reached a consensus on what is shared and to what extent among members.

In addition to the ambiguity related to shared and differentiated mental models, group learning scholars have not explained whether the learning of a few, the majority, or all group members constitutes group learning (Mohammed & Dumville, 2001). Group learning models suggest that all members are engaged in learning processes because of the emphasis on shared representations among members (Edmondson, 1999: Bunderson & Sutcliffe, 2002; Gibson & Vermeulen, 2003). In a related vein, a TMS are formed because all members take or accept responsibility for the encoding, storage, and retrieval of information related to their expertise domains (Wegner, 1986). Hollingshead (2001) suggested that cognitive interdependence and convergent expectations (i.e., similar predictions about how the other will behave) motivate members to learn task-relevant information. Acceptance and shared recognition of expertise enable members to support each other's expertise by directing new information to the right people. Further, while a TMS is conceptualized through the encoding, storage, and retrieval phases, group learning literature pays little or no attention to these basic learning processes (Wilson et al., 2007). Thus, it can be argued that describing basic learning processes through information processing phases adds conceptual clarity to the group learning literature that has focused to explain learning processes in real groups.

Scholars have contributed to the conceptual ambiguity by describing the assisting and interacting role of TMS in group learning (Mohammed & Dumville, 2001; Lewis et al., 2005; London, Polzer, & Omoregie, 2005). Mohammed and Dumville (2001) argued that a group's failure to develop TMS can create problems for group learning and Lewis et al. (2005) that TMS influences group learning and learning transfer. TMS influences group learning because group members develop and update their expertise perceptions while performing tasks and observing other members' task performance. Interactions among people in groups that have formed TMS make it possible to transfer the learned skills to functionally related tasks in a new task context because members notice similarities across problems and map their prior knowledge to the new problem. Learning transfer is a phenomenon in which knowledge acquired in one situation affects learning or performance in another London et al. (2005) noted that the development of interpersonal congruence (group members seeing each other similarly) and TMS are elements of group learning that arise from feedback processes and interventions.

As scholars have started to integrate the TMS and group learning literature, it has become increasingly difficult to distinguish TMS from group learning. That is, while some scholars suggest that TMS acts as an antecedent of group learning (Mohammed & Dumville, 2001) others conceptualize TMS as a learning system (Lewis et al., 2005; London et al., 2005). Lewis et al. (2005) argued that TMS facilitates group learning at the individual and collective level and referred to learning that occurs as a consequence of groups having formed a TMS as "TMS learning." Unfortunately, scholars have not distinguished TMS learning from process-based frameworks. According to Kozlowski and Ilgen (2006), one way to distinguish group learning from TMS is to regard learning as a dynamic behavioral process of interaction and exchange among members and TMS as a construct that emerges over time in groups. When conceptualized as a process, it becomes more apparent that learning is contextually based and socially bound (Kozlowski & Ilgen, 2006). However, because other scholars have described TMS as an "emergent state" (Marks, Mathieu, & Zaccaro, 2001), confusion in the literature prevails.

Levels of Analysis – Multilevel Perspective

Learning occurs at multiple levels. At times, we learn independently, but most of the time we learn by interacting with others (Bandura, 1977). A comprehensive account of group learning consequently requires a multilevel perspective that focuses on factors, characteristics, and processes that unfold at the individual, group, and organizational levels (Klein, Dansereau, & Hall, 1994). Multiple-level perspectives suggest that micro phenomena are embedded in macro contexts and that macro phenomena emerge through the interaction and dynamics of lower-level elements (Klein et al., 1994; Klein & Kozlowski, 2000). In accounts based on the multilevel perspective, phenomena at different levels should thus be specified as well as the interactions between different levels.

Unfortunately, the levels issues have often remained unspecified in the literature on TMS and group learning (for an exception, see Peltokorpi 2012). TMS scholars have often extended trustful ties of intimate couples to groups and teams without sufficient explanation of the different levels of complexity. Group learning scholars have also been ambiguous about individual and group-level learning processes. A shared assumption in the literature on TMS and group learning is that groups through repeated social interactions form a shared cognition which is necessary for group functioning. However, while TM theory suggests that expertise awareness is shared among group members (Wegner, 1986), the group learning literature has not provided a comprehensive explanation of what needs to be shared and to what extent. In TM theory, group memory and the related learning processes are also dynamic configurations of individual memory, distributed knowledge of the content of individual memory, and group interaction processes that link that information into an emergent whole. Individual members in differentiated TMS have unique information that is essential to performing the group task. Rather than possessing similar knowledge items, members need to "know who know knows what" to withdraw knowledge. Thus, TM learning is a shared group-level awareness of who knows what. Whereas the TM literature places emphasis on shared awareness of expertise for all information processing phases, group learning scholars have not agreed upon what kind of shared mental presentations facilitate learning.

Transactive Memory Perspective of Group Learning

I draw on TM theory to conceptualize group learning processes by three interrelated phases: encoding, storage, and retrieval. The simultaneous existence of all these three phases makes learning in groups efficient and possible. For example, information cannot be stored or retrieved effectively without shared expertise awareness. The process of retrieving the correct information from domain experts enables to increase the storage capacity and makes retrieval more efficient in groups. All these three phases are also influenced by lower and higher-level elements (Peltokorpi, 2012, 2014). Individual members thus influence group learning through their motivation and insights.

Encoding

Group members during the encoding phase establish through repeated interactions a balance between the shared and the unique information that enables efficient information storage and withdrawal. Learning at the individual and group levels also requires a shared awareness of who knows what in groups. Group members learn about each other's expertise areas in various ways such as educational background (London et al., 2005). Functional skill diversity is theorized (Wegner, 1986) and shown to help groups to develop well-functioning TMS (Lewis, 2004). In newly formed groups, clearly defined task-relevant expertise speeds up TMS formation because members do not have to spend a long time negotiating/assigning expertise areas. Members can also learn from each other expertise from diffuse cues such as gender, age, and personal characteristics. Indeed, a TMS study shows that gender stereotypes affect task allocation and expertise inferences (Hollingshead & Frailin, 2003). If stereotypes play a large role in

TMS formation, available expertise can be left untapped and non-experts held accountable for information domains incongruent with their skills. Overall, the formation of accurate shared awareness of expertise is a difficult process because can be influenced by self-relevant motives, impression management tactics, and the opportunity for identity threats and defensive reactions (London et al., 2005).

The awareness of distributed expertise in groups influences what and how much task-related information group members decide to learn (Hollingshead, 2001; Lewis et al., 2005; Wittenbaum, Vaugan, & Stasser, 1998). An awareness of other members' expertise is found to influence an individual's choice and motivation to learn in an area other than those already associated with other member(s) (Wittenbaum et al., 1998). Members are more motivated to specialize and engage in individual learning processes when group tasks are interdependent and other members are specialized in other information domains (Hollingshead, 2001). If all members become aware of each other's expertise through interactions and observations, they tend to start either negotiating or assigning task-relevant expertise areas to all group members (Brandon & Hollingshead, 2004). As a result of expert inferences and reliance on other group members as domain specialists, members can specialize, and information domains become more differentiated in groups. Shared awareness of expertise is mutually enhancing for group members – validating members' knowledge and helping group members relate to each other (Wittenbaum, Hubbell, & Zukerman, 1999). In these ways, TMS influences both the content and extent of each member's learning.

Various factors such as feedback, group training, and low turnover can help groups to form more accurate shared awareness of expertise. First, feedback from other group members and leaders also enhances expertise inferences by decreasing role ambiguity (Gibson, 2001) and increasing self-disclosure (London et al. 2005). Second, group training helps members to learn who is good at which tasks (Moreland, Argote, & Krishnan, 1996) and realize that their contributions are interdependent and enhance each group member's ability to anticipate what another member might do next. Third, high turnover tends to create confusion if experts with important task-relevant information are removed (Moreland et al., 1996). A study on group learning also shows that turnover is harmful if newcomers and old-timers are unfamiliar with each other and have difficulties working together efficiently (Argote, Insko, Yovetich, & Romero, 1995).

Further, task characteristics – task complexity, task interdependence, task uncertainty, and group reward structure – can influence encoding processes. First, group tasks need to be complicated and composed of separate but interdependent parts for groups to form TMSs. For example, Brandon and Hollingshead (2004) proposed that task complexity increases cognitive interdependence and the pooling of unique but overlapping knowledge among members with a positive influence on TMSs. Participants in most TMS studies have performed complicated tasks and been cognitively interdependent. Task complexity can also increase task conflicts that enable members to refine their expert inferences (Ellis, 2006). Finally, scholars suggest that group reward structures facilitate task specialization and TMS formation (Brandon & Hollingshead, 2004). While researchers have not examined the impact of rewards on TMSs, related studies suggest that group rewards facilitate teamwork and communication (Hatcher & Taylor, 1991).

The aspects of group structure affecting expert inferences are clear task roles, group norms, and group size. First, clear task roles are theorized to facilitate expertise inferences (Wegner, 1986) and found to foster TMS development in a laboratory study (Hollingshead, 2000). The influence of role-based expertise on TMS might be considerable because a study suggests that individuals learn and recall more information in their own expertise areas when their partners have different task-related expertise (Wittenbaum & Park, 2001). Second, group norms as shared beliefs/standards that guide members' behaviors can assist TMSs formation through the sharing of unique information. While there is no direct empirical evidence of the group norm-TMS linkage, a study of group norms on decision-making performance suggests that critical norms improve group information sharing and decision quality (Postmes, Spears, & Cihangir, 2001). Third, group size affects social interactions and learning in groups through the amount of information needed to maintain a high level of group expertise (Austin, 2003). While people in large groups can specialize and develop their expertise, they must remember information about more people (Palazzolo, 2005; Peltokorpi, 2014). In large groups, members may not realize that the information they seek is known by someone in the group and the costs of retrieving such information can be so high that neither information seekers nor holders are motivated to share it.

Storage

TM theory (Wegner, 1986) makes a distinction between individual and group-level storage phases. The individual-level information storage refers to specialized task-related knowledge stored by each group member; and group-level information storage to a shared awareness of task-related expertise in groups. The shared awareness of expertise increases group-level information storage by allowing each member to specialize and pass relevant information to domain experts. The information stored in this decentralized manner allows groups to complete their tasks more efficiently since each member is responsible for storing and aware of who is responsible for storing specific task-related information. In an efficient TMS, requisite depth and spread of task information are achieved by interrelated information stored by group members who act as information storage bins. The storage of differentiated information by group members is crucial due to the cognitive limits of information that any individual may possess.

While information depth is achieved by specialization, information spread is achieved by differentiated but interrelated information domains in groups. Overlaps among the stored information help group members to use distributed specialized information efficiently. Hinsz et al. (1997) argued that information is processed efficiently if there is a balance between the commonality and uniqueness of information within the group. Commonality is the number of group members who have access to a piece of information. If access to information is limited only to one member, groups are less likely to attend to the information, the information can remain unshared, and groups have difficulty recalling the information in the future. Even if the information is shared, group members may have different frames of reference or mental representations of the knowledge domain, allowing them to encode, store, and retrieve only a certain amount of task-relevant information. To properly interpret all the information received, groups need to have a common or shared frame of reference. Indeed, the truth-supported wins model posits that it is enough for two members to share access to the same set of information for the group to attend to and acquire the information collectively (Hinsz et al., 1997).

While TM theory focuses on the role of individual group members as external memory repositories, information can also be stored in various information technology (IT) supported external sources such as shared databases, bulletin boards, and expertise systems (Moreland, 1999; Peltokorpi, 2004). Shared computer databases help group members to gain access and withdraw codified knowledge and expertise systems provide linkages to experts in groups and organizations. Databases store a large amount of information, which can be used efficiently if it is updated frequently and has good indexing mechanisms. Because individuals are argued to prefer to use social interactions to locate and retrieve knowledge and refrain from contributing their valuable knowledge to shared databases (Cross & Sproull, 2004), individuals are more efficient information storage domains in TMS (Wegner, 1995). Information in non-human repositories also decays faster than information stored by recognized human experts who are motivated to learn and update the stored information. Routines, roles, division of labor, and standard operating procedures also help groups to store and retrieve information efficiently (Argote, 1999; Peltokorpi, 2014). Information is stored in routines because learning leads to changes in routines.

All storage repositories have common indexing, filtering, and maintenance features that influence group learning (Wilson et al., 2007). Good indexing systems facilitate awareness of where information is stored and how it can be retrieved. Filtering is a process that screens out irrelevancies before the information is stored, and maintaining a memory system to updating information, deleting obsolete data, etc. In a well-functioning TMS, all group members take roles in information storage by forwarding relevant information to recognized experts, and these experts update and maintain the stored information. This requires frequent interactions among group members to direct incoming information to the right people. Thus, large groups tend to have problems efficiently storing information (Peltokorpi, 2012, 2014). Furthermore, research suggests that groups with differentiated TMS are vulnerable to turnover (Lewis et al., 2005).

Retrieval

Information retrieval occurs at the individual and group level. When the information items get more complicated or beyond each member's expertise areas, information items are stored and retrieved from external sources such as domain experts. Externally stored items of information are retrievable when members know what they are and where they are located. Successful retrieval of a memory item requires two pieces of information: (1) a retrieval cue for the item and (2) a notion of the location of the item. For example, the label in a software development team can be accounting software and the location is Brian who is a member with experience with accounting applications. When a member encounters a task-related problem related to accounting software, he or she can consult Brian to solve the problem. If Brian does not hold the requested information item, he or she may recall another member who is a more adequate domain expert and helps the retrieval process to come to a successful conclusion. In comparison to individual-level retrieval, collective information retrieval processes are social, interactive processes in which two or more group members collaborate to locate and retrieve information (Hollingshead, 1998).

The group information retrieval process occurs through an individual and collective awareness of who knows what. These collaborative information searchers are complex since the information can be accessible and available to all, some, one, or no group member(s). In addition to knowing what others know, knowing who they know enables information retrieval beyond individual networks and group boundaries (Hollingshead, Fulk, & Monge, 2002). In these transactive information searches, individuals in the center of a social network have an advantage over those who are isolated, more accurate perceptions of expertise, and a greater ability to access information (Brandon & Hollingshead, 2004). The complexity related to the information held and expertise directories added to individual cognition can create problems during the retrieval phase. For example, group members need to have a shared awareness of expertise for TMSs to function efficiently. While this is easy in dyads, it is more difficult in groups due to the larger number of people (Peltokorpi, 2012, 2014). In poorly formed TMS, an incorrect recognition of expertise directs information away from true experts. Situations can also arise in which existing expert allocation leads to suboptimal processing of external information because it does not correspond to the expertise of any members. Expertise may also be in dispute confusing information allocation to experts and information retrieval from experts. It is also possible that groups have failed to store the needed knowledge, people with the relevant information have left the group, or people forget where the information is stored. These factors hinder group effectiveness in time-critical situations due to inaccuracy and time lags in locating and retrieving information (Kozlowski & Bell, 2003).

Groups have a range of ways to maximize the speed and accuracy of search processes and information retrieval. For example, groups may develop routines that facilitate retrieval processes (Zellmer-Bruhn, 2003). Furthermore, members of organizational groups are often assigned to a specified narrow range of tasks that help with information location and retrieval. If groups have not explicitly assigned their members to certain information domains, members need to update their expert inferences dynamically to retrieve the right information from the right people. Time can also influence groups' ability to retrieve information. For example, a study by Levesque, Wilson, and Wholey (2001) suggests that mental models converged over time due to increased role differentiation and independent work practices. In other words, individuals specialized over time and retrieved less information from other members. This suggests that the longer groups are in existence, the lower the probability the groups will retrieve new and updated learning.

Discussion

Group learning has attracted increasing interest in research on organizational behavior (Wilson et al., 2007). Since groups are key building blocks of organizational effectiveness, understanding whether and how groups learn affects organization-level performance. Group research has also shifted from group effectiveness models to understanding group processes. There has also been a growing body of theory and research on group learning, but definitions of the construct have varied considerably across studies, and there are gaps and ambiguities in those conceptualizations. The main purpose of this paper was to reduce conceptual ambiguity between TMS and group learning literature and explain group learning processes through TM theory.

The most apparent difference between TM and group interaction-based accounts of group learning is the acknowledgment of mutual existence and the differentiated nature of the information at the collective and individual levels. While process-based models focus on processes and shared mental models that facilitate group learning (Bunderson & Sutcliffe, 2002; Gibson & Vermeulen, 2003), TM theory suggests that a dynamic constellation of overlapping and differentiated information allows groups to create, store, and retain more information and learn more effectively. TM theory also holds that learning in groups occurs both at the individual and group level. From the TM perspective, groups learn through the gradual specialization of their members and their contributions to collective processes that enable groups to reach their collective goals.

While group learning was conceptualized here through the phases of encoding, storage, and retrieval, it is important to note that group learning occurs only when all these phases are functioning well. Through group interaction processes, specialized information of members is shared and combined dynamically. As group members share differentiated but interdependent information, they can discover novel ways to combine information to create new information that information can be combined to create new information (Peltokorpi, 2008; Peltokorpi & Hasu, 2014; Wegner, 1986). By observing information retrieval and combination processes, group members develop a more comprehensive awareness of who knows what in their groups. Accurate awareness of expertise in groups also facilitates group coordination and performance (Lewis et al., 2005).

For groups to learn efficiently, their tasks and interaction processes need to be well coordinated. While the group learning literature has elaborated discussions of processes that enable or hinder learning (Edmondson et al., 2007), TM scholars have just started to discover what factors influence TMS formation and functioning in groups. For example, without some rare exceptions (Peltokorpi & Hasu, 2015; 2016; Peltokorpi & Manka, 2008), surprisingly little has been discussed about the influence of group leaders on TMS. It can be assumed that group leaders with transformational leadership types can facilitate TM-based group learning by motivating group members to engage in self-disclosure processes, accept responsibility for information domains, and facilitate information sharing. The TM literature has also paid scant attention to the impact of boundary-spanning activities and the existence of multiple domain experts in similar information domains on TMS and group learning. Because of the strengths and weaknesses in the literature on group learning and TMS, cross-fertilization between these interrelated streams of literature is warranted. For example, future research could examine potential differences between TMS and group learning constructs. This is relatively easy because of reliable TMS measures for field studies (Lewis, 2003) and group learning (Edmondson, 1999).

While I did not give focused attention to temporarily in this paper, groups learn as they evolve, and time-related processes should therefore be considered in future conceptual and empirical works. When working toward task goals, individual members of the group and the group as a whole are argued to engage in three types of learning: adaptive, generative, and transformative (London & Sessa, 2006). A group may react to stimuli automatically, causing it to adapt. A group can also be purposefully proactive, generating and using new knowledge. Alternatively, a group can radically recreate itself, transforming into a new entity. According to London and Sessa (2006), feedback contributes to all these types of group learning. Further, Edmondson (1999) argued that groups that learn from errors perform better than groups that are less able to learn from errors. After an error with severe consequences, groups can learn to be more open to errors with slightly less severe consequences in the future (London & Sessa, 2006).

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