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Managing the Unexpected Across Space: Improvisation, Dispersion, and Performance in NPD Teams

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Organizations are increasingly moving toward a team-based structure for managing complex knowledge in new product development (NPD) projects. Such teams operate in an environment characterized by dynamic project requirements and emergent nonroutine issues, which can undermine their ability to achieve project objectives. Team improvisation—a collective, spontaneous, and creative action for identifying novel solutions to emergent problems—has been identified as a key team-situated response to unexpected challenges to NPD team effectiveness. Geographic dispersion is increasingly becoming a reality for NPD teams that find themselves needing to improvise solutions to emergent challenges while attempting to leverage the knowledge of team members who are physically distributed across various locations. However, very little is known about how teams' improvisational actions affect performance when such actions are executed in increasingly dispersed teams. To address this gap in the literature, this paper draws on the emerging literature on different forms and degrees of team dispersion to understand how team improvisation affects team performance in such teams. In particular this paper takes into account both the structural and psychological facets of dispersion by considering the physical distance between team members, the configuration of the team across different sites, as well as the team members' perception of being distant from their teammates. Responses from 299 team leaders and team members of 71 NPD projects in the software industry were used to analyze the relationship between team improvisation and team performance, as well as the moderating effect of the three different conceptualizations of team dispersion. Results of the study indicate that team improvisation has a positive influence on project team performance by allowing team members to respond to unexpected challenges through creative and timely action. However, increasing degrees of team member dispersion (both structural and psychological) attenuate this relationship by making it difficult to have timely access to other team members' knowledge and by limiting real-time interactions that may lead to the development of creative solutions. The results of this research offer guidance to managers about when to balance the desire to leverage expertise to cope with unexpected events. Moreover, the present paper provides directions for future research on improvisation and team dispersion. Future research is encouraged to investigate factors that may help highly dispersed teams to overcome the shortcomings of team dispersion in dealing with emergent events.

Team-based structures in the form of project teams are seeing increased use in the context of complex knowledge work such as new product development (NPD) and software development (Akgün, Keskin, Byrne, and Gunsel, 2011) because such endeavors require the sharing and integration of knowledge (Dayan and Di Benedetto, 2009; De Clercq, Thongpapanl, and Dimov, 2011; Hoegl and Parboteeah, 2007; Tiwana and McLean, 2005). More significantly, given improvements in the capabilities of information and communication technologies, such teams are increasingly being composed of members who are physically dispersed across different locations (Bertels, Kleinschmidt, and Koen, 2011; Boh, Ren, Kiesler, and Bussjaeger, 2007; Maruping and Agarwal, 2004). This has the distinct advantage of enabling teams to draw upon product development expertise regardless of where that expertise is physically located (Bertels et al., 2011; Boh et al., 2007). Such access to expertise is critical in NPD contexts. NPD project teams are often faced with unstructured, unanticipated, and nonroutine situations in which team members must bring their skills to bear in order to overcome barriers and achieve project objectives (Akgün et al., 2011; Faraj and Sproull, 2000; MacCormack, Verganti, and Iansiti, 2001; Tiwana and McLean, 2005). For instance, recent research finds that software development teams continue to face significant challenges in determining user requirements for software products a priori as well as challenges in responding to changes in customer

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expectations during project development (Lee and Xia, 2010; Maruping, Venkatesh, and Agarwal, 2009).

Unpredictable changes in the NPD environment, such as changes in product requirements or a sudden budget cut for the project, often require quick responses by the team so that tasks can still be accomplished. Such emergent issues can render existing routines and contingency plans ineffective (Kamoche and Pina e Cunha, 2001; LePine, 2003; Waller, Gupta, and Giambatista, 2004), and the ability of teams to *improvise*—defined as the composition of a set of spontaneous and creative solutions within a short time frame—has been identified as a key determinant of success in time-dependent task accomplishment (Bechky and Okhuysen, 2011; Crossan, Vieira Da Cunha, Vera, and Pina e Cunha, 2005; Moorman and Miner, 1998; Pina e Cunha, Vieira da Cunha, and Kamoche, 1999; Vera and Crossan, 2005).

Team improvisation has been primarily examined in the context of colocated work teams across different organizational settings. For instance, Bechky and Okhuysen (2011) investigated team improvisation through their observation of SWAT teams. The mission performed by SWAT teams is often characterized by unexpected events (e.g., changes in suspects' behaviors, differences in the expected configuration of the building layout in a raid, and unpredictable weather conditions) that can disrupt members' expectations of how the mission will unfold, thus requiring quick and immediate action in response. Other studies have examined the relationship between improvisation and team outcomes in a variety of colocated teams including firefighting, consulting, audit, and facilities management teams and NPD (e.g., Kamoche and Pina e Cunha, 2001; Vera and Crossan, 2005). This extant corpus of work on team improvisation in colocated settings underscores that teams are able to effectively deal with emergent issues through creative and spontaneous action whereby team members exchange and integrate ideas for real-time problem solving.

Although the prior literature has served as an important stepping stone for understanding improvisation in teams, there remain significant theoretical gaps that need to be addressed. The paucity of research on improvisation in dispersed team contexts is an especially important theoretical gap. As already noted, dispersed teams are becoming a ubiquitous form of organizing teams for problem solving. Like most team actions, team improvisation requires collective, interdependent action (Bechky and Okhuysen, 2011; Vera and Crossan, 2005). The effects of these actions on team performance have been studied in the context of colocated teams. Yet research on distributed teams indicates that when teams are geographically dispersed, their capacity for spontaneous collective action can be affected (e.g., Cummings, Espinosa, and Pickering, 2009). Notably, Kirkman, Rosen, Tesluk, and Gibson (2004) cautioned against assuming that factors that influence team effectiveness in colocated team settings will have the same effects as team members become more dispersed. Taken together, these studies

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suggest that team dispersion should be considered as an important contingency in the study of team improvisation and its effect on team performance. In considering the effect of team dispersion, this paper subscribes to a recent perspective by focusing on the *degree* to which team members are dispersed rather than taking a dichotomous perspective between colocated and dispersed teams (O'Leary and Cummings, 2007). Specifically, it is contended that dispersion, defined in spatial (the physical distance between team members), configurational (the arrangement of team members across physical sites), and cognitive (the perception of distance and accessibility of team members) terms can hinder teams' ability to realize positive outcomes from their improvisational actions. Against this backdrop, the objective of this research is to examine the influence of team improvisation on team performance in NPD project teams with different degrees of dispersion.

The importance of studying the effects of improvisation under different degrees of dispersion in NPD project teams is particularly noteworthy for several reasons. First, team dispersion represents somewhat of a conundrum in its implications for the outcomes of improvisation. On the one hand, distributed teams tend to have access to a broader array of knowledge resources (Boh et al., 2007). Consequently, one would expect that such access would enable teams to realize positive outcomes from their improvisation because a greater breadth of knowledge can be brought to bear on emergent problems (Hinds and Mortensen, 2005; Van der Bij, Song, and Weggeman, 2003). On the other hand, however, distributed teams face a variety of challenges in collaborating effectively (Cramton, 2001; Cummings et al., 2009). When team members are geographically dispersed, they lack shared context and understanding of each others' situation (Cramton, 2001; Hinds and Mortensen, 2005; Kiesler and Cummings, 2002). Thus, by contributing to the debate on the complex relationship between team improvisation and team performance through considering team member dispersion, this paper sheds some light on the call by Vera and Crossan (2005) for a better understanding of the contextual conditions that facilitate or hamper the ability of teams to respond to emergent and unexpected issues. Second, by studying the effect of team dispersion on the ability of teams to effectively deal with emergent issues, this paper provides a better understanding of how organizations may design and support teams that are likely to regularly respond to unexpected events. By gaining a more thorough understanding of the mechanisms by which dispersion affects the team improvisation–performance link, organizations can be better positioned to devise measures that support teams with different degrees of dispersion and to support them in dealing with emergent situations (Crossan et al., 2005; McNally and Schmidt, 2011).

In this paper, the effects of team dispersion and team improvisation on team performance are theorized and tested in a field study of 299 team members and team leaders of 71 software development teams. Software development teams are an ideal context for examining the effects of team dispersion and team improvisation. Software development is an inherently complex knowledge-intensive product development process that requires a high degree of nonroutine action by team members (Akgün et al., 2011; Faraj and Sproull, 2000; Iansiti and MacCormack, 1997; Walz, Elam, and Curtis, 1993). While basic project requirements are often established a priori, project success derives from the ability to fulfill emergent needs and requests for customization, as well as the ability to capture and integrate extemporaneous ideas that emerge from implementers and end users (Lee and Xia, 2010; MacCormack et al., 2001; Maruping, Venkatesh, et al., 2009). Software development projects rely on heuristic processes with no clear and readily identifiable path to the solution (Lee and Xia, 2010), require a high degree of unplanned action by team members (Magni, Provera, and Proserpio, 2010; Xia and Lee, 2005), and force team members to regularly engage in creative problem solving. Furthermore, development projects are considered inherently creative because they involve the generation and evaluation of new ideas and solutions to business problems (Tiwana and McLean, 2005).

Theoretical Background

Improvisation in Teams

Although improvisation in organizational settings has been studied at different levels of analysis, including individual (Magni, Proserpio, Hoegl, and Provera, 2009; Weick, 1998), team (Hatch, 1997; Vera and Crossan, 2005) and organization (Miner, Bassoff, and Moorman, 2001), there is consensus about core aspects of its definition. Specifically, improvisation is broadly defined as the creative and spontaneous action of utilizing immediately available resources to identify novel solutions to emergent problems within a short time frame (Moorman and Miner, 1998; Vera and Crossan, 2005). At the team level of analysis, which is the focus in this research, improvisation is a collective action and is defined as: the creative and spontaneous action of working to achieve a team objective in a new way. As a collective action, team improvisation is more than just the sum of individual improvisations because the joint activities of individuals create a collective system of action (Hatch, 1997; Moorman and Miner, 1998). For example, in a software development team, one member might raise a problem related to an unexpected blockage of the system due to a software compatibility issue. A second team member may respond to this issue through an association between the first team members' comment and another similar problem that occurred in the past. Then, a third member might link these issues to a third, inclusive aspect that allows the team to develop a creative and emergent solution in a short time frame. In such a scenario, the development team did not plan the solution in advance; what is more, the pattern that arises for solving the problem in a short time is not clearly discernable and is not simply the sum of independent improvisational actions (Crossan et al., 2005). In an excellent illustration of team improvisation, Vera and Crossan (2005) recount the experience of a facility management team that had to deal with a mechanical breakdown of an air-conditioning system during a wedding reception one summer. Soaring summer temperatures were causing the unit to overheat and break down. They were not able to repair the system using standard procedures; however, they had to devise a creative solution to this problem in a short time frame so that the reception could proceed as planned. Finally, through a quick and continuous exchange of ideas among team members on-site, the team developed an unconventional solution that involved setting up a sprinkler system to cool the unit down so that it would operate properly. As this incident illustrates, team improvisation emerges from the interdependent interactions of team members as they work together to overcome emergent barriers to effectiveness in their work (Vera and Crossan, 2005). Thus, team improvisation represents a collective action of team members during which the convergence of creativity and spontaneity occurs (Vera and Crossan, 2005).

As a *spontaneous* action, team improvisation is extemporaneous, unpremeditated, and unplanned, and refers to the team's immediate action of utilizing immediately available resources in the task environment to address the issues at hand (Pina e Cunha et al., 1999). Conventional wisdom suggests that there is a temporal sequence to the way in which events occur such that actions are first composed and then subsequently implemented. Spontaneity deviates from this convention by viewing composition and execution of action as co-occurring in time (Moorman and Miner, 1998; Vera and Crossan, 2005). From this perspective, team actions become more spontaneous in nature when the temporal gap between composition and execution of action narrows (Moorman and Miner, 1998). Such spur of the moment activities are critical in situations where the team's failure to respond immediately may result in a lost opportunity or an aggravated problem (e.g., Majchrzak, Jarvenpaa, and Hollingshead, 2007; Vera and Crossan, 2005) or life-threatening situations (e.g., Bechky and Okhuysen, 2011). The time-dependent nature of spontaneity requires that teams react and compose actions by utilizing immediately available resources in a "bricolage" action (Baker and Nelson, 2005; Pina e Cunha et al., 1999). That is, because bricoleurs do not have the luxury of time, they must draw upon the pool of resources at hand in crafting actions (Baker and Nelson, 2005; Miner et al., 2001; Weick, 1998).

As a *creative* action, team improvisation attempts to develop something new and useful to the situation. In the context of team improvisation, creativity taps into the extent to which the development of solutions to emergent issues deviates from normal, established routines (Amabile, 1996; Gilson and Shalley, 2004; Vera and Crossan, 2005). The value and importance of creative actions has been underscored in nonroutine task environments where the means–end relations associated with established routines become ambiguous (Waller et al., 2004). Team improvisation occurs when a team's actions are simultaneously creative and spontaneous (Hatch, 1997; Moorman and Miner, 1998; Vera and Crossan, 2005). Thus, actions that are creative but not spontaneous are not considered to be improvisational (e.g., when a team invests time and resources into identifying new products in which a chemical component can be used). Similarly, actions that are spontaneous yet not creative are not considered to be improvisational (e.g., when a control crew executes established protocols for shutting down a power plant).

As outlined by previous literature (e.g. Moorman and Miner, 1998), it is important to note that improvisation is conceptually distinct from several correlates such as adaptation, flexibility, and responsiveness. *Adaptation* represents the process of changing an internal system in response to external conditions (Burke, Stagl, Salas, Pierce, and Kendall, 2006; LePine, 2003). As Burke et al. (2006) define it, adaptation can occur through modifications of existing structures or through the invention of new ones. At first glance, it appears that there is significant overlap between adaptation and improvisation. After all, both concepts reflect actions taken in response to some situational stimulus. However, there are important conceptual differences between the two. Adaptive actions can be planned in advance such as when contingency plans are drafted by a team—e.g., if situation A occurs we will execute plan 1, if situation B arises we will execute plan 2 (Burke et al., 2006). Such preplanned actions, although adaptive to situations as they arise, are clearly not spontaneous. Further, the specific actions taken may not necessarily be creative in nature. They can involve the implementation of context-relevant protocols or routines that already exist (Waller et al., 2004). In addition, adaptive actions do not carry the requirement of composition and execution being temporally proximal in the same way that improvisation does (Moorman and Miner, 1998). Finally, some researchers suggest that adaptation can be seen as an outcome of improvisation (Moorman and Miner, 1998). *Flexibility* is the ability to respond to environmental changes (Lee and Xia, 2010). It generally refers to the capability of altering an internal system to match the needs of the external environment. In a team context, it represents the degree to which team members are able to easily and seamlessly switch from one subtask to another, exchanging the task among team members (Campion, Medsker, and Higgs, 1993). Unlike improvisation, flexibility is not an action (although it can result from actions). Additionally, flexibility can be achieved without creative action, and there is not necessarily any stipulation on the time frame within which actions must be taken. Finally, *responsiveness* refers to the degree to which a team's output meets the requirements of customers (Lee and Xia, 2010). Responsive actions can be executed over time or spontaneously. Moreover, responsive actions may not necessarily be creative. For example, a development team can be responsive to a client's request for a lead management module in a software package by including the new module in its next release of the software.

Dispersion in Teams

Traditional views on team dispersion have tended to view teams as being either colocated or virtual (Kirkman and Mathieu, 2005). In fact, much of the empirical work on dispersed teams has focused on contrasting process (e.g., Chattopadhyay, George, and Shulman, 2008) and performance (e.g., Hollingshead, McGrath, and O'Connor, 1993) in dispersed versus colocated teams. The cumulative results in this corpus of research have been mixed, with some studies finding that face-to-face teams outperform dispersed teams while others suggest no performance differences between the two types of teams (Martins, Gilson, and Maynard, 2004). While this body of research has done much to improve our understanding of how dispersed teams operate and perform in comparison to colocated teams, recent literature suggests that such a dichotomous view is limited and does not reflect the true state of teams. Consequently there has been a move toward understanding the implications of finer gradations of team dispersion. Such finer gradations are believed to result in meaningful differences in team dynamics and outcomes (Kirkman et al., 2004; O'Leary and Cummings, 2007). A unifying theme across these varying views on team dispersion is that the *degree* of dispersion of team members plays a significant role in influencing the way team members interact, thus underscoring the importance of departing from a dichotomous perspective (Kirkman et al., 2004; O'Leary and Cummings, 2007).

Recent advances in conceptualizing team dispersion recognize that it is multifaceted. O'Leary and Cummings (2007) note that team dispersion can be conceptualized in terms of the physical distance between team members' locations. This *spatial* form of dispersion can pose a challenge to teams that wish to engage in face-to-face interactions (Dennis, George, Jessup, Nunamaker, and Vogel, 1988; Saunders, Van Slyke, and Vogel, 2004). For instance, when team members work in different parts of the same city, they can drive or take public transportation if face-to-face team interaction is necessary. However, as distances between team members increase (e.g., different city, different country, and different continent), it becomes more difficult to orchestrate such interactions on a whim as many proximity studies have suggested (Herbsleb and Grinter, 1999). Teams can also be *configurationally* dispersed (O'Leary and Cummings, 2007). Configurational dispersion describes the arrangement of team members across physical sites (e.g., how many different buildings, cities, and countries). Prior research suggests that while managing interdependent actions of team members across two sites may be feasible, facilitating such interaction becomes increasingly difficult as the number of sites involved rises (Baba, Gluesing, Ratner, and Wagner, 2004; O'Leary and Cummings, 2007; O'Leary and Mortensen, 2010). Finally, research suggests that distance can be psychological (Wilson, O'Leary, Metiu, and Jett, 2008). That is, team members can psychologically experience distance/proximity. Such *cognitive* dispersion is often informed by objective reality and influences the way in which team members interact (Hoegl, Ernst, and Proserpio, 2007; Hoegl and Proserpio, 2004; Wilson et al., 2008). In sum, recognition of these different facets of team dispersion yields important insights about the challenges dispersed teams might face as they work together to solve problems. We expect that these challenges can be especially relevant when teams need to act expeditiously in solving complex problems.

The nature of the task is an important consideration in understanding the implications of team member dispersion for team functioning (Kiesler and Cummings, 2002). Tasks that are highly interdependent and knowledge intensive are more likely to necessitate extensive interaction among team members (Boh et al., 2007; Espinosa, Slaughter, Kraut, and Herbsleb, 2007). Teams with a dispersed membership face significant challenges in managing tasks with such characteristics. This is especially true of software development teams (Espinosa et al., 2007; Kraut and Streeter, 1995; Salomo, Keinschmidt, and de Brentani, 2010). Software development is an inherently complex task involving numerous interdependencies. Units of software code must be developed, tested, modified, and integrated by multiple individual developers (Curtis, Krasner, and Iscoe, 1988; Maruping, Venkatesh, et al., 2009). Further, this must be accomplished within strict production deadlines, and interaction among team members has proven to be a critical determinant of performance in software development (Faraj and Sproull, 2000; Kraut and Streeter, 1995; Maruping, Zhang, and Venkatesh, 2009b). Kraut and Streeter (1995) observed that software developers were often able to solve problems through spontaneous communication at the water cooler or the coffee room. In a recent qualitative study, Espinosa et al. (2007) found that as dispersion of team members increases, there is a drop in the coordination capabilities of team members. In sum, team member dispersion has important implications for successful team functioning. As such, it is a useful lens for understanding the effects of improvisation in software development teams. In the next section, hypotheses relating to team dispersion, improvisation, and performance in project teams are outlined, with a particular focus on software development teams.

Hypotheses Development

In light of the theoretical framework developed above, the model is conceptualized as is depicted in Figure 1, and specific hypotheses are derived next.

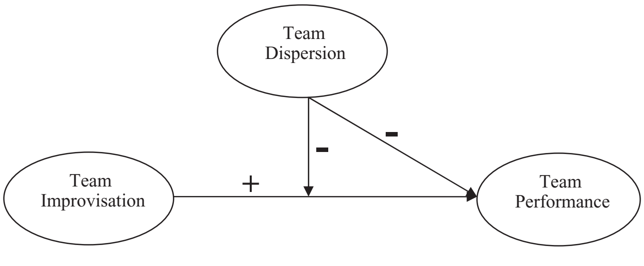

Figure 1. Research Model

Dispersion and Performance in Project Teams

Previous studies have underscored the importance of team member proximity in affecting team outcomes in projects characterized by a high level of complexity and ambiguity where routines cannot be applied a priori (Hoegl and Proserpio, 2004). Complex projects require team members to continuously integrate new inputs and understand what inputs need to be added by whom and in what sequence, in order for project quality to be attained (Faraj and Sproull, 2000). Close proximity between team members enhances their ability to ensure that they have a shared representation of the problem at hand, and understand each others' roles and responsibilities in real time, monitoring team member work progress (Espinosa et al., 2007; Maznevski and Chudoba, 2000). As the dispersion of a team's members increases, such activities become more challenging to perform because the decrease of physical copresence reduces the opportunity for spontaneous, informal communication processes and erodes the establishment of shared context (Cramton, 2001; Hinds and Mortensen, 2005). In addition, dispersed team members are less able to monitor each others' progress on tasks, determine availability for quick meetings, and verify needed information to complete their own tasks (Espinosa et al., 2007). As a result, highly dispersed teams are likely to experience process losses and performance problems (Hinds and Mortensen, 2005). In an illustration of this dynamic, Maznevski and Chudoba (2000) found that dispersed software project teams that did not engage in face-to-face discussions of major problems performed poorly compared with those that conduct periodic face-to-face meetings.

As noted earlier, software development is a highly complex process requiring intense interaction between developers (Curtis et al., 1988; Kraut and Streeter, 1995; Xia and Lee, 2005). Software developers must ensure that they understand what the software under production is supposed to do—which in itself requires them to have an accurate assessment of the business rules for which the software is being developed (Xia and Lee, 2005). These business rules typically shape the dependencies that exist between different units of software code (Lee and Xia, 2010). Individually written units of code may not necessarily work well with units of code written by other developers (Curtis et al., 1988). Therefore, developers must integrate their efforts to combine various software components, a process that involves a collective understanding of technical specifications, configurations, and protocols (Curtis et al., 1988; Maruping, Zhang, et al., 2009; Walz et al., 1993). Software developers are often

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faced with integration challenges such as code incompatibility and redundancy that affect the performance of the software (Walz et al., 1993). Finally, there are often temporal dependencies among various units of software code. A developer must often wait for a unit of software code to be completed before she can use it in her software code (Massey, Montoya-Weiss, and Hung, 2003).

When software development team members are in close proximity to each other, there is more opportunity for them to interact and exchange ideas (Kraut and Streeter, 1995). Interaction in close proximity provides a rich environment for information exchange because developers are able to immediately verify information, clarify inconsistencies in understanding, and provide supporting information when necessary (Herbsleb and Grinter, 1999). When team members are in close proximity, developers can also more easily engage in spontaneous communication if an important question comes up or if feedback is needed on software code. It is easier to coordinate development effort under such conditions. Software developers can share information about the intricacies of the software code (e.g., necessary data types and functionality of specific units of code) more readily. In many cases, such conversations can take place in front of a developer's workstation, making software integration easier. As team members become increasingly dispersed, the ability to integrate different developers' input becomes more difficult (Espinosa et al., 2007). Developers are less likely to engage in spontaneous communication when their teammates are dispersed. Even though dispersed teams can engage in rich communication via information and communication technologies such as videoconferencing, meetings have to be scheduled to ensure that all necessary parties are present for discussions (Espinosa et al., 2007). This affects developers' ability to receive timely feedback on important task-related issues (Massey et al., 2003). In some cases, if developers do not receive immediate responses to their inquiries, frustration can set in, and they may proceed without the input of their teammates. Team dispersion also creates a lack of shared context among team members, which can result in misunderstanding—ultimately eroding team performance (Cramton, 2001; Hinds and Mortensen, 2005). These types of team conditions yield poor software development team outcomes. In light of these challenges, it is expected that—other things being equal—greater dispersion among project team members will yield lower team performance than greater proximity among project team members.

H1: Team dispersion will have a negative influence on performance in project teams.

Improvisation and Performance in Project Teams

Team improvisation is particularly relevant in complex projects, as these types of projects cannot be entirely understood a priori; do not rely on the application of routines; and require flexibility and fast, extemporaneous reactions (Kamoche and Pina e Cunha, 2001; Maruping, Venkatesh, et al., 2009). Maruping, Venkatesh, et al. (2009) found that colocated software project teams that have processes in place for responding to unanticipated changes in system requirements performed better than teams that did not have such processes. Kamoche and Pina e Cunha (2001) point out that improvisation is critical in accomplishing those projects characterized by a lack of best practices.

Vera and Crossan (2005) note that, although spontaneity of action is a critical dimension of improvisation, there is a fair amount of planning and deliberateness that is required. Improvisation involves rules and routines that are preestablished. Thus, although spontaneous in character, improvisational actions are, in many cases, rehearsed. Vera and Crossan (2005) linked this process to the improvisation demonstrated by jazz musicians or stage actors. Individual musicians have honed their skills over time to develop the capability of engaging in spontaneous and creative behavior. They are well aware of the musical rules involving notes, tempo, etc. When improvising, they bring these rehearsed rules and routines into action and in so doing are able to be spontaneous and creative during a live performance. Similarly, software developers hone their problem-solving skills over time. They are well aware of the rules governing the development of code (e.g., variable scope, data types, encapsulation, and structure of relational databases). When developing novel solutions to a problem, they are able to bring their knowledge of these rules to bear (Faraj and Sproull, 2000; Hoegl et al., 2007; Spanjol, Tam, Qualls, and Bohlmann, 2011). Thus, to some degree, their actions in developing software code are preplanned.

In the context of software development, team improvisation can yield positive outcomes. The complexities embodied in software development necessitate the effective utilization of expertise (Faraj and Sproull, 2000; Maruping, Zhang, et al., 2009). Although preestablished routines exist (embodied in software development processes) for software development, every project differs with respect to the specific requirements (e.g., functionality, platforms, business rules, and data types) that must be met. Given the idiosyncrasies associated with each software project, the ability to develop solutions to specific software requirements often requires some degree of creativity (Tiwana and McLean, 2005). Hence, software development teams must bring their expertise to bear in solving these problems. It is also well established that the requirements for software projects often change during the project (MacCormack et al., 2001; Maruping, Venkatesh, et al., 2009). Software development teams must therefore expend additional effort to address these changes as they occur while adhering to established deadlines. The spontaneity embedded in improvisation becomes critical in ensuring that problems are addressed in a timely manner (Vera and Crossan, 2005). Creativity enables software developers to be novel, perhaps more efficient, in addressing the requirements that need to be met (Dayan and Di Benedetto, 2010; Gilson and Shalley, 2004). Such creativity might be manifested in novel ways of marshalling existing resources, using new software development tools or implementing software design. In sum, because software projects generally have such uncertainties and complexity, software development teams must be able to improvise in order to perform well. Therefore, other things being equal, it is expected that software development teams that engage in more improvisation are more effective than software development teams that engage in little or no improvisation. More formally:

H2: Team improvisation will have a positive influence on performance in project teams.

Team Dispersion and Team Improvisation

Although team improvisation is expected to generally be beneficial for team performance, the dispersion of team members can affect the extent to which project teams are able to realize gains from such actions. Specifically, highly dispersed project teams face challenges in effectively engaging in improvisational actions. Successful team improvisation is not carried out in isolation (Vera and Crossan, 2005). Rather, team members must look out for each other (Vera and Crossan, 2005). This can be accomplished by playing a supporting role when a team member is improvising. In the context of theater performance, Vera and Crossan (2005) note that, in order for a production to be successful, actors must support each others' improvisational efforts when on stage. Actors often rely on cues to understand how and when they need to support a fellow actor's improvisational efforts. Similarly, successful improvisation within project teams requires continuous interaction, support, and a certain level of "being present" to know what one's teammates are doing (Kamoche and Pina e Cunha, 2001) so team members may adjust their activities according to others' actions. When team members are in close proximity to one another, it is relatively easy to establish team awareness during an improvisation episode. Developers can engage in spontaneous action to provide necessary resources to support the team's improvisational effort. When team members are dispersed, it is more difficult to develop an awareness of the team's status (Cramton, 2001; Espinosa et al., 2007). Much of this coordination occurs through informal encounters, which occur less when team members are dispersed (Curtis et al., 1988; Espinosa et al., 2007; Herbsleb and Grinter, 1999; Hoegl et al., 2007). When improvising, developers may experience delays in getting responses to queries for clarification or help from teammates (Herbsleb and Grinter, 1999). Without support from fellow developers on the team, efforts to improvise are likely to prove futile. In some cases, improvisation under such circumstances can prove detrimental to performance as developers may unknowingly undermine each other's development efforts by changing code or blocking access to needed resources (e.g., access to the central database for testing a unit of code).

As noted earlier, spontaneity is a critical aspect of team improvisation. Although actors know that improvisation is going to occur during a performance—and, therefore, prepare for it—they cannot predict, a priori, when such improvisation will actually occur (Vera and Crossan, 2005). Spontaneity incorporates temporal considerations into improvisation. Improvisation occurs in the spur of the moment and, in some cases, is a reaction to emergent, unanticipated events (Moorman and Miner, 1998; Vera and Crossan, 2005; Weick, 1998). Therefore, it becomes essential for team members to be ready to spring into action when improvisation occurs. Such spontaneity is necessary in creative problem solving because software development teams must often deal with unanticipated contingencies while continuing to adhere to established deadlines (MacCormack et al., 2001; Maruping, Venkatesh, et al., 2009). When improvising, developers might need important information on other aspects of the software code that their teammates are more familiar with. Having immediate access to such information is critical to the developer's ability to successfully improvise. When the development team membership is in close proximity, it is easier to get immediate responses to queries or calls for assistance. Developers can get real-time responses to their needs while improvising. As team members become increasingly dispersed, it is less likely that developers will get immediate responses to their needs (Cummings et al., 2009; Curtis et al., 1988; Herbsleb and Grinter, 1999). Given the temporal sensitivity associated with improvisation, developers may become frustrated at a protracted response to their needs and proceed without input from their teammates. Such uncoordinated action may result in what Vera and Crossan (2005) refer to as chaotic improvisation, which yields little or no positive performance outcomes and can potentially lead to negative outcomes.

In sum, dispersion erects numerous barriers to the coordination necessary for team improvisation to be successfully managed, thus rendering improvisational efforts less effective. Consequently, the expectation is that as project team dispersion increases, team improvisation will be less effective in improving team performance. Formally:

H3: Team dispersion will moderate the relationship between team improvisation and performance in project teams such that the relationship will be positive when team dispersion is low and will weaken with increasing levels of team dispersion.

Method

Research Setting and Participants

To test the hypotheses, a field study of software development teams was conducted. Participation was solicited from two large technology consulting firms in Italy. Development teams in the participating firms primarily design and develop information technology solutions, such as web-based applications and portals, supply chain management systems, systems integration, workflow management systems, and customer relationship management systems for their clients. Although all of the teams were located in Italy (rather than being dispersed across different countries or time zones), they varied in the extent to which their members were dispersed across various cities in Italy. Teams were assembled based on needed expertise and appointed to manage and complete software projects. Each team had its own team leader who was responsible for ensuring successful progress and accomplishment of the project objectives. Those teams that had been formed for more than three months were selected so that participants would be able to respond to the kind of questions presented in the survey. Team members at both participating firms had similar information and communication technology resources at their disposal to support team communication (e.g. e-mail, file sharing, chat, telephone, instant messaging, and telefax). Respondents' participation in the study was strictly voluntary. Data were gathered during the project through a standardized questionnaire containing 5-point Likert-type scales. In order to maximize the commitment to the study, the firms' human resource and line managers were engaged to identify the teams that satisfied our criteria for inclusion. Once the team leaders had been identified, the research goals were explained. Team leaders were asked to notify their teams of the research study. Participants were assured that their responses would be strictly confidential and that research outputs would contain data in aggregated form without any individual identification. Of a total of 325 individuals involved, 299 usable surveys from 71 teams were completed (a 92% response rate). Consistent with prior research, it was required that at least three questionnaires be completed for each team (the team leader and at least two team members) in order to be considered usable. No team in the sample had a response rate lower than 80%. The high response rate supported the use of the data at the team level of analysis (Barrick, Bradley, Kristof-Brown, and Colbert, 2007).

Twenty-nine percent (87) of the respondents were women. Eighteen percent were less than 25 years old, 31% were 25–30 years old, 28% were 31–35, and 23% were more than 35 years old. In terms of educational attainment, 14% of the respondents had a high school (or comparable) degree and 86% had a university degree. Team sizes ranged from 3 to 10 members (mean [M] = 4.57; standard deviation [SD] = 1.68).

Measurement

In order to obtain reliable team-level ratings for the variables in the study and to avoid potential common source bias, responses were collected from multiple sources in each team, including obtaining team performance ratings from team leaders. Because some of the data from this team-level study were collected from multiple individuals within each team, it was necessary to justify the aggregation of individual-level within-team ratings to team-level scores (Klein and Kozlowski, 2000). To accomplish this, the intraclass correlation coefficients (ICCs) for the team-level constructs were examined. This included a one-way analysis of variance (ANOVA) based on team membership to test the between-group variation, and the computation of ICC(1) to verify the between-group versus within-group variability in the individual-level responses. The ICC(1) reflects the extent to which variation in individual-level ratings can be attributed to between-team differences (Bliese, 2000). The ICC(2) was calculated for team improvisation and dispersion. The ICC(2) reflects the stability of the team-level means (Bliese, 2000).

Team performance. Team leaders responded to questions about the extent to which their team performed effectively. A three-item scale of team effectiveness derived from Hoegl and Gemuenden (2001) was used. The scale captures the extent to which a team's project deliverables met all client requirements and was of a high quality. A sample item is "The team is effective at satisfying customers' demands." Based on this scale, team leaders were asked to rate their team's effectiveness. The reliability was .71.

Team improvisation. Team improvisation was measured using a six-item scale developed by Vera and Crossan (2005). The scale assesses the degree to which team members perform both creative and spontaneous behaviors during the project. Sample items include "The team responds in the moment to unexpected problems" for the spontaneity facet and "The team tries new approaches to problems" for the creativity facet. Consistent with Vera and Crossan (2005), all items used the team as a referent. Members within each team were asked to rate the extent to which their team engaged in such behaviors over the course of the project. The scale had a reliability of .84. Results of a one-way ANOVA indicated significant between-team differences in ratings of team improvisation ($F = 4.28$; $p < .01$). The ICC(1) for improvisation was .42, suggesting that this truly was a team-level phenomenon. The ICC(2) was .77 indicating stable team-level means for this construct. A team-level score for improvisation was computed by averaging within-team responses to the scale.

Team dispersion. Objective and subjective measures were used to assess different degrees of team dispersion. In particular, following the recommendations of O'Leary and Cummings (2007), the objective measure of team dispersion tapped into the spatial and configurational dimensions of dispersion. *Spatial dispersion* refers to the distance between team members. The spatial distance index proposed by O'Leary and Cummings (2007) was adopted and is calculated as the distances between sites, weighted by the number of members at the sites, based on a matrix of all possible, nonredundant, member-to-member connections. In addition to spatial dispersion, the configuration of dispersion (i.e., the arrangement of members across sites independent of the spatial distances among them) was also taken into account. In particular, *configurational* dispersion was assessed by adopting O'Leary and Cummings's (2007) site index, which considers the number of sites represented in the team. In addition to these objective measures of dispersion, a subjective conceptualization of dispersion was included, based on previous work by Hoegl and Proserpio (2004). Specifically, *cognitive dispersion* was measured using a four-item scale from Hoegl and Proserpio (2004), which assesses the degree to which team members share the perception of being easily reachable, if all or most team members work directly in the vicinity of each other, and if it is problematic to call spontaneous face-to face meetings. Sample items include: "Most members of my team work directly in the vicinity, so that they could visit each other without much effort" and "It is at times problematic to get the team members together in one place for spontaneous meetings (e.g., for discussions and decisions)." The scale had a reliability of .93. The results of a one-way ANOVA based on team membership suggested significant between-team variation in members' ratings of cognitive dispersion ($F = 3.07$; $p < .01$). The ICC(1) and ICC(2) for the scale was .34 and .67, respectively. Team members' responses were averaged to create team-level scores for team cognitive dispersion.

Controls. Following Hoegl, Parboteeah, and Munson (2003), team size was included as a control variable. Larger team sizes have been associated with both increased and decreased performance. Larger teams are argued to give team members access to a broader array of resources. However, larger teams also create greater coordination complexity, thereby hindering the ability of individuals to collaborate and perform effectively. Because software development projects are characterized by varying degrees of task interdependence in team members' work, the behavior of each team member has an impact not only on the effectiveness of that individual, but also on the effectiveness of the team as a whole (Griffin, Neal, and, Parker, 2007). Thus, task interdependence was included as a control variable. *Task interdependence* was measured using a three-item scale adapted from Campion et al. (1993). A sample item is "My team cannot accomplish its tasks without information or materials from other members of the team." This scale had a reliability of .67. A one-way ANOVA revealed significant between-team variation on individual ratings of this scale ($F = 1.45$; $p < .05$). The ICC(1) and ICC(2) for task interdependence was .10 and .31, respectively. Moreover, because *task innovativeness*—the extent to which unanticipated issues (for which there are no predetermined solutions) emerge in the task environment—can be related to team outcomes (Vera and Crossan, 2005), it was included as a control variable in our model. Task innovativeness was measured using a three-item scale adapted from Vera and Crossan (2005). A sample item is "The project requires team members to deal with unexpected events." The degree to which members have to

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Table 1. Descriptives, Correlations, and Reliability

	Variable	Mean	SD	Reliability	1	2	3	4	5	6	7	8
1	Effectiveness	3.99	.59	.71								
2	Improvisation	3.68	.43	.84	.28**							
3	Cognitive dispersion	2.03	.70	.93	−.20	−.25**						
4	Spatial dispersion	.00	.98	–	−.07	−.10	.53**					
5	Configurational dispersion	2.08	.77	–	−.09	−.02	.52**	.79**				
6	Interdependence	3.77	.39	.67	.14	.01	.02	−.10	−.07			
7	Innovativeness	4.09	.36	.76	−.03	−.13	.22	.22	.29*	.32**		
8	Team size	4.57	1.68	–	.01	−.03	−.11	−.27*	−.51**	−.12	−.13	
9	Team composition (% women)	.31	.26	–	−.07	−.19	−.13	−.03	−.05	−.13	−.14	−.16

Notes: $n = 71$; * $p < .05$, ** $p < .01$.
SD, standard deviation.

deal with emergent and unexpected situations in performing their activities may affect the way members react to such situations, impacting their improvisational actions. Following Joshi, Liao, and Jackson (2006), the proportion of women within each team was calculated. Finally, because the present study included 21 teams from Firm 1 and 50 teams from Firm 2, it was necessary to control for possible organizational effects (i.e., dependencies between observations from one firm). To accomplish this, the independent variables and the dependent variable were regressed on firm membership, and the standardized residuals were retained. The standardized residuals obtained ("purified" from organizational effects) were then used as the basis for further analysis (Hoegl et al., 2003). This procedure effectively controls for all constant and unmeasured differences across the firms that may affect the relationships examined.

Table 1 shows the descriptive statistics, correlations, and scale reliabilities for the variables in the study. As illustrated in Table 1, the correlation between team improvisation and team performance is positive and significant ($r = .28$, $p < .01$), providing preliminary support for the hypothesis relating the two. However, although it is of the expected sign, the correlation between team dispersion and performance is nonsignificant (spatial dispersion: $r = -.07$, p = not significant [ns]; configurational dispersion: $r = -.09$, p = ns; cognitive dispersion: $r = -.20$, p = ns).

Analysis and Results

To test the hypotheses, moderated regression analysis was performed. Consistent with guidelines outlined by Baron and Kenny (1986), a three-step approach to testing for moderation was employed. In the first step, we entered the control variables: team size, task interdependence, task innovativeness, and team gender composition. In the second step, the main effect terms were entered into the model. In the third and final step, the interaction terms were entered into the model. Consistent with Aiken and West (1991), the variables were mean centered before creating the interaction term for the analysis so as to limit the potential for multicollinearity in the model. The results of the regression analysis are presented in Table 2. H1 predicted that dispersion would have a negative influence on team performance. The coefficients for all the three facets of team dispersion are not significant in predicting team performance. Thus, H1 is not supported. H2 predicted a positive relationship between team improvisation and team performance. Team improvisation has a statistically significant positive influence on team performance in all the three models presented ($\beta = .28$, $p < .05$; $\beta = .26$, $p < .05$; and $\beta = .25$, $p < .05$ respectively), providing support for H2.

H3 predicted that team dispersion would moderate the relationship between improvisation and team performance. Support for the moderation hypothesis was assessed in several ways. First, the significance of the interaction coefficient was examined. Second, the pattern of the interaction was examined via a graphical plot. The coefficients for the interaction between team improvisation and the different facets of dispersion are negative and significant in predicting team performance (spatial dispersion: $\beta = -.36$, $p < .01$; configurational dispersion: $\beta = -.34$, $p < .01$; cognitive dispersion: $\beta = -.33$, $p < .05$). These results provide support for H3. In order to understand the form of the moderation, the interaction effects were plotted following the guidelines outlined by Aiken and West (1991). The relationship between team improvisation and team performance was plotted at one SD above and below the mean for each dimension of

Table 2. Regression Models Predicting Team Performance

	DV: Team Performance						
	Model 1 (Controls)	Model 2a Spatial Dispersion	Model 2b Spatial Dispersion	Model 3a Configurational Dispersion	Model 3b Configurational Dispersion	Model 4a Cognitive Dispersion	Model 4b Cognitive Dispersion
Controls							
Team size	.02	.03	.02	.01	.05	.02	.03
	(1.056)	(1.062)	(1.070)	(1.095)	(1.106)	(1.111)	(1.123)
Task interdependence	.16	.15	.16	.17	.19	.16	.09
	(1.212)	(1.242)	(1.249)	(1.247)	(1.251)	(1.214)	(1.252)
Innovativeness	−.05	−.01	−.01	−.02	−.11	−.04	.03
	(1.194)	(1.108)	(1.111)	(1.3.01)	(1.376)	(1.102)	(1.106)
Team composition (proportion of women on team)	−.04	.02	.03	.02	.08	−.05	−.02
	(1.038)	(1.271)	(1.271)	(1.105)	(1.138)	(1.260)	(1.260)
Main effects							
Dispersion		.04	.07	.10	.14	−.16	−.29*
		(1.071)	(1.304)	(1.173)	(1.234)	(1.164)	(1.393)
Improvisation		.28*	.14	.26*	.21**	.25*	.30*
		(1.080)	(1.315)	(1.220)	(1.189)	(1.146)	(1.180)
Interaction effect							
Improvisation × dispersion			−.36**		−.34**		−.33*
			(1.436)		(1.140)		(1.410)
R^2	.02	.11	.20	.11	.21	.12	.20
ΔR^2		.09	.09	.09	.10	.10	.08
ΔF		2.82**	7.35*	3.13*	8.43**	3.62*	6.16*

Notes: $n = 71$; * $p < .05$; ** $p < .01$. Standardized coefficients shown. Variance inflation factors (VIF) are reported in parentheses.

team dispersion. Figures 2, 3, and 4 support the prediction that team dispersion moderates the relationship between team improvisation and team performance. Specifically, team improvisation has a positive relationship with team performance in teams with low levels of dispersion. In contrast, the relationship between team improvisation and team performance is weaker in teams with high levels of dispersion. These interaction plots were further probed using a mean split of team dispersion to examine the simple slopes of the relationship between team improvisation and team performance. The objective forms of team dispersion show that team improvisation has a positive relationship with team performance when spatial dispersion ($b = .42$, $p < .01$) and configurational dispersion ($b = .37$, $p < .01$) are low. In contrast, team improvisation has a negative relationship with team performance when spatial dispersion ($b = -.41$, $p < .05$) and configurational dispersion ($b = -.41$, $p < .05$) are high.

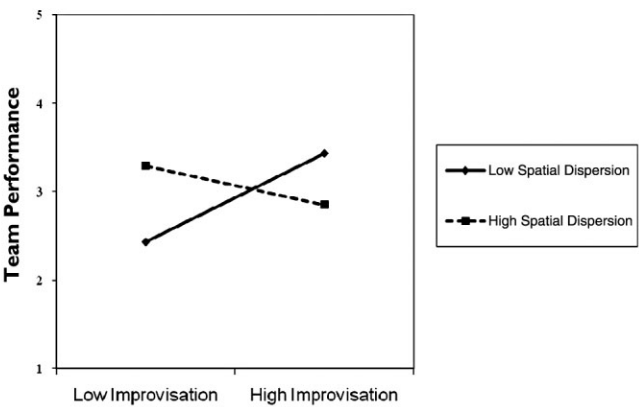

Figure 2. Interaction between Team Improvisation and Spatial Dispersion

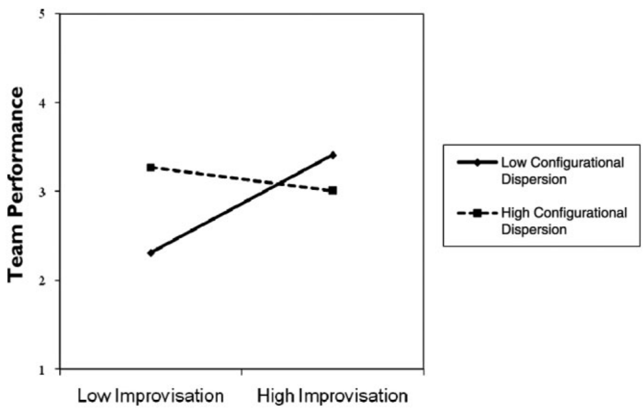

Figure 3. Interaction between Improvisation and Configurational Dispersion

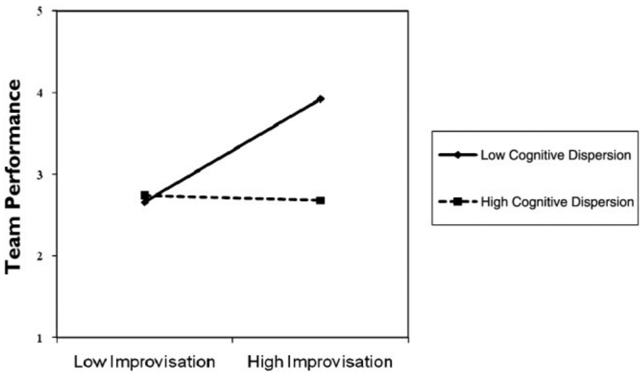

Figure 4. Interaction between Improvisation and Cognitive Dispersion

Finally, it is found that team improvisation has a positive relationship with team performance when cognitive dispersion ($b = .36$, $p < .05$) is low and a nonsignificant relationship when cognitive dispersion ($b = .12$, ns) is high. As depicted in Table 2, potential multicollinearity among predictors was accounted for. The variance inflation factor values reported in parentheses indicate that multicollinearity was not a threat to the findings because they are far below the threshold of 10 suggested by Hair, Black, Babin, Anderson, and Tatham (2005).

In order to assess the stability of the results, a robustness check was performed following the procedure by Hinds and Mortensen (2005). In particular, a simple dichotomous measure of distribution was computed in which teams were considered distributed (dispersion = 1) if teams were spread across at least two locations, and colocated (dispersion = 0) if all team members were operating at the same site. This dichotomous measure yielded results that were similar, although weaker, than the measures described above, thus confirming the robustness of the results.

Discussion

The goal of this research was to expand understanding of team improvisation and its impact on performance in teams. Specifically, the paper sought to examine the effectiveness of improvisation in the context of project teams. This was driven by the recognition that increasingly, organizations are moving toward a team-based structure for managing complex knowledge-intensive tasks. Naturally, such project teams tend to operate in an environment characterized by dynamic project requirements and emergent nonroutine issues that can undermine their effectiveness. In a departure from views in the extant literature, it was argued that team improvisation would have a positive influence on performance. In addition, the role of team dispersion was incorporated as an important feature of project teams, which is being increasingly used as organizations seek to take advantage of specialized knowledge at multiple locations.

In light of the results of the study, this paper makes several theoretical contributions. First, it contributes to the improvisation literature by incorporating the role of team dispersion as an important and increasingly prevalent aspect of team context that can influence the outcome of team improvisation. Previous research on improvisation has primarily focused on elements of the task environment and team composition as contextual factors (Moorman and Miner, 1998; Vera and Crossan, 2005). Structural features of teams—that is, their design—have not been explicitly incorporated into existing theorizing on the effects of improvisation. In this research, it was noted that team dispersion is increasingly becoming a common feature of teams that find themselves needing to engage in improvisation in their task work. As such, there was a need for research to shed light on the implications that such emerging structures would have for teams' improvisational efforts. In theorizing on the moderating role of team dispersion, it was reasoned that increasing levels of team member dispersion would attenuate the effects of improvisation on team performance. The underlying logic was that team dispersion erects barriers to timely and effective interaction and also reduces shared context—key building blocks for spontaneous and creative action to have positive outcomes (Vera and Crossan, 2005). Interestingly, it was found that at high levels of team dispersion, team improvisation can negatively affect team performance. This represents an important boundary condition that suggests that team improvisation is not necessarily a panacea for managing complex tasks. Thus, future research needs to incorporate team dispersion as an important feature of teams engaging in improvisational activities.

A second contribution of this work is in linking team improvisation to performance in project teams. Previous research had suggested that team improvisation is neither inherently bad nor inherently good. Rather its influence on outcomes depends largely on the influence of supportive contextual factors (Moorman and Miner, 1998; Vera and Crossan, 2005). However, in this paper, it was predicted that team improvisation would have a positive main effect on performance. Several reasons underlie this departure from the prevailing view of team improvisation. One is that the effects of improvisation on performance were theorized in the context of project teams. Project team work—particularly software development—

is highly knowledge intensive and is inherently complex (Espinosa et al., 2007; MacCormack et al., 2001). Consequently, such work benefits from improvisational activities. The other reason is that project teams often face unstructured, nonroutine, and unanticipated challenges in their work. Blind adherence to institutionalized routines under such conditions has proved to be detrimental to team performance (LePine, 2003). Consistent with expectations, team improvisation had a positive main effect on team performance in this study.

A third contribution of this work is the examination of improvisation and dispersion in the context of project teams. Previous research has not examined improvisation—as a spontaneous and creative process—in the context of project teams. Such a view highlights the need to contextualize the study of team improvisation by theorizing the role of team types. While improvisation has been argued to have no significant influence on outcomes in work teams, it has a positive influence on performance in the context of project teams as found in this paper. By theorizing the effects of improvisation in project teams, this research responds to recent calls to incorporate context when examining organizational phenomena (Johns, 2006). Moreover, Vera and Crossan (2005) highlighted the dearth of quantitative and empirical studies of improvisation at the team level. Thus, the field study reported in this paper contributes to a small but growing body of empirical work on improvisation in teams.

Strengths and Limitations

This research study has several strengths that should be noted. First, the study design involved data collection from multiple sources within participating teams. In particular, responses to questionnaire items were obtained from a majority of members in each project team as well as their leaders. This is particularly noteworthy given the difficulty of obtaining such data in a field setting. Second, the treatment of improvisation departs from the theatrical perspective that has been used in prior literature. The action-oriented view adopted from Vera and Crossan (2005) made it possible to examine improvisation in an organizational team context. Specifically, the research design was strengthened by focusing on one particular type of organizational team—project teams—in a field setting as they operated in their natural environment. Third, the field study involved 299 participants in 71 different project teams. Compared with previous field studies on improvisation and distributed teams, this is a fairly large sample size. Moreover, different respondents were used to measure the independent and dependent variables in the model. While team members provided responses pertaining to the independent variables, team leaders responded to questions pertaining to the dependent variable. Finally, this research is among the first to take into account both objective and subjective conceptualizations of team dispersion simultaneously in predicting team performance. This responds to the call by O'Leary and Cummings (2007) who urged researchers to empirically account for the two different approaches to measuring team dispersion in contexts characterized by high degrees of complexity.

Despite the strengths of the study, as with any research, the findings need to be interpreted in light of a few limitations. One limitation is the use of a survey method and a cross-sectional design in the study. Such a design raises the potential for common method bias as participants can engage in hypothesis guessing and social desirability while completing the questionnaire (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003). However, this concern is allayed because recommendations by Podsakoff et al. (2003) were followed through the use of multiple respondents within each team. The study also involved different respondents for the independent and dependent variables in the model. Moreover, the scope of the empirical data gathered for this research primarily allows generalization of the results obtained to the domain of software development teams. Future research should assess whether the present study's findings could be replicated in NPD contexts outside software development. Finally, this study may suffer from omitted variable bias. Although different conceptualizations of dispersion were adopted and potential confounding variables were controlled for, it was not possible to measure all of the potential factors that may have influenced the relationship between team improvisation and performance. A more limited approach was taken because of restrictions in the degrees of freedom (given 71 teams). Because of organizational concerns over survey length, there were limits to the number of questions that could be asked of participants. Thus, there may be other factors that play an explanatory role that were not evaluated. In particular, the inclusion of social contingencies such as groupthink, expertise, team risk aversion, peer pressure, and power might help to shed some light on the triggers of team improvisation across different degrees of team dispersion, thus increasing the variance explained. Future research should take such social contingencies into account while also accounting for team dispersion when studying teams that deal with unexpected events. Despite the low R^2 values in the models, they are consistent with similar research on distributed teams (Hoegl et al., 2007; Kirkman et al., 2004). Maintaining a parsimonious model that relates team improvisation and team dispersion to team performance could represent the first step toward achieving a deeper understanding of how to support dispersed teams above and beyond their task and to cope with emergent issues.

Theoretical Implications and Future Research Directions

The results of this study provide several implications for research. First, a positive relationship between team improvisation and team effectiveness was theorized and corroborated. However, as noted earlier, previous research suggested that improvisational actions are not inherently positive or negative (Vera and Crossan, 2005). This finding suggests that the effects of improvisation need to be examined with respect to a variety of team outcomes. For example, while the results indicate a positive effect for improvisation on team effectiveness, others have found no main effect relationship with innovation. This could very well be linked to the nature of the outcome being examined. One contrast is that innovation, as an outcome, reflects the novelty of ideas that have been put into action (Amabile, 1996; Taylor and Greve, 2006). Thus, as Vera and Crossan (2005) observe, improvisation may not necessarily lead to innovative outcomes. Rather, contextual factors such as expertise and teamwork need to be taken into account. In the context of team effectiveness, the focus is on the actions through which teams identify and craft solutions to nonroutine challenges in their projects. As such, team improvisation reflects a purposeful departure from established routines, in conditions where adherence to routines can be detrimental to performance (LePine, 2003). In light of these differences, we suggest that future field research examine the impact of team improvisation on other outcomes that are critical to teams (e.g., team viability, efficiency, and learning). In addition, we suggest that future research examine the potential drivers of team improvisation. While it is particularly important to understand the effects of team improvisation on team outcomes, it is believed that future research should investigate contextual characteristics that may trigger team improvisation. Pursuit of such a research agenda would be consistent with previous research that has called for a better understanding of how organizations can prepare teams to deal effectively with surprises in the task environment (Bechky and Okhuysen, 2011; Mirvis, 1998; Waller et al., 2004) in a timely manner before problems escalate (Bechky and Okhuysen, 2011). Moreover, it is possible that team improvisation can have different effects on outcomes when employed in various types of teams. For instance, while team improvisation was found to be important in the project teams studied in this paper, it may be less critical in the context of manufacturing teams where tasks are fairly structured and routine. The effects of improvisation could be varied in the context of action teams such as surgical teams. For instance, Bechky and Okhuysen (2011) recently found improvisational actions to be critical for success in SWAT teams and in film crews.

This research also highlights the importance of team dispersion as an important contingency in dealing effectively with emergent issues. While previous studies (e.g., Vera and Crossan, 2005) emphasized the importance of team dynamics as supportive contextual factors that enhance the effects of improvisation on teams' outcomes, the role of team dispersion has not been addressed despite its increasing importance both in the literature and managerial practice. Thus, this paper contributes to extant team improvisation research by incorporating the role of team dispersion. The results showed that high degrees of team dispersion can actually cause team improvisational efforts to negatively affect performance. Moreover, this study contributes to previous literature not only by considering the role of team dispersion, but also by taking different conceptualizations of team dispersion—objective and subjective—into account. The results are particularly relevant because they reveal a similar pattern across different conceptualizations of dispersion and their impact on team effectiveness. Indeed, whereas previous studies suggest that differences in team outcomes may be tied to the different types of dispersion (O'Leary and Cummings, 2007), this study shows that the effects of team improvisation on performance are similar across different forms of team dispersion. This result can be traced back to the nature of improvisational action. Situations characterized by the need for extemporaneous and creative action within a short time frame may override attempts to overcome interaction barriers.

Contrary to prior findings, a significant direct relationship was not found between team dispersion and team effectiveness. One possible explanation can be traced to the fact that all project teams in the study sample had access to similar sets of communication technologies and that such technologies may help individuals to overcome some of the challenges of dispersion. According to Hoegl et al. (2007), computer-mediated communication can help teams in solving the communication and coordination problems associated with dispersion. This explanation is consistent with previous findings indicating that communication effectiveness is more related to the context in which interaction occurs rather than to the media that is adopted for managing the interaction process. In light of this result and the significant interaction effect of team dispersion on the relationship between team improvisation and performance, it is possible to argue that effective exchange of information among team members is constrained by a contextual need for quick and emergent action. Thus, in contextual conditions that do not require team members to react in response to emergent needs, computer-mediated communication is sufficient for supporting the interaction of dispersed team members.

An important next step for research on team improvisation in dispersed team contexts will be to identify various interventions that will enable highly dispersed teams to realize positive outcomes from their improvisation. Recent research on team dispersion suggests that the barriers it erects are not entirely insurmountable (Cummings et al., 2009). One increasingly promising avenue involves the use of appropriate technologies to facilitate team awareness (Espinosa et al., 2007). Espinosa et al. (2007) have suggested that the use of communication technology to enhance task and presence awareness may be useful in overcoming barriers to effective coordination in distributed teams. We think that this is a promising avenue for identifying ways to leverage the breadth of expertise that distributed teams provide. By enhancing task awareness, distributed teams have more shared context on the status of various aspects of the task that may be impacted by improvisational actions. In addition, presence awareness gives a clearer indication of which team members are available to provide real-time, spontaneous input into problem solving. The use of information and communication technology can also be leveraged to establish shared expectations about where expertise resides and who is responsible for various aspects of the task (Choi, Lee, and Yoo, 2010). Choi et al. (2010) have recently shown that information and communication technology can be effective in helping teams to establish transactive memory systems. Such systems can make it easier to deploy and integrate knowledge resources for creative problem solving in a timely manner.

Managerial Implications

In addition to providing implications for theory, this research offers several insights for managers. A key implication is that managers need to be deliberate in their staffing of project teams. In doing so, they ought to be cognizant of expectations regarding the level of certainty and routineness associated with the project. The present study offers some guidance for supporting the trade-off between the desire for dispersed expertise and the need to cope with emergent situations. Specifically, in projects where key parameters are ill defined, solutions need to be customized, or requirements can shift, managers are better off designing teams with colocated members because such teams are likely to need to engage in improvisation in order to work effectively. However, when key project outcomes and parameters are well known, task interdependence is moderate, and templates for task execution exist, team improvisation may be less necessary, and, therefore, managers can utilize distributed teams. In light of the positive influence of team improvisation on team effectiveness, another key implication is that managers should foster an environment that is conducive to improvisation for teams with low degrees of dispersion, while they should put in place mechanisms that help dispersed teams to overcome the barriers erected by dispersion when dealing with unexpected events. This is particularly true for project teams that tend to engage in complex knowledge-intensive work. The tasks faced by such teams rarely have predetermined templates for achieving project goals. Rather, the ability to creatively and spontaneously craft solutions using available resources is paramount. Thus, it behooves managers to create favorable conditions for team improvisation.

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