Dynamically Integrating Knowledge in Teams:

Transforming Resources into Performance

Heidi K. Gardner,[1] Francesca Gino,[1] and Bradley R. Staats[2]

[1]*Harvard Business School, Harvard University*

[2]*Kenan-Flagler Business School, University of North Carolina at Chapel Hill*

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RUNNING HEAD: Dynamically Integrating Knowledge in Teams

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ABSTRACT

In knowledge-based environments, teams must develop a systematic approach to integrating knowledge resources throughout the course of projects in order to perform effectively. Yet, many teams fail to do so. Drawing on the resource-based view of the firm, we examine how teams can develop a *knowledge-integration capability* to dynamically integrate members' resources into higher performance. We distinguish among three sets of resources: relational, experiential, and structural, and propose that they differentially influence a team's knowledge-integration capability. We test our theoretical framework using data on knowledge workers in professional services, and discuss implications for research and practice.

Faced with a rapidly changing and competitive environment, many companies have turned to team-based approaches to build and maintain high performance and foster innovation (Gibson, Waller, Carpenter, & Conte, 2007; Gino, Argote, Miron-Spektor, & Todorova, 2010; Pearce & Ensley, 2004). Across a range of contexts, from consulting and product development to engineering and software services, work is delivered by fluid teams of knowledge workers who come together to execute a project before breaking up and moving on to the next project (Edmondson & Nembhard, 2009; Huckman, Staats, & Upton, 2009). Knowledge workers are individuals who process information rather than physical goods (Von Nordenflycht, 2010). In organizational contexts consisting of teams of knowledge workers, understanding firm performance involves examining *team* performance, since the organization's output is created through the execution of project teams (Haas & Hansen, 2007; Huckman & Staats, 2011).

These teams typically operate in dynamic contexts in which, to perform well, they must access and use each member's unique portfolio of resources. Although synergistic groups can outperform even extraordinary individuals (Laughlin, Bonner, & Miner, 2002), as noted by Hackman and Katz (2010:10), the likelihood of a group reaching its full potential "all depends on the degree to which the group has, and uses well, the full complement of resources that are required for exceptional performance."

Several lines of work in the academic literature about teams address this question of what it means for a group to use its resources well, including research on transactive memory in groups (Liang, Moreland & Argote, 1995; Austin, 2003; Lewis, 2004), the pooling of members' distributed knowledge (Stasser, Stewart, & Wittenbaum, 1995; Stewart & Stasser, 1995; Larson, Christensen, Abbot, & Franz, 1996), and the identification and sharing of members' functionally diverse or specialized knowledge (Drach-Zahavy & Somech, 2001; Bunderson & Sutcliffe,

2002; Bunderson, 2003). These different lines of research have provided important insights on how group members coordinate knowledge inputs and combine them into a collective outcome.

Yet, the meaning of "using [resources] well" differs depending on a team's task (Steiner, 1972; Kozlowski, Gully, Nason, & Smith, 1999; Carlile & Rebentisch, 2003). In many team tasks, particularly those undertaken by knowledge workers who have discretion about how to conduct their problem solving discussions (i.e., discretionary tasks, Steiner, 1972), using resources well is more than just a matter of identifying and then completing a transfer of members' disparate knowledge (e.g., as in the case of a team assembling the clues in a hidden profile task). Rather, as Kozlowski et al. (1999) theorize, teams undertaking complex, rapidly changing work must integrate their members' knowledge in an ongoing process of mutual adjustment as their work is taking place, in order to be successful (Thompson, 1967; Van de Ven, Delbecq, & Koenig, 1976). It is therefore especially important for such teams to develop a systematic approach to integrating knowledge inputs that allows them to do so consistently throughout the course of the project; neither ad hoc problem solving nor unsystematic team communication is sufficient to provide the reliability required in this situation. As rich as the teams' literature is regarding the identification and transfer of members' knowledge, it is surprisingly silent about the way in which teams systematically integrate members' knowledge resources and do so dynamically in response to changing contextual features.

To delve into these questions, we draw on a literature from the field of strategy that traditionally has been used to understand how *firms* employ resources to generate superior performance: the resource-based view (RBV) of the firm (Barney, 1991; Wernerfelt, 1984). Strategic management research has highlighted the importance for firms to develop internal capabilities, and has demonstrated that internal firm capabilities are a key differentiator between

firms that succeed and those that do not (Helfat & Peteraf, 2003; Nelson & Winter, 1982). Within the RBV literature, a stream of research focusing on firms' development of dynamic capabilities is particularly instructive for understanding processes used to integrate resources for enhanced performance. Specifically, *dynamic* capabilities are learned, repeatable patterns of actions that provide a systematic ability to integrate resources to enhance performance (Teece, Pisano, & Shuen, 1997; Zollo & Winter, 2002; Eisenhardt & Martin, 2000). We bring the RBV perspective and the construct of dynamic capabilities from the firm level to the team level. We propose that by doing so, we can begin to resolve an important theoretical puzzle in the teams' literature: why do some teams fail to use their members' knowledge resources effectively? We argue that the answer lies in the failure of some teams to build a *knowledge-integration capability*, which we define as *a reliable pattern of team communication that generates joint contributions to the understanding of complex problems*.

Therefore, this paper examines how the development of a knowledge-integration capability allows some teams to convert members' knowledge resources into higher performance while others fail to develop this capability and leave resources untapped. Drawing from Kogut and Zander (1992), we distinguish among three sets of resources: relational (intra-team familiarity), experiential (collective work experience and training) and structural (how relational and experiential resources are distributed across team members). We develop theory to explain how these knowledge resources within a team are associated with the development of its knowledge-integration capability, which is necessary for teams to reach and sustain high levels of performance. We also explore how this development varies with task uncertainty. We test our predictions using a combination of archival and longitudinal survey data of 79 audit and consulting teams from a global Big Four accounting firm.

Our theoretical model allows us to answer two important questions. The first relates to the understanding of why teams differ in their ability to convert member knowledge and expertise into performance. The second question examines the types of resources that facilitate the development of a knowledge integration capability and one condition (uncertainty) that may influence it. In answering these questions, we advance theory in both strategic management and teams' research. With respect to the former, we offer micro-level detail on the structuring and integration of knowledge-based resources. We identify one dynamic capability, a team's knowledge-integration capability, and investigate what factors aid in its development and how it is associated with team performance. We also offer insight on how and where to deploy resources most effectively in teams and give guidance to management practice about the types of resource portfolios to build, finding that resources can be a double-edged sword whereby some knowledge resources improve performance while others may diminish it.

With respect to research on teams, we build on a growing body of work that examines why some groups are more effective than others (Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Hackman & Katz, 2010) by exploring teams' capacity to develop dynamic capabilities for systematic, reliable knowledge integration. We examine how not only the amount of team resources but also their configuration relates to the development of teams' knowledge-integration capability and ultimately team performance. Additionally, we examine an important moderating variable, task uncertainty, and explore how it corresponds to a team's ability to integrate knowledge. Thus, by integrating a teams and a strategy perspective, our paper develops a theoretical framework within which future investigations of knowledge-based teamwork and team performance can be pursued more fruitfully and systematically.

KNOWLEDGE UTILIZATION IN TEAMS

The question of how teams use knowledge-based resources to achieve high levels of performance is not new in the literature. Indeed, three well-developed streams of research address how team members can leverage their knowledge stores to improve performance outcomes: work on transactive memory systems (TMS), information pooling, and functional diversity. The transactive memory approach, grounded in the work of Wegner and colleagues (Wegner, 1986; Wegner, Erber, & Raymond, 1991), proposes that a shared knowledge system emerges in groups for learning, storing, and retrieving information. This system facilitates group performance by providing a guideline for matching member knowledge to group tasks, as demonstrated both in the lab (Liang, Moreland, & Argote, 1995; Littlepage, Robinson, & Reddington, 1997; Lewis, Lange, & Gillis, 2005) and in organizational settings (Austin, 2003; Lewis, 2003). Research finds that members' level of task knowledge and intra-team shared task experiences are antecedents to the development of TMS (Austin, 2003; Lewis, 2003), and that communication is a key factor in the development of a team's transactive memory (Lewis, 2004). Once developed, group members engage in three key communication practices to utilize the system: directory updating (learning what others know), allocating information to deemed experts, and retrieving information from them (Hollingshead, 1998).

The information-pooling approach examines information exchange during team interactions; group discussions are framed as the means by which groups exchange unshared information (Stasser, Taylor, & Hanna, 1989). Two central findings in this area have emerged: (1) teams favor information that is shared (commonly held) over information that is unshared (uniquely held), thereby harming performance (Stasser & Titus, 1985; 1987; Stasser et al., 1989), and (2) team members' preferences are shaped more by more frequently discussed information

(Stasser, Stella, Hanna, & Colella, 1984). These dynamics are impacted by many factors, such as group size (Stasser et al., 1989), member familiarity (Gruenfeld, Mannix, Williams, & Neale, 1996), and affectivity (Kooij-de Bode, van Knippenberg, & van Ginkel, 2010).

Work on functional diversity examines the distribution of team members across a variety of functional categories and how these differences facilitate or hinder team interactions as teams pursue their objectives (Bunderson & Sutcliffe, 2002; Drach-Zahavy & Somech, 2001). Empirical work in this area related to the use of team knowledge focuses on team member efforts to share information and keep each other current on key issues (Bunderson & Sutcliffe, 2002; Cummings, 2004; Huckman & Staats, 2011). Individual members who have a broad functional background tend to be motivated to share knowledge because they understand its value to the whole task and believe teammates will accept it; in contrast, if each team member is a deep specialist whose knowledge does not overlap with that of others, knowledge sharing is more likely to suffer (Cronin & Weingart, 2007).

These three streams of research on the link between leveraging teams' knowledge resources and team performance support three clear conclusions: (1) group performance and decision quality improve when members possess the right type and level of task knowledge, (2) outcomes are better when team members are aware of the knowledge others hold, and (3) the distribution of knowledge resources within teams affects their ability to share and pool information from different members. Together, these findings parallel the view in the dynamic capabilities literature, detailed below, that experiential, relational, and structural knowledge resources are critical for performance.

Yet, these findings also highlight two implications that warrant further examination. First, even after overcoming the difficulties of sharing knowledge, teams vary in their abilities to use

member knowledge to solve problems or make better decisions (Hackman & Katz, 2010). While we know a great deal about whether information will be shared (Drach-Zahavy & Somech, 2001; Bunderson & Sutcliffe, 2002) and to some degree whether it will be accessed and pooled into a joint outcome (Stasser & Titus, 1985; 1987; Stasser et al., 1989), we know far less about teams' ability to integrate and transform knowledge into novel solutions to address complex problems.

Second, for teams facing a project that extends over a long time, the process of integrating members' knowledge is more than just a matter of identifying and then completing a one-time transfer. Instead, it requires team members to engage in ongoing mutual readjustments (Kozlowski et al., 1999; Zollo & Winter, 2002). Especially when operating in dynamic and uncertain environments, teams must develop a systematic approach for consistently integrating members' knowledge throughout the project's duration; ad hoc problem solving is inadequate to provide the necessary reliability. Important questions arise from these implications: Why are some teams better than others at converting member knowledge and expertise into performance, especially on lengthy, complex tasks? What types of resources facilitate knowledge integration and under what conditions will teams be more or less effective at knowledge integration?

These questions become especially critical as we move our studies from ad hoc groups facing discrete, short-term tasks in lab settings to intact groups in today's organizations, where teams must continually adapt and readapt to a barrage of shifting demands. Each of the teams' literature streams reviewed above offers an important piece to explain how teams work together to solve complex problems. Yet, prior work has not provided a conceptualization and measure of a team-based capability that captures a team's ability to reliably integrate its knowledge resources over time—a capability that allows teams to reach high levels of performance. Nor has it developed a framework for theorizing how contextual demands such as task uncertainty affect

this capability. We address both theoretical gaps in this paper by drawing on the strategy literature on dynamic capabilities and the resource-based view of the firm.

THEORETHICAL MODEL AND HYPOTHESES

The RBV of the firm perspective explores how *firms* develop reliable ways to integrate knowledge resources to generate superior performance, even when facing uncertain contexts. It suggests that organizations are made up of unique combinations of heterogeneous resources (Wernerfelt, 1984) used to construct or alter capabilities in order to create value (Nelson & Winter, 1982; Barney, 1991; Sirmon, Hitt, & Ireland, 2007). Beyond merely possessing resources, it is firms' ability to deploy them productively that transforms the resources into valuable capabilities (Teece, Pisano, & Shuen, 1997). While RBV and capability-building are both traditionally conceptualized as organization-level phenomena, at the core of each are individuals, nested in groups (e.g., teams or departments), who are responsible for executing activities (Argote & Ingram, 2000; Helfat & Peteraf, 2003). We therefore suggest that the concepts of RBV extend to the level of the team: just as an organization needs to strategically leverage its resources, a team must use members' experiences and expertise to deliver project outcomes.

Our investigation focuses on knowledge resources because knowledge is the most critical competitive asset that a firm can possess (Grant, 1996). Drawing on Kogut and Zander's (1992) work on knowledge of the firm, we examine three classes of team knowledge resources: *relational*, *experiential*, and *structural*. A team's *relational* resource captures individuals' prior shared work experience, or knowledge acquired by working together on the same team (Espinosa, Slaughter, Kraut, & Herbsleb, 2007; Huckman et al., 2009). A team's *experiential* resource measures team members' know-how, defined as "the accumulated practical skill or

expertise that allows one to do something smoothly and efficiently" (von Hippel, 1988: 6). For instance, individuals' industry and firm experience and their work-related training contribute to a team's experiential resource. Finally, not only does the level of a resource matter, but so too does its *structure* within the team (Kogut & Zander, 1992; Dierickx & Cool, 1989; Teece et al., 1997). Here, we consider the distribution of relational and experiential resources across the team (the extent to which each resource is concentrated within a small number of members or distributed more evenly within the team).

While assembling resources is a necessary first step in generating team performance, resources must then be converted into a valuable capability—a process known in the RBV of the firm literature as *bundling* or *integration* (Sirmon et al., 2007; Sirmon, Gove, & Hitt, 2008; Sirmon & Hitt, 2009). Integrating of resources is inherently a challenge in coordination (Adner & Helfat, 2003; Helfat & Peteraf, 2003), which is not a static exercise. Rather, successful performance depends on continuous integration as circumstances change—a *knowledge-integration capability* (Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002).

We use the term "dynamic knowledge-integration capability" for teams to refer to a reliable pattern of team communication that generates joint contributions to the understanding of complex problems within a team. Having communications at the heart of our construct is consistent with prior RBV literature, which asserts that communication is an essential, generalizable feature of most dynamic capabilities (Eisenhardt & Martin, 2000). Translating the definition from the RBV of the firm to the group level implies that a team dynamic knowledge-integration capability involves three interrelated aspects. First, existing research suggests that team communications *reliably* produce better results to the extent that they are efficient and do not overwhelm, confuse, or distract the receiver (Cronin & Weingart, 2007). Therefore,

communications between team members need to be concise, timely, and in the right amount (Apker, Propp, Zabava Ford, & Hofmeister, 2006). Second, studies examining factors that enable teams to capture the best ideas and inputs across members—that is, to produce truly *joint contributions*—suggest that team interactions need to support members' participation and foster teamwork (Edmondson, 1999) rather than encouraging political or motivated knowledge sharing (Wittenbaum, Hollingshead & Botero, 2004). Such collaborative interactions promote rich, unemotional debate instead of confrontations that can undermine members' willingness to express doubts or accept others' opinions (Kozlowski et al., 1999). Third, recombining existing knowledge to *solve complex problems* requires teams to communicate content that is relevant, objective, and clear so that members can see the validity of their own and others' contributions, allowing them to discuss, evaluate, and apply ideas *(*Bunderson & Sutcliffe, 2002; Hoegl & Gemuenden, 2001).

In short, the dynamic capabilities literature provides a foundational definition for team knowledge-integration capability while small groups research suggests that the characteristics of efficiency, collaborativeness, and validity are all essential components of that capability. Thus, although strategy research falls short in giving scholars clear guidance on how best to measure a firm-level capability, small group research provides insight on the dimensions most critical for developing a measure of team knowledge-integration capability.

Team Knowledge Resources and Team Knowledge-Integration Capability

The extent to which team members have worked with one another in the past and are thus familiar with one another (i.e., relational resources) has been shown to improve general team performance (Goodman & Leyden, 1991; Reagans, Argote, & Brooks, 2005; Espinosa et al., 2007; Staats 2011). We propose that enhancing the knowledge-integration capability within a

team corresponds to better performance. Relational resources can help team members improve the validity, efficiency, and collaborativeness of their ongoing communication, thereby enhancing knowledge integration.

First, higher levels of team relational resources enhance the perceived validity of intra-team communication by shaping the cognitive structures of team members. More familiar group members engage in greater perspective-taking (Krauss & Fussell, 1990), developing a more accurate and complete understanding of what their teammates need to move forward on a task. This process is enhanced when an individual possesses an awareness of what her team members do and do not know (Moreland & Myaskovsky, 2000). In such a case, team members familiar with one another are likely to deliver content well tailored to their audience, who will perceive the communication as more valid, relevant, and clear than it would be otherwise.

Greater relational resources also can improve the efficiency with which members integrate knowledge. Group members who work together are more likely to develop a shared vocabulary (Monteverde, 1995; Cramton, 2001) that enables them to understand one another and exchange information efficiently. A shared vocabulary and other sources of common ground or mutual knowledge that arise from shared experience (Krauss & Fussell, 1990) increase the likelihood that knowledge integration will be effective (Clark & Marshall, 1981). By working with each other over time, group members learn who has what expertise (e.g., Hollingshead, 1998; Lewis, 2004) and how much information they need to retrieve and provide in a given situation. These repeated experiences are valuable for the ongoing sharing and adaptation that knowledge integration requires (Hansen, 1999).

Finally, greater relational resources improve the collaborativeness of group communications, enabling more widespread participation and joint problem solving. As group

members increasingly interact, they develop shared beliefs that directly influence trust (Gruenfeld et al., 1996). In fact, team members are more likely to trust knowledge shared by known team members than that offered by unknown ones (Gruenfeld, Martorana & Fan, 2000; Kane, Argote, & Levine, 2005). Once trust is in place, group members are more willing to take risks (Edmondson, 1999), and knowledge integration improves as ideas are shared more freely and openly (Dirks, 1999; Zand, 1972). Thus, we hypothesize the following:

> *Hypothesis 1: A team's relational resources will be positively associated with a team's knowledge-integration capability.*

In addition to relational resources built through team members' previous work with one another, a second important knowledge resource that teams can access is their members' accumulated work expertise, or know-how. As noted by Kogut and Zander (1992), such knowledge is not strategically valuable by itself, but rather gains value when combined through capabilities that permit the creation of new knowledge. Team experiential resources are linked to both firm (e.g., Dimov & Shepherd, 2005; Zarutskie, 2010) and team performance (Gardner, 2009). These resources are especially critical in the context of knowledge-intensive organizations such as professional service firms, where most of the firm's knowledge resources reside in their employees (Von Nordenflycht, 2010; Hitt, Bierman, Uhlenbruk, & Shimizu, 2006).

Greater experiential resources should aid knowledge integration for several reasons. First, greater work experience is likely to increase a team member's knowledge of relevant topics, thereby improving the relevance, clarity, and accuracy of the individual's knowledge (Schmidt, Hunter, & Outerbridge, 1986), as well as the efficiency with which it can be exchanged. Team members may also be able to draw on past models of knowledge integration from their own previous projects in creative ways that benefit the overall information processing of the current group (Littlepage et al., 1997; Reagans et al., 2005). With greater prior work experience, team

members should also be more confident about the validity of their own and others' contributions, motivating them to share knowledge freely (Bunderson & Sutcliffe, 2002).

Further, the more work experiences team members have, the more likely that at least some of those experiences will resemble those of other team members, enabling them to develop a compatible set of expectations about projects, clients, situations, and so forth (Cronin & Weingart, 2007). In other words, even if team members have not worked directly with one another, greater separate work experience on similar projects will allow members to generate a compatible knowledge base, improving collaborativeness and thus aiding their knowledge-integration capability (Bunderson & Sutcliffe, 2003). Thus, we predict:

> *Hypothesis 2: A team's experiential resources will be positively associated with a team's knowledge integration capability.*

While the levels of both relational and experiential resources within a team affect development of the knowledge-integration capability, so too does the structure of a resource (Kogut & Zander, 1992; Dierickx & Cool, 1989; Teece et al., 1997; Sparrowe, Liden, Wayne, & Kraimer, 2001; Staats, Valentine & Edmondson, 2011). In other words, we suggest that how a team's relational and experiential resources are distributed across the team can have important implications for the team.

We first examine the consequences of the distribution of relational resources across a team. Relational resources enable members to successfully locate knowledge within a group, share their knowledge, and respond to others' knowledge (Edmondson, 1999; Gruenfeld et al., 1996; Lewis et al., 2005). Therefore, when relational resources are distributed more broadly across dyads, holding the aggregate level of relational resources constant, these collaborative benefits are more likely. In contrast, when relational resources are concentrated within a small number of team members, the broader group is likely to have difficulty efficiently and

effectively integrating its knowledge because of unshared beliefs and information. This idea is consistent with research on faultlines in teams that finds that the presence of concentrated subgroups within a team can hamper team processes (Lau & Murnighan, 1998; 2005). Concentrated relational resources in a team may also lead to inefficient help-seeking, since familiar members may be comfortable talking only to small subsets of team members whom they know and trust but not with other members whose knowledge may be equally important to the task (Hofmann, Lei, & Grant, 2009).

Research on social networks also supports the view that distributed relational resources may be especially valuable for a team (Reagans & Zuckerman, 2001). If relational resources are widely distributed across an intra-team network, then network density or social closure may improve both trust and information exchange (Portes & Sensenbrenner, 1993; Coleman, 1988). Thus, we propose the following hypothesis:

> *Hypothesis 3a: Distributed relational resources within a team will be positively associated with a team's knowledge-integration capability.*

Next, we turn to the distribution of experiential resources within a team. The question is whether teams benefit more from having their work experience concentrated within a small number of members, or if widely distributed experience (holding constant the amount of experience) is more beneficial for maximizing knowledge integration.

Broader distribution of experiential resources is likely to undermine the efficiency of team communication, thereby impeding the development of a knowledge-integration capability. Teams need clear direction to coordinate the integration of members' knowledge inputs (Hackman, 2002). People are most likely to take direction from those they perceive as having legitimate task knowledge (Lewis, 2004), and work experience is an important source of legitimacy in most task settings. It follows that having experiential resources more concentrated

within a few team members will provide the team with a more streamlined set of directions and thereby enhance the efficiency of their communications.

In addition, wide resource distribution generally diminishes both the collaborativeness and validity (i.e., perceived relevance and objectivity) of team communications. At the extreme, completely distributed experiential resources in a team imply that all members have the same level of work experience. Without clear differences in their levels of experience, team members may engage in direct rivalries for dominance over the group's process and output, reducing information exchange and collaboration (Hambrick, 1994; Bendersky & Hays 2011). Further, group members' level of work experience is likely to intertwine with their egos and identity (Polzer, Milton & Swann, 2002), such that task debates may escalate into unproductive conflicts in which participants' egos are at stake (Jehn & Mannix, 2001), leading people to strategically manipulate their knowledge sharing and use (Wittenbaum, Hollingshead & Botero, 2004). The more team members vie for influence or dominance in a team, the less likely others will be to believe that their communication is unbiased and objective. Thus, the more evenly experiential resources are distributed across a team, the more likely that competitive dynamics will undermine collaboration and the validity of team communication, and disrupt team knowledge-integration capability. We therefore predict the following:

> *Hypothesis 3b: Distributed experiential resources within a team will be negatively associated with a team's knowledge-integration capability.*

The Moderating Role of Uncertainty on the Link between Resources and Knowledge-Integration Capability

Teams increasingly work in turbulent, unpredictable environments (Kozlowski et al., 1999). Both the external environment and the internal team context can create uncertainty about

a team's task, including the nature of individuals' work, the steps and knowledge required to complete their task, and even the demands of clients when expectations are shifting rapidly. Based on prior research, we define task uncertainty as members' incomplete information about the task they are facing (Argote, Turner, & Fichman, 1989; Galbraith, 1973). To integrate knowledge when teams are facing an uncertain task, it is essential for them to communicate openly and exchange information clearly and truthfully. In fact, when a team encounters uncertain tasks, even the steps needed to reach an outcome may not be clear; thus, team members must exchange adequate and appropriate information to minimize wasted time, openly reveal their preferences to avoid conflict over work assignments, and concisely convey their plan of action and check in with other team members to avoid duplication.

We posit that relational resources will have a stronger positive association with teams' knowledge-integration capability under more uncertain task conditions. Teams that have prior experience working together have developed more accurate expectations about each other's knowledge (Mathieu, Goodwin, Heffner, Salas, & Cannon-Bowers, 2000; Rentsch & Hall, 1994). We expect that this certainty about team members makes teams less anxious when facing uncertainty about a task. Task uncertainty is a source of arousal; people feel tense and stressed when uncertain about a task, and respond in ways consistent with threat rigidity predictions (Argote et al., 1989), including reduced cognitive functioning and constricted control (Staw, Sandelands, & Dutton, 1981). These threats impede knowledge integration by reducing information sharing, reducing discussion of shared information, and concentrating influence over decision-making (Argote et al., 1989; Gladstein & Reilly, 1985). Even if teams do experience arousal resulting from task uncertainty, relational resources may counter these tendencies that would otherwise disrupt knowledge integration. Prior research has shown that more familiar

groups display disinhibition, or gradual nonconformity to behavioral norms and expectations (Orengo Castellá, Zornoza, Prieto Alonso, & Peiró Silla, 2000), and that strong interpersonal relations make members more willing to behave in ways inconsistent with a traditional status hierarchy (Leik, 1963). In teams with greater relational resources, therefore, members may feel more comfortable resisting the constriction of control that naturally happens under uncertainty. Thus, we expect teams in organizational settings to be able to draw on their relational resources to integrate their knowledge more effectively in the face of uncertainty:

> *Hypothesis 4: Uncertainty moderates the relationship between a team's relational resources and knowledge-integration capability, such that the positive effect of relational resources is stronger under high uncertainty than under low uncertainty.*

While we hypothesize that relational resources help teams integrate their knowledge in the face of uncertainty, a dynamic capabilities perspective leads us to a different prediction for experiential resources. Namely, prior work finds that when organizations encounter changing and dynamic circumstances, prior experience may become a core rigidity or a competency trap (Levitt & March, 1988; Leonard-Barton, 1992). While uncertain circumstances require exploration to identify an appropriate and perhaps even new approach, experienced organizations may wrongly attempt to exploit only their existing knowledge (March, 1991; Teece et al., 1997).

Extending this line of thinking to the team level suggests that the level of experience may hurt, more than help, knowledge integration when teams face uncertain conditions. First, teams with higher levels of experience may be more set in their ways. Even though these teams have greater experience, when they face uncertain conditions they may be less likely to engage in knowledge integration instead of sticking to their existing routinized approach (Gersick & Hackman, 1990). Additionally, more experienced team members may escalate their commitment to their existing solutions, so that even if others attempt to engage in knowledge integration, the

overall climate for such behavior is poor.[1]

Based on this logic, we reason the following:

> *Hypothesis 5: Uncertainty moderates the relationship between a team's experiential resources and its knowledge-integration capability, such that the effects of experiential resources are less positive under high uncertainty than under low uncertainty.*

We also expect uncertainty to moderate the relationship between the distribution of relational resources in a team and the team's knowledge-integration capability. In particular, uncertainty is likely to correspond to an increase in the benefits of broadly distributed relational resources across a team. When facing uncertain tasks, team members need to rapidly and repeatedly draw on the knowledge of other team members, and distributed relational resources will enable efficient and effective integration across more linkages in the team. If only a subset of team members have worked with others in the past, it will be more difficult for all team members to communicate with one another when they particularly need to do so, and it will be harder to combat the anxiety and stress that task uncertainty tends to produce (Argote et al., 1989). When faced with uncertainty, teams need to seek help efficiently from others. But without widely distributed relational resources that aid in trust-building and information sharing (Coleman, 1988; Portes & Sensenbrenner, 1993), discussions to integrate knowledge may not occur or those discussions that do occur may be less effective because of unclear content or ill-timed and confrontational discussions. Thus, we hypothesize:

> *Hypothesis 6a: Uncertainty moderates the relationship between a team's distribution of relational resources and its knowledge-integration capability, such that the positive effect of distributed relational resources is stronger under high uncertainty than under low uncertainty.*

[1] An additional question is whether higher levels of experience represent increased diversity in underlying knowledge. Consistent with a dynamic capabilities perspective, with *levels* of experience we make the assumption that the *type* of experience is generally similar. Diversity in experience type could harm knowledge integration, due to process conflicts (Jehn, Northcraft, & Neale, 1999), or aid knowledge integration, due to alternative perspective taking that helps to break out of competency traps (e.g., Pelled, Eisenhardt, & Xin, 1999). While a valuable topic for future research, diversity in experience type is outside the bounds of our empirical examination.

We also expect uncertainty to moderate the relationship between the distribution of experiential resources in a team and the team's knowledge-integration capability. As posited above, distributed experiential resources undermine the efficiency of team communication by spreading responsibility for task direction, resulting in confusion about whose knowledge should hold most sway in the collective task and diminishing the team's knowledge-integration capability. Further, greater resource distribution inhibits the collaborativeness and validity of team communications. When a team is uncertain about its task, these negative effects on knowledge integration are likely to be even worse, because uncertainty demands efficient and ongoing information exchange (Galbraith, 1973). Thus, we hypothesize the following:

> *Hypothesis 6b: Uncertainty moderates the relationship between a team's distribution of experiential resources and its knowledge-integration capability, such that the negative association of distributed experience is stronger under high uncertainty than under low uncertainty.*

Team Knowledge-Integration Capability and Performance

Ongoing knowledge integration within teams can aid their performance (Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002). Effective knowledge integration improves team *efficiency* – it ensures that the right information is moving back and forth between the right team members at the right time so that they can solve the ongoing problems they encounter (Argote, 1999; Argote & Ingram, 2000). With a knowledge-integration capability, team members work *collaboratively* in a way that encourages ongoing, constructive dialogue so that the valuable resources within the team can be effectively utilized for team performance. Finally, when teams' integrate knowledge effectively they communicate information that is relevant, objective, and clear allowing team members to identify the *validity* of their own and others' contributions. This permits members to use one another's ideas to aid team performance

*(*Bunderson & Sutcliffe, 2002; Hoegl & Gemuenden, 2001). Thus, we hypothesize the following:

> *Hypothesis 7: A team's knowledge-integration capability will be positively associated with team performance.*

Moderated Mediation Model

Our full theoretical model is depicted in Figure 1. Hypotheses 1, 2, and 3 predict that relational, experiential, and structural resources are related to a team's knowledge-integration capability. Hypotheses 4, 5, and 6 predict that task uncertainty moderates the relationship between the resources the team possesses and its knowledge-integration capability. Hypothesis 7 predicts a positive relationship between knowledge-integration capability and performance. Together, these seven hypotheses specify a moderated mediation model (Edwards & Lambert, 2007) in which interaction between uncertainty and the three resources indirectly influence team performance by contributing to the knowledge-integration capability. Thus, we offer our final summary hypothesis:

> *Hypothesis 8: A team's knowledge-integration capability mediates the moderating effects of uncertainty in the relationship between the team's relational, experiential, and structural resources and team' performance.*

---------- Insert Figure 1 about here----------

Methods

The professional services sector is a rich setting that offers several benefits for our investigation into the relationship of resources, uncertainty, and knowledge integration with team performance. Managing knowledge work and workers is a primary competitive challenge in the 21st century (Haas & Hansen, 2007). Because knowledge is both the key input and key output in professional services firms, these firms are viewed as an archetype of a knowledge-intensive firm (Alvesson, 1993; Starbuck, 1992). And because the project team is the primary vehicle for conducting work in these firms (Werr & Stjernberg, 2003), it is important to examine these

phenomena at the team level.

Further, researching project teams in professional services firms offers practical benefits. For example, projects' duration (from team origination to project completion) is often limited to several months, thus offering a chance to follow teams through their entire lifecycle. These firms provide a rich, field-based context in which to examine the association of uncertainty with a team's ability to leverage its internal resources to produce successful performance outcomes.

Design Overview

Our overarching research design was intended to minimize issues of same-source bias to the greatest extent possible. To this end, we collected team process data from team members and contextual and performance data from partners who were responsible for the projects but uninvolved in day-to-day project work. We also collected data for constructing the independent and control variables from archived information.

Sample

We drew on a sample from the two largest divisions, audit and consulting, of a global, Big Four accounting firm that we will call "AuditCo." Our aim was to capture a sample that realistically would represent the range of tasks that AuditCo teams confront. The chief operating officer of AuditCo, our primary research contact for the project, and his office accordingly compiled an initial list of active project teams. We contacted teams from this list if they met certain logistical criteria (i.e., a project start date within an eight-week period, project duration of 3–16 weeks, and 3–10 full-time team members). Once we gained consent from the lead partner for each client team, we surveyed 722 individuals across 104 teams.

Individuals were considered to be part of a core project team only if they were employees of AuditCo and spent at least 50% of their time on the project. This definition therefore excludes

(1) most firm partners (whose typical daily workload includes at least two "live" projects as well as other responsibilities), (2) internal firm experts (e.g., practice specialists), (3) other firm support personnel (e.g., library researchers, secretaries), and (4) client employees who provided assistance to the team.

Measures

Two surveys were sent to each team member. Survey 1 included the relational resource and uncertainty variables and was sent within the team's first three days on the project. Survey 2, administered during the team's final week on the project, asked team members to rate the team's knowledge-integration capability. In general, people responded within four days of receiving the survey. Five hundred people answered both surveys. The response rate for Survey 1 was 82%, and 70% for Survey 2. Respondents were 66% male, with an average age of 30 and 4.7 years' experience working at AuditCo. These figures closely mirror the demographics of the overall firm, according to statistics provided by AuditCo's Human Resources Department.

For each participating team, we surveyed a senior partner who was responsible for the client relationship and ultimately for assessing the team's performance, but who had not been involved in day-to-day work of the team. This survey provided input on "team performance" and some control variables, and was collected within one month of the project's completion.

Analyses provide evidence that it is appropriate to aggregate the team-rated items (knowledge-integration capability, uncertainty, communication volume, and project demands) to the team level (Klein & Kozlowski, 2000): inter-rater agreement results showed that $R_{wg(j)}$ statistics exceed .80 for all variables, and inter-rater reliability results showed positive ICC(1) results with significant F values, $p<.05$. For uncertainty, relational resources, and experiential resources, we centered each variable prior to entering them in the models to facilitate

interpretation and minimize multicollinearity with the interaction terms (Aiken & West, 1991).

Knowledge-Integration Capability. Survey 2 asked team members to describe the exchanges of knowledge within their team using a seven-point scale that ranged from positive through neutral to negative. For example, the first item that respondents rated was: "Communications within our team were... Relevant – Neutral – Irrelevant." The survey items measure different dimensions of effective and efficient information sharing and high-quality intra-team communications that capture a team's knowledge-integration capability (Hoegl & Gemuenden, 2001; Leathers, 1972): relevance, timeliness, objectivity, clarity, supportiveness, conciseness, truthfulness, non-confrontational, adequacy, and fostering teamwork. Appendix 1 provides the exact wording of items used to assess each team's knowledge-integration capability. Factor analysis confirmed that all items loaded onto a single factor; therefore, we averaged responses to create a single score per team (α=.95). Mean $R_{wg(j)}$ was .93.

Team performance. The extent to which a team's output meets or exceeds its key stakeholders' standards is a core indicator of team effectiveness (Hackman & Walton, 1986). We used assessments from each project team's responsible partner as the basis for evaluating team performance. Using five-point agreement scales, each partner scored his/her team on four survey items: "The client was 100% satisfied with the outcome of this audit," "Based on their satisfaction with this year's audit, the client is very likely to recommend AuditCo to other companies," "The AuditCo team communicated effectively (i.e., in a timely, clear, concise, non-confrontational way) with the client throughout the audit [project] cycle," and "This team was excellent in communicating the value of the audit [project] to the client." Item scores were averaged to create a single score of team performance each team (α=.76).

Task uncertainty. Survey 1 directed team members to "Please answer the following

questions based on your individual assessment of the task." Following Van de Ven and Delbecq (1974), we used three items to measure task uncertainty, each of which was reverse coded: "There is a clearly defined body of knowledge or subject matter that I can use to guide my work on this particular client project," "I understand the sequence of steps that I can follow to complete this project," and "It is clear to me what the outcome of this project will look like." Responses were averaged to create a single score of task uncertainty per team (α=.75). Mean $R_{wg(j)}$ was .88.

Relational resources. To measure relational resources, prior work has relied on experimental methods (e.g., Littlepage et al., 1997) or archival data (e.g., Reagans et al., 2005). Given that the firm's archival data did not track relational resources, we constructed a survey to measure individuals' prior shared work experience. On Survey 1, all team members were given a roster of their teammates and asked to indicate how many months they had previously worked with each other member, using a five-point scale (1=no prior experience together; 2=<2 months; 3=2-6 months; 4=6–12 months; 5=more than one year). To create a team-level measure of relational resources, we averaged the responses across each reported dyadic relationship.

Experiential resources. To capture the experiential resources of each team, we used three indicators of team members' prior experience: organizational tenure, professional tenure (i.e., number of years in accounting for auditors, or in consulting for consultants) and level of professional/technical qualifications (i.e., level of technical certification/degree), consistent with prior research (e.g., Hitt et al., 2006).

In using this approach we capture the quantitative aspects of team members' prior experience (Quiñones, Ford, & Teachout, 1995; Tesluk & Jacobs, 1998); to capture multiple levels of specificity (e.g., organizational and job), we used both organizational and professional

tenure as a measure of an individual's experience with the organization and in the individual's specific job. This is a reasonable proxy in our setting as work is completed through projects that are, on average, of similar lengths. Because our teams consist of auditors or consultants who are not multi-functional, we assume that individuals' projects are of a similar type.

The three items were standardized separately by division and then averaged to create a composite score for each person. Team members completed these items as part of a larger set of demographic questions at the end of Survey 1. Team members' scores were averaged to create a team-level measure of experiential resources.

Distribution of relational resources. To measure within-team distribution of relational resources, we used the Blau index (Blau, 1977). This measure captures how prior experience working together between any two members in the team is spread across team members (Harrison & Klein, 2007). We calculate the index using the following formula, $1 - \sum_{i=1}^{n} p_i^2$, where p_i is an individual *i's* share of the team's relational resources score (i.e., the sum of the individual's dyadic values divided by the sum of the entire team's dyadic values) and *n* is equal to the team size. Thus, a team with concentrated relational resources (e.g., two workers with prior experience working together, while all other workers have no experience working together) would have a low value, while a team with distributed, or equal relational resources across all workers, would have a value of (n – 1) / n.

Distribution of experiential resources. We use the same approach to capture the distribution of experiential resources, substituting each team member's share of the team's experience for relational resources in the prior calculation. The interpretation of the variable is similar to before. A low value corresponds to concentrated experiential resources (e.g., one member with high experience working with a number of team members with low values of

experience), while a high value reveals that experiential resources are distributed more equally across team members. Although our measure of experiential resources does not directly capture the heterogeneity in knowledge across team members, studies at the individual level have found that experience and knowledge correlate (Schmidt et al., 1986; Tesluk & Jacobs, 1998); therefore, our measures of level of tenure and educational background should capture variation in individuals' underlying knowledge.

Control variables. We included four control variables in each model. First, because larger teams may have more trouble with knowledge integration (Hackman, 2002), we controlled for team size. Second, because communication frequency has a demonstrated effect on team performance (Patrashkova & McComb, 2004), we also controlled for the volume of communications. On Survey 2, respondents were asked to report how many times per week, on average, their team discussed the audit/project in person, by telephone, and via email; responses were averaged to the team level.

Third, because project work that is more demanding could require a greater knowledge-integration capability, we controlled for project demands. Partners were asked to rate the focal project as compared to the "average" AuditCo project on the following items using a five-point Likert scale: "This audit team has a more complex or technically challenging issue to address," "This audit requires more professional judgment (i.e., forming opinions, not just gathering facts)," and "This audit demands that the ideas of all team members be shared in order to succeed." Project demand items were averaged to create a single score per team (α=.70).

Finally, since some projects might be more important than others and thus garner more focused attention from team members, we asked partners to answer seven questions comparing the current project to the average AuditCo project using a five-point Likert scale. Questions

included: "This client is considered a 'high-profile' client within [*AuditCo*]," "Future engagements with this client depend on the client's satisfaction with this audit," and "This audit (and related recommendations in the management letter) will help shape the client's actions and agendas in a material way (e.g., to improve controls procedures, make performance improvements, or change/implement new systems)."

RESULTS

Table 1 presents means, standard deviations, and intercorrelations for all team-level variables. An inspection of the correlations reveals that relational resources are positively related to a team's knowledge-integration capability (r=0.29, p<0.05), whereas uncertainty is inversely related to a team's knowledge-integration capability (r=-0.33, p<0.05). In addition, a team's knowledge-integration capability is positively related to team performance (r=0.34, p<0.05). Results also indicate a lack of association between most of our covariates (specifically: team size, communications volume, and projects' demands) and team performance. Only project importance is significantly related to team performance (r=0.32, p<0.05).

---------- Insert Table 1 about here ----------

Resources and Knowledge-Integration Capability

To test our theoretical model depicted in Figure 1, we conducted ordinary least squares regressions with heteroskedasticity robust standard errors. The results of our analyses are summarized in Table 2. We start by examining the first-stage relationships: direct relationships of our independent variables with the knowledge-integration capability. Column 1 of Table 2 includes the uncertainty, resource, and control variables. As predicted by Hypothesis 1, the coefficient for relational resources is positive and significant (β=0.32, p<0.01). However, surprisingly, the coefficient on experiential resources is negative and significant (β=-0.40,

$p<0.001$), thus rejecting Hypothesis 2. We expand on this unexpected finding in the Discussion section below. Examining the structural resources of a team, we find support for our hypotheses as the coefficient for the distribution of relational resources is positive and significant ($\beta=0.89$, $p<0.05$) and the coefficient for the distribution of experiential resources is negative and significant ($\beta=-1.61$, $p<0.01$), supporting Hypotheses 3a and 3b, respectively. We also checked for curvilinearity of our independent variables and found no evidence of nonlinear relationships. Finally, we calculated variance inflation factors for all models to check for multicollinearity, and found all values to be below the recommended threshold of ten (Cohen et al., 2003).

---------- Insert Table 2 about here ----------

Uncertainty Moderation Analyses

In Column 2 of Table 2, we add the interaction terms to the model in order to test Hypotheses 4, 5, and 6—our moderation hypotheses. Consistent with Hypothesis 4, the coefficient for the interaction of relational resources and uncertainty is positive and significant ($\beta=0.59$, $p<0.05$). Using the approach of Preacher, Curran, and Bauer (2006) to examine and plot the interaction effect (see Column 1 in Table 3 and Figure 2), we find that relational resources are related to a greater knowledge-integration capability when uncertainty was high or at average values ($p<0.01$ in both cases), but were not associated with a greater knowledge-integration capability when uncertainty was low ($p=0.21$).

---------- Insert Figure 2 & Table 3 about here ----------

Shifting to the interaction of a team's experiential resources and uncertainty, we find that it is negative and significant ($\beta=-0.96$, $p<0.05$): higher team experiential resources relate to a lower knowledge-integration capability in the face of uncertainty, supporting Hypothesis 5. Again using the Preacher et al. (2006) approach (Column 2 of Table 3 and Figure 3), we find that

team experiential resources are related to less knowledge integration when uncertainty was high or at average values ($p<.001$ and $p<.01$ respectively), but were not associated with the knowledge-integration capability when uncertainty was low ($p=.51$).

---------- Insert Figure 3 about here ----------

Turning to teams' structural resources, we examine the coefficient for the interaction of the distribution of relational resources and uncertainty, finding it to be negative and significant ($\beta=-2.99$, $p<0.001$); thus Hypothesis 6a is not supported. While more evenly distributed relational resources are, on average, related to greater knowledge integration, we see no additional benefit when teams are faced with uncertain tasks, but instead find evidence for the opposite effect. The Preacher et al. (2006) analysis and plot (Column 3 of Table 3 and Figure 4) show that for low and average values of uncertainty, increasing the distribution of relational resources across team members is related to a greater knowledge-integration capability ($p<.001$ and $p<.01$, respectively). However, under conditions of high uncertainty, changing the distribution of relational resources in a team does not change the relationship to the knowledge-integration capability ($p=.61$). We note, however, that at very high levels of uncertainty—that is, for the top 4% of projects—there is a negative relationship with the knowledge-integration capability.

---------- Insert Figure 4 about here ----------

Regarding our last moderation hypothesis, we find that the coefficient for the interaction of the distribution of experiential resources and uncertainty is positive but not significant, thus failing to support Hypothesis 6b.

Team Performance Hypothesis

Hypothesis 7 predicted that knowledge-integration capability would positively relate to

team performance. As shown in Column 3 of Table 2, we find support for this hypothesis, as the coefficient for the knowledge-integration capability is positive and statistically significant. One standard deviation increase in the knowledge-integration capability relates to a 4.6% increase in team performance.

Moderated Mediation Hypothesis

Our theoretical model (see Figure 1) corresponds to moderated mediation, as the relationship of our relational, experiential, and structural resources with the mediator, knowledge-integration capability, is moderated by uncertainty, and the mediator is directly related to project performance. To test for moderated mediation, we follow the approach of Preacher, Rucker, and Hayes (2007) and used a bootstrap technique to test the magnitude of each indirect relationship at high and low values of the moderator (plus and minus one standard deviation, respectively). If the magnitude of the indirect relationship differs significantly from zero, then mediation has occurred.

We tested for moderated mediation separately for each of our four independent variables and for the moderator, uncertainty. The results for the indirect effects, reported in Table 4, support the moderated mediation hypothesis for relational resources, experiential resources, and the distribution of relational resources. Also, in Column 4 of Table 2, we include the interaction between knowledge-integration capability and uncertainty; the variable is not statistically significant. This finding is consistent with our theoretical model, which proposes that moderation occurs in the first stage, not the second (Edwards & Lambert, 2007). Together, these results support Hypothesis 8 and indicate that knowledge-integration capability mediates the moderating relationship of task uncertainty on relational and experiential resources, and the distribution of relational resources, but not the distribution of experiential resources with team performance.

---------- Insert Table 4 about here ----------

DISCUSSION

Using multi-source data concerning 79 client-facing project teams in a professional services firm, we find that both relational resources and the structure of those resources aid the development of teams' knowledge-integration capability, while both experiential resources and the structure of those resources detract from development of that capability. We also find that uncertainty plays an important moderating role in these relationships. Relational resources help teams develop their knowledge-integration capability in the face of uncertainty, although the structure of relational resources (i.e., their distribution within a team) only improves knowledge-integration capability under average and low uncertainty. In contrast, high experiential resources are related to a lower knowledge-integration capability in the face of uncertainty.

Our finding regarding the main association with experiential resources and a team's knowledge-integration capability is counter to our hypothesis. Although we had hypothesized that higher levels of experiential resources would aid in the development of teams' knowledge-integration capability, we found that they actually impeded such development. On reflection, we believe this result can be understood by considering the context of our study and our uncertainty moderation result. In particular, we predicted and found that the interaction of uncertainty with experiential resources would detract from knowledge-integration capability development. We motivated this hypothesis by using a dynamic capabilities perspective, arguing that experiential resources might lead to rigidities that inhibit the efficiency, collaborativeness, and validity of team members' communication. While some projects in our sample did encounter more uncertainty than others, and thus we found a significant interaction relationship, all project teams were operating in dynamic and uncertain environments. If our study had examined teams

executing simple procedural tasks, then our existing Hypothesis 2 might have been supported. However, since all teams faced uncertainty, it is possible that rigidities due to higher experiential resources inhibited teams on all projects in the study. Future work should investigate whether these relationships differ in varying settings (e.g., procedural tasks) and also examine ways in which teams facing uncertain tasks can overcome the possible problems of high levels of experiential resources.

The other unexpected result we found is that the distribution of relational resources is related to greater knowledge-integration capability development for teams facing low or medium levels of uncertainty, but not for teams facing high levels of uncertainty (and only for teams facing the highest 3% of uncertainty does it detract from capability development). It is possible that when conditions are highly uncertain, a smaller number of very deep dyadic relationships may be as effective as a greater number of more shallow dyadic relationships, holding the total relational resources constant (cf. Hansen, 1999). Future work should explore this hypothesis further and investigate underlying mechanisms.

Theoretical Contributions

Organizations increasingly deploy teams to deliver innovative outputs. However, these teams often fail to meet expectations because they are unable to capitalize on their resources (Ilgen et al., 2005; Hackman & Katz, 2010). Drawing from the firm-level RBV, we examined how teams can achieve high levels of performance by building a dynamic knowledge-integration capability. Specifically, we explored how different types of resources relate to the development of the capability, and how task uncertainty moderates this process. In so doing, we make several contributions to both the teams and strategy literatures.

First, with respect to teams' research, we build on a growing body of work that examines

why some groups are more effective than others (Ilgen et al., 2005; Hackman & Katz, 2010). In particular, we propose that a team knowledge-integration process is one key to this puzzle. Kozlowski et al. (1999) theorize that teams completing complex, rapidly changing work must integrate their knowledge in an ongoing process of mutual adjustment, while the work takes place, to be successful (Thompson, 1967; Van de Ven et al., 1976). Drawing on the strategy literature, we are able to conceptualize how this takes place—through the dynamic knowledge-integration capability—and then measure development of the capability as well as its association with team performance.

The capability perspective not only aids in gaining further understanding of knowledge integration, but by building on that perspective, we also offer a theoretical framework within which future investigations of knowledge-based teamwork and team performance can be pursued more fruitfully and systematically. Recent work on teams has underscored challenges with that literature's dominant research framework of Input-Process-Output (Marks, Mathieu & Zaccaro, 2001; Ilgen et al., 2005; Hackman & Katz, 2010). Proposed changes from this framework include modeling simultaneous I-P-O cycles as well as sequential cycles that note the direct linkages from output in one temporal episode to input in another. In addition to these important extensions, the focus in the capabilities literature on repeatability (e.g., Teece et al., 1997; Zollo & Winter, 2002; Sirmon et al., 2007) highlights not only that output can provide feedback loops to the next cycle's input (as in the IMOI model in Ilgen et al., 2005), but also that feedback loops may exist between the inputs and the processes. In other words, ongoing, repeated interactions shape team processes and eventually team performance. Our paper is a first step toward understanding how inputs and processes may interact. By explicitly modeling this feedback loop, team researchers can develop more nuanced and impactful theory.

Our study also contributes to the literature on teams by building on the growing body of work on relational resources and fluid teams (e.g., Reagans et al., 2005; Espinosa et al., 2007; Huckman et al., 2009). We find that relational resources not only are related to the development of the knowledge-integration capability, but also are particularly valuable in situations characterized by high uncertainty. Relational resources may help team members speak the same language (Monteverde, 1995; Cramton, 2001), develop a shared knowledge regarding who knows what (Lewis et al., 2005), and build interpersonal comfort in risk-taking (Gruenfeld et al., 1996; Edmondson, 1999). Future work should seek to examine these different mechanisms simultaneously to understand each one's relative contribution to our results.

Finally, while reviews of the teams' literature highlight the increasing uncertainty that teams encounter, they also note that little empirical work has directly studied uncertainty in the field (Kozlowski et al., 1999; Ilgen et al., 2005; Hackman & Katz, 2010). In this paper, we examine a dynamic, complex knowledge-work setting and directly measure task uncertainty. In so doing, we shed light on the important role uncertainty plays in the development of a knowledge-integration capability.

Second, our paper also contributes to work in the strategy field. Studies in strategic management increasingly focus on the micro-foundations of capability, the study of which also requires study of organizational members and their interactions (Argote & Ingram, 2000; Helfat, 2000). To avoid recreating the wheel, we must draw upon the wealth of relevant findings about organizational behavior. By grounding our study in the teams' literature, we are able to robustly measure one dynamic capability, thereby extending prior theoretical and qualitative work that has examined dynamic capabilities (e.g., Eisenhardt & Martin, 2000). With this approach, we can gain insight into the micro-factors shaping the development of a dynamic capability.

Our study offers guidance as to the types of resource portfolios to build, along with insight into how and where to deploy resources most effectively within a team. Early work in the RBV tradition focused attention on characteristics of the underlying resources (e.g., are they valuable, rare, inimitable, or non-substitutable?) and their relationship to creating competitive advantage (Barney, 1991). Subsequent work notes that performance is a function not merely of having resources, but rather of bundling and combining those resources (Teece et al., 1997; Eisenhardt & Martin, 2000; Sirmon et al., 2007). We support this latter perspective, finding that resources are related to bundling in non-obvious ways. We find that having resources is actually a double-edged sword: the need for combining resources, in our case through knowledge integration, means that depending on the resource, more might aid performance (e.g., relational resources) or harm it (e.g., experiential resources). Future work should continue to integrate research in strategic management and organizational behavior to increase our understanding of the complex ways in which various resources are transformed into performance.

Limitations and Future Directions

Several limitations of this work should be noted. The first concerns possible same-source bias. While we were able to use a separate evaluator for one dependent variable (i.e., a partner to evaluate team performance), the same individuals (i.e., team members) were used to evaluate both the knowledge integration capability of the team and the independent variables, uncertainty and relational resources. We chose to have team members evaluate the knowledge integration capability since they were closest to the project and in the best position to evaluate conversations' perceived quality; outsiders might interpret some of the quality as merely noisy signals. Additionally, we mitigated the risk of bias as much as possible by collecting the independent variables at the start of the project and our communication quality evaluation at the

project's end. Nevertheless, we cannot categorically rule out the possibility of bias.

Second, we restricted ourselves in this study to teams with a lifespan of several months, as opposed to several years. While we think this shorter time period matches the reality of many project-based organizations (Edmondson & Nembhard, 2009; Huckman et al., 2009) and offers a considerable advantage over the time periods captured in most lab-based studies, future work should explore these dynamics in teams that stay together for longer time periods. Third, taking our survey sample from a single firm raises questions of generalizability. The relatively large number of teams (N=79) and inclusion of both audit and consulting projects should ameliorate the issue to some degree. Nevertheless, future work should explore our findings both in other knowledge-intensive firms and across settings.

Fourth, we referred to several micro-processes in developing hypotheses about how resources that teams possess lead to knowledge-integration capability development. These micro-processes included both cognitive (e.g., ability to process information) and relational factors (e.g., interpersonal trust, social acceptance). Future research could examine in more detail relationships in our model by identifying specific micro-mediators that drive them (see Marks et al., 2001).

Fifth, our work focused inward on knowledge resources available to a team. However, team members regularly obtain information and acquire knowledge from outside sources. Further work could investigate the role of predictors and outcomes at both the individual and team levels, including behaviors such as boundary spanning (Ancona & Caldwell, 1990), which aids performance by complementing internal resources with those outside the team. In addition, we acknowledge that we have restricted our investigation to three types of resources that were demonstrated to be important to the domain of dynamic capabilities. Future researchers could

broaden the scope of this research model by including additional resources. Further, while we model structural resources by examining the concentration and distribution of such resources, additional insight may be gained by considering other configurations of resources within a team. Altogether, such investigation would deepen our understanding of how teams can effectively integrate knowledge resources and achieve high levels of performance.

Another limitation of our research is its focus on only one moderator for the relationship between relational, experiential, and structural resources and a team's knowledge-integration capability—namely, task uncertainty. Other moderators related to the nature of a project the team is working on, or situational factors that may impact the work (e.g., time pressure), are also certainly important, however. We hope our work will inspire future investigations into the effects of these and other moderators.

Seventh, we evaluate experiential resources using quantitative measures (e.g., organizational tenure) as opposed to qualitative measures (e.g., different task types). Our measure is grounded in the prior literature (e.g., Hitt et al., 2006), and previous research indicates that increasing experience leads to greater knowledge (Schmidt et al., 1986; Tesluk & Jacobs, 1998). Future work should explore how experience accumulates across different task types as well as how multi-functional teams affect the building of a knowledge integration capability.

Finally, another fruitful venue for future research is the role of leadership in managing teams with different levels and distributions of knowledge resources. We have suggested that it is critical for teams to build a capability to integrate relational and experiential resources. Team leaders may play an important role in the process of integration. Future research examining this possibility would further our understanding of the boundary conditions of our theoretical model.

Practical Implications and Conclusion

Our research offers valuable practical insights for both team leaders and team members. First, our findings support a relationship between knowledge-integration capability and team performance. Our theorizing suggests that the challenges of integrating distributed resources are not simply solved by good communication, but rather that when teams develop a reliable, systematic process with communications that are efficient, collaborative, and valid it is possible to build a capability for knowledge-integration. Second, our findings suggest that managers should give special attention to developing the knowledge-integration capability within more experienced teams. Instead of aiding knowledge integration, higher levels of experiential resources may actually detract from it. Rather than simply trusting that an experienced team will "take care of business," managers may need to allocate additional attention to ensuring that knowledge integration does not suffer, especially as uncertainty increases. Finally, our results place a potentially powerful lever in the hands of managers. While prior work on relational resources has generally found that more is better, the present study identifies potential for some targeted intervention. Namely, when teams face higher uncertainty, relational resources are particularly valuable, as they may enable a team to build its knowledge-integration capability. Managers forming teams to face uncertain tasks should therefore aim to increase both the overall level of relational resources as well as the distribution of such resources within each team. Given the difficulties of replicating relational resources by moving an entire team, managers can work to build a sustainable competitive advantage through especially careful allocation of individuals to teams in order to achieve higher levels of relational resources.

In conclusion, this paper advances theory by investigating how teams can develop a dynamic knowledge-integration capability. We find that development of this capability allows some teams to convert members' knowledge resources into higher performance while others fail

to develop this capability and therefore leave some resources untapped. Altogether, we hope that by bringing an RBV approach to teams' research, we are helping to build a productive bridge for ongoing dialogue between the fields of strategic management and organizational behavior.

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TABLE 1

Summary Statistics and Correlation Table (N = 79)

Variable	Mean	σ	Min	Max	1	2	3	4	5	6	7	8	9	10
1. Knowledge-Integration Capability	5.93	0.68	3.30	7.00										
2. Team Performance	3.85	0.66	1.00	5.00	**0.34**									
3. Team Size	7.68	2.31	3.00	15.00	-0.01	-0.19								
4. Communications Volume	4.28	0.71	1.83	6.00	0.01	0.11	0.08							
5. Project Importance	3.90	0.84	1.67	5.00	-0.05	**0.32**	0.13	**0.33**						
6. Project Demands	3.91	0.69	2.33	5.00	-0.07	0.16	0.14	**0.25**	**0.53**					
7. Uncertainty[a]	2.08	0.43	1.28	3.22	**-0.33**	-0.08	-0.07	0.18	0.22	0.15				
8. Relational Resources[a]	2.00	0.71	1.00	3.80	**0.29**	**0.25**	-0.06	-0.02	-0.01	0.04	-0.20			
9. Experiential Resources	0.01	0.48	-1.18	1.11	-0.19	-0.02	-0.16	0.19	0.04	0.09	0.09	0.21		
10. Distribution in Relational Resources[a]	0.65	0.19	0.00	1.00	0.18	-0.18	0.21	0.09	-0.08	-0.17	-0.18	0.07	0.16	
11. Distribution in Experiential Resources[a]	0.71	0.15	0.00	0.87	-0.22	-0.06	**0.42**	0.17	**0.40**	**0.26**	0.12	0.09	0.06	**0.25**

Note. Bold denotes significance of less than 0.05.

[a] In models this variable is centered by subtracting the mean. Values here are before centering.

TABLE 2

Regression Results for Knowledge-Integration Capability and Team Performance (N = 79)

	Dep Var: Knowledge-Integration Capability		Dep Var: Team Performance	
	(1)	(2)	(3)	(4)
Team Size	0.01	0.00	-0.05	-0.05
	(0.03)	(0.02)	(0.04)	(0.04)
Communications Volume	0.09	0.03	0.02	0.05
	(0.12)	(0.14)	(0.07)	(0.09)
Project Importance	0.10	0.00	0.29*	0.28*
	(0.11)	(0.09)	(0.11)	(0.11)
Project Demands	0.01	0.09	-0.01	-0.00
	(0.12)	(0.11)	(0.13)	(0.13)
Uncertainty[a]	-0.30	0.62	-1.34	-2.65
	(0.18)	(1.44)	(1.06)	(1.85)
Relational Resources[a]	0.32**	0.37***	0.20+	0.20+
	(0.10)	(0.10)	(0.12)	(0.12)
Experiential Resources[a]	-0.40***	-0.53***	-0.04	-0.03
	(0.11)	(0.10)	(0.18)	(0.17)
Distribution in Relational Resources[a]	0.89*	1.19***	-0.69	-0.52
	(0.37)	(0.29)	(0.48)	(0.51)
Distribution in Experiential Resources[a]	-1.61**	-1.14**	-0.14	-0.27
	(0.50)	(0.40)	(0.52)	(0.53)
Relational Resources × Uncertainty		0.59*	0.10	-0.02
		(0.24)	(0.25)	(0.24)
Experiential Resources × Uncertainty		-0.96*	-0.43	-0.27
		(0.39)	(0.46)	(0.49)
Distribution in Relational Resources × Uncertainty		-2.99***	-0.53	-0.72
		(0.75)	(1.42)	(1.47)
Distribution in Experiential Resources × Uncertainty		1.55	2.23	2.14
		(2.02)	(1.73)	(1.70)
Knowledge Integration Capability			0.26*	0.21
			(0.13)	(0.16)
Knowledge Integration Capability × Uncertainty				0.25
				(0.29)
Constant	5.62***	5.41***	2.09*	2.19*
	(0.58)	(0.58)	(0.87)	(0.91)
Observations	79	79	79	79
R-Squared	0.3241	0.4930	0.3673	0.3761

(a) Variable has been centered.

Notes: +, *, **, and *** denote signficance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively. Models are ordinary least squares with heteroskedasticity robust standard errors.

TABLE 3
Interpreting the Uncertainty Interaction Coefficients

	Relational Resources × Uncertainty	**Experiential Resources × Uncertainty**	**Distribution in Relational Resources × Uncertainty**
95% Region of Significance:			
Lower bound	-4.12	-4.09	0.19
Upper bound	-0.28	-0.27	0.86
Percentage of Projects:			
Below the lower bound	0%	0%	72%
Between the bounds	25%	25%	24%
Above the upper bound	75%	75%	4%
Simple Slopes:			
Low uncertainty	Not Sig, p=0.33	Not Sig, p=0.52	Sig, p<0.001
Average uncertainty	Sig, p<0.01	Sig, p<0.001	Sig, p<0.01
High uncertainty	Sig, p<0.01	Sig, p<0.001	Not Sig, p=0.78

Notes: The above values of calculated using the Johnson-Neyman technique, following the approach of Preacher, Curran, and Bauer (2006). These results imply that the coefficient in each column is significant and negative when uncertainty is less than the lower bound, not statistically significant when uncertainty has values between the lower and upper bound, and significant and positive when uncertainty has a value greater than the upper bound.

TABLE 4
Moderated Mediation Tests

	Relational Resources		**Experiential Resources**		**Distribution in Relational Resources**		**Distribution in Experiential Resources**	
	Uncertainty		Uncertainty		Uncertainty		Uncertainty	
	Low	High	Low	High	Low	High	Low	High
Indirect Effect	0.02	0.12*	-0.01	-0.16*	0.64*	-0.07	-0.08	-0.47

Note: * denotes signficance at the 0.05 level.

FIGURE 1
Theoretical Model

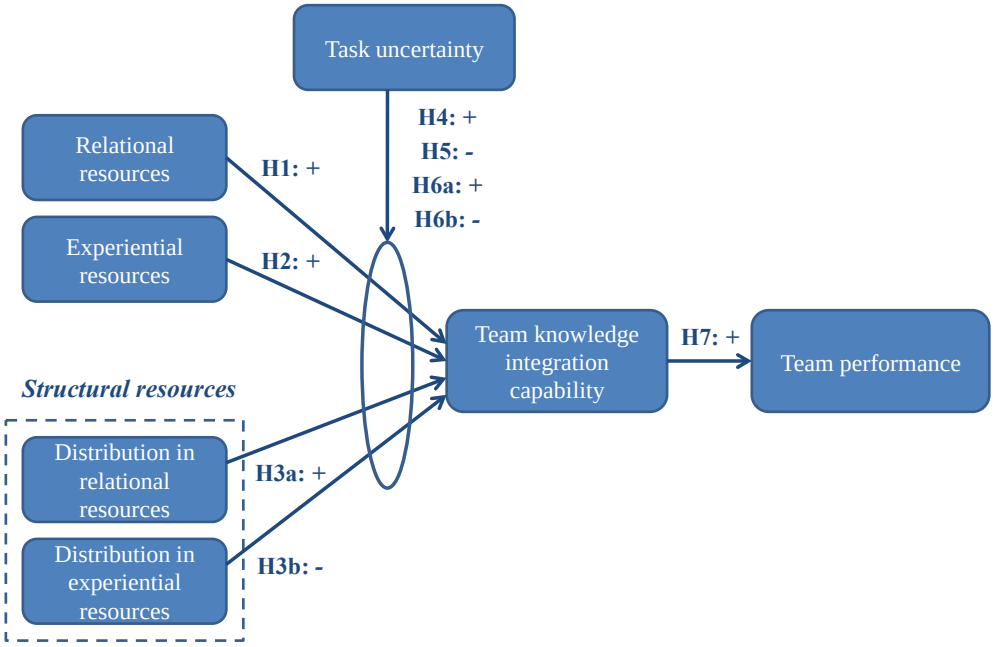


FIGURE 2
Interaction of Relational Resources and Uncertainty on Knowledge-Integration Capability

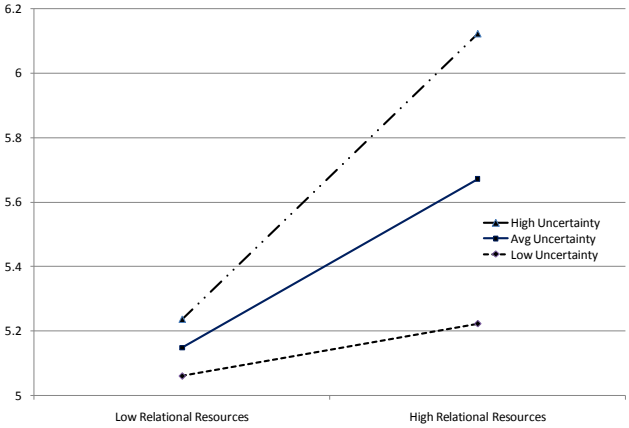


FIGURE 3
Interaction of Experiential Resources & Uncertainty on Knowledge-Integration Capability

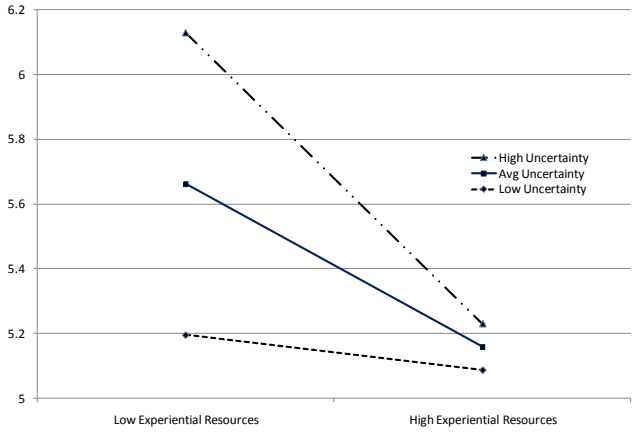
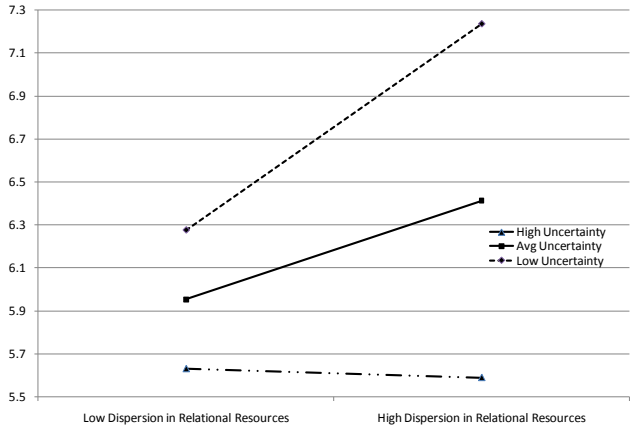


FIGURE 4
Interaction of Distribution in Relational Resources and Uncertainty on Knowledge-Integration Capability



APPENDIX 1

Measure of the knowledge-integration capability (adapted from Leathers 1972)

For each question below, please choose an answer to describe the communications that happened WITHIN YOUR TEAM.

Communications within our team were...

1. Relevant - Neutral - Irrelevant
2. Timely - Neutral - Delayed
3. Objective - Neutral - Biased
4. Clear - Neutral - Confused
5. Supportive - Neutral - Inconsiderate
6. Concise - Neutral - Digressive
7. Truthful - Neutral - Deceptive
8. Non-confrontational - Neutral - Confrontational
9. Right amount - Neutral - Too many/too few
10. Fostering teamwork - Neutral - Hampering teamwork

Author biographies

Heidi K. Gardner (hgardner@hbs.edu) is an assistant professor of business administration at Harvard Business School, Harvard University. She received her Ph.D. in organizational behavior from the London Business School. Her research focuses on team effectiveness, leadership, collaboration and innovation in knowledge-intensive environments, particularly professional service firms.

Francesca Gino (fgino@hbs.edu) is an associate professor of business administration at Harvard Business School, Harvard University. She received her Ph.D. in economics and management from the Sant¹Anna School of Advanced Studies. Her research focuses on judgment and decision making, social influence, group dynamics, and ethics.

Bradley R. Staats (bstaats@unc.edu) is an assistant professor in the Operations, Technology & Innovation Management area at the Kenan-Flagler Business School at the University of North Carolina at Chapel Hill. He received his doctorate in Technology and Operations Management from Harvard Business School. His research focuses on how the ongoing fragmentation of work affects individual and team learning and productivity.