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Knowledge Transfer in Organizations: The Role of Members, Tasks, Tools,
and Networks

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Abstract

This article describes advances in the study of knowledge transfer in organizations over the fifteen years since Argote and Ingram (2000) appeared in *Organizational Behavior and Human Decision Processes*. Argote and Ingram developed mechanisms of knowledge transfer and discussed factors that facilitate or impede transfer. Conditions under which knowledge transfer improves organizational performance were identified and conditions under which knowledge transfer is a source of competitive advantage for organizations were theorized. The current article concludes that research subsequent to the publication of Argote and Ingram has both increased the depth of our understanding of knowledge transfer and broadened the factors considered as predictors and consequences of transfer. Challenges to studying knowledge transfer, primarily in the area of measurement, are described, and new measurement approaches are discussed. We conclude with a discussion of future research directions that are likely to be productive and suggest that expanding the study of knowledge transfer to new problems domains, such as entrepreneurship, would advance knowledge of those domains as well as increase understanding of knowledge transfer.

Keywords: knowledge transfer, organizational learning, knowledge repositories, competitive advantage, networks, routines, transactive memory

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and Networks

In their 2000 OBHDP article, Argote and Ingram analyzed knowledge transfer, the process through which one social unit learns from or is affected by the experience of another unit. For example, one hospital surgical team might learn from another how to improve patient outcomes. Or a manufacturing plant might transfer practices from its sister plants. A consulting team might learn solutions from other teams in the organization that confronted similar problems. Knowledge transfer is also referred to as vicarious learning, as learning indirectly from the experience of others and, primarily within the field of economics, as knowledge spillover.

A long tradition of research in psychology has analyzed knowledge transfer at the individual level. Research has examined how individuals' experience on one task affects their performance on another (e.g., see Singley & Anderson, 1989). Research has also examined vicarious learning: how one individual learns from another (Bandura, 1971). Levitt and March (1988) theorized that knowledge transfer also occurs at the organizational level of analysis: organizations learn not only from their own direct experience but also indirectly from the experience of other organizations.

Argote and Ingram (2000) built on psychological and organizational research to analyze how knowledge transfer occurs across social units. The social units could be teams (Bresman, 2010) or other units of an organization such as shifts within a manufacturing facility (Epple, Argote, & Devadas, 1991), organizations (Irwin & Klenow, 1994), or populations of organizations (Miner & Anderson, 1999). Although psychological factors play important roles in knowledge transfer across social units, other

factors come into play including social networks, technologies, routines, and personnel mobility. In line with the emphasis of Argote and Ingram (2000), we focus on the transfer of knowledge between units within an organization. We also develop the implications of where knowledge is embedded in organizations for its transfer to other firms. Reviews of research on knowledge transfer between firms are provided by Van Wijk, Jansen, and Lyles (2008) and (Ingram, 2002).

Knowledge transfer is an important mechanism for improving the performance of recipient units. For example, a study of the introduction of a second shift within a manufacturing plant found that the second shift reached a level of productivity in several weeks that it had taken the first shift many months to achieve (Epple, Argote, & Murphy, 1996). Much of the knowledge the first shift acquired had been embedded in the technology and routines of the plant, which both the first and second shifts used. Similarly, results from a study of drug discovery indicated that knowledge transferred across related research programs within the same firm (Henderson & Cockburn, 1996). Further, firms learned from the experience of their competitors. The effect of competitors' experience, however, was smaller than the effect of the focal firm's own experience.

Although knowledge transfer can significantly benefit organizational performance, knowledge transfer does not automatically occur (Argote & Miron-Spektor, 2011). Galbraith (1990) found that one third of the attempts to transfer knowledge within the same firm failed and were terminated. Similarly, Darr, Argote, and Epple (1995) and Szulanski (1996) found significant variation in the extent to which knowledge transferred across organizational units.

Major goals of the Argote and Ingram (2000) article and the special issue in which it appeared (Argote, Ingram, Levine, & Moreland, 2000) included advancing understanding of mechanisms through which knowledge transfer occurs as well as identifying factors that facilitate or impede knowledge transfer. Stimulating future research on knowledge transfer across social units was another major goal of the article. In addition, the article aimed to identify the conditions under which knowledge transfer improved organizational performance and to develop a theory about when knowledge transfer is a source of competitive advantage for firms.

In order to accomplish these goals, Argote and Ingram (2000) used a framework of knowledge reservoirs or repositories developed by McGrath and Argote (2001) and Arrow, McGrath, and Berdahl (2000). According to the framework, knowledge is embedded in the three fundamental elements of organizations—members, tasks, and tools—and the networks formed by crossing them. The member-member network is the organization's social network. The task-task network is the sequence of tasks or routines that the organization uses. The tool-tool network describes the interrelationships among the tools the organization uses. The member-task network describes which members perform which tasks. Similarly, the member-tool network specifies which members use which tools. The task-tool network specifies which tools are used to perform which tasks. The member-task-tool network describes which members perform which tasks with which tools.

Knowledge can be transferred by moving the members, tasks, tools, or networks in which knowledge is embedded from one social unit to another or by modifying those knowledge repositories. An example of moving the knowledge repositories is moving

personnel from one organizational unit to another. Through personnel movement, knowledge acquired in one unit can transfer to another. Tools, routines, and networks can also be moved from one unit to another to transfer the knowledge embedded in them. In addition, knowledge can be transferred from a donor to a recipient by changing the repositories at the recipient site. These changes are mediated by individuals who themselves can be changed through mechanisms such as education, training, communication, and opportunities to observe donors.

According to the framework, organizational performance is enhanced both by the internal compatibility or congruence of the networks and by their external compatibility or congruence with other networks. For example, assigning tasks to the most qualified members would enhance the internal congruence of the member-task network and thereby improve organizational performance. When members seek advice from other members with the most task expertise, the member-member network is congruent with the member-task network, an example of congruence between networks. Other researchers have emphasized the importance of the congruence of components of organizations for effective performance (Tushman & Nadler, 1980).

Argote and Ingram (2000) argued that the extent to which knowledge is a source of competitive advantage for firms depends on where the knowledge is embedded. When knowledge repositories are moved from one context to another, they might not be congruent with or fit the new context. Argote and Ingram proposed that moving the networks from one context to another is more difficult than moving members, tasks, or tools. Because the networks have many interrelated components, transferring them successfully to new contexts is problematic. Thus, knowledge embedded in the networks

is harder to transfer than knowledge embedded in members, task, or tools. For example, a member-task network or a division of labor developed in one context might not fit another where members have different expertise and skills.

Argote and Ingram also proposed that the networks involving members play a special role in competitive advantage. Selection, socialization, communication, and training processes within organizations typically shape members of organizations to be more similar to each other than to members of different organizations (e.g., see Jackson, Brett, Sessa, Cooper, Julin, & Peyronnin, 1991). Thus, moving networks involving members is a more effective way to transfer knowledge within rather than between organizations, because the networks involving members are more similar within than between organizations. For example, if members of an organization are socialized to make decisions in a decentralized fashion, then decentralized networks are likely to be prevalent. A decentralized communication network developed in one part of the organization would transfer more easily to another part than to a different organization where centralized decision making was the norm. Further, competitors typically do not have visibility into networks involving members. Knowledge in networks involving members is hard for competitors to see and to imitate and, thus, is a particularly strong source of competitive advantage for firms (see Lippman & Rumelt, 1982; Barney, 1986; Rivkin, 2000, for discussions of competitive advantage; and Campbell, Coff, & Kryscynski, 2012, for a discussion of when knowledge embedded in members can be a source of competitive advantage).

The current article provides a brief summary of research on knowledge transfer, highlighting major findings and identifying current themes. We discuss how research has

both deepened and expanded our understanding of knowledge transfer since Argote and Ingram (2000) was published. The challenges and opportunities of current research on knowledge transfer are described. Future directions for fruitful research are developed.

The Literature: Major Findings and Current Themes

At the time the special issue of OBHDP appeared, research on knowledge transfer across social units was in an early stage. In addition to the studies described above, several major studies predated the 2000 OBHDP article. Zander and Kogut (1995) examined predictors of knowledge transfer both within a firm and outside a firm to competitor organizations. From their analysis of survey data on the diffusion of Swedish innovations, the authors concluded that knowledge that was codified, teachable, and related to capabilities that many firms possessed transferred more readily within firm boundaries than knowledge lacking these characteristics. Results also indicated that turnover of key personnel increased the likelihood of knowledge transfer across firm boundaries. The study highlighted the divergent facilitators of knowledge transfer within and across firm boundaries.

Darr, Argote, and Epple (1995) analyzed knowledge transfer in 36 fast food establishments in a geographic area in the U.S. All of the establishments were franchised from the same parent organization and produced the same product. Several of the franchisees had only one store, whereas others had several stores. Based on an analysis of archival data spanning two years, the authors found that stores learned from their own direct experience and from the experience of other stores owned by the same franchisee but not from the experience of stores owned by different franchisees. That is, knowledge transferred across stores owned by the same franchisee. Results from the analysis of

archival data were reinforced by survey and interview data, which indicated that the frequency of transfer mechanisms, such as phone calls, meetings, and personal acquaintances, was greater within than between franchisees.

Szulanski (1996) analyzed the transfer of best practices within firms. Taking a communication theory perspective, Szulanski examined how characteristics of the source or donor of the knowledge, characteristics of the recipient, characteristics of the relationship between the source and the recipient, and characteristics of the knowledge being transferred affected the ease of transfer. Szulanski (1996) found that units high in “absorptive capacity,” the ability to recognize valuable external knowledge and assimilate it (Cohen & Levinthal, 1990), were more likely to transfer best practices successfully than their counterparts with lower absorptive capacity. A poor relationship between a donor and a recipient impeded knowledge transfer. Further, knowledge that was high in “causal ambiguity,” where cause-effect relationships were not well understood, was harder to transfer than knowledge low in causal ambiguity.

Over the last 15 years, significant advances have been made in understanding knowledge transfer. Considerable evidence demonstrates that knowledge is difficult to transfer across organizational contexts. Huckman and Pisano (2006) provided compelling evidence of the effects of the context on knowledge transfer in their study examining outcomes of surgeons who performed the same procedures in different hospitals. The authors found that surgeons’ procedure experience at a focal hospital improved patient outcomes at that hospital but that surgeons’ procedure experience at other hospitals did not. Thus, knowledge did not transfer across different organizational contexts.

Similarity between contexts has been found to facilitate knowledge transfer. Research indicates that knowledge is more likely to transfer when the source and recipient share similar characteristics than when they do not. For example, Darr and Kurtzberg (2000) found that similarity in business strategy facilitated knowledge transfer across organizational units. Further, the negative effect of geographic distance observed on knowledge transfer (Galbraith, 1990; Lester & McCabe, 1993) was mitigated by strategic similarity (Darr & Kurtzberg, 2000).

The challenge of moving interrelated components that fit each other to new contexts was central to the arguments of Argote and Ingram. Simulation results and empirical studies have supported the difficulty of moving knowledge repositories with many components that have co-evolved to fit the current context to new contexts. In a simulation, Rivkin (2000) showed that knowledge transfer was impeded by the extent of interactions between knowledge elements because of the recipient's need to understand those contingent interactions. In an empirical study on routines, Gupta, Hoopes, and Knott (2015) found that managers neglected the interdependencies between elements of routines, which impaired their large-scale replication. These findings demonstrate that the interactions or interdependencies of an organization's knowledge inhibit its spread across contexts.

Research has deepened our understanding of how members, tasks, tools, and their networks affect knowledge transfer across social units as well as expanded the scope of factors predicting knowledge transfer. We begin this section by reviewing major findings organized according to the framework of members, tasks, tools, and their networks. We

then discuss factors not fully fleshed out in the framework that have been investigated in subsequent research.

Members

Argote and Ingram (2000) argued that individual members are powerful mechanisms for transferring knowledge because they can transfer tacit as well as explicit knowledge. Further, individuals are more equipped to adapt knowledge than other knowledge repositories, and adaptation is often required to move knowledge across contexts.

Researchers have found empirical evidence that personnel mobility is an effective mechanism for transferring knowledge between as well as within organizations (see Mawdsley & Somaya, 2016, for a review). Underscoring the effectiveness of personnel mobility as a knowledge transfer mechanism and the ability of members to move knowledge across different contexts, Rosenkopf and Almedia (2003) found that personnel mobility across firms was associated with knowledge transfer, regardless of geographic distance, and that the effects of mobility increased with technological distance. Song, Almeida, and Wu (2003) found that hiring firms learned more from personnel mobility across firms the more the hiring firm's current technological developments were not dependent upon its prior technological developments. That is, the less path-dependent a firm's technological trajectory, the more likely the firm learned from new hires.

Somaya, Williamson, and Lorinkova (2008) contrasted the effects of personnel mobility to and from competing firms and to and from cooperating firms on firm performance. With the exception of the outward mobility of members to competitors, the

mobility events enhanced firm performance. Outward mobility to competitors, however, hurt the donor firms' performance and their competitive advantage.

Kane, Argote, and Levine (2005) demonstrated that personnel mobility can be a mechanism for transferring routines across groups. Groups that shared a superordinate social identity with a new member were more likely to adopt the new member's routine when it had the potential to improve their performance and reject the new routine when it did not. By contrast, groups that did not share a superordinate identity with the new member rejected both superior and inferior routines. Thus, sharing a superordinate identity increased the receptivity of groups to new ideas and facilitated the transfer of routines through the movement of individuals.

Results of a comparison of managers' receptivity to internal versus external knowledge by Menon and Pfeffer (2003) appear somewhat inconsistent with results from the Kane et al. (2005) study. Menon and Pfeffer found that managers devalued internally sourced knowledge and valued externally sourced knowledge. We conjecture that different structures of rewards, including status, could explain the apparent differences in results between the two studies. Managers in the Menon and Pfeffer study seemed to focus on increasing their individual outcomes: managers expressed concern that valuing knowledge of internal colleagues would elevate the status of those colleagues and decrease their own status, whereas valuing knowledge from outside sources would not have such a deleterious effect. By contrast, participants in the Kane et al. study acted in the best interests of the group when members shared a superordinate identity. It would be interesting to investigate whether sharing a superordinate identity or group incentives could overcome the attitude against internal knowledge observed in the Menon and

Pfeffer study. Another difference between the two studies was that the knowledge transferred by new group members in the Kane et al. study had been developed outside the group, so its members had not been exposed to the potentially arduous process of developing new knowledge. Menon and Pfeffer argued that observing the difficulties of developing knowledge, as often occurs with internally generated knowledge, can lead members to devalue that knowledge.

Research has examined the conditions that increase groups' receptivity to knowledge brought in by new members (see Rink, Kane, Ellemers, and Van Der Vegt, 2013, for a review). Choi and Levine (2004) studied the conditions in which groups were more likely to implement a task strategy brought in by a new group member. Groups that had been using a task strategy that was assigned as opposed to self-chosen and groups that were failing at the task were more likely to use the new member's strategy. The finding that groups were more likely to persist in using strategies that they had chosen is consistent with past work showing that individuals are more committed to decisions in which they participated (Mathieu & Zajac, 1990). The finding that groups that were failing were more likely to adopt a new strategy than those that were succeeding is consistent with Cyert and March's (1963) theory that organizations are more likely to change when their performance falls short of their aspirations.

The results of a study by Groysberg and Lee (2009) on the mobility of star financial analysts across firms add to our understanding of the conditions under which moving individuals across firm boundaries creates value. Results indicated that the performance of stars decreased after they moved to a new firm. This negative effect was greater for stars who engaged in explorative work at their new firms compared to stars

who engaged in exploitative work and for stars who moved solo compared to those who moved with their teams. Similarly, in a study of employee mobility in the National Basketball Association, Campbell, Saxton, and Banerjee (2014) found that players who moved in groups experienced smaller negative shocks to performance after moving than players who moved by themselves.

Research on the sharing of uniquely held knowledge by group members provides insights into how individuals can become aware of uniquely held knowledge that new members possess. Many studies have built on Stasser's work on factors facilitating the sharing of uniquely held information in groups (Stasser, 1988; Stasser & Titus, 1987). Bonner and Bolinger (2013) found that instructing group members to bring in knowledge related to their current task increased the sharing of knowledge in groups and their subsequent performance. Socially isolated members who have unique expertise have been found to make more unique knowledge contributions than socially connected members with unique expertise (Thomas-Hunt, Ogden, & Neale, 2003). Similarly, groups in which members shared social ties and had the same knowledge outperformed groups in which members who shared social ties possessed different knowledge (Phillips, Mannix, Neale, & Gruenfeld, 2004). Reviews of this research can be found in Lu, Yuan and McLeod (2012) and Wittenbaum, Hollingshead, and Botero (2004).

Research has examined the consequences of new and diverse knowledge brought in by new group members. Gruenfeld, Martorana, and Fan (2000) found that groups generated new knowledge when members returned from sojourns in other groups. Choi and Thompson (2005) found that membership change in groups enhanced the creative output of groups compared to groups in which membership was stable. Harrison and

Klein (2007) reviewed how diversity in groups affects group processes and outcomes and discussed how variety in the knowledge sources of organizational members can support group performance.

Modifying members' knowledge and skills through training is also a mechanism for knowledge transfer. Lapré and Van Wassenhove (2001) studied how training affected the transfer of technical knowledge across steel wire plants. The formal training efforts had no significant effect on plant outcomes, which the authors attributed to a lack of management buy-in and a lack of inter-departmental problem solving.

Two characteristics of training programs seem especially relevant for knowledge transfer in organizations. First, training that includes demonstrations and opportunities to observe has been found to be more effective at promoting knowledge transfer than training that lacks these features (Nadler, Thompson, & Van Boven, 2003). Demonstrations and opportunities to observe allow individuals to acquire tacit as well as explicit knowledge. Second, training members of a group together has been found to improve group performance relative to individual training because it facilitates the distribution and sharing of knowledge among group members (Liang, Moreland, & Argote, 1995). In a recent meta-analysis of the effect of group training, Salas, Tannenbaum, Kraiger, and Smith-Jentsch (2012) concluded that group training significantly improved group performance.

Member- Member Networks

Research on how social networks, member-member networks, affect knowledge transfer has increased dramatically over the last 15 years. Researchers have investigated how the strength of ties, typically defined in terms of their frequency and emotional

intensity, affects transfer (Granovetter, 1973). Weak ties provide access to more information, but strong ties provide more bandwidth for understanding the information. Researchers have also analyzed how the structure of networks, including their density (Coleman, 1988) and range (Reagans & McEvily, 2003), influences knowledge transfer. In addition, research has examined how knowledge transfer is affected by positions in the network, especially whether an individual bridges a "structural hole" such that he or she is the only link from one part of the network to another (Burt, 1992). Occupying such a position provides access to a wide array of information. In addition, researchers have examined how the extent to which third party ties are shared affects transfer (e.g., see Reagans, Singh, & Krishnan, 2015) and how social networks affect the development of transactive memory systems (Lee, Bachrach, & Lewis, 2014; Argote, Aven, & Kush, 2015).

Research on networks and knowledge transfer has progressed from analyzing whether one network feature is better than another to analyzing the conditions under which one network feature is better than another (e.g., Hansen, 1999) and to considering how the network features act in concert (Tortoriello, Reagans, & McEvily, 2012). Phelps, Heidl, and Wadhwa (2012) and van Wijk, Jansen, and Lyles (2008) reviewed the literature on networks and knowledge transfer. In this section, we highlight a few key studies.

Hansen (1999) demonstrated the differing benefits of strong and weak ties. Strong ties were useful for the transfer of complex knowledge, whereas weak ties were useful for finding distant knowledge. Weak ties were problematic, however, when the knowledge was complex, and strong ties were not effective for searching for distant

information. Furthering our understanding of the transfer of complex knowledge, Sorenson, Rivkin, and Fleming (2006) showed that close ties, ties between actors in social proximity to each other, have the greatest advantage over distant ties in transferring knowledge of moderate complexity. Sorenson et al. (2006) argued that although knowledge of low complexity diffuses readily and knowledge of high complexity always poses transmission challenges, close ties can best enable the transfer of moderately complex knowledge. Adding to the taxonomy of ties, Levin, Walter, and Murnighan (2011) focused on dormant ties—inactive relationships that can be rekindled—and found that strong, dormant ties can provide both the transfer benefits of strong ties and the access-to-novelty benefits of weak ties.

Reagans and McEvily (2003) found that two dimensions of network structure, cohesion and range, increased the rates of knowledge transfer over and above the strength of the tie between the source and recipient. Network cohesion is the density of third-party ties around the source–recipient relationship, and network range is the span of ties connected to the source and recipient. Reagans and McEvily found that tie strength matters when the knowledge being transferred is tacit, but that the effects of network structure do not depend on whether the knowledge is tacit.

A branch of social networks research focusing on two-mode networks shows promise for testing the theory outlined in Argote and Ingram (2000). Two-mode networks, networks with nodes of two types and edges connecting nodes of different types (Robins & Alexander 2004), provide a method to study the interplay between members, tasks, and tools in organizations. Two-mode networks have been used to

model configurations of members and tasks (Conaldi & Lomi, 2013; Zhu, Huang, & Contractor, 2013).

Inkpen and Tsang (2005) integrated theoretically the literatures on social networks, social capital, and knowledge transfer. The authors observed that social capital developed between partners facilitates the transfer of knowledge across network members.

Other researchers have examined the more macro structure of organizations. Tsai (2002) found that centralized structures impeded knowledge transfer across units, whereas social interaction facilitated knowledge transfer. Fang, Lee, and Schilling (2010) demonstrated in a simulation that semi-isolated subgroups with a moderate number of connections across subgroups promoted the most organizational learning. The semi-isolation of the subgroups promoted the development of diverse ideas, and the connections across subgroups promoted the transfer of those ideas. Cummings (2004) found that knowledge sharing within groups and external to the focal group was positively related to performance and that structural diversity moderated the relationship between external knowledge sharing and performance. Groups with members in different locations, in different functions, in different business units, and reporting to different managers benefited more from gaining external knowledge than did their counterparts who lacked these characteristics.

Tasks

Research has examined how characteristics of the task affect knowledge transfer. Research continues on the extent to which the task involves tacit knowledge or knowledge that is not well understood and difficult to articulate (Nonaka & Von Krogh,

2009). Szulanski, Ringov, and Jensen (in press) analyzed how the effectiveness of knowledge transfer methods depended on the extent to which the knowledge was causally ambiguous as well as on the timing of the use of the method (see also Szulanski, 2000). Results indicated that “front-loading” methods, methods with affordances for transferring tacit knowledge, were effective when causal ambiguity was high and the relationship between the source and recipient was good.

Researchers have also expanded the dimensions of tasks that are investigated to include task demonstrability and whether the task involves corrupt activities. Task demonstrability refers to the ease of showing the correctness or appropriateness of solutions (Laughlin, 1988). Kane (2010) found that demonstrably better routines transferred more often than routines whose benefits were harder to discern but that those less demonstrably better routines did transfer when groups shared a superordinate identity. Aven (2015) found that patterns of knowledge sharing in organizations differed for corrupt and non-corrupt tasks.

Another research stream examines transfer across task conditions. Bereby-Meyer, Moran, and Unger-Aviram (2004) examined group knowledge transfer in a negotiation task for groups in either high or low learning treatments. High learning groups were those with high learning goals and values and team discussion. Results indicated that high learning groups outperformed low learning groups under both stable and variable task conditions (see also Bunderson & Sutcliff, 2003) and that low learning groups performed worse than groups without any task experience under conditions of task change. Miron-Spektor and Beenan (2015) found that simultaneously providing learning

and performing goals increased the novelty and usefulness of products relative to providing learning and performance goals sequentially.

Researchers have also examined how performing one task in organizations affects the performance of another. Benkard (2000) analyzed the extent of knowledge transfer during the production of two models of a commercial aircraft and found considerable but incomplete knowledge transfer across the models. Levitt, List, and Syverson (2013) analyzed the extent of knowledge transfer between three models at an automotive plant and found some negative transfer between two of the models.

Researchers have also examined whether task heterogeneity or task homogeneity improves performance. A mechanism through which task heterogeneity could improve performance is knowledge transfer: knowledge about how to perform one task is applied to another task. Several studies have found that organizations learn more from heterogeneous or diverse task experience than from homogenous experience (Haunschild & Sullivan 2002; Schilling, Vidal, Ployhart, & Marangoni, 2003; Wiersma, 2007).

Other studies have identified conditions under which task heterogeneity has a positive effect on performance. Boh, Slaughter, and Espinosa (2007) found that heterogeneous experience in related software systems increased the productivity of software development teams, whereas homogeneous experience increased the productivity of individual workers. Staats and Gino (2012) found that the effect of task heterogeneity depended on whether an individual experienced the heterogeneity within a single day or across several days. Performing heterogeneous tasks over multiple days improved individual productivity, whereas performing homogeneous tasks within a single day increased individual productivity. Egelman, Epple, Argote, and Fuchs (in press)

found that plant productivity increased when multiple generations of the firm's primary product were produced concurrently, reflecting the firm's ability to transfer knowledge across similar products. No significant transfer of knowledge was found, however, between the primary product family and other products.

Task-Task Networks

Organizational knowledge can be embedded in the task-task network or in what is more commonly referred to as routines. A routine is a repetitive pattern of interdependent tasks performed by multiple members of an organization (Feldman & Pentland, 2003). Routines enable organizational knowledge to persist in the face of member turnover (Rao & Argote, 2006; Ton & Huckman, 2008).

Routines are mechanisms for transferring knowledge. The effectiveness of routines as transfer mechanisms has been found to depend on several factors, including a shared superordinate identity (Kane et al., 2005) and common ownership (Darr et al., 1995). Knott (2001) found that when establishments left franchises, they drifted from the routines they had learned through membership in the franchises, and their performance deteriorated. Further, Knott (2003) found that franchisor control of franchisees enabled the spread of routines within the franchisees. Without information and directions from the franchisor, independent establishments did not learn about superior routines from the franchise or see them as fitting their operations.

On the other hand, Aime, Johnson, Ridge, and Hill (2010) found that one routine—a particular kind of football offense—transferred across competitors in the National Football League through the movement of coaches across teams. Although the study found that the routine transferred widely, it is important to note that the movement

of the routine was accompanied by the movement of individuals. Another characteristic of the Aime et al. study context is that the routines, plays in football games, are visible to competitors, whereas in many organizational contexts, competitors do not have visibility into each other's routines. Research is needed to investigate whether the visibility of the routine explains why the routine transferred so widely across competitors in the Aime et al. study and more narrowly in other studies (e.g., Gupta, et al., 2015; Kane et al., 2005; Knott, 2003).

Templates have been described as working examples of organizational routines that include both essential and non-essential aspects of how work gets done (Nelson & Winter, 1982). Jensen and Szulanski (2007) found that template use enhanced the effectiveness of knowledge transfer by providing evidence of the knowledge's efficacy and by facilitating problem solving in the transfer process. Winter, Szulanski, Ringov, and Jensen (2012) found that the modification of templates in franchisees hurt the units' performance. The study shows how adapting to new contexts can be very challenging and is unlikely to be done effectively by modifying a proven template.

Research has examined how routines form and can be adapted to changes in the context. Turner and Fern (2012) showed that as members acquired experience with a routine, the performance of the routine converged. When the context changed, however, members diverged in their performance of the routine, and the extent of divergence was amplified by members' experience. Miller, Pentland, and Choi (2012) used an agent-based simulation to examine how different types of memory affected organizations' abilities to form, perform, and adapt their routines. Their simulation results indicated that transactive memory was important for the formation and efficiency of routines

performed. Further, declarative memory increased the efficiency of routines performed only in stable environments

Tools

Researchers have examined the effects of a tool in the form of a knowledge management system on knowledge transfer. Two studies investigated the effects of repository forms of knowledge management systems. Haas and Hansen (2005) found a negative effect of the frequency of use of a knowledge management system on the performance of consulting teams. By contrast, in a study of a retail grocery chain, Kim, Mukhopadhyay, and Kraut (2016) found a generally positive effect of using a knowledge management system. Thus, the repository form of knowledge management systems appears to be more effective for more routine tasks, such as ones in grocery stores, than for uncertain tasks, such as those encountered by consulting teams.

More recent studies have examined knowledge management systems that connect members through Web 2.0 technologies. Hwang, Singh, and Argote (2015) analyzed the effect of an online Question and Answer forum on knowledge sharing in an IT consulting firm. The researchers found that participants initially shared information in the online forum with others in the same geographic location and at same hierarchical status. As participants gained experience in the system, they learned to span these geographic and hierarchical boundaries and shared knowledge with geographically distributed members of different status.

With the increased use of online communities that are external as well as internal to organizations, research on these communities has accelerated (Faraj, Jarvenpaa, & Majchrzak, 2011). Several studies have investigated what motivates individuals to share

knowledge in such communities. Enhancing one's reputation and reciprocating others have been found to be key predictors of knowledge sharing (Faraj & Johnson, 2011; Wasko & Faraj, 2005).

Research on tools has also analyzed knowledge transfer in the context of introducing new technologies in organizations. Ko, Kirsch, and King (2005) found that communication competence and source and recipient motivation predicted knowledge transfer between consultants and clients in the implementation of a new information system. Tanriverdi (2005) found that the relatedness of information technology between units in multi-business firms facilitated the creation, transfer, and integration of knowledge, which, in turn, increased firm performance. Edmondson, Winslow, Bohmer, and Pisano (2003) examined surgery teams' performance improvements after the introduction of a new technology. When the surgery cases required codified knowledge, teams that adopted the technology towards the end of the adoption period experienced faster performance improvements than teams that adopted the technology earlier, due to the late adopters' ability to transfer knowledge from earlier teams.

Tool-Tool Networks

Research has examined how knowledge embedded in tools transfers to other units and affects their performance. As noted previously, Epple, Argote, and Murphy (1996) found that the second shift at a manufacturing plant reached a level of productivity in a couple of weeks that it had taken the first shift many months to achieve. The researchers attributed the significant knowledge transfer to knowledge being embedded in the tools and routines of the plant by the first shift and used by the second shift. Levitt, List, and Syverson (2013) extended the analysis of introducing a second shift to quality outcomes

and reached a similar conclusion to Epple et al. (1996): knowledge transferred from the first to the second shift via the technology at the plant.

The contrast of the results about adding a second shift and introducing new product models (see Levitt et al., 2013) is consistent with arguments advanced in Argote and Ingram (2000). A second shift uses the tools and routines of the first shift. Because the tasks are the same on the two shifts, the tools and routines developed on the first shift fit or are congruent with the tasks of the second shift. By contrast, the tools and routines developed to perform the tasks required for one model might not fit the tasks required on others. The lack of congruence would limit transfer and impede performance.

Member-Task and Member-Tool Networks

Research has deepened our understanding of how transactive memory systems influence the transfer of organizational knowledge. A transactive memory system is a collective system for encoding, storing, and retrieving information (Wegner, 1987; Liang, Moreland, & Argote, 1995; Hollingshead, 1998; Lewis, 2003). Transactive memory systems represent both member-task (who is best at performing which task) and member-tool (who is best at using which tool) networks. Knowledge of who knows what has been found to foster knowledge transfer (Borgatti & Cross, 2003) and to improve group performance (Ren & Argote, 2011).

Several studies have shown that a transactive memory system developed for one group of individuals might not fit another. Lewis, Belliveau, Herndon, and Keller (2007) found that groups with one new member performed worse than either groups with intact membership or groups with totally reconstituted membership. When one member was

replaced, incumbent members seemed to slot the new member into the division of labor developed with the previous member, whose expertise might not match the new member's. Argote, Aven, and Kush (2015) found that the transactive memory systems of decentralized groups were disrupted by turnover, which impaired their performance. By contrast, centralized groups were better able to incorporate the contributions of new members, which enabled them to strengthen their transactive memory systems and improve their performance.

Lewis et al. (2005) investigated the effect of task changes on transactive memory utilization and performance. Although groups that had developed a transactive memory system on one task did not perform better, on average, on another task, groups whose members had been reassigned for the second task but were able to maintain the same division of expertise performed better than groups whose members were not able to maintain expertise stability.

Evidence also suggests that one group would find it difficult to copy the transactive memory system of another. Gino, Argote, Miron-Spektor, and Todorova (2010) found that groups were more creative on a subsequent task when they learned directly from their own experience rather than indirectly by observing another group, even a high-performing group, complete the task. Further, differences in transactive memory systems between groups that learned directly and those that learned vicariously accounted for the creativity differences. Groups that learned vicariously through observation did not have opportunities to learn who was good at what in their own group and apparently were not able to transfer the transactive memory system of the group they observed to their own group.

Research has also extended the study of transactive memory systems from the group to the organizational level by analyzing the transactive memory systems of top management teams. Heavey and Simsek (2015) found that transactive memory systems, external ties, and environmental dynamism interacted to predict firm performance. At low levels of dynamism, a positive relationship between transactive memory systems and firm performance existed that did not depend on the strength of external ties. By contrast, at high levels of dynamism, the association between transactive memory systems and performance was negative for weak external ties and positive for strong external ties. Thus, strong external ties were most valuable in dynamic environments where they enabled top management teams with strong memory systems to respond to environmental change.

Expanded Predictors

Knowledge transfer depends on motivation, ability, and opportunity (Argote, McEvily, & Reagans, 2003). Although characteristics of members such as their motivations could be included in the member-task-tool framework, the Argote and Ingram (2000) article emphasized factors affecting the ability and opportunity to transfer knowledge more than factors affecting motivation. Subsequent research has investigated how motivation affects knowledge transfer. Building on Cyert and March's (1963) behavioral theory of the firm, Baum and Dahlin (2007) investigated how aspiration levels affected search in a study of accidents in the U.S. railroad industry. Baum and Dahlin (2007) found that as performance deviated from the aspiration level, an organization relied less on its own experience and more on the experience of other organizations in the industry. In an experiment at the group level of analysis, Håkonsson, Eskildsen, Argote,

Mønster, Burton, and Obel (2016) found that groups were more likely to adopt new production routines when their performance had declined over time. Thus, groups and organizations are most open to learning from the experience of others when they have not met their aspirations, which are a function of their own past performance and the performance of other similar groups and organizations.

Research has also been done on how incentive systems (Quigley, Tesluk, Locke, & Bartol, 2007) and culture or climate affect knowledge transfer. For example, Collins and Smith (2006) found that commitment-based human resource practices, such as group incentives and training, affected the organization's climate, which, in turn, affected knowledge transfer. Edmondson (1999) examined how culture affected learning behaviors in groups, including their use of outside knowledge, and found that groups exhibiting a greater degree of psychological safety engaged in more learning than groups where members did not feel psychologically safe.

Researchers have extended the study of knowledge-related behavior to include knowledge hiding, defined as an intentional attempt by one individual to withhold knowledge requested by another (Connelly, Zweig, Webster, & Trougakos, 2012). Connelly and Zweig (2015) studied the consequences of different types of knowledge hiding. Evasive hiding appears to lead to the most negative consequences from the perspective of either the person who hides the knowledge or the target. Connelly et al. (2012) argued that knowledge hiding is not simply the absence of knowledge sharing but, rather, involves an intentional attempt to withhold knowledge. Interestingly, the predictors of knowledge hiding include many of the same factors that predict knowledge sharing, such as the quality of relationship between a donor and recipient. Further

research is needed on the relationship between knowledge transfer and knowledge hiding and on predictors and consequences of knowledge hiding.

Research has begun to investigate how emotion affects knowledge transfer (Levin, Kurtzberg, Phillips, & Lount, 2010; Håkonsson et al., 2016). Examining the effect of donor and recipient affective states on the likelihood of transfer, Levin et al. (2010) showed that happy recipients were more likely to adopt a donor's knowledge than were angry and frustrated recipients. Further, knowledge transfer was more likely when donor and recipient pairs were in the same affective state, either both in a happy state or both in an angry and frustrated state, than when they were not. In addition, research has examined how status affects transfer—both at the individual (Thomas-Hunt, Ogden, & Neale, 2003) and organizational levels (Sine, Shane & Di Gregorio, 2003). For example, Sine et al. (2003) found that knowledge developed in a high status organization was more likely to transfer than knowledge developed in a low status organization.

Research has expanded our understanding of how the quality of relationships between members affects knowledge transfer (Szulanski, 1996). Building on research on social identity theory (Tajfel, 1981; Abrams & Hogg, 1990) and ingroup favoritism (Brewer, 1979; Hewstone, Rubin, & Willis, 2002), Kane, Argote, and Levine (2005) hypothesized and found that sharing a social identity led group members to be open to the ideas of members from other groups and to adopt those ideas that were likely to improve performance. Greenaway, Wright, Willingham, Reynolds, and Haslam (2015) found that participants made higher quality products when they believed their instructions had been created by an ingroup rather than an outgroup member and, further, that the effect was attenuated when a shared superordinate identity encompassed both the ingroup and the

outgroup. Thus, a shared superordinate identity promoted effective communication and knowledge transfer.

Our understanding of knowledge transfer has been expanded by scholars in other fields. Wright, Dunford, and Snell (2001) discussed how the resource-based view of the firm indicates that human resources can support firm strategy and shows how firms' management of their knowledge resources supports their competitive advantage. Kang, Morris, and Snell (2007) showed how firms create value by facilitating knowledge flows across different groups in the organization as a function of different human resource dimensions. Similarly, Ployhart (2015) developed how organizational behavior factors can provide competitive advantage to firms. In addition, researchers in the fields of operations management (Siemsen, Roth, & Balasubramanian, 2008) and economics (Benkard, 2000; Levitt et al., 2013) have also contributed to our understanding of knowledge transfer in organizations.

Challenges and Opportunities

Challenges and opportunities exist in the area of measuring knowledge transfer. The strengths and weaknesses of current approaches to measuring knowledge transfer are discussed in this section. New developments that have potential for providing alternative measures are described.

Knowledge transfer can be challenging to measure. The most appropriate approach depends on the goals of the research and the empirical context. Four general approaches to measuring knowledge transfer have been used. The first is through survey questions (e.g., see Szulanski, 1996). Similar to all measures based on surveys, care must be taken to develop reliable and valid measures. In addition, measures should be

obtained from multiple types of respondents to avoid problems of common method bias. An advantage of the survey approach is that it can be used to measure knowledge transfer in different types of units where the content of what is being transferred might differ.

The second approach to measuring knowledge transfer is to rely on archival data and to assess whether a relationship exists between the performance of the recipient unit and the experience of some other unit or group of units. For example, Darr, Argote, and Epple (1995) showed that the performance of a focal pizza store was affected by the experience of other stores owned by the same franchisee (see Baum & Ingram, 1998, for another example in their study of hotels). A similar approach is often used in psychological studies to determine how experience on one task affects performance on another. In addition, a growing number of studies use the U.S. Census Bureau's Longitudinal Employer-Household Dynamics dataset to track employment movements and the subsequent performance of the hiring firms (Starr, Balasubramanian, & Sakakibara, 2014; Agarwal, Campbell, Franco, & Ganco, 2016).

Because organizational performance is typically studied in the field, using this approach requires that many factors be controlled for to insure that performance gains are not due to factors other than the experience of donor units. This approach has the advantage of being objective and capturing tacit as well as explicit knowledge. Berry and Broadbent (1984, 1987) showed that as individuals gained experience on a task, their performance on the focal task improved and their performance on a second, related task also improved, indicating that individuals transferred knowledge from the first to the second task. Individuals, however, were not able to articulate why their performance improved, which suggested that the knowledge they had acquired was tacit. Surveys and

verbal protocols are not well-suited for capturing tacit knowledge, but performance-based approaches are.

A third approach to measuring knowledge transfer is to measure changes in routines or practices associated with the experience of another unit. For example, Kane, Argote, and Levine (2005) showed that personnel mobility resulted in changes in the routines of recipient units. Measuring knowledge transfer through changes in routines has the advantage of being objective and able to capture tacit as well as explicit knowledge. A disadvantage is that the approach does not capture knowledge embedded in other repositories in organizations. In addition, routines can change for reasons other than knowledge transfer, such as complying with regulations, which need to be accounted for in empirical studies.

The fourth approach examines knowledge transfer between firms using patent citations (Almeida & Kogut, 1999; Rosenkopf & Almeida, 2003; Song et al., 2003; Agarwal, Ganco, & Ziedonis, 2009; Singh & Agrawal, 2011). Knowledge transfer is measured by the recipient's patents citing the source's patents. Patent citations allow many characteristics of the knowledge transferred to be identified, including the patent's inventors and their location, organizational assignee, and date of application. Patent data also have the advantage of being accessible and being continually improved in quality for research purposes.

Tracking knowledge transfer with patent data, however, has limitations, the greatest being whether a patent citation theoretically captures knowledge transfer. The U.S. Patent Office requires that a patent application include: "A paragraph(s) describing to the extent practical the state of the prior art or other information disclosed known to

the applicant, including references to specific prior art or other information where appropriate” (Manual of Patent Examining Procedure, 2014). If the patent examiner finds that the inventors have omitted references to other patents, the examiner adds the references. Alcacer and Gittleman (2006) raised questions about how these examiner-added patent citations affect measures of knowledge flows. Studies have found that examiners systematically differ from inventors on the types of citations added, with examiners adding many more technically similar citations than inventors (Alcacer & Gittelman, 2006). Since 2001, the USPTO has marked examiner citations, which can then be excluded from analyses on knowledge transfer to examine the robustness of results.

Several new developments hold promise for advancing the measurement of knowledge transfer in organizations. First, social media such as blogs, question and answer forums, and online communities are increasingly being used in organizations (Bughin & Chui, 2013). The communication traces from social media could be mined to determine if knowledge transfer occurred—at least for explicit knowledge that is transferred through communication traces. This is already being done to identify expertise of members. Zhang, Ackerman, and Adamic (2007) found that expertise rankings based on the number of answers in an online knowledge-sharing community correlated very highly with expertise ratings provided by humans. Mining online communication for evidence of knowledge transfer has the advantage of being unobtrusive. Such a technique is most likely to be useful in contexts where a significant amount of explicit knowledge is exchanged online and as a complement to other measures.

Although social media and other data generated from improved text recognition technologies allow us to observe precise patterns of communication across many new contexts, ensuring that we are measuring knowledge transfer is an important issue. One could observe a particular piece of knowledge used in different organizational units, but the knowledge could have been developed independently by the units. Identifying a mechanism through which one unit received knowledge from another helps to mitigate this concern.

Although analyzing communication provides information about what individuals say, analyzing what individuals do would also be very valuable. Actions reflect tacit as well as explicit knowledge. A method that holds promise in this area is filming what transpires in public areas of social contexts to capture changes in actions. The recordings would provide a wealth of information that could be mined to identify changes in recurring actions of organization members as well as in other areas such as the lay-out of work. Smets, Burke, Jarzabkowski, and Spee (2014) discussed the benefits and limitations of conducting organizational research using video ethnography and concluded that the limitations are dwarfed by the benefits.

Developments in social and cognitive neuroscience (Senior, Lee, & Butler, 2011) show potential for advancing the measurement of knowledge transfer. Physiological techniques such as functional magnetic resonance imaging or f(MRI) have advanced our understanding of individual learning and knowledge transfer (e.g., see Walsh & Anderson, 2011). In order to use these new tools to study knowledge transfer across social units, the tools would have to be adapted to study larger collectives. Methods for aggregating from individuals to collectives would also need to be developed.

Although we see potential for developing new measures of knowledge transfer with desirable properties, these developments are in early stages. Considerable work is needed to determine their usefulness in measuring knowledge transfer and the strengths and weaknesses of the various measures. In addition, while issues of informed consent and protecting privacy are important in all research, new questions arise with these new developments that require careful thought.

Future Directions

We see several promising directions for future research on knowledge transfer. The first direction is to deepen our understanding of knowledge transfer by elaborating our understanding of issues currently being addressed and resolving anomalies or puzzles in the literature. In addition to solving puzzles in the literature already discussed, we recommend refining the characterization of knowledge repositories, deepening understanding of the relationship between learning from direct experience and learning from the experience of others, and improving our understanding of how relevant knowledge is identified. The second direction is to apply our understanding of knowledge transfer to advance the analysis of other phenomena, including organizational form, entrepreneurship, and strategic management.

Dimensions of Knowledge Repositories

Although considerable progress has been made in characterizing dimensions of the social or member-member network, less progress has been made in characterizing the other knowledge networks. For example, dimensions of social networks include their density, the ratio of the number of actual ties to the number of potential ties, and centrality, the extent to which relationships are more or less hierarchically distributed

(Freeman, 1979). Dimensions of social networks could be adapted to apply to other networks, new dimensions appropriate for the networks could be developed, and the effects of the new dimensions could be investigated.

Direct versus Indirect Experience

An area that would benefit from additional research is the relationship between learning from one's own experience and learning from the experience of other units or knowledge transfer. Several studies have found that direct experience and indirect experience complement each other: direct experience enabled teams to make better use of experience of other units (e.g., Bresman, 2010). Other studies have found that direct experience and indirect experience substitute for each other: learning from direct experience reduced the benefits of learning from indirect experience or knowledge transfer (Wong, 2004; Schwab, 2007). Similarly, Levine and Prietula (2012) suggested that organizational memory and learning from indirect experience can substitute for each other. Research is needed to identify the conditions under which learning from direct experience and learning from indirect experience complement each other and when they substitute for each other. Another related question that would benefit from future research is whether certain knowledge is best learned from direct experience and other knowledge is best learned through indirect experience or knowledge transfer.

Identification of Relevant Knowledge

Developing a deeper understanding of how organizational units identify relevant and applicable knowledge to transfer is a promising area of research. Research has been done on organizational search (e.g., see Katila & Ahuja, 2002) and on how social networks affect search (e.g., see Hansen, 1999). In addition, considerable research has

been done on “absorptive capacity” (Cohen & Levinthal, 1990), defined as the ability of an organization to recognize the value of external information, assimilate it, and apply it (see Volberda, Foss & Lyles, 2010, for a review).

We suggest that these macro approaches to identifying relevant knowledge would be complemented by research taking a micro approach. Research in psychology points to the importance of analogies for individuals to identify knowledge to import across boundaries (Gick & Holyoak, 1983; Gentner, 1983). By the use of analogy, lessons derived from one context can be applied to another. Researchers have begun to apply the concept of analogical reasoning to groups and organizations (Thompson, Gentner, & Loewenstein, 2000; Gavetti & Rivkin, 2005). For example, Dunbar (1995) examined the role of analogies in research teams and found that analogy use was more effective the more heterogeneous the knowledge backgrounds of the individuals. We encourage future research on factors that enable the identification of relevant knowledge through the use of analogical reasoning in organizations.

Knowledge Transfer and Organizational Form

Recent years have witnessed the growth of the “multi-unit organizational” form, such as franchises and chains (Greve & Baum, 2001). While once used primarily in industries such as hospitality and fast food, these multi-unit organizations have expanded into areas such as health care and education. The advent of new technologies such as additive manufacturing could make it feasible to use multi-unit organizations in manufacturing as well as service industries.

A major advantage of multi-unit organizations is that they facilitate knowledge transfer—both from the corporate office to the units and from one unit to another. Before

opening a new establishment, an owner typically is provided training as well as detailed information about work products, technologies, and routines by the corporate office. In addition, a prospective owner might be required to apprentice at another establishment to learn how to operate an establishment effectively. Further, representatives from the corporate office often visit units to identify new innovations and communicate those innovations to other units. Establishments also share developments among themselves, especially if they have a common owner (Darr et al., 1995), identity (Kane et al., 2005), or business strategy (Darr & Kurtzberg, 2000).

More research on the multi-unit organizational form is needed as it moves into new arenas such as education and health care, where the social consequences of performance are high, many tasks are not routine, and highly skilled workers are needed. Do multi-unit organizations enable knowledge transfer in these new domains? How do the different features of these new domains facilitate or impede knowledge transfer? Do organizations, such as schools or hospitals, which are part of multi-unit organizations, perform better than their counterparts that are single organizations? Research on multi-unit organizations in these new domains can enrich our understanding of knowledge transfer and have implications for the effective design of multi-unit organizations in these new domains.

Another emerging issue in the area of organizational form that would benefit from research is the effect of new technologies such as social media (e.g., blogs, forums) on knowledge transfer. Because a major function of organizational design is to facilitate information sharing and knowledge transfer (Galbraith, 1973; Burton, Obel, & Håkonsson, 2015), these new technologies have important implications for organizational

design, including which activities are performed inside organizations and which are handled externally, as well as implications for how activities are grouped within firms.

These new technologies enable more activities to be performed externally (Lakhani, Lifshitz-Assaf, & Tushman, 2013), which has significance for theory about which activities should be handled inside the firm and which should be handled through market transactions or hybrid arrangements. Williamson (1991) argued that activities high in transaction costs should be internalized within the firm. These new technologies change the costs of many transactions, enabling more of them to be performed externally. We need a greater understanding of the implications of these new technologies for knowledge transfer and firm performance, which in turn will have implications for organizational design.

Knowledge Transfer and Entrepreneurship

Interest in entrepreneurship research has expanded since the publication of Argote and Ingram in 2000. New firms lack direct experience of their own and are frequently resource-scarce in their early stages. Therefore, learning from the experience of others is central to their performance and survival prospects. The study of knowledge transfer can inform how entrepreneurs and their young firms are likely to grow and succeed (see Fahrenkopf and & Argote, 2015; Agarwal, Gambardella, & Olson, 2014).

Research in entrepreneurship has examined how founders' pre-entry experiences provide knowledge for their new firms (Sørensen & Fassiotto, 2011). Considerable evidence exists that spin-off firms, firms with founders who have prior experience in the same industry as their new firms, perform better than other de novo entrants (Agarwal, Echambadi, Franco, & Sarkar, 2004; Dahl & Sorenson, 2014; Klepper & Sleeper, 2005).

Further, progeny firms whose founders worked at higher quality parents have higher survival rates than progeny firms whose founders came from lower quality parents (Klepper 2002; Agarwal, Echambadi, Franco, & Sarkar 2004). Thus, spinoff founders benefit from the knowledge of their parent firms.

Prior firm experience before the start-up of new ventures has been found to influence their success. Carroll, Bigelow, Seidel, and Tsai (1996) found that de novo firms with preproduction experience performed better initially than de novo firms lacking experience or firms that came from other firms in related industries. Balasubramanian (2011) found that incumbents established more productive new plants than diversifying entrants, which established more productive new plants than de novo entrants. Further, the advantage of incumbents and diversifying entrants increased with the importance of “industry learning intensity,” the extent to which learning by doing was important in the industry. Balasubramanian (2011) concluded that the productivity differences between incumbent, diversifying, and de novo firms were due to learning subsequent to start up rather than to initial differences in productivity. That is, pre-production experience enhanced post-start-up learning.

Experience at small firms is especially valuable for founders of new firms. Small firms offer potential entrepreneurs knowledge related to a wider range of tasks than large firms as well as knowledge related to the management of small-sized organizations, both of which can be beneficial when founding new organizations. These benefits result in individuals with prior experience at small firms founding firms that perform better than firms founded by individuals with prior experience at larger firms, even when the

propensity of individuals interested in becoming entrepreneurs to join small firms is taken into account (Elfenbein et al., 2010; Sørensen & Phillips, 2011).

Several studies have aimed to identify the type of knowledge that founders transfer from their parent firms. Phillips (2002) examined knowledge transfer from parent to progeny law firms and found that such transfer enhanced the progeny's survival chances. Organizations formed by progeny who came from the same parent firm and occupied similar niches as their parents were more likely to survive than their counterparts lacking such characteristics. Phillips (2002) suggested that founders transferred routines from their parent firms to their new firms. Similarly, Wezel, Cattani, and Pennings (2006) examined when interfirm mobility transferred knowledge across organizational boundaries in the Dutch accounting industry. Findings indicated that transfer is greatest, as measured by the dissolution risk of the firm from which the individual left, when individuals move in collectives, when the receiving firms are young, and when the movements are between firms in the same geographic location.

We suggest that a transactive memory system is a potential mechanism to explain the findings that better outcomes are obtained when founders move in collectives to start new firms (see Phillips, 2002; Wezel et al., 2006; and Agarwal, Campbell, Franco, & Ganco, 2016). Because members of these new firms have worked together in the past, they have had opportunities to learn who is good at what and how to coordinate effectively. Further, because founders are the initial members of a new firm, the issue of their transactive memory system not fitting the recipient organization does not arise. Thus, founders can import a transactive memory system they developed at their previous firm to their new firm and thereby enhance the performance of the new firm.

The benefits founders could gain from a previously developed transactive memory system are consistent with how the backgrounds of founder teams relate to the performance of new firms. Agarwal et al. (2016) examined the performance of startups with founder teams made of individuals with varying performance levels as measured by prior earnings. The authors found that founder prior performance was positively related to the new venture's performance and that the positive relationship was mediated by the size and organizational experience of the founding team. That is, the effect of the founders' prior performance on the new firms' performance was explained in part by the organizational experience of the founding team.

Other researchers have suggested that founders transfer technologies to their new firms. Agarwal et al. (2004) found that progeny firms were endowed with different levels of technological and market know-how and that the extent of their know-how related to the amount available at their parent organizations at the time of the progeny firm's founding. Similarly, Klepper and Sleeper (2005) found that technologies pursued by spin-offs overlapped with those of their parent firms, which suggested that founders transferred knowledge of technologies to new firms. By contrast, Carroll, Bigelow, Seidel, and Tsai (1996) did not find evidence that founders transferred technologies from their parent firms to their new ventures.

As we move forward with research on entrepreneurship, it would be fruitful to understand the nature of the knowledge that is being transferred from parent to progeny firms. Researchers have suggested knowledge embedded in routines, technologies, and transactive memory systems as promising candidates to investigate. In addition, research is needed to identify the mechanism(s) explaining the empirical regularities that founders

who move in collectives form higher performing firms than founders who move solo and that spinoff firms perform better than other de novo entrants. More generally, research is needed to understand the conditions under which new entrepreneurial firms succeed and to understand the role of knowledge transfer in explaining their success.

Further work is also required to understand how founders shape the context in which initial employees or those hired into the newly formed firm draw on their prior knowledge. Beckman and Burton (2008) demonstrated that founders with diverse functional experience built more diverse teams than their homogeneous counterparts. By contrast, Dencker, Gruber, and Shah (2009) provided evidence that founders with diverse experiences fill their firms with less knowledge diversity. Their survey of entrepreneurs on their knowledge of industry, marketing and sales, and technical areas indicated that entrepreneurs' breadth of knowledge negatively influenced the number of employees hired. Both findings suggest that entrepreneurs use their prior knowledge in running their new firms, and that founders' knowledge shapes the knowledge requirements of their new firms. But, we need further investigation on the conditions that allow initial employees to serve as complements or supplements to the founders' prior experiences.

Empirical studies on who is hired into young firms show that entrepreneurs often fill their organizations with those who have experiences at organizations where the entrepreneur worked previously (Cheyre, Klepper, & Veloso, 2015). Experience in the same organization can facilitate the transfer of tacit knowledge into the firm and/or limit the breadth of knowledge accessible to the young organization. Beckman (2006) found that founders with more common experience were more likely to engage in exploitative learning than explorative learning. Understanding the implications of the tendency to

hire those with experiences in the same organization on knowledge transfer would advance knowledge about the performance of entrepreneurial firms as well as increase understanding of knowledge transfer.

Knowledge Transfer, Innovation, Competitive Advantage, and Strategy

We encourage research on innovation to recognize organizational learning and knowledge transfer as important mechanisms through which innovations develop and spread. Further, we suggest that innovations developed through these mechanisms are especially likely to convey competitive advantage.

For example, consider the innovations developed at the pizza stores studied by Darr et al. (1995). The innovations were developed through learning by doing at particular stores as employees tried to find solutions to problems they were experiencing. These innovations contrast with innovations designed to solve more general problems, such as new farming methods to improve crop yield or ATM machines to automatically dispense cash. The latter innovations can increase productivity but given their widespread use, they are not likely to be a source of competitive advantage (unless the organization figures out a unique way of using the practice or the technology that is hard for competitors to copy). By contrast, firms that are able to develop solutions to the challenges they are facing and transfer those solutions throughout their establishments have a competitive advantage over their counterparts.

Further, as Argote and Ingram (2000) argued, the configuration of an organization's knowledge repositories can be a source of competitive advantage for organizations. Argote and Ingram proposed that knowledge in the networks, such as routines and transactive memory systems, is challenging to move across contexts because

the networks have many components that have coevolved to fit the current context and, thus, whose compatibility with a different context would be problematic. Considerable evidence exists on the challenges of moving routines (e.g., Rivkin, 2000; Knott, 2003; Gupta et al., 2015) or transactive memory systems (Gino et al., 2010; Lewis, Kang, & Gillis, 2005; Lewis et al., 2007) across contexts. More research is needed to identify conditions that facilitate or impede the transfer of knowledge in the various repositories across social units.

Argote and Ingram also proposed that the networks involving members, such as transactive memory systems, play an especially important role in the competitive advantage of firms because knowledge in those networks transfers more easily within than between organizations. Argote and Ren (2012) developed further how embedding knowledge in transactive memory systems can be a source of competitive advantage for organizations. The authors argued that transactive memory systems develop from experience, are idiosyncratic to a particular organization, and are hard for competitors to imitate. Thus, transactive memory systems have characteristics that make them good candidates to be sources of competitive advantage for organizations. We have indirect evidence supporting the proposition that knowledge in the networks involving members is a source of competitive advantage, but more direct tests of the proposition are needed.

Conclusion

We have made significant progress in our understanding of knowledge transfer over the last fifteen years. We have a deeper understanding of how knowledge transfer occurs in organizations by modifying or moving their members, tasks, tools, and the networks of members, tasks, and tools. We also have more insight into how emotions,

identity, and motivation affect knowledge transfer. In addition to the fields of psychology, organizational behavior, and strategic management, where the initial work on knowledge transfer occurred, knowledge transfer is now being investigated by scholars in economics, human resource management, information systems, and operations management. Thus, our understanding of knowledge transfer has increased in both depth and breadth over the last fifteen years.

Argote and Ingram (2000) argued that knowledge transfer is an important mechanism for increasing the performance of recipient units, and we have more evidence of the performance-enhancing effects of knowledge transfer. Argote and Ingram (2000) also developed how the configuration of an organization's knowledge repositories can be a source of competitive advantage by both facilitating internal knowledge transfer and limiting external transfer. We have some evidence supporting their conjectures, but more research is needed on the conditions under which knowledge transfers across organizational units and on the characteristics of knowledge that is a source of competitive advantage.

Several other issues related to knowledge transfer would benefit from additional research, including developing dimensions of the various knowledge repositories, increasing understanding of the relationship between learning directly from a unit's own experience and transferring knowledge from another unit, and developing a deeper understanding of how units identify relevant knowledge to transfer. In addition, we have argued here that knowledge transfer has important implications for the success of entrepreneurial firms, for innovation, and for organizational form. We hope that this

article stimulates additional research on these important issues surrounding knowledge transfer in organizations.

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