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Where's The Boss? The Influences Of Emergent Team Leadership Structures On Team Outcomes In Virtual And Distributed Environments

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WHERE'S THE BOSS? THE INFLUENCES OF EMERGENT TEAM LEADERSHIP STRUCTURE ON TEAM OUTCOMES IN VIRTUAL & DISTRIBUTED ENVIRONMENTS

by

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ABSTRACT

The influence of leadership on team success has been noted extensively in research and practice. However, as organizations move to flatter team based structures with workers communicating virtually across space and time, our conceptualization of team leadership must change to meet these new workplace demands. Given this need, the current study aims to begin untangling the effects of distribution and virtuality on team leadership structure and subsequent team outcomes that may be affected by differences in conceptualizing such structures. Specifically, the goals of this study were threefold. First, this study investigated how the physical distribution of members may impact perceptions of team leadership structure, depending on virtual tool type utilized for communicating. Second, this study explored how different indices of team leadership structure may have different influences on team outcomes, specifically in terms of conceptualizing the degree to which multiple members are perceived as collectively enacting particular leadership behaviors via a network density metric, and conceptualizing team leadership in regards to the specialization of members into particular behavioral roles, as captured via role distance and role variety indices. Finally, this study expanded on current research regarding team leadership structure by examining how the collective enactment of particular leadership (i.e., structuring/planning, problem solving, supporting social climate) behaviors may facilitate specific teamwork processes (i.e., transition, action, interpersonal), leading to enhanced team performance, as well as how leadership role specialization may impact overall teamwork and team performance.

Findings from a laboratory study of 188 teams participating in a simulated decision making task reveal a significant interaction for the influences of physical distribution and

virtuality on perceptions of leadership structure, such that less distributed teams (i.e., those with fewer isolated members) were more likely to perceive their distributed members as participating in the collective enactment of necessary leadership responsibilities when communicating via richer media (i.e., videoconferencing, teleconferencing) than less rich media (i.e., instant messaging). However, virtuality and distribution did not impact the degree to which members were perceived as specializing in a particular leadership role, or the overall variety of leadership roles being performed. In terms of team outcomes, the perceived collective enactment of leadership emanating from distributed team members significantly predicted teamwork, while the perceived collective leadership of collocated members did not have a significant impact. Specifically, greater distributed team member involvement in the collective enactment of structuring/planning leadership positively impacted team transition processes, while the collective enactment of supporting the social climate positively predicted team interpersonal processes. Although the relationship between perceived leadership role specialization, in terms of role distance and role variety, and team performance was mediated by overall teamwork processes as expected, leadership role specialization had a negative impact on overall teamwork.

Finally, while team action processes did not serve to mediate the relationship between perceived problem solving network density and team performance, team transition processes mediated the relationships between the collective enactment of structuring/planning for distributed members and team performance. The collective enactment of supporting the social climate by distributed team members and its relationship to team performance was also mediated by interpersonal teamwork processes. Together, these results reveal the importance in considering context, specifically virtuality and physical distribution, when designing, developing

and maintaining effective team leadership, teamwork, and team performance. Furthermore, they provide unique insight regarding how different configurations of leadership may be possible in teams. Study limitations, practical implications, and recommendations for future research and practice are further discussed.

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CHAPTER ONE

Statement of the Problem

Many of the greatest scientific feats accomplished come not from lone scientists and researchers, but instead from teams of individuals collaborating around the world (Whitfield, 2008). Given the ever growing, complex nature of problems in medicine, space exploration, technology, and many other natural and social science fields, researchers are increasingly collaborating within and across disciplines to produce high impact work. Indeed, a recent review conducted by Wuchty, Jones, and Uzzi (2007) examining over two million patents and 20 million research publications found that since the 1950's, collaborative efforts involving multiple researchers have had a significantly higher impact than sole authors.

However, while such collaborations may bring together the scientific expertise needed to solve problems, this does not mean that the team members are also experts in teamwork. Failures in communication, coordination, performance monitoring, and other teamwork processes have plagued teams for years, often with disastrous results (Salas, Cooke, & Rosen, 2008). For example, the Mars Climate Orbiter was lost in 1999 when members of the engineering team failed to coordinate effectively with NASA and used the wrong measurement system to construct software, causing the orbiter to disintegrate when it entered the atmosphere at an incorrect angle (Sauser, Reilley, & Shenhar, 2009). Thus, in addition to possessing content area expertise, there may be other functions critical to effectively facilitating the necessary processes that enable subsequent team effectiveness (Salas, Rosen, Burke, & Goodwin, 2009).

Furthermore, given advances in technology and communication, teams may also operate in distributed locations, requiring them to collaborate through virtual media such as videoconferencing or teleconferencing (Connaughton & Shuffler, 2007; Martins, Gilson, &

Maynard, 2004). Indeed, virtuality and distribution have become the norm in most team situations, with it no longer being a question of whether or not teams are virtual and distributed, but instead the degree to which teams are virtual and distributed (Kirkman & Mathieu, 2005). Virtuality therefore has come to be viewed on a continuum, with low virtuality teams being those whose synchronous communications are rich in task information and social cues (e.g., videoconferencing) and high virtuality teams being those whose asynchronous communications are weaker in providing relevant task and social information (e.g., email, instant messaging). Distribution, while in research often dichotomized into full distribution or collocation, can also be viewed along a similar continuum, with teams capable of being partially distributed (e.g., half the team collocated, other members isolated) in many different possible configurations.

While the ability for teams to be distributed and connected via virtuality does offer benefits, such contextually driven interactions can also pose a variety of challenges to critical team processes, as seen in the Mars Climate Orbiter example where the team members creating the software and those building the orbiter were located in two different regions of the United States (Sauser, et al., 2009). Certainly, while virtuality offers the opportunity of being able to bring together teams of qualified individuals no matter what their geographic location (Maynard, Mathieu, Rapp, & Gilson, 2012), it is important to note that this distribution of members and types of virtual tools utilized may impact how social presence—or a lack thereof—is conveyed in teams, which can in turn inhibit team processes and effectiveness (Kirkman & Mathieu, 2005).

Given these complexities that science and other similar teams may face in terms of teamwork, it is important to understand what factors may be able to help improve their performance and reduce the likelihood of critical errors such as those experienced by the Mars

Orbiter team. One proposed avenue for effectively facilitating teamwork in complex environments is that of team leadership (Bell & Kozlowski, 2002; Burke, DiazGranados, & Salas, 2011; Kayworth & Leidner, 2002). The purpose of leadership in any given team is to establish goals and set direction that will lead to the accomplishment of these goals (Zaccaro, Rittman, & Marks, 2001). From a functional leadership perspective, this means performing a range of behaviors, both those specific to the task at hand as well as those behaviors aimed at enhancing the social climate of the team (Zaccaro, Heinen, & Shuffler, 2009). Previous research suggests that team leadership is a critical component of ensuring effective team processes and team outcomes (Burke, et al., 2006; Salas, Sims, & Burke, 2005; Zaccaro, 2007).

However, team leadership does not necessarily have to rely solely upon a single individual, as is often the assumption (Pearce & Conger, 2003). Indeed, there may be multiple leaders on a team, with different members sharing leadership responsibilities or rotating leadership to ensure effectiveness (Zaccaro & DeChurch, 2012). While still a relatively new area of study, primarily focused on face to face teams, there have been promising findings supporting the idea that team centric leadership whereby multiple members participate in leading can facilitate effective teamwork and enhance team performance (Balkundi & Harrison, 2006; Carson, Tesluk, & Marrone, 2007; Mehra, Smith, Dixon, & Robertson, 2006; Pearce & Conger, 2003). Team leadership in virtual and distributed environments may, therefore, be even more effective than traditional vertical leadership, as having multiple team members step up to take on leadership needs can aid in ensuring specific team needs are being met across the team lifecycle (Day, Gronn, & Salas, 2006).

While team leadership may be one avenue for enhancing virtual and distributed team effectiveness, one critical question that has yet to be answered is that of how virtuality and

distribution may in fact impact the emergence and structure of team leadership. Specifically, it is critical to understand how physical distribution may impact perceptions of leadership, and how the use of virtual tools may facilitate or inhibit such perceptions. Furthermore, there are multiple ways to conceptualize how leadership structures may be emerge as a function of being in these complex environments, especially in terms of examining the degree to which the same behaviors are collectively enacted versus the specialization of members into certain leadership roles. Thus, while current research is advancing towards improving our understanding of what it truly means to collectively lead in a team setting, there is a critical need for empirical research that breaks down these issues, particularly for complex virtual and distributed environments.

Purpose of the Current Study

Thus, the current study is designed to serve as an initial step towards addressing the aforementioned research gaps. Specifically, the aims of this research are threefold. First, this study investigates how the physical distribution of members may impact perceptions of team leadership structure, depending on virtual tool type utilized for communicating. Although distribution and virtuality have been acknowledged to influence teams, the typical dichotomization of these contextual variables leaves much to be explored, especially from a leadership perspective. Therefore, instead of simply comparing highly virtual and distributed teams to face to face teams, as is common in this line of research (Connaughton & Shuffler, 2007), the current study breaks down both distribution and virtuality to better understand the nuances of each, particularly in terms of how they impact social presence. Specifically, this research explores the influences of partial distribution on team leadership structure development, as having some members collocated and some members distributed in the same team may have differing impacts on leadership emergence and effectiveness. Furthermore, given the widespread

use of different virtual tools, this study examines three different media, videoconferencing, teleconferencing, and instant messaging, in terms of how their varying levels of social presence may combine with distribution to affect how leadership emerges at the team level.

The second goal of this research is to explore how different indices of team leadership structure may have different influences on team outcomes. Multiple techniques for collectively assessing leadership have been proposed as of late, yet few of these have been empirically tested (Contractor, DeChurch, Carson, Carter, & Keegan, 2012; Yammarino, et al., 2012). Of particular needs is the consideration of both the degree to which team members may participate in performing the same type of leadership behavior, as well as the specialization of team members in regards to performing unique leadership roles. Conceptually these are two very different aspects of team leadership that may both influence teamwork and team performance, albeit in different ways. Therefore, the current research addresses both of these aspects using multiple indices, including network density to operationalize shared leadership for both collocated and distributed members as well as two forms of leadership role specialization as captured by role distance and role variety.

Finally, this study expanded on current research regarding team leadership structure by examining how the collective enactment of particular leadership behaviors (i.e., structuring/planning, problem solving, supporting social climate) may facilitate specific teamwork processes (i.e., transition, action, interpersonal), leading to enhanced team performance. While prior research has highlighted the direct effects of team leadership on team performance, the current research builds upon this by exploring teamwork as a mediating mechanism, further explaining how team leadership may influence team outcomes. Additionally, by breaking leadership into specific behaviors that theoretically should be linked to the success

of particular teamwork processes, the current research provides a more fine-grained analysis regarding team leadership's impact on outcomes than in prior studies.

Overall, this research is designed to make several important contributions. First, it expands upon current understanding of the nuanced effects of virtuality and physical distribution on the emergence of team leadership structure, hopefully creating a better foundation upon which to build future selection and development programs for leadership in these contexts. Second, this research will provide additional empirical evidence regarding the importance of leadership as a team-level variable, especially in terms of how different operationalizations may have differential effects on processes and outcomes. Finally, this research provides a foundation for beginning to explore the mediating mechanisms that may link team leadership and team performance, offering a better understanding as to why such collectively enacted leadership may facilitate improved performance and providing guidance regarding the specific leadership behaviors to be targeted in order to enhance teamwork processes.

CHAPTER TWO: LITERATURE REVIEW

Leadership Structure in Teams

Given the rise of teams in organizations today (Salas, et al, 2008), team leadership has received increasing recognition as a pivotal component to the development, maintenance, and promotion of effective teams (Burke, Stagl, Klein, Goodwin, Salas, & Halpin, 2006). Teams are defined as "a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission" (Salas, Dickinson, Converse, & Tannenbaum, 1992; p. 4). According to Zaccaro and colleagues (2001), the purpose of leadership in any given team is to establish goals and set direction that will lead to the accomplishment of these goals. Put another way, the responsibility of team leaders "is to do, or get done, whatever is not adequately handled for the group needs" (McGrath, 1962, p. 5). That is, team leadership involves performing whatever necessary functions may be required for reaching team success (Morgeson, DeRue, & Karam, 2010). However, given the wide range of functions that are required for successful team leadership, it may be necessary for the structure of team leadership to involve more than a single member. The following provides an overview of the different types of leadership functions critical to specific teamwork processes, along with a discussion of how team leadership may need to be conceptualized as a team property whereby one, multiple, or all members are involved in leading the team in order to effectively fulfill such functions.

Functional Approach to Team Leadership

There are many theories of leadership, and how leadership should be approached in team situations. However, perhaps the most prominent approach is that of functional leadership, which proposes that the purpose of team leadership is to identify team needs and perform whatever

functions are necessary in order to meet those needs (Fleishman, et al., 1991; Morgeson, et al., 2010). In order to add value beyond simply stating the necessity of "good" or "effective" leadership, the functional approach to leadership provides a more fine-grained analysis of the explicit roles that should be completed in order to meet individual, team, and organizational needs (Zaccaro, Heinen, & Shuffler, 2009). These functions can be broken down into specific categories of behaviors, with a number of theories and taxonomies being put forward delineating specific behaviors thought to enable effective leadership. Initiating structure and consideration, for example, are two widely researched behaviors that have been shown to influence several valuable organizational outcomes such as subordinate and organizational performance, job attitudes, and employee turnover (House & Aditya, 1997; Judge, Piccolo, & Illies, 2004).

Multiple taxonomies identifying and classifying more narrowly-defined leadership behaviors have also been proposed. Fleishman, Mumford, Zaccaro, Levin, Korotkin, and Hein (1991) identified 65 different classification systems developed between the years 1944 and 1986 alone. The authors then proposed an integrated taxonomy of functional leadership in which they specified 13 behavioral leadership categories subsumed within the larger dimensions of *managing personnel resources*, *information search and structuring*, *information use in problem solving*, and *managing material resources*. More recently, Yukl (2012) conducted an extensive review of the leadership literature to identify those leadership behaviors deemed to be effective to organizations, resulting in four meta-categories of task-oriented, relations-oriented, change-oriented, and external leadership functions, with 15 leadership behaviors subsumed under these categories.

Across all of these existing taxonomies of leadership behaviors, two categories of behaviors consistently seem to emerge: relationship-oriented and task-oriented leadership

behaviors (Burke, et al., 2006; Fleishman, et al., 1991). Task-oriented behaviors are those which facilitate the effective enactment and coordination of tasks needed to reach team goals. DeRue and colleagues (2011) incorporate initiating structure and aspects of transactional leadership into the larger category of task-oriented leadership, while Burke and colleagues (2006) also included initiating structure and transactional behaviors in their categorization of task-focused leadership, along with boundary-spanning, or the collaboration with others outside of the team in order to scan the environment and negotiate resources needed (Hirst & Mann, 2004). Relationship-oriented leadership behaviors are more focused upon the interpersonal nature of teams and ensuring that members are motivated, developed, and can get along from a relationship standpoint in order to successfully perform tasks (Zaccaro, et al., 2009).

While such taxonomies of leadership behavior are invaluable resources in terms of identifying general leadership functions, few of them thoroughly consider the role of team leaders, particularly in terms of pairing team lifecycle needs with anticipated leadership behaviors needed for success. Noting this discrepancy, more recent approaches have focused upon delineating functional behaviors specific to teams and their processes. For example, Zaccaro, Rittman, and Marks (2001) developed a framework of team leadership grounded in the functional leadership tradition, describing four categories of leadership behaviors proposed to influence a subset of team processes identified as critical to team effectiveness.

Further expanding this work, Morgeson and colleagues (2010) recently mapped leadership behaviors onto a well established taxonomy of team processes in order to provide a more streamlined view of the specific leadership behaviors needed for different aspects of teamwork (Marks, Mathieu, & Zaccaro, 2001). Merging the previously mentioned bi-modal approach to functional behaviors, Morgeson and colleagues (2010) argue that for teams, the

aforementioned task-oriented behaviors should be further broken down into transition- and action-oriented leadership behaviors in order to align with the phases of teamwork (Marks, et al., 2001). Taken as a whole, these three higher order categories of team leadership behaviors can be utilized as a framework for understanding the precise leadership functions that may be most critical to specific teamwork processes.

Transition and action leadership behaviors. The primary goal of task-oriented team leadership behaviors are to ensure that the tasks at hand can be accomplished successfully by the team (Yukl, 2012). This means that team leadership is responsible for ensuring that prior to launching into task performance, the right structures and plans, such as communication networks, coordination plans, and procedures for monitoring, are put into place in order to facilitate later teamwork (Salas, Sims, & Burke, 2005). Such *structuring and planning* behaviors occur during a team's transition phase, whereby the team is focused on identifying their mission, specifying goals, and creating plans regarding how to best meet these goals (Marks, et al., 2001). Once teams launch into performing their task, the action phase of performance has begun. During this phase, team members must monitor their performance, back up one another if a member gets overloaded, and recognize when issues arise. One of the most critical leadership behaviors during this phase of teamwork is therefore being able to *recognize and solve problems* that may arise unexpectedly (Morgeson, et al., 2010). Problem solving refers to finding ways to handle disruptions that may occur during operations, either due to team member issues or task/resource issues (Yukl, 2012). Both of these leadership behaviors may need to be implemented numerous times throughout a performance period for a team, as teams may go through several episodes of transition and action as new information and challenges emerge

during task performance that require a revisiting of goals and plans (Marks, et al., 2001; Mathieu, et al., 2008)

Extensive research has connected these two leadership behaviors to team outcomes and leadership effectiveness (e.g., Ancona & Caldwell, 1992; Kim & Yukl, 1995; Kane, Zaccaro, Tremble, & Masuda, 2002; Morgeson, 2005; Shipper & Dillard, 2000). Indeed, in their study of collective leadership in maintenance teams, Hiller and colleagues (2006) found that teams who collectively exhibited high levels of planning and problem solving had improved team performance. Collectively, transition and action leadership behaviors have been linked to various team outcomes, especially initiating structure (Judge, et al., 2004). In their meta-analysis, Burke and colleagues (2006) found that the aforementioned transactional, initiating structure, and boundary spanning behaviors predicted team effectiveness and team productivity. Furthermore, DeRue and colleagues (2011) found that task-focused leadership behaviors positively predicted group performance and leadership effectiveness, highlighting in particular the effects of task-oriented leadership behaviors on aspects of task performance. Together, these extensive reviews provide support that transition and action oriented leadership behaviors do in fact have a significant influence on team outcomes.

Interpersonal leadership behaviors. Researchers have noted the importance of attending to the social aspects of teamwork, as interpersonal conflicts can reduce the effectiveness of teams (Campion, Medsker, & Higgs, 1993; Marks, et al., 2001). Interpersonal team leadership behaviors are those which facilitate the attitudes, behaviors, and cognitions of team members in order for teams to work effectively together (Burke, et al., 2006). Such behaviors enhance the social development of the team in order to ensure that team members can work effectively together on the tasks at hand (Yukl, 2012). Furthermore, these behaviors are intended to build

trust and respect among group members as well as to encourage team members to focus on working towards the greater good of the collective (DeRue, et al., 2011).

There are multiple behaviors that can fall into the interpersonal category, many of which have been empirically linked to enhanced team outcomes. In their review of leadership behaviors, Burke and colleagues (2006) noted transformational, consideration, empowerment, and motivational behaviors as being those person-focused leadership behaviors which support social effectiveness in teams. Specifically, they found that these person-focused leadership behaviors were positively associated with perceived team effectiveness, team productivity, and team learning. DeRue and colleagues (2011) took a similar approach in their meta-analysis of leadership behaviors, considering relational-oriented behaviors to include consideration, empowerment, participative, developing, enabling, and servant leadership. Again, they found a significant, positive relationship between relational-oriented leadership behaviors and group performance, indicating the positive effects that such behaviors can have on team effectiveness.

Morgeson and colleagues (2010) proposed that *supporting the social climate* is a critical interpersonal team leadership function. This overarching behavior is a compilation of interpersonal leadership behaviors derived from an extensive review of the literature. It encompasses elements of consideration, showing respect for team members, responding to team members' concerns, and supporting the team by looking out for the well-being of team members and the team as a whole. Collectively, this behavior and its associated components combines the critical aspects of interpersonal leadership that have been most prominently linked to team outcomes such as improved team satisfaction and viability (Pirola-Merlo, Hartel, Mann, & Hirst, 2002), improved team climate (Phillips, Douthitt, & Hyland, 2001), and team performance (Kim, et al., 1999). Thus, in sum, it appears that when interpersonal leadership behaviors, or those

behaviors aimed at enhancing the social environment of a team in order to facilitate effective teamwork, are performed in order to meet team needs, teams experience improved interpersonal processes, and subsequently higher performance.

Teams Leadership as an Emergent Team-Centric Variable

Certainly, there are numerous functions that are critical to team leadership. Furthermore, given the episodic and dynamic nature of teamwork, it may be the case that numerous behaviors may need to be performed at the same time, or many times over the lifecycle of a performance episode. For example, a team may need to simultaneously be receiving guidance via structuring and planning while also creating a supportive social climate, or may require repeated problem solving interventions in a complex task. Thus, while leadership research has primarily focused on identifying a single individual as a team leader, it may well be the case that viewing team leadership as an emergent team-centric variable involving multiple team members is a more realistic and appropriate perspective (Conger & Pearce, 2003; Yammarino, et al., 2012).

The notion of team members collectively performing leadership functions is not a novel one (Robbins, 1952; Berkowitz; 1953; Gibb, 1954; Tannenbaum & Massarik, 1957). However, there has been a recent revitalization of the topic. Though the research on vertical leadership is thorough and extensive, the idea that multiple team members may be involved in the process of leadership has emerged as a critical component in the modern organizational world. The ever-changing environmental conditions of teams and organizations make the sharing of leadership critical for survival, especially when tasks are interdependent and complex (Merkens & Spencer, 1998; Pearce, 2004). Moreover, team members actively involved in accomplishing team tasks and goals may best understand the complexity of the modern organizational setting. Thus, those

individuals are often in the best position to recognize and address needs of leadership (Jackson, 2000).

Leadership as a team level variable has been conceptualized in many ways (Carson, et al., 2007; Friedrich, et al. 2009), but the underlying theme among these definitions is that such leadership involves the distribution of the leadership responsibilities within the team (see Lambert, 2002; Jackson, 2000; Pearce & Conger, 2003), while not negating the possibility of a singular, vertical leadership. The different conceptualizations of team-centric leadership differ on what constitutes leadership and the manner in which responsibilities are distributed. For example, there is a stream of leadership research that explicitly views collective leadership as an emergent state (Day, Gronn, & Salas, 2004 – leadership capacity), while another stream of research does not reject the possibility that shared leadership could be formally prescribed (Pearce & Sims, 2002).

For the purposes of the current study, team leadership refers to an emergent team property resulting from the distribution of leadership influence across multiple team members (Carson, et al., 2007, p. 1218). Based on this definition, team leadership involves multiple individuals stepping into leadership roles as needed. Furthermore, drawing upon the functional leadership approach previously discussed, team leadership involves the implementation of multiple leadership behaviors, including transition, action, and interpersonal-oriented leadership behaviors. The organization of this leadership may take different forms, depending on contextual factors. For example, in a virtual team, one or more team members who are very comfortable using the type of technology needed to communicate may step up to facilitate task-oriented leadership behaviors such as planning, as their comfort level and expertise in the technology provides them with the abilities to structure such plans. Furthermore, a member of the same

virtual team with excellent social skills may be equipped to step up to facilitate a supportive social climate, meeting another critical leadership need in the relationship-oriented area. Thus, three members of the same team may each be exhibiting leadership behaviors, with two performing similar behaviors while a third provides a different type of leadership, although all are working together to fulfill team needs.

This example serves as just one instance of how leadership might emerge collectively in a team setting, as given the previous definition, there are many possible configurations, especially when multiple leadership behaviors are necessary. There is no one "correct" way to conceptualize leadership at the team level, as the concept has only recently regained traction in the organization literature (Gockel & Werth, 2010; Hoch & Kozlowski, 2012). However, there are two key elements in considering leadership as a team level variable: 1) the degree to which members share or participate in performing a single leadership behavior or role, and 2) the degree to which team members are specialized in a particular leadership role or behavior (Contractor, et al., 2012; D'Innocenzo & Kukenberger, 2010). For the purposes of the present study, the former is referred to as collective team leadership, while the latter is referred to as team leadership specialization.

Team Leadership as Collective Enactment. Perhaps the most common approach to date in terms of understanding leadership as a team level variable is the conceptualization of how much members collectively work together in performing leadership behaviors (Contractor, et al., 2012; Yammarino, et al., 2012). Current approaches typically utilize a social network approach to analyze this degree of sharedness, whereby individual members rate one another regarding perceptions of leadership. From these ratings, a density metric can be created to represent collective leadership enactment, offering an average for the team in terms of the extent to which

members perceive one another as having influence. This form of team leadership has been referred most often as shared or collective leadership (Carson, et al., 2007). Furthermore, the degree to which team members share in performing leadership has been linked to overall team success, with this type of networked measure exhibiting stronger effects than other aggregate measurement approaches (Mathieu, et al., in press). This effectiveness of density as a collective leadership metric is likely due to the fact that by becoming involved in the team leadership process, members become more committed and engaged in the task, and are also more likely to accept leadership from other members, resulting in a more effective team due to performance needs being met across the board (Carson, et al., 2007).

Although this collective leadership approach offers the advantage of being able to assess the degree to which team members tend to perceive one another as performing similar types of leadership, it does not provide information regarding how leadership behaviors may be dispersed. As such, while it is possible to calculate a network density value for either overall leadership or a particular leadership behavior (e.g., problem solving), this approach cannot capture the degree to which members may be performing more than one behavior. However, it is possible to create multiple network density indices based on other structural features which may impact how team leadership emerges. As will be later discussed, this means that for teams where some members are physically collocated and others are distributed, it is possible, and appropriate, to calculate different densities in order to assess the perceptions of how involved distributed team members are in the leadership process, separate from the perceptions of leadership for collocated team members.

Team Leadership as Specialization. In order to tap into the dispersion aspect not captured by density measures of team leadership, it is important to also consider

operationalizations of specialization. In addition to overall sharing of leadership in general or the participation of multiple members in performing a single leadership behavior, team members may also each possess a specific leadership role. This is similar to the idea of transactive memory systems, whereby different team members possess unique knowledge as well as an overarching understanding of who possesses what knowledge (Lewis, 2003). Just as transactive memory systems facilitate team performance by maximizing the contributions of member knowledge and expertise, a specialization of leadership responsibilities is likely to also positively impact teams, as members can concentrate on effectively performing a specific leadership role, knowing that other members are taking on other necessary leadership functions. Indeed, variety in other team variables (e.g., functional background, external social ties, access to different types of data) has been found to positively impact team outcomes (Argote & Ingram, 2000; Carpenter, 2002; Ferrier, 2001).

While theoretically having members take on unique leadership roles has been argued as a positive aspect of leadership that should facilitate team effectiveness (Contractor, et al., 2012; Conger & Pearce, 2003; Day, et al., 2004; Yammarino, et al., 2012), currently this is an area much lacking in the team leadership literature, as the majority of work to date has primarily focused on the sharing of leadership. However, existing literature regarding variety in team composition variables offers a starting point for developing two possible metrics: role variety and role distance. Drawing upon the work of Harrison and Klein (2007), it can be argued that for team leadership, role variety is one method for operationalizing specialization, as variety captures the degree to which team members vary qualitatively from one another. From a leadership perspective, an example of a team high in role variety could exist when one member performs problem solving leadership, another performs social climate support, while yet another

performs problem solving leadership. However, currently available indices of variety, such as Blau's (1977) index of diversity, place individuals in a single qualitative category. As previously discussed, team leadership provides a unique situation whereby members may at times need to step in and aid in performing additional leadership behaviors in order to meet team needs (Zaccaro, et al., 2001). Therefore, it is entirely possible that team members could perceive one another as fitting into more than one category of leadership (e.g., frequently performing both problem solving and supporting the social climate).

In order to account for this, the concept of role distance should also be considered along with role variety. Role distance captures the degree to which a team member is perceived to be specialized in a singular leadership behavior. While it does not necessarily account for the specific behavior performed, as described by role variety, it does provide additional data regarding the degree to which a member concentrates on performing a single behavior effectively. Role distance can be assessed when members provide valued data whereby team members not only are asked about the type of leadership behaviors performed within the team, but are asked to rate the extent to which members perform a particular behavior. Given this data, distances in scores on the different behaviors performed can be calculated, then summed across the team in order to provide an overarching picture of the degree to which team members are specialized in any one of a set of possible leadership behaviors.

Combined, these two overarching approaches to operationalizing leadership structures at the team level provide the potential for unique insights regarding how leadership may be perceived and emerge at the team level. As no single measure currently exists to capture both the specialization and collective enactment of leadership behaviors, the use of multiple indices is necessary. While none of these measures can perfectly capture all of the nuances of leading at

the team level, by including multiple indices, it is expected that a more holistic picture can emerge regarding the emergence and effectiveness of team leadership.

Contextual Influences on Team Leadership Structure: Team Distribution and Virtuality

Certainly, team leadership can be critical for team success. However, the context in which teams operate can influence the emergent structure of team leadership, and the subsequent effectiveness of such leadership (Hoch & Kozlowski, 2012). Of particular interest are virtuality and distribution, as these contextual features can influence the social presence needed to convey influence, a critical component of leadership (Bell & Kozlowski, 2002; Kirkman & Mathieu, 2005). Indeed, Pearce, Perry, and Sims (2001) identify geographic dispersion as a condition by which to negatively impact the likelihood of leadership emerging as a team level variable. However, there may be ways in which to mitigate the negative impacts of distribution on team leadership, such as the use of richer media such as teleconferencing or videoconferencing which convey more social cues (Daft & Lengel, 1984; Hinds, Liu, & Lyon, 2011). The following provides a discussion regarding the contextual influences of distribution and virtuality in terms of their impact on team leadership emergence, and specifically how they may interact to affect perceptions of such leadership.

Team Distribution

Team distribution is not a new concept, but it has become an increasingly important factor to consider in the development and implementation of teamwork (O'Leary & Mortensen, 2010). Distributed teams have been labeled in numerous ways, including "virtual teams", "geographically distributed teams" and "dispersed teams". For the purposes of this study, distributed teams is the preferred construct name due to its simplicity and connection to the primary components of what make up this type of team: the geographical distribution of team

members across space and time (Cascio & Shurygailo, 2003; Connaughton & Daly, 2003; 2004a; 2004b; O'Leary & Mortensen, 2010). As such, distributed teams can be defined as teams whose members are geographically and/or organizationally dispersed and therefore must utilize a combination of telecommunications and information technologies to accomplish an organizational task (Townsend, DeMarie, & Hendrickson, 1998). Team members may be fully distributed, with all members located in different geographical regions, they may be partially distributed, with some team members collocated and others in one or more geographical regions, or they may be completely collocated (Bell & Kozlowski, 2002). While it is a common assumption that team members who are distributed must be spread across large distances, full distribution can also occur for teams with members located a very short distance from one another, even within the same city or organization.

Current research has focused on both the positive and negative aspects of distributed teams. Indeed, there is extensive debate as to whether distribution is a challenge to teams or a distinct advantage (Connaughton & Shuffler, 2007). Some researchers view distribution as allowing teams to cast a wider net to find team members with particular skills or knowledge that will benefit the team's end goals. Martins, Gilson and Maynard (2004) recognize that as goals for a team changes, distribution allows for more fluid membership such that specific expertise can be added as needed. Zaccaro, Ardison, and Orvis (2004) highlight several advantages of distributed teams, including a greater participation of skilled participants, increased speed of response time to incidents, and increased exposure for team members to new ideas, perspectives and experiences which can broaden their knowledge to apply to future goals. From a leadership perspective, this may mean being able to bring together members with unique strengths in terms of the types of leadership functions they are capable of performing successfully, such that

leadership may be able to be distributed among team members to maximize effectiveness (Morgeson, et al., 2010).

While there are positive aspects of distributed teams, much of the current empirical work tends to focus on the drawbacks of distribution. Previous research has found that distributed teams are often linked to negative outcomes. For example, distribution tends to be connected to lower levels of trust (Jarvepaa & Leidner, 1999), in that it takes longer for trust to be established and it is more difficult to maintain in a distributed environment. Hinds and Bailey (2003) in their review of the literature connecting conflict and distribution found that affective conflict (conflict between team members) is higher in dispersed teams than in face to face teams. In respect to cohesion, Warkentin, Sayeed, and Hightower (1997) found that distributed team members are more likely to report lower levels of cohesion than face to face team members. In terms of satisfaction, a review of the distributed team literature found that distributed team members typically report lower levels of satisfaction than face to face team members (Martins, et.al., 2004). Finally, and perhaps most importantly, distributed teams tend to take longer to reach performance goals and objectives, presumably due to many of the aforementioned complications (Cappell & Windsor, 2000; Daly, 1993).

One problematic area regarding current research on team distribution is that it is often dichotomized into fully distributed vs. fully collocated (i.e., face to face) teams (Connaughton & Shuffler, 2007). This distinction is troublesome, as real world virtual teams typically are partially distributed, with groups of team members located in different geographical regions, utilizing technology to complete tasks together (Goodwin & Halpin, 2006). This is especially true for complex tasks that demand high levels of expertise, where individuals and teams of experts from different universities and/or businesses are brought together to work on such projects.

Unfortunately, this dichotomization of distribution has led to little empirical research regarding the impact of partial distribution on teams, specifically in terms of team processes and performance. Though it has been shown that full distribution can have constraining effects on collaboration and its relevant affective, behavioral, and cognitive components, such as trust (e.g., Jarvenpaa & Leidner, 1999), information exchange (e.g., Cramton, 2001), and communication (e.g., Cogburn & Levinson, 2003), few studies compare full distribution to partial teams in order to understand the differential impacts of the degree of distribution. Of those that do, most have found that the balance of distribution matters significantly in terms of team outcomes, in that an uneven distribution of members across locations can encourage competition and decrease teamwork (see Polzer et al., 2006; O'Leary & Mortenson, 2005; Ocker et al., 2009; Huang & Ocker, 2006; Bos et al., 2006).

Given this dearth of research regarding partially distributed teams as previously discussed, the focus of the current study involves expanding existing knowledge regarding different forms of partial distribution. Instead of simply comparing fully distributed teams to collocated teams, three different forms of partial distribution are taken into consideration, maximizing all of the possible combinations of distribution for a four person team where at least one member is distributed. These four configurations, as illustrated in Figure 1, include: 1) a fully distributed configuration; 2) a configuration whereby two members are collocated and two are isolated; 3) a configuration whereby there are two sets of collocated members; and 4) a single isolated member with the other three members collocated. These four forms of distribution were selected for examination because they operationalize the idea of distribution as a continuum, whereby some teams are more distributed (i.e., 1-1-1-1), some are moderately distributed (e.g., 2-1-1-1, 2-2) and others are less distributed (i.e., 3-1). Given the vast amount of research

regarding face-to-face teams, a fully collocated condition was not included, as the interest for this study was in advancing our understanding of the differences among different forms of distribution.

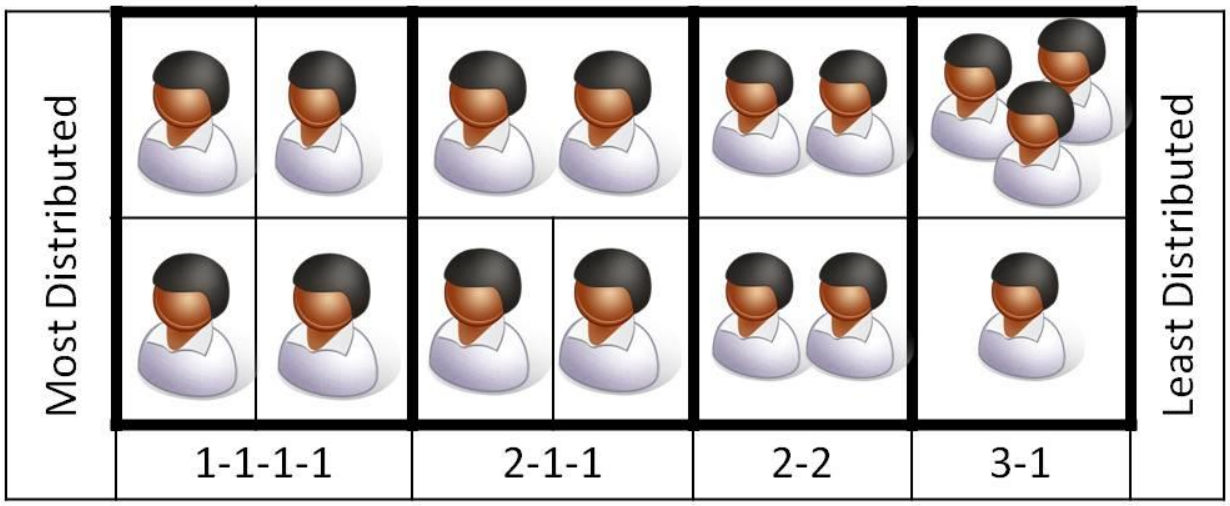

Figure 1. Illustration of Physical Distribution Configurations

Distribution and Team Leadership Structure

Certainly, distribution may be viewed as either an advantage or a disadvantage, depending on the context and the nature of the distribution in terms of being fully or partially distributed. From a team leadership perspective, distribution may play a critical role in both the collective enactment of specific leadership behaviors as well as the overall emergent pattern of distinct roles among members. The theoretical rationale for this lies in the idea that distribution interferes with the ability to convey social presence and cues (Hinds & Mortensen, 2005; Humphrey, 2004; O'Leary & Mortensen, 2005). Distribution of members can serve as a boundary, leading to lowered levels of interaction from both a task and a social perspective (Kraut, Fussell, Brennan, & Siegel, 2002; O'Leary & Cummings, 2007). For leadership, this lack of interaction can mean that members are unable to convey social influence, a critical defining feature of leadership (Fleishman, et al., 1991; Yukl, 2012). Furthermore, less interaction means

that team members will be less likely to convey that they have the necessary knowledge, skills, and abilities needed to be successful as a team leader, causing other members to potentially ignore or misinterpret their attempts at influence (Zaccaro, LaPort, & Jose, 2012). Indeed, Kerr and Jermier (1978) note the role of physical distance creating conditions whereby effective leadership may be challenging or altogether impossible. This may be driven by lower quality exchanges and therefore lowered influence capabilities (Antonakis & Atwater, 2002; Napier & Ferris, 1993).

Combining this perspective with the concept of partial distribution, it is expected that when teams are less distributed, members who are collocated with one another will be more likely to turn to one another for leadership due to ease of communication and higher levels of social presence conveying social influence. Therefore, members of less distributed teams will be less likely to perceive their distributed members as performing leadership behaviors, resulting in overall lower ratings of leadership for distributed team members as a network. However, when teams are more distributed, members will essentially be on more equal ground in terms of all experiencing a limited level of social presence, and therefore will be more likely to perceive one another as performing leadership functions. In terms of the leadership of collocated members in distributed teams, the configuration of the team should not matter, as collocated members in all three types of partially distributed teams are expected to rely upon one another for leadership behaviors; thus, no hypothesis is offered for collocated members and distribution. Furthermore, it is expected that the type of behavior being enacted should not matter, such that less dense networks of leadership will be found for the each of the behaviors of structuring/planning, problem solving, and supporting the social climate in terms of distributed members. Thus, it is hypothesized:

Hypothesis 1a. Team physical distribution configuration will negatively impact collective leadership of perceived structuring and planning for distributed team members, such that less distributed teams will have lower perceived collective leadership of structuring and planning than more distributed teams.

Hypothesis 1b. Team physical distribution configuration will negatively impact collective leadership of perceived solving problems for distributed team members, such that less distributed teams will have lower perceived solving problems network density than more distributed teams.

Hypothesis 1c. Team physical distribution configuration will negatively impact perceived collective leadership of social climate support for distributed team members, such that less distributed teams will have lower perceived collective leadership of social climate support than more distributed teams.

As previously discussed, team leadership structure refers not only to the perceptions of members performing the similar types of leadership behavior, but also to the degree to which team members are specialized, both in terms of total specialization of members into a single leadership role (i.e., role distance) and the total variety in leadership roles. For both of these aspects of leadership specialization, it is expected that distribution will also have a negative effect, but in a slightly different manner. As a greater number of team members are distributed from one another, it is expected that it will be more difficult for members to convey the specific skills they have in terms of performing specific leadership behaviors. That is, while members may be able to recognize that another member is performing some type of leadership, the lack of social presence will cause more difficulty in discerning the specific role that member is fulfilling,

meaning that there will be both perceived lower role specialization as well as lower overall variety in roles for more distributed teams. Therefore, it is hypothesized:

Hypothesis 2a. Team physical distribution configuration will negatively impact perceived leadership role variety, such that more distributed teams will have less perceived leadership role variety than less distributed teams.

Hypothesis 2b. Team physical distribution configuration will negatively impact perceived leadership role distance, such that more distributed teams will have less perceived leadership role distance than less distributed teams.

Moderating Effects of Team Virtual Tool Use

Within distributed teams, technologically mediated tools are necessary for communication to occur, as members may be separated by space and time and therefore are unable to meet face to face on a regular basis (Jarvenpaa & Leidner, 1999). As such, the type of communication media selected may significantly influence how well and how often social cues are conveyed to team members, which can critically impact team leadership (Bell & Kozlowski, 2002; Connaughton & Shuffler, 2007). There are many theoretical perspectives aimed at understanding how virtuality influences communication within team environments, with media richness being perhaps the most relevant to the current understanding of how virtual tool use may influence team leadership.

While the use of virtual tools is becoming commonplace throughout teams and organizations, consistent empirical research regarding their differential impact on team processes and performance is lacking (Connaughton & Shuffler, 2007). Multiple theories exist to explain the differences in media and why some may be more or less effective, including media richness (Daft & Lengel, 1986) and media naturalness (Kock, 2002; 2004; 2005). For example, media

richness theory places different forms of communication on a continuum organized by the degree to which media replicates the social cues and information of face to face situations. From this perspective, face to face interaction is the richest media, providing the most contextual cues and information, and letters or other paper based media as the least rich due to their lack of social cues (Daft & Lengel, 1986). Media naturalness builds upon this theory, identifying multiple components of technologies that make them more or less natural, in terms of their replication of face to face environments.

According to media naturalness theory, as technologies become less natural (i.e., more aspects of human face-to- face interaction are suppressed), the task of interaction becomes more cognitively effortful because of the need to process information in a different way, the ambiguity of the communication increases, and the level of physiological arousal decreases due to the lack of cues that typically trigger physiological responses to face to face interactions. While these theories aid in our understanding as to why media may elicit differential effects, most empirical studies of virtual teams and organizations examine a limited set of virtual tools (e.g., email, chat systems) that are simply classified as either virtual or not (Kirkman & Mathieu, 2005). As these tools can potentially differ in their degree of virtuality, such a dichotomous classification system stifles a rich, meaningful understanding of the degree to which these tools vary in their effectiveness and the degree to which they facilitate or hinder the collaborative processes vital to team and organizational performance.

In sum, virtuality is best viewed as a continuum, with highly virtual tools (e.g., instant messaging) offering less rich cues than low virtual tools (e.g., videoconferencing; Kirkman & Mathieu, 2005). Table 1 provides a summary of the types of virtual tools utilized in the present study and where they fall along the continuum of media richness. When technologies convey

rich, valuable information, exchanges are less virtual than when compared to exchanges via technologies that provide less rich information. This use of less virtual tools may be beneficial for virtual teams, as it can provide the social cues necessary for effective social influence (Daft & Lengel, 1986). Utilizing this classification of virtuality, it is critical to clarify the implications that differing degrees of virtuality may have upon team composition, shared team leadership, processes and performance, especially in terms of how it may offer both challenges and opportunities.

Table 1. Levels of Virtuality & their Operationalizations

Level of Virtuality	Characteristics	Virtual Tool Operationalization in Present Study
High virtuality	• Least rich form of media • Provides few social cues/information • Lowest informational value, difficult to transmit task information • Lowest synchronicity	Instant Messaging
Medium virtuality	• Provides some social cues/information • Offers informational value in terms of social information and ability to transmit task information • Relatively synchronous	Teleconferencing
Low virtuality	• Richest form of media outside of face to face • Provides many social cues/information • High informational value • Highest synchronicity	Videoconferencing

From a team leadership perspective, virtuality may provide an avenue by which leadership can be more effectively conveyed. When teams are limited in their social interactions by distribution, the utilization of richer media such as videoconferencing and teleconferencing may counteract the effects of distribution, as they provide more of the cues needed to convey

social presence. Thus, leadership exhibited by distributed members may be more likely to be perceived by other team members (Zaccaro & Bader, 2004). This moderating effect of virtuality on distribution should hold for all of the operationalizations of team leadership structure (i.e., collective leadership, leadership specialization), as richer cues will be beneficial in all three contexts. Therefore, it is hypothesized that:

Hypothesis 3a. Virtual tool use will moderate the relationship between team physical distribution configuration and collective leadership of structuring and planning, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.

Hypothesis 3b. Virtual tool use will moderate the relationship between team physical distribution configuration and collective leadership of solving problems, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.

Hypothesis 3c. Virtual tool use will moderate the relationship between team physical distribution configuration and collective leadership of solving problems, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.

Hypothesis 3d. Virtual tool use will moderate the relationship between team physical distribution configuration and perceived leadership role variety, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to greater role variety for more distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect less distributed teams' role variety.

Hypothesis 3e. Virtual tool use will moderate the relationship between team physical distribution configuration and perceived leadership role distance, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to greater role distance for more distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect less distributed teams' role distance.

Team Leadership Structure & Team Outcomes

While distribution and virtual tool use may serve as antecedents to the emergence of team leadership, the resulting structures are expected to have an impact on subsequent team processes and performance. Research has illustrated the impact of leadership as a collective team property on team outcomes, as it is proposed that contributing leadership both meets the needs of the team as well as increasing the commitment of members offering such leadership (Mathieu, et al., in press). In addition to the work previously discussed by Pearce and colleagues (2004), Carson, Tesluk, and Marrone (2007) found in their study of shared leadership, teams with more dense leadership networks (i.e., higher levels of shared leadership) were associated with higher levels of team performance as rated by clients. Other studies have offered support for the link between team leadership and team member satisfaction and overall effectiveness (e.g., Avolio, et al., 1996; Ensley, Hmielseski, & Pearce, 2006; Erez, Lepine, & Elms, 2002). From a virtual context, Muethel and colleagues (2012) offered empirical support for the link between shared leadership

and team performance in dispersed teams. Thus, while research in this area is still growing, there appears to be some initial support to the idea that team leadership does in fact have a positive influence on team outcomes, including teamwork and team performance.

Teamwork

For teams to be effective, they must successfully perform both teamwork and taskwork (Salas, Kosarzycki, Tannenbaum, & Carnegie, 2004). Teamwork is defined as a set of behaviors, cognitions, and attitudes that are enacted to achieve mutual goals and meet the demands of the outside environment (Salas, et al., 2007). Teamwork processes refer to the functions performed by team members to accomplish team goals (Marks, Mathieu, & Zaccaro, 2001). While traditionally team process was simply divided into taskwork and teamwork, as previously discussed, Marks and colleagues (2001) advanced this view by developing a taxonomy of processes that includes three higher order categories: transition, action, and interpersonal. Each of these phases has been empirically linked to team outcomes, and are expected to be positively impacted by the enactment of team leadership.

More specifically, the transition phase of team process involves a focus upon activities that prepare the team for engaging in action at a later time (Mathieu, et al., 2008). This includes processes such as mission analysis, goal specification, and formulating strategies. While transition processes are important as they provide a foundation for future actions, this type of process has received the least amount of attention in the research. Of the studies that do exist, these transition variables have been linked to team performance. For example, Mathieu and Schulze (2006) found that dynamic planning was positively related to team performance. However, further research is necessary to more clearly delineate the relationship of the factors that may influence transition processes and their subsequent relationship to team performance.

The second phase of team process is the action phase, which has received a significant amount of attention in the literature (Mathieu, et al., 2008). Action processes involve team members working on accomplishing tasks, monitoring and adjusting behaviors, coordinating with team members, and monitoring and backing up one another. Critical action processes that have been found to influence team performance include communication and coordination (LePine, Piccolo, Jackson, Mathieu, & Saul, 2009). Additionally, Porter (2005) showed the importance of backup behaviors in decision-making performance. Finally, interpersonal processes involve the interpersonal functioning of team members across both transition and action phases of team process. Interpersonal processes can include conflict, motivation, confidence building, and affect (Mathieu, et al., 2008). Research has been conducted on all of these factors, finding that they can each differentially influence the success of teams. For example, De Dreu and Weingart (2003) found that conflict, both relationship and task, has a strongly negative correlation with team performance as well as team member satisfaction.

In sum, each of these three types of processes can significantly impact team outcomes and should be of importance to understanding the functioning of teams. As previously discussed, there are particular leadership behaviors which may help facilitate these specific processes. Namely, structuring and planning is expected to more effectively facilitate transition processes, as this leadership behavior should aid in facilitating the analysis of the team mission by helping team members identify what needs to be accomplished and prioritizing tasking, ensuring that team members understand the goals of the team and assigning roles as needed so that all necessary tasks are performed (Morgeson, et al., 2010). For action processes, solving problems is critical to effective team action, as this action often focuses on identifying when a problem occurs. By stepping in and helping team members implement solutions to problems, seeking

multiple perspectives that can aid in developing the most effective solution, and creating solutions as needed, team members performing this leadership behavior should be able to ensure that action processes are smoothly implemented (Zaccaro, et al., 2009). Finally, supporting the social climate should aid in facilitating effective interpersonal processes, particularly through setting the right climate by responding to team member needs, demonstrating respect, and going beyond personal interests to fulfill team needs (Morgeson, et al., 2010). Creating such a climate should aid in managing team member emotions, encouraging team members to motivate one another, and ensure that conflict is handled appropriately, all critical interpersonal processes (Marks, et al., 2001).

Team Performance

Overall, team leadership should be effective at facilitating the processes that comprise teamwork, which in turn should lead to enhanced team performance, as the relationship between teamwork and team performance has been well established (LePine, et al., 2008; Marks, Mathieu, Zaccaro, 2001). By having multiple team members fulfilling leadership needs as they arise, teams should have all necessary resources needed to ensure that all teamwork processes and emergent states develop and operate smoothly (Marks, et al., 2000). Indeed, a number of studies have illustrated the link between team leadership and team outcomes (e.g., Avolio, et al., 1996; Carson, et al., 2007; Kukenberger, et al., 2011; Pearce & Sims, 2000; Pearce & Sims, 2002).

Thus, it is expected that team leadership will facilitate effective teamwork, with teamwork serving as a mediating mechanism between team leadership structure and team performance. However, as previous studies have found direct relationships between team leadership and team performance, it is expected that both direct effects and indirect effects will

exist, supporting the idea of partial mediation. Specifically, having greater specialization in terms of role distance and role variety should help to facilitate overall teamwork and subsequent performance. From the perspective of role distance, having members specialized in a single leadership role should allow that member to focus on performing that behavior effectively, as this requires a reduced cognitive load in comparison to trying to perform multiple leadership roles. Thus, greater team role distance in terms of leadership should enable better teamwork overall. From the perspective of role variety, having a greater variety in the roles being performed across the team should help meet all of the leadership needs in the team, again facilitating better teamwork and subsequent performance. In sum, it is hypothesized that:

Hypothesis 4a. Overall teamwork processes will partially mediate the relationship between perceived leadership role variety and team performance.

Hypothesis 4b. Overall teamwork processes will partially mediate the relationship between perceived leadership role distance and team performance.

While greater specialization is important to overall teamwork success, it may be necessary for multiple members to also step in and perform more than one behavior at times in order to ensure that effective teamwork processes will occur. For example, while a member may primarily focus on performing structuring and planning, if there are multiple problems to be solved simultaneously, that member may need to step in to aid a fellow team member in providing social influence in regards to solving problems to prevent a disruption in action-oriented teamwork. Furthermore, regardless of whether members are collocated or distributed, greater collective leadership should facilitate effective teamwork; thus, both sets of network densities should positively predict teamwork. In sum, in terms of collective leadership, having

greater density will aid in facilitating effective teamwork in terms of the three leadership behavior—teamwork process pairings. Thus, it is hypothesized:

Hypothesis 5a. Transition teamwork processes will partially mediate the relationship between collocated collective leadership of structuring and planning.

Hypothesis 5b. Transition teamwork processes will partially mediate the relationship between distributed collective leadership of structuring and planning.

Hypothesis 6a. Action teamwork processes will partially mediate the relationship between collocated collective leadership of solving problems.

Hypothesis 6b. Action teamwork processes will partially mediate the relationship between distributed collective leadership of solving problems.

Hypothesis 7a. Interpersonal teamwork processes will partially mediate the relationship between collocated collective leadership of supporting social climate.

Hypothesis 7b. Interpersonal teamwork processes will partially mediate the relationship between distributed collective leadership of supporting social climate.

Summary of Hypothesized Model

Figure 2 provides a summary of the relationships tested in this study. It should be noted that this figure is for illustrative purposes only and is not intended to be tested as an entire model (e.g., via structural equation modeling) due to power constraints. It is expected that team member virtual tool use and distribution will interact to impact the emergent structure of leadership in teams, operationalized as perceptions of collective leadership and leadership role specialization.

More specifically, teams with fewer physically distributed members will be less likely to perceive those distributed members as collectively participating in leadership for each of the three leadership behaviors of interest, due to the inability to convey social presence across space and time and reliance upon fellow collocated members for leadership. Additionally, the more that teams are distributed, the less likely members are to detect differences in the types of leadership roles performed, leading to less role distance and variety. However, virtual tool use will moderate these relationships, such that physically distributed teams whose members communicate with less virtual, richer forms of media (i.e., videoconferencing, teleconferencing) will be more likely to have denser leadership structures emerge than teams communicating with more virtual, less rich forms of media (i.e., instant messaging).

Furthermore, team leadership will facilitate effective teamwork, with teamwork serving as a mediating mechanism between team leadership and team performance. More specifically, sharing different types of leadership behaviors will affect teamwork in terms of specific aspects of leadership influencing specific aspects of teamwork. A greater degree of collective leadership for structuring and planning will positively impact transition processes in teams, while a greater degree of collective leadership in problem solving will positively impact action processes. Additionally, density in the leadership behavior of creating a supportive social climate will positively impact interpersonal aspects of teamwork. Finally, having members specialized in particular leadership behaviors, as captured by role distance and role variety, will positively facilitated teamwork overall.

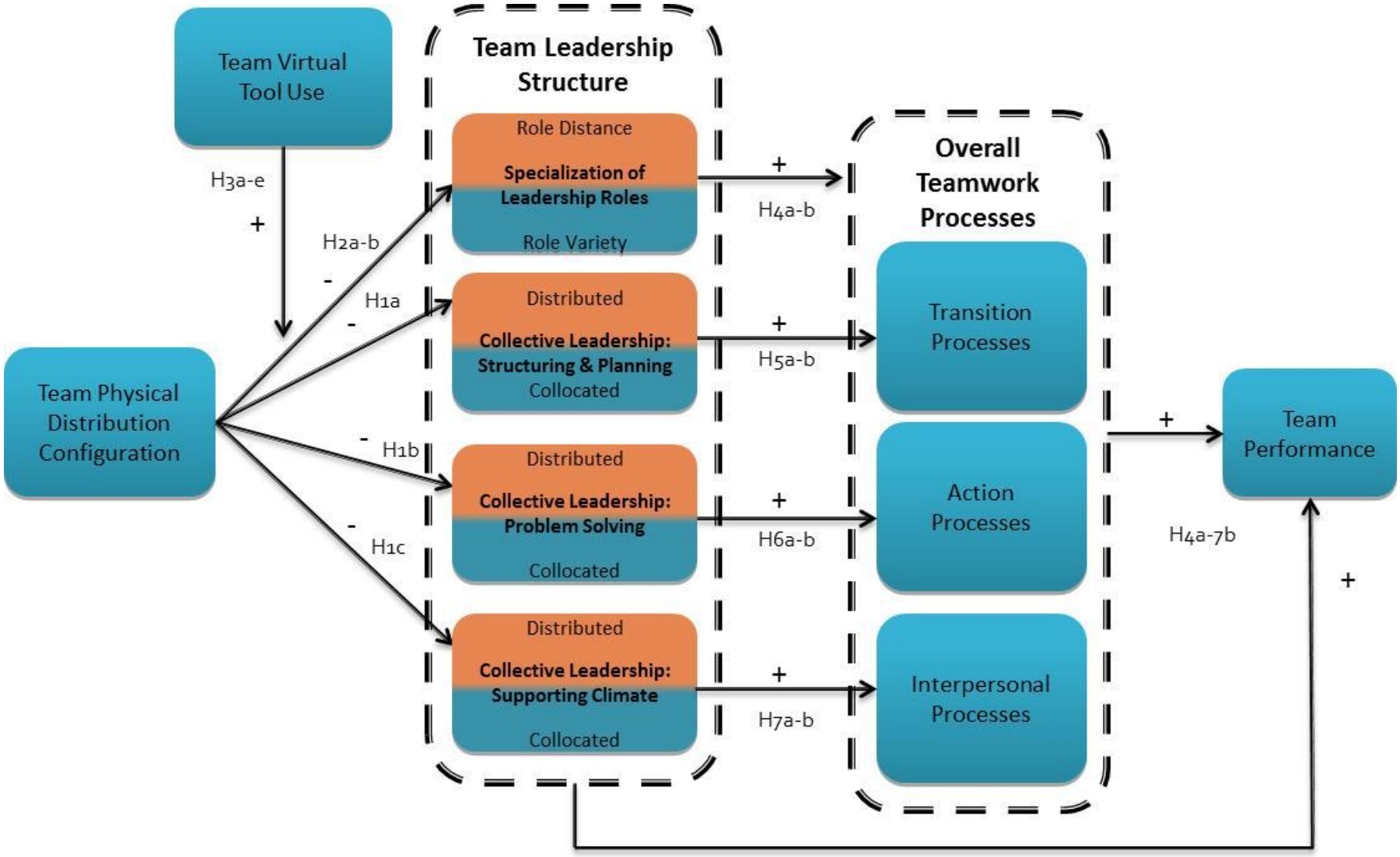

Figure 2. Hypothesized Relationships between Study Variables

Table 2. Summary of Study Hypotheses

H1a	Team physical distribution configuration will negatively impact the perceived collective leadership of structuring and planning for distributed team members, such that less distributed teams will have lower perceived collective leadership of structuring and planning than more distributed teams.
H1b	Team physical distribution configuration will negatively impact the perceived collective leadership of solving problems for distributed team members, such that less distributed teams will have lower perceived collective leadership of solving problems than more distributed teams.
H1c	Team physical distribution configuration will negatively impact the perceived collective leadership of social climate support for distributed team members, such that less distributed teams will have lower perceived collective leadership of social climate support than more distributed teams.
H2a	Team physical distribution configuration will negatively impact perceived leadership role variety, such that more distributed teams will have less perceived leadership role variety than less distributed teams.
H2b	Team physical distribution configuration will negatively impact perceived leadership role distance, such that more distributed teams will have less perceived leadership role distance than less distributed teams.
H3a	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived collective leadership of structuring and planning, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.
H3b	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived collective leadership of solving problems, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.
H3c	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived collective leadership of solving problems, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.
H3d	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived leadership role variety, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to greater role variety for more distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect less distributed teams' role variety.
H3e	Virtual tool use will moderate the relationship between team physical

	distribution configuration and perceived leadership role distance, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to greater role distance for more distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect less distributed teams' role distance.
H4a	Overall teamwork processes will partially mediate the relationship between perceived leadership role variety and team performance.
H4b	Overall teamwork processes will partially mediate the relationship between perceived leadership role distance and team performance.
H5a	Transition teamwork processes will partially mediate the relationship between collocated perceived collective leadership of structuring and planning.
H5b	Transition teamwork processes will partially mediate the relationship between distributed perceived collective leadership of structuring and planning.
H6a	Action teamwork processes will partially mediate the relationship between collocated perceived collective leadership of solving problems.
H6b	Action teamwork processes will partially mediate the relationship between distributed perceived collective leadership of solving problems.
H7a	Interpersonal teamwork processes will partially mediate the relationship between collocated perceived collective leadership of supporting social climate.
H7b	Interpersonal teamwork processes will partially mediate the relationship between distributed perceived collective leadership of supporting social climate.

CHAPTER THREE: METHODS AND MATERIALS

Participants

Participants were 752 undergraduate students divided into 188 four-person teams for a three hour laboratory study. Study participants were recruited from local universities and colleges in the southeastern United States (U.S.). Participants ranged in age from 18 to 52 years old (M = 19.66, SD = 3.49). Participants were compensated for their time either with financial compensation of $24 for participating in both the online and in person portions of the three hour study, or will receive 3.25 research credit points for their classes. Participants were allowed to choose which compensation they prefer upon arrival at the study. Participants were recruited through both an online sign up system for undergraduate students needing class credit, and through IRB-approved advertisements posted online and on campus in approved locations.

Design

In this study, both virtuality and distribution of participants were manipulated in a 3 x 4 factorial design. Teams were randomly assigned to one of the three virtuality conditions and one of four distribution conditions described below prior to the session starting. In each instance, team members were located in rooms spread out throughout a single building. Experimenters were not in the rooms with participants, but were able to see and hear them at all times during the sessions through the use of video and audio equipment. Participants were able to ask questions of the experimenters via the audio equipment provided in all conditions.

The manipulation of virtual tools involves addressing the varying levels of virtuality for three different types of virtual tools. Specifically, this involved manipulating the use of 1) instant messaging (high virtuality), 2) teleconferencing (medium virtuality), or 3) videoconferencing software (low virtuality), all from the same meeting software system (GoToMeeting). While real

world teams often utilize a combination of virtual tools at any given time, team members were able to communicate with only one of these tools. The second factor, degree of distribution, was operationalized as the physical distribution of team members throughout the interaction period. This factor has four levels, increasing in the number of isolates in each team: Partial Distribution Type 1 (three members collocated and one distributed member), Partial Distribution Type 2 (two sets of collocated members), Partial Distribution Type 3 (two members collocated, remaining two members distributed) and Fully Distributed (all members distributed). This design was selected because it enabled a direct comparison among the differing levels of virtuality and distribution, which has not been done in previous research regarding leadership in virtual and distributed environments.

Teams utilized GoToMeeting conferencing software during the sessions in order to communicate with one another. GoToMeeting is a web-based program that allows for participants in different locations to connect to a central location and share control of a single screen, while seeing, hearing, and typing to one another using the system. Teams in the videoconferencing conditions were able to see one another using webcams attached to large 36" flat screen television monitors, with the videos of teammates displayed above the simulation task they were playing. Participants in videoconferencing conditions were able to see and hear one another, but did not have access to the chat feature of the system. For the teleconferencing conditions, videos and chat were turned off, but team members were able to hear one another. Finally, for the instant messaging conditions, the audio and video features were disabled, but participants were able to utilize the chat system. Participants in all conditions were instructed to use their role name (Prime Minister A, B, C, or D) during communications in order to help clarify who was talking or typing at any point in time.

Task

In order to allow leadership to emerge and to assess team outcomes, teams played a computer based simulation called Democracy 2, similar to other computer based testbeds utilized in team-based research studies (e.g., Burke, 2000; Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005; Wildman, 2010). This simulation places participants in the role of a team of prime ministers responsible for a fictional country (Libria). The overall goal of the team was to improve the well-being of the country in order to gain re-election. In order to achieve this, team members had to work together to decide if and how they should change the policies of the country in order to satisfy the needs of the constituent groups that comprise the population (e.g., farmers, parents, socialists, middle income). These policies mimic issues that are faced by real world countries, such as tax rates, welfare, community policing, and agriculture. In order to change or cancel policies, the prime ministers were allocated political capital points that they can spend over a course of 10 decision rounds, which equal one year of play time in the game. The policies range in terms of how many political capital points they cost to implement.

During each decision round, the team members reviewed the current state of the country in terms of constituent happiness, debt, expenses, and projections on the percentage of the population currently planning to vote for them in the next election. Team members then decided what policies to change or cancel in order to increase happiness, reduce debt, and increase the percentage of the population planning to vote for the team. Teams were able to make no decisions in a round in order to build up political capital points in order to implement more costly changes in a different round. As changes were implemented (or not) in each round, the percentage of voters, debt, expenditures, and happiness of constituents would go up or down depending on what types of changes are made. After each decision round, team members

received a summary review of where they stood in terms of each of these outcome variables. After the final round, the population voted and a resolution was provided in terms of whether or not the team is re-elected.

In order to require full collaboration to win re-election, each prime minister was responsible for a set of five constituents, for which they have unique information regarding what policies directly impact these constituents. The prime ministers were provided with handouts that have a decision of their constituents, a description of each policy, which constituents it impacts, what departments they belong to, how much capital it costs to cancel, raise, or lower policies, and how long it would take for the policies to have an impact. Each prime minister had one constituent that made up a large majority of the population, and therefore needed to be attended to in terms of making policy changes that will please these constituents. Therefore, the most effective strategy in order to win was for team members to work together to make decisions that will please these four larger constituents as a whole. However, some of the needs and wants of these constituents conflicted with others, so teams had to discuss and work through these conflicts in order to develop an effective strategy.

To interact with the game, team members shared the same game screen across computers, depending on their distribution condition. Figure 2 provides an example of what team members saw throughout the game. Team members were able to access information about the constituents, polices, voter happiness, and other information relevant to game play through clicking on various parts of the screen. While team members could use the screen to understand which constituents are affected by which policies, the most efficient way to gain this information was for the team members to review their own handouts and provide information, as it was more readily

accessible in this manner. Any team member could take control of the computer screen at any point in the game. However, only one team member could control at a time.

While originally designed as an individual player game, Democracy 2 was been adapted to allow for multiple, interdependent roles. There are multiple types of interdependence in teams, as defined by Saavedra and colleagues (1993). The specific type of interdependence for which Democracy 2 was adapted is team task interdependence. This type of interdependence is characterized by team members working as a unit to jointly diagnose and problem solve in order to complete the overall team task (Saavedra, Earley, & Dyne, 1993). In order to elicit this type of interdependence in Democracy 2, several adaptations were made to the original game. First, team members were given a team goal of having to be re-elected as a group, not as individual prime ministers. This group goal creates an environment where team members are encouraged to cooperate together in order to achieve success as a team. Second, while there is some common information shared by all members, each team member is provided with unique information about certain aspects of the game. Specifically, team members are given information about certain policies that affect both their constituents as well as other constituents. Additionally, each team member is responsible for a constituent that makes up a major percentage of the population. In order to win re-election, all four of these constituents must have their needs met. This unique information was provided in the form of unique handouts that each team member was provided with at the beginning of the performance round. While all of the information provided is also available within the game, it was much more readily accessible in the handouts and can be utilized much more quickly than going through all of the menus in the game, an important factor when considering the time limit discussed below.

Third, the structuring of policies was done in such a way that there were multiple groups affected by a single policy change. Some policies affected one constituent group positively, while affecting another constituent group negatively, meaning that team members had to communicate and work together to decide how and when to change policies. Fourth, a time limit of 60 minutes was imposed on all teams during the performance round. In order to achieve the goal of being re-elected during this time period, team members had to share their unique information about their constituents and policies as well as pay attention to changes and adjustments after each decision round. Based on initial pilot testing, while an individual player could potentially win re-election if given all of the information provided to all team members, it would be highly unlikely to do so within this time limit.

This simulation was selected because it provides an engaging collaborative environment with a short training time. Furthermore, this environment requires teamwork, since in order to be successful, teams must create strategies, make decisions, and engage in discussions involving input from all team members. This complex decision making task simulates a challenging environment similar to what real world virtual and distributed teams may face. As these teams are often design to utilize the unique information held by team members, the Democracy 2 environment also requires unique information to be shared by team members. Furthermore, this environment provides time pressure for making decisions as well as autonomy in how the task can be completed, also similar conditions in terms of real world virtual and distributed teams.

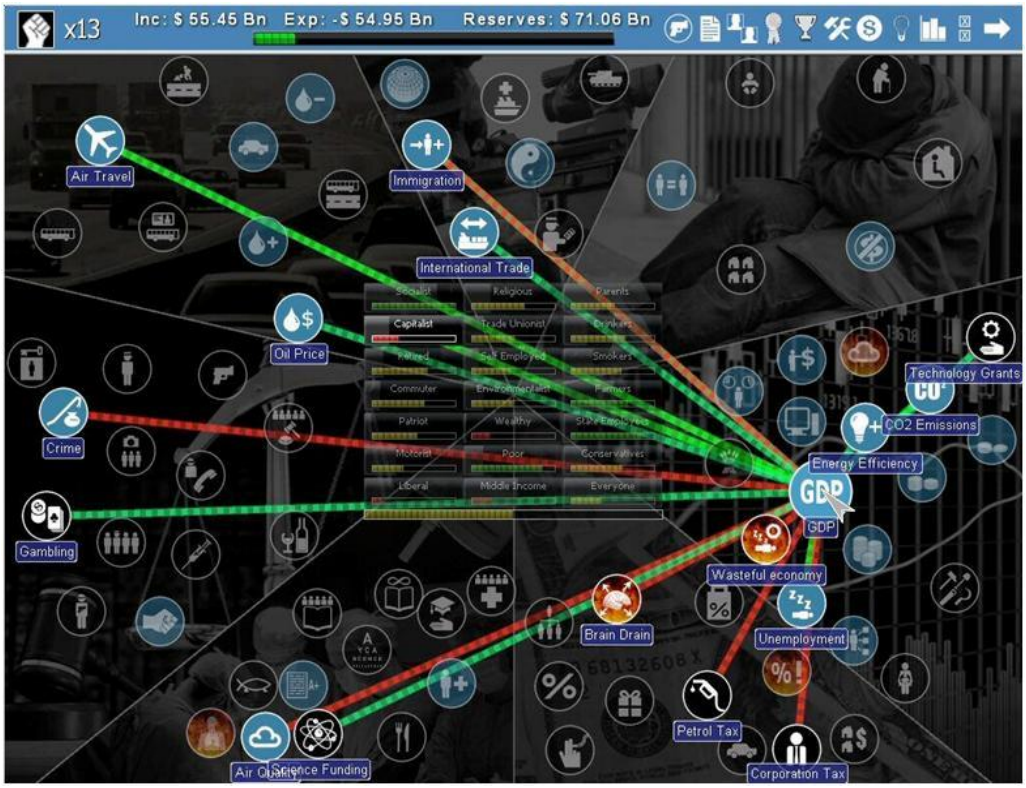

Figure 3. Screenshot of Example Democracy 2 Round

Procedure

Figure 3 provides a chronological summary of the events that occurred during the experiment. Prior to participating in the in-person, on-site portion of the study, each participant completed an online, 20-30 minute battery of measures at their convenience. This set of measures included demographic items that served as control variables presented in the measures section. These measures were be completed online prior to the in-person portion in order to limit survey fatigue.

After completing the online survey, participants received instructions regarding how to sign up for the second, in-person portion of the study. Prior to their session start time, teams were randomly assigned to one of the 12 conditions described previously. Additionally, each individual participant was randomly assigned to one of the four prime minister roles. Upon

arrival on their scheduled day and time to the in-person portion of the experiment, all four participants were escorted into the appropriate research rooms. Each research room was equipped with a large 36” television monitor that served as a computer monitor for the purposes of the study, a mouse and keyboard, and computer that was networked to an experimenter computer and the Internet in order to connect to the GoToMeeting software. Participant study material, including a notebook with information on their prime minister role, informed consent, and training materials, scrap paper, and pens were placed in each research room in advance, based on where the participants are located. Up to four research rooms were utilized depending on the geographic configuration condition. Care was taken by experimenters to escort participants into their appropriate research room as soon as they arrived, in order to minimize any interaction time prior to the start of the study. Participants who were collocated were be asked to remain quiet and not talk to other participants prior to the start of the session.

Two experimenters were present during each study session. One experimenter remained seated at the experimenter computer during the entire session in order to be available for communicating with all participants at any time during the study. This experimenter was responsible for monitoring the participants during the training video, guiding them through the answers for the guided practice portion, and setting up the practice and performance rounds in Democracy 2. The second experimenter served as a runner in order to deliver materials to the participants throughout the session as needed, to make any necessary adjustments to equipment in research rooms, and to escort participants during breaks.

Once all participants were escorted into their appropriate room, the experimenter seated at the experimenter computer utilized the GoToMeeting software to communicate with participants for the duration of the session. Experimenters were able to see and hear participants

during every session via GoToMeeting, regardless of the condition. Participants were able to communicate with the experimenters at any time simply by speaking out loud, even in the instant messaging conditions. However, participants were only able to communicate with their teammates using the virtual tool for their study condition (i.e., instant messaging, teleconferencing, or videoconferencing).

Participants were informed that they were going to be working as a four-person team of prime ministers for a fictional country using the game Democracy 2. Each participant was given an informed consent form that the experimenter reviewed with them. After participants agreed to participate by signing the informed consent, the experimenter proceeded by instructing the participants on how to launch an initial training video on their monitors that gave them information regarding how to play Democracy 2. This 20-minute training video was based upon a tutorial that was developed by the designers of Democracy 2, and provided general information regarding the purpose of the game, goals, and how to maneuver in the game. The training video included both demonstrations of how to play the game and voiceover summaries of necessary information. All participants received the same information regarding Democracy 2. However, at the end of each training video, participants received specific information regarding how to use GoToMeeting in relation to their virtuality condition. Participants who were collocated watched the training video together, while participants who were distributed watched the training video on their own television monitor.

Once participants completed the training video, the experimenter allowed time for questions. Following any questions, the experimenter led the team members through a guided practice session. The team members were given a list of tasks to complete in a practice country within the simulation, and allocated ten minutes to complete these tasks. This list consisted of

tasks such as finding out the number political capital points available, determining the constituents' levels of happiness, and determining how long it takes to implement a policy. This set of tasks was designed to help familiarize team members with both the on-screen layout of the simulation as well as the paper handouts provided. Once the list was complete or time was up, the experimenter walked the team through the correct answers, again allowing for questions. After this was completed, the teams were given an additional 30 minutes to play in the practice country, with the goal of trying to achieve re-election. The purpose of this interaction time was to further familiarize the team with the game as well as facilitate the development of teamwork processes and emergent states.

Once teams completed their 30 minute practice session, they filled out a set of surveys designed to assess teamwork and emergent states relevant to other aspects of the larger project. After completing this round of measures, team members engaged in a 60-minute performance session, in which they completed a series of ten decision rounds in the Democracy 2 game. Team members were not able to ask game specific questions of the experimenters, but could get technical assistance if needed at any time. No specific instructions were provided other than for the team to work together to achieve their goals. Once this 60-minute round was up or the team had completed all decision rounds, they completed a second set of measures. These measures will capture the leadership behaviors performed by the team members, as discussed in the Measures section. Finally, team members were debriefed regarding the nature of the study and compensated.

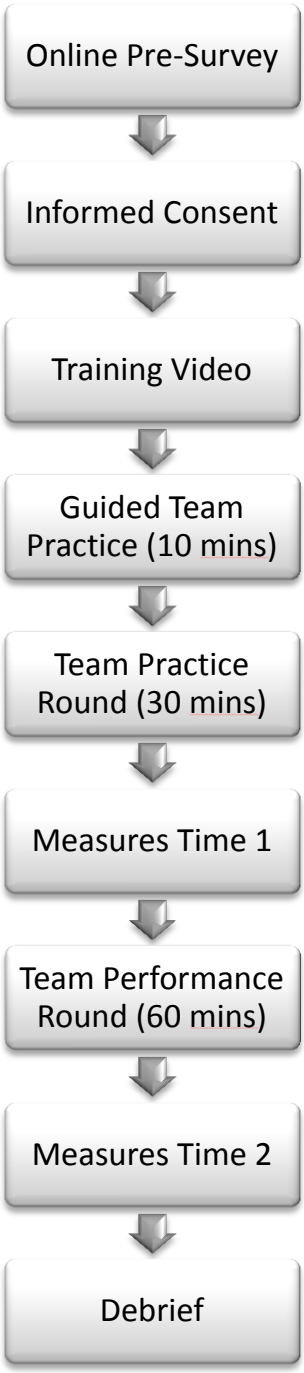

Figure 4. Chronological Flowchart of Experimental Procedure

Measures

Study data was collected using several formats, including self report, team member ratings, behaviorally anchored rating scales, and data output from Democracy 2. An online pre-survey was used to collect control variable data. Team leadership was assessed through team member ratings of one another's leadership behaviors. Teamwork was assessed by trained expert raters using behaviorally anchored ratings scales for transition, action, and interpersonal teamwork processes. Finally, team performance was captured using output from the Democracy 2 simulation, created via a formula specific to the goals of the particular tasks involved.

Control Variables

The demographic survey included customary control data such as age, gender, and GPA. Items assessing technology acumen was also be assessed for control purposes, as participants more comfortable with technology may respond better to the simulation. The demographic survey was administered prior to team members coming in for the actual session, in order to reduce the possibility of survey fatigue. See Appendix A for full scale descriptions.

Team Leadership Behaviors

Team leadership behaviors were assessed utilizing a network type measure of leadership similar to that administered by Carson, Tesluk, & Marrone (2007). Each individual team member was rated on the degree to which he/she performed leadership behaviors during the performance round of the study by all other team members. However, instead of a single item measure of leadership, a sub-set of questions regarding leadership behaviors of structuring and planning, problem solving, and supporting the social climate were derived from Morgeson and colleagues' (2010) measure of leadership behaviors. For each sub-set, team members rated their fellow team members on how often the team member performed the leadership behaviors, using a scale of 1

("Not at All") to 5 ("Frequently if Not Always"). Example items include, "Responds promptly to team member needs or concerns"; "Looks out for the well-being of team members"; "Identifies when key aspects of the work need to be completed"; and "Creates solutions to problems." Cronbach's alphas for each subscale were well within the acceptable range (structuring/planning $\alpha = .92$, problem solving $\alpha = .94$, supporting social climate $\alpha = .93$). In order to assess the different aspects of team leadership structure of interest, four unique indices were created utilizing this data: 1) collocated team member perceived collective leadership network density, 2) distributed team member perceived collective leadership network density; 3) adapted Blau index of perceived team leadership specialization diversity; and 4) a leadership role specialization index.

Perceived Collective Leadership Network Density. First, measures of network density were created for the distributed and collocated team members. These density measures reflected the degree to which members were perceived by one another as performing the leadership behavior of interest. Thus, teams where multiple members were rated by others as frequently performing leadership behaviors had higher density scores than those where only a one or two members were perceived as performing leadership behaviors. As previously discussed, this division of members into distributed and collocated was done in order to assess the separate effects for collocated members and distributed members in regards to leadership perceptions. Thus, the measures of density for the collocated team members reflected the leadership ratings of and by collocated members, and the measures for distributed members reflected the ratings of and by distributed members.

Sub-measures were created for each, one for each leadership behavior, for a total of six density measures: 1) structuring/planning collocated, 2) structuring/planning distributed; 3)

problem solving collocated, 4) problem solving distributed; 5) supporting collocated, 6) supporting distributed. These measures were calculated following the approach provided by Sparrowe and colleagues (2001) and utilized by Carson and colleagues (2007) in their assessment of shared leadership density. All values of team members' ratings of one another's leadership were summed, then that sum was divided by the total number of possible relationships, or ties, among the team members, following the formula: $\frac{\sum Actual\ Ties}{\sum Possible\ Ties}$. The total number of possible ties was adjusted based on the number of collocated and distributed team members for each configuration of distribution so that the resulting metrics would be comparable across conditions (see Table 3). The possible range for this metric was .20 (no members perceived to be performing the leadership behavior) to 1.0 (all members perceived to be equally performing the leadership behavior).

Table 3. Calculation of Network Density for Perceptions of Team Leadership

Configuration of Members	Collocated Perceived Leadership Network Density	Distributed Perceived Leadership Network Density
3-1	$\frac{\sum Actual\ Ties}{30}$	$\frac{\sum Actual\ Ties}{30}$
2-2	$\frac{\sum Actual\ Ties}{20}$	$\frac{\sum Actual\ Ties}{40}$
2-1-1	$\frac{\sum Actual\ Ties}{10}$	$\frac{\sum Actual\ Ties}{50}$
1-1-1-1	N/A (all members are distributed)	$\frac{\sum Actual\ Ties}{60}$

Blau Index of Perceived Team Leadership Specialization Variety. In addition to the density measures, two indices of specialization were also calculated. First, an adapted version of Blau's functional diversity index was utilized to capture the variability of leadership roles on the team, or the degree to which members were similar or different in terms of the behavior that they

were perceived by their team members as performing most frequently. As described by Harrison and Klein (2007), a Blau index is most appropriate for examining variety, defined for the purposes of the current study as variety in the types of leadership roles being performed. From the aforementioned behavior ratings, team members perceptions of one another's leadership was averaged, based on acceptable ICC(1), ICC(2), and r_{wg} ranges supporting aggregation (Bliese, 2000). These ranges were as follows for structuring/planning, problem solving, and supporting, respectively: ICC(1) = .56, .59, .55; ICC(2) = .83, .85, .83. Median r_{wg} values were above the accepted .70 values for demonstrating aggregation, .75, .76, and .80 respectively.

Each team member's average ratings on each of the three behaviors were reviewed, and the behavior that was performed most frequently (i.e., the highest rating) was selected as that member's role. Team members had to score above a 3 on one of the behaviors in order to be selected as holding a leadership role; otherwise, the member was marked as a non-leader for their role. For members who were high on more than one role, the standard deviations of the team member ratings were reviewed, and the behavior with the lowest deviation (and therefore the most consistently rated behavior) was selected as that member's role. Once roles have been assigned, a Blau index will be calculated, using the formula:

$$\text{Variety in perceived leadership roles} = 1 - \sum P_k{}^2$$

In this formula, p is the proportion of unit members in kth category. Therefore, a team is more diverse in its perceived leadership roles if there is one member from each category (solving problems, structuring, supporting, non-leader) than when members have all the same roles (e.g., 2 solving problems, 2 supporting). The resulting range of this index was 0 to .56 (M = .20, SD = .15).

Perceived Leadership Role Specialization Distance Index. While the adapted Blau index provides information regarding the diversity among the highest rated perceived roles, it does not account fully for specialization, as a member could be perceived as relatively high on two different behaviors (e.g., a four on supporting, a five on problem solving), with only the highest selected for the Blau index. Therefore a second measure of perceived leadership role specialization was created drawing upon distances, represented by the following formula:

$$\sqrt{\sum (highest\ LB - second\ highest\ LB)^2 + (highest\ LB - third\ highest\ LB)^2}$$

This index captures the distance between a team member's highest perceived leadership behavior rating and the other two behaviors in order to assess the degree to which that team member is specialized in a single role. The individual distances for each team member is then summed to create a total team index of specialization, such that higher sums represent greater perceived leadership specialization and lower sums represent less perceived leadership specialization of members in a unique role. The resulting range of scores on the index across teams was 0 to 7.51 (M = 2.24, SD = 1.04).

Teamwork Processes

In order to assess teamwork processes, behaviorally anchored rating scales (BARS) were developed specific to the task based on the Marks, Mathieu, and Zaccaro (2001) team process taxonomy. The BARS method involves having expert observers rate team behavior according to a pre-defined numerical scale. Unlike other observational techniques, BARS includes a rating of quality rather than just frequency count of behaviors. Each scale is anchored with examples of low and high quality behaviors on either end of a Likert-style numerical range (Smith & Kendall, 1963). These anchors are designed to ensure that some insight into the effectiveness of exhibited behaviors is captured by the observer ratings.

The current teamwork BARS were adapted from previously created measures for similar tasks (e.g., DeChurch & Marks, 2006; Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005; Kukenberger, 2012), and assessed teamwork for nine sub-processes divided across three higher order categories of transition, action, and interpersonal processes. Transition was comprised of ratings for mission analysis, goal specification, and strategy formulation, while action processes was comprised of ratings for monitoring progress towards goals, systems monitoring, and team monitoring and backup behavior. Interpersonal processes included conflict management, affect management, and motivation and confidence building. Ratings were averaged across the subcategories for each higher order category, as well as overall to create an overall teamwork process rating.

A team of six expert coders trained to recognize the aforementioned teamwork processes jointly coded 20% of the communication logs from the 188 sessions in order to establish inter-rater agreement. R_{wg} values were calculated for transition, action, interpersonal, and overall teamwork processes. The median r_{wg} for each set of processes was found to be in an acceptable range (.80, .85, .85, .83 respectively). Disagreements in coding were reviewed and resolved to reach 100% agreement on all of the ratings for the subset of jointly coded teams. The remaining team communication logs were then equally divided and coded independently by the expert coders, with a subject matter expert periodically reviewing the coding to ensure consistency.

Team Performance

Performance of the team was assessed via performance outcomes produced by the Democracy 2 game. Specifically, a formula was used to produce a weighted score combining the team's final balance, amount of debt, overall popularity score, and popularity scores for the four largest constituents.

CHAPTER FOUR: RESULTS

Table 4 provides a summary of the means, standard deviations, and correlations among the team level variables included in the study. Factorial analysis of covariance (ANCOVA) was utilized to test the effects of virtuality and distribution on leadership structures (Hypotheses 1-3), as this allowed for the inclusion of the control variables of team mean age, gender, GPA, and technology experience. Bootstrapping via the Hayes (2012) PROCESS macro for SPSS was utilized to test the mediating effects of teamwork on the relationship between team leadership and performance (Hypotheses 4-7). Bootstrapping is superior to the Baron and Kenny (1986) approach for testing mediation because (1) it does not impose the assumption of normality of the sampling distribution, (2) it can be applied to small samples with more confidence, and (3) it provides confidence intervals regarding the magnitude of indirect effects, making it a more descriptive method of analysis.

Table 4. Means, Standard Deviations, and Correlations for Study Variables

		M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Age Mean	19.68	2.24																
2	Gender Mean	.47	.29	-.05															
3	GPA Mean	3.52	2.05	.09	.05														
4	Technology Use Mean	4.51	.51	-.16*	.01	.05													
5	Dis Density Structuring	.71	.13	-.01	-.02	.02	.19**												
6	Col Density Structuring	.77	.14	-.02	-.01	.01	.22**	.53**											
7	Dis Density Solve Problems	.76	.13	-.01	-.06	-.03	.13*	.87**	.36**										
8	Col Density Solve Problems	.81	.12	-.11	-.03	.05	.19*	.35**	.74**	.39**									
9	Dis Density Support	.76	.14	-.02	-.04	-.01	.07	.83**	.34**	.90**	.32**								
10	Col Density Support	.81	.12	.00	-.05	-.01	.21**	.43**	.74**	.42**	.83**	.44**							
11	Role Distance	2.24	1.04	.01	-.02	-.05	-.18*	-.32**	-.34**	-.10	-.13	-.10	-.17*						
12	Role Variety	.39	.22	.07	.06	.01	-.02	-.20**	.01	-.21**	-.08	-.26**	-.08	-.26**					
13	Teamwork Overall	3.39	.71	.00	.01	-.16*	-.09	.34**	-.02	.40**	.00	.39**	.04	.12	-.24**				
14	Transition	3.31	.84	.01	.00	-.14*	-.08	.25**	-.09	.31**	-.04	.30**	.01	.14*	-.20**	.91**			
15	Action	3.38	.78	-.03	.02	-.15*	-.10	.34**	.01	.40**	.03	.38**	.07	.12	-.19**	.93**	.82**		
16	Interpersonal	3.47	.76	.03	-.02	-.14*	-.05	.31**	.03	.37**	-.01	.35**	.05	.07	-.26**	.82**	.62**	.62**	
17	Performance	.52	.10	-.04	.12	-.05	.10	.14*	.25**	.12	.22*	.08	.11	-.20*	.02	.14*	.15*	.10	.13*

Note: ** $p < .01$, * $p < .05$. Dis Density = Perceived Collective Leadership of Distributed Members, Col Density = Perceived Collective Leadership of Collocated Members

Virtuality & Distribution Effects: Perceived Collective Leadership

The first set of results presented focuses on the interactions of virtuality and distribution on distributed team member leadership perceptions in terms of the resulting network density of ratings for and by distributed team members' collective leadership. Hypothesis 1a-c proposed that for distributed team members, the physical distribution of the team would impact the density of collective leadership perceptions for the behaviors of structuring/planning, solving problems, and supporting the social climate (1a-c respectively), with less distributed teams (i.e., 3-1 and 2-2 conditions) having lower perceived collective leadership than more distributed teams (i.e., 2-1-1 and 1-1-1-1 conditions). Furthermore, Hypotheses 3a-c predicted that team virtual tool use would moderate the relationship between distribution and distributed team members' perceived collective leadership density, such that low virtuality tools (i.e., videoconferencing) would counterbalance the effects of distribution for less distributed teams. Tables 5-10 provide the results of the ANCOVAs for each of the three leadership behaviors assessed using the distributed team leadership network density measures, while Figures 5-7 plot the interaction effects.

Structure and Planning

ANCOVA results revealed that for the leadership behavior of structuring and planning, there was no significant main effect for distribution ($F(3,183) = 1.04$, $p = .38$, $\eta^2 = .02$). However, there was a significant main effect for virtuality ($F(2,184) = 4.97$, $p < .01$, $\eta^2 = .06$), and a significant interaction between virtuality and distribution ($F(6,180) = 2.84$, $p < .05$, $\eta^2 = .09$). In terms of the main effect of virtuality, teams utilizing instant messaging to communicate exhibited less dense networks of perceived collectcive leadership for distributed members ($M = .68$, SD = .14) than either teleconferencing ($M = .73$, SD = .12) or videoconferencing teams ($M = .74$, SD = .11).

Table 5. Summary of ANCOVA Results for Perceived Collective Leadership: Structure & Planning

Variable	Sum of Squares	df	Mean Square	F	η^2
Covariates					
Age	.00	1	.00	.24	.00
Gender	.00	1	.00	.02	.00
GPA	.01	1	.01	.60	.01
Technology Expertise	.11	1	.11	7.69**	.04
Main Effects					
Virtuality	.14	2	.07	4.97**	.06
Distribution	.05	3	.02	1.04	.02
Interaction Effects					
Virtuality x Distribution	.25	6	.04	2.84*	.09
Error	2.44	170	.01		
Total	97.76	186			
Corrected Total	2.95	185			

Note: N = 186. * $p < .05$, ** $p < .01$

To clarify the nature of the interaction between virtuality and distribution, the data was plotted, and means and standard deviations for each of the conditions provided (see Figure 5 and Table 6). As expected, teams that were less distributed and utilized videoconferencing (M =.77, SD = .09 for 3-1 distribution, M =.74, SD = .12 for 2-2 distribution) or teleconferencing (M =.72, SD = .13 for 3-1 distribution, M =.73, SD = .12 for 2-2 distribution) experienced more dense networks than those communicating via instant messaging (M =.60, SD = .15 for 3-1 distribution, M =.63, SD = .15 for 2-2 distribution). Teams that were more distributed did not illustrate major differences in network density regardless of the type of virtual tool used, as expected. Thus, while Hypothesis 1a was not supported, Hypothesis 3a was supported.

Table 6. Means and Standard Deviations for Perceived Collective Leadership: Structure & Planning

Virtuality Condition	Distribution Condition	Mean	SD	N
	3-1	.77	.09	16
	2-2	.74	.12	16
Videoconference	2-1-1	.70	.10	14
	1-1-1-1	.72	.13	14
	Total	.74	.11	60
	3-1	.72	.13	16
	2-2	.73	.12	16
Teleconference	2-1-1	.72	.12	17
	1-1-1-1	.74	.12	16
	Total	.73	.12	65
	3-1	.60	.15	13
	2-2	.63	.15	16
Instant Message	2-1-1	.72	.09	17
	1-1-1-1	.75	.12	15
	Total	.68	.14	61
	3-1	.70	.14	45
	2-2	.70	.14	48
Total	2-1-1	.71	.10	48
	1-1-1-1	.74	.12	45
	Total	.71	.13	186

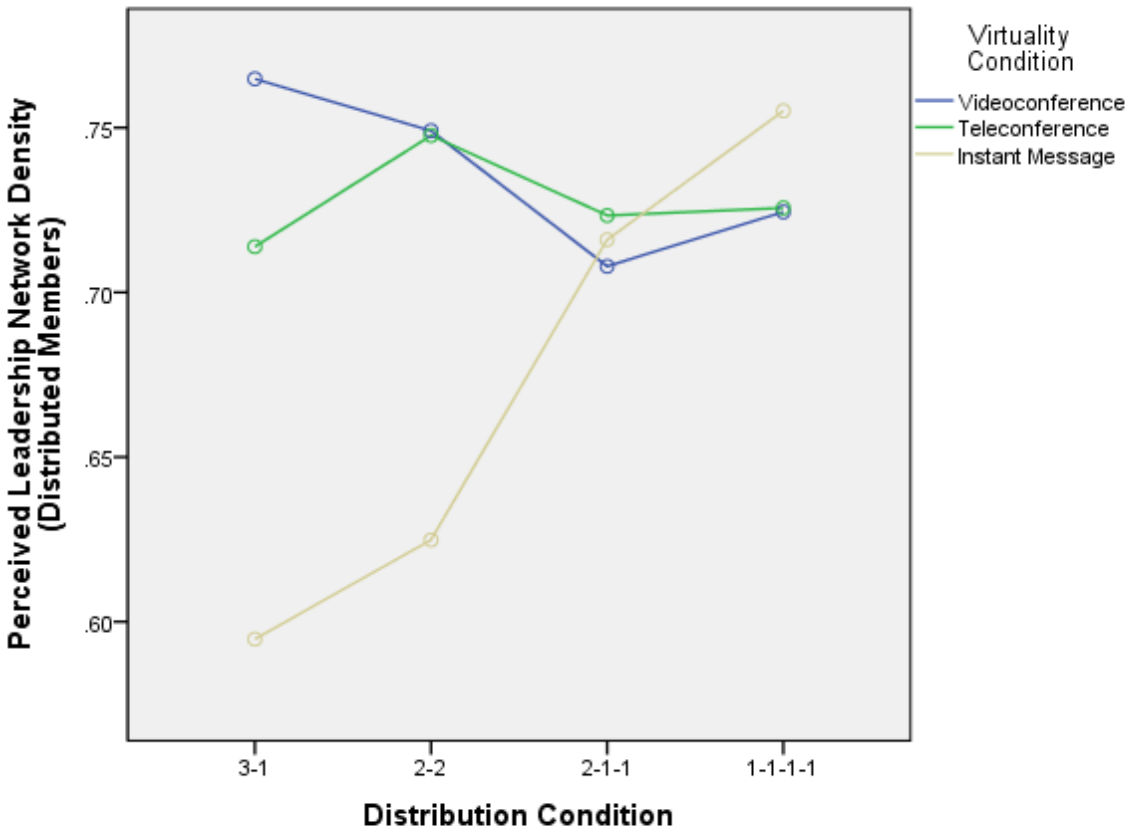

Figure 5. Distribution and Virtuality Interaction Effects for Perceived Collective Leadership: Structure & Planning

Solving Problems

ANCOVA results (Table 7) revealed that for the collective leadership behavior of solving problems, there was no significant main effect for distribution ($F(3,183) = .62$, $p = .60$, $\eta^2 = .01$). However, there was a significant main effect for virtuality ($F(2,184) = 6.06$, $p < .01$, $\eta^2 = .07$), and a significant interaction between virtuality and distribution ($F(6,180) = 3.37$, $p < .01$, $\eta^2 = .11$). In terms of the main effect of virtuality, teams utilizing instant messaging to communicate exhibited less dense networks of perceived collective leadership for distributed members (M =

.71, SD = .16) than either teleconferencing (*M* = .77, SD = .12) or videoconferencing teams (*M* = .78, SD = .11).

Table 7. Summary of ANCOVA Results for Perceived Collective Leadership: Solving Problems

Variable	Sum of Squares	df	Mean Square	F	η^2
Covariates					
Age	.00	1	.00	.23	.00
Gender	.01	1	.00	.45	.00
GPA	.01	1	.01	.02	.00
Technology Expertise	.08	1	.08	4.70*	.03
Main Effects					
Virtuality	.20	2	.10	6.06**	.07
Distribution	.03	3	.01	.62	.01
Interaction Effects					
Virtuality x Distribution	.33	6	.06	3.37**	.11
Error	2.79	170	.02		
Total	109.73	186			
Corrected Total	3.39	185			

Note: N = 186. * $p < .05$, ** $p < .01$

To clarify the nature of the interaction between virtuality and distribution, the data was plotted (see Figure 6 and Table 8). As expected, teams that were less distributed and utilized videoconferencing (*M* =.82, SD = .09 for 3-1 distribution, *M* =.80, SD = .12 for 2-2 distribution) or teleconferencing (*M* =.77, SD = .12 for 3-1 distribution, *M* =.79, SD = .13 for 2-2 distribution) experienced more dense networks than those communicating via instant messaging (*M* =.63, SD = .19 for 3-1 distribution, *M* =.67, SD = .15 for 2-2 distribution). Teams that were more distributed did not illustrate major differences in network density regardless of the type of virtual tool used, as expected. Thus, while Hypothesis 1b was not supported, Hypothesis 3b was supported.

Table 8. Means and Standard Deviations for Perceived Collective Leadership: Solving Problems

Virtuality Condition	Distribution Condition	Mean	SD	N
	3-1	.82	.09	16
	2-2	.80	.12	16
Videoconference	2-1-1	.73	.10	14
	1-1-1-1	.77	.15	14
	Total	.78	.12	60
	3-1	.77	.12	16
	2-2	.79	.13	16
Teleconference	2-1-1	.77	.11	17
	1-1-1-1	.76	.11	16
	Total	.77	.12	65
	3-1	.63	.19	13
	2-2	.67	.15	16
Instant Message	2-1-1	.75	.10	17
	1-1-1-1	.79	.16	15
	Total	.71	.16	61
	3-1	.75	.16	45
	2-2	.75	.14	48
Total	2-1-1	.75	.10	48
	1-1-1-1	.77	.14	45
	Total	.76	.14	186

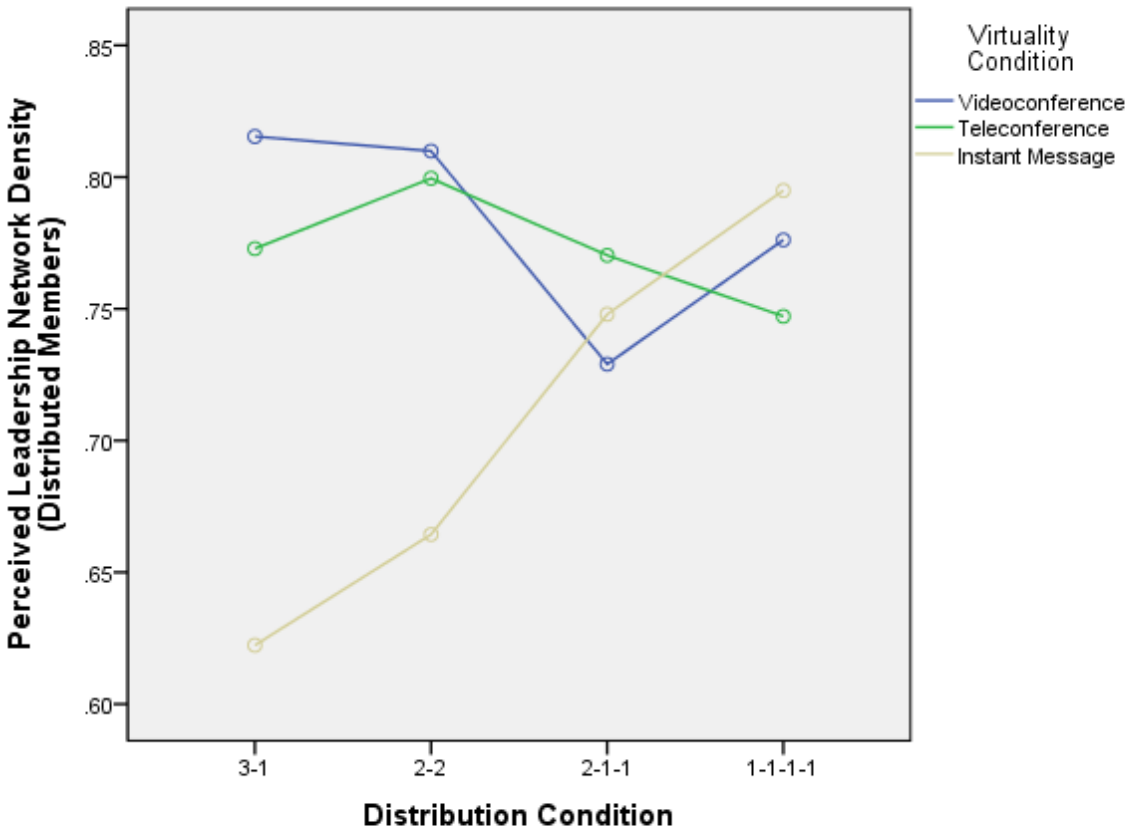

Figure 6. Distribution and Virtuality Interaction Effects for Perceived Collective Leadership: Solving Problems

Supporting the Social Climate

ANCOVA results (Table 9) revealed that for the collective leadership behavior of supporting the social climate, there was no significant main effect for distribution ($F(3,183) = .67$, $p = .57$, $\eta^2 = .01$). However, there was a significant main effect for virtuality ($F(2,184) = 7.14$, $p < .01$, $\eta^2 = .08$), and a significant interaction between virtuality and distribution ($F(6,180) = 3.09$, $p < .01$, $\eta^2 = .10$). In terms of the main effect of virtuality, teams utilizing instant messaging to communicate exhibited less dense networks of perceived leadership for distributed

members (*M* = .71, SD = .16) than either teleconferencing (*M* = .77, SD = .12) or videoconferencing teams (*M* = .79, SD = .12).

Table 9. Summary of ANCOVA Results for Perceived Collective Leadership: Supporting the Social Climate

Variable	Sum of Squares	df	Mean Square	F	η^2
Covariates					
Age	.00	1	.00	.00	.00
Gender	.01	1	.01	.28	.00
GPA	.00	1	.00	.15	.00
Technology Expertise	.04	1	.04	2.05	.01
Main Effects					
Virtuality	.25	2	.12	7.14**	.08
Distribution	.04	3	.01	.62	.01
Interaction Effects					
Virtuality x Distribution	.32	6	.05	3.09**	.10
Error	2.93	170	.02		
Total	109.60	186			
Corrected Total	3.53	185			

Note: N = 186. * $p < .05$, ** $p < .01$

To clarify the nature of the interaction between virtuality and distribution, the data was plotted (see Figure 7 and Table 10). As expected, teams that were less distributed and utilized videoconferencing (*M* =.82, SD = .10 for 3-1 distribution, *M* =.79, SD = .14 for 2-2 distribution) or teleconferencing (*M* =.79, SD = .15 for 3-1 distribution, *M* =.76, SD = .12 for 2-2 distribution) experienced more dense networks than those communicating via instant messaging (*M* =.60, SD = .17 for 3-1 distribution, *M* =.67, SD = .17 for 2-2 distribution). Teams that were more distributed did not illustrate major differences in network density regardless of the type of virtual tool used, as expected. Thus, while Hypothesis 1c was not supported, Hypothesis 3c was supported.

Table 10. Means and Standard Deviations for Perceived Collective Leadership: Supporting the Social Climate

Virtuality Condition	Distribution Condition	Mean	SD	N
	3-1	.82	.10	16
	2-2	.79	.14	16
Videoconference	2-1-1	.76	.09	14
	1-1-1-1	.77	.14	14
	Total	.79	.12	60
	3-1	.79	.15	16
	2-2	.76	.12	16
Teleconference	2-1-1	.77	.10	17
	1-1-1-1	.76	.10	16
	Total	.77	.12	65
	3-1	.60	.17	13
	2-2	.67	.17	16
Instant Message	2-1-1	.75	.11	17
	1-1-1-1	.79	.14	15
	Total	.71	.16	61
	3-1	.75	.17	45
	2-2	.74	.15	48
Total	2-1-1	.76	.10	48
	1-1-1-1	.77	.13	45
	Total	.76	.14	186

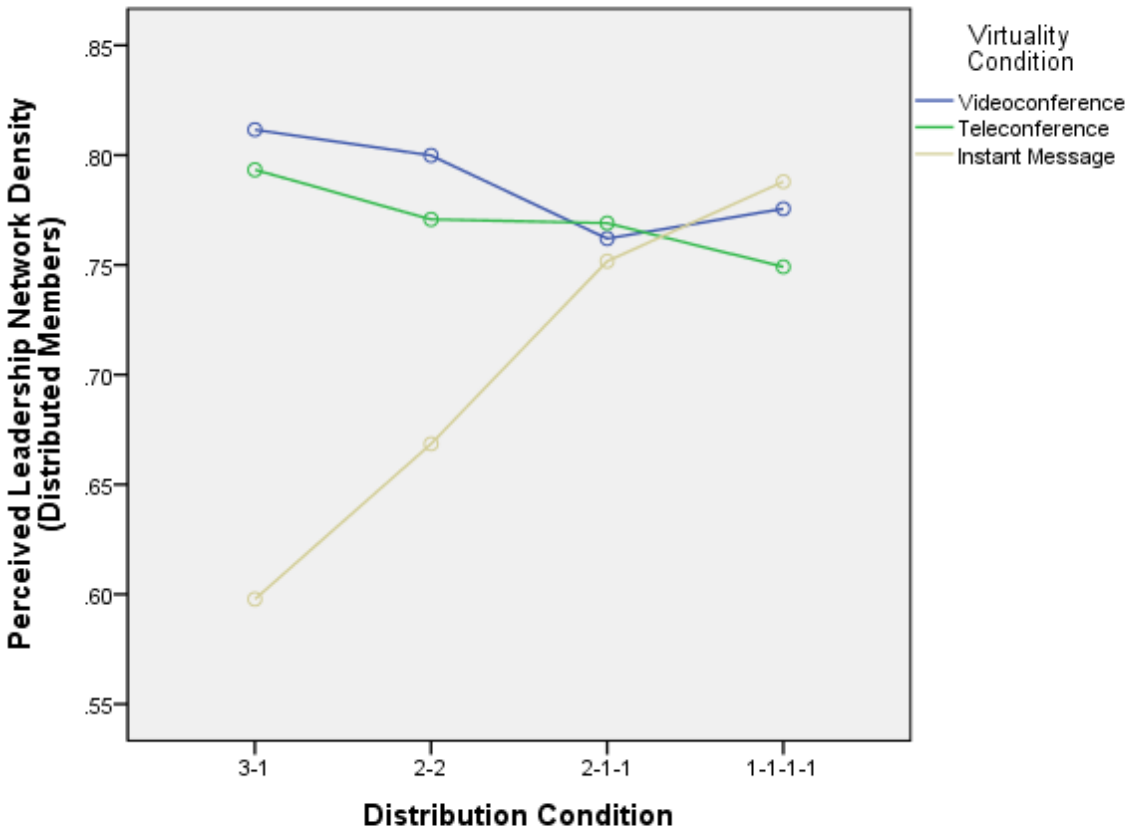

Figure 7. Distribution and Virtuality Interaction Effects for Perceived Collective Leadership: Supporting the Social Climate

Virtuality & Distribution Effects: Perceived Leadership Role Specialization

The second set of results presented focuses on the interactions of virtuality and distribution on perceived leadership role specialization for both the adapted Blau role variety index and role specialization based on distance index. Hypothesis 2a-b proposed that distribution would impact perceptions of leadership role specialization as operationalized by role variety and role distance (2a and 2b respectively), with less distributed teams (i.e., 3-1 and 2-2 conditions) having greater specialization than more distributed teams (i.e., 2-1-1 and 1-1-1-1 conditions). Furthermore, Hypotheses 3d-e predicted that team virtual tool use would moderate the

relationship between distribution and perceived leadership role specialization, such that low virtuality tools (i.e., videoconferencing) would counterbalance the effects of distribution for more distributed teams. Tables 11-12 provide the results of the ANCOVAs for the two different role indices.

Perceived Leadership Role Variety

ANCOVA results revealed that for the perceived leadership role variety index, there was no significant main effect for distribution ($F(3,183) = .44$, $p = .72$, $\eta^2 = .01$), or for virtuality ($F(2,184) = .38$, $p = .68$, $\eta^2 = .00$). There was also not a significant interaction between virtuality and distribution ($F(6,180) = .39$, $p = .88$, $\eta^2 = .01$). Therefore, Hypotheses 2a and 3d were not supported.

Table 11. Summary of ANCOVA Results for Perceived Leadership Role Variety

Variable	Sum of Squares	df	Mean Square	F	η^2
Covariates					
Age	.01	1	.01	.58	.00
Gender	.01	1	.01	.60	.00
GPA	.00	1	.00	.15	.00
Technology Expertise	.00	1	.00	.01	.00
Main Effects					
Virtuality	.02	2	.12	.38	.00
Distribution	.03	3	.01	.44	.01
Interaction Effects					
Virtuality x Distribution	.32	6	.01	.39	.01
Error	4.10	170	.02		
Total	12.16	186			
Corrected Total	4.25	185			

Note: N = 186.

Perceived Leadership Role Distance

ANCOVA results revealed that for the perceived leadership role distance index, there was no significant main effect for distribution ($F(3,183) = .78$, $p = .51$, $\eta^2 = .01$), or for virtuality ($F(2,184) = .51$, $p = .60$, $\eta^2 = .01$). There was also not a significant interaction between virtuality and distribution ($F(6,180) = 2.02$, $p = .07$, $\eta^2 = .06$). Therefore, Hypotheses 2b and 3e were not supported.

Table 12. Summary of ANCOVA Results for Perceived Leadership Role Distance

Variable	Sum of Squares	df	Mean Square	F	η^2
Covariates					
Age	.13	1	.13	.13	.00
Gender	.02	1	.02	.01	.00
GPA	.25	1	.25	.24	.00
Technology Expertise	5.21	1	5.21	5.04*	.03
Main Effects					
Virtuality	1.05	2	.52	.51	.01
Distribution	2.41	3	.80	.78	.01
Interaction Effects					
Virtuality x Distribution	12.53	6	2.09	2.02	.06
Error	188.98	170	1.03		
Total	1216.19	186			
Corrected Total	217.08	185			

Note: N = 186, * $p < .05$

Mediation Effects of Teamwork: Perceived Leadership Role Specialization

Hypotheses 4a-b present the mediation effects of overall teamwork processes on the relationship between the two role specialization conceptualizations, perceived leadership role variety and distance, and team performance. Specifically, it was expected that overall teamwork processes would partially mediate the relationship, such that there would be both a direct and indirect effect for the perceived leadership role specialization indices on team performance. The

following summarizes the results for the mediation analyses conducted using Hayes (2013) PROCESS macro for assessing mediation via bootstrapping techniques. As all hypotheses were directional and theory driven, one-tailed tests were used (Hayes, 2013; Jones, 1952, 1954; Kimmel, 1957). Additionally, the control variables of team mean age, GPA, and gender were not significant in any of the mediation tests and were subsequently removed from analyses.

Perceived Leadership Role Variety

In order to assess the indirect and direct effects of perceived leadership role variety as measured by the adapted Blau variety index, bootstrapping techniques were used to generate confidence intervals for these effects. Table 13 provides the two models for assessing the influences of the independent variable and mediator variable on the dependent variable. Perceived leadership role variety did significantly impact teamwork overall processes, however this effect was in the opposite direction, as the relationship was negative. Furthermore, while teamwork overall processes did positively and significantly impact team performance, perceived leadership role variety was not a significant predictor. In terms of the direct and indirect effects, for the direct effect, the confidence intervals did include zero (-.001, CIs -.09, .08); however, the confidence interval for the indirect effect of perceived leadership role variety did not include zero (indirect effect = -.03, CIs -.06, -.004). Thus, this partially supports Hypothesis 4a, as there was a significant indirect but non-significant direct effect. In sum, the relationship between perceived leadership role variety and team performance is fully mediated by overall teamwork processes; however, a negative relationship exists between the mediator and independent variable such that greater variety in team members' perceived leadership roles leads to lower overall teamwork.

Table 13. Regression Results for the Perceived Leadership Role Variety Mediation Model

Predictor	B	(SE)	LLCI	ULCI
	Mediator Variable Model: Teamwork Overall Processes			
Constant	4.25**	(.51)	3.43	5.13
Perceived Leadership Role Variety	-1.30**	(.41)	-1.98	-.63
Technology Use	-.14	(.11)	-.33	.04
	Dependent Variable Model: Team Performance			
Constant	.35*	(.08)	.23	.48
Teamwork Overall Processes	.02*	(.01)	.02	.04
Perceived Leadership Role Variety	-.01	(.05)	-.09	.08
Technology Use	.02	(.01)	-.08	.05

Note. * $p < .05$, ** $p < .01$, LLCI = 95% Lower Level Confidence Interval, ULCI = 95% Upper Level Confidence Interval

Perceived Leadership Role Distance

In order to assess the indirect and direct effects of perceived leadership role distance as measured by the specialization index examining the degree to which team members are perceived to be specialized in a single leadership role, bootstrapping techniques were used to generate confidence intervals for these effects. Table 14 provides the two models for assessing the influences of the independent variable and mediator variable on the dependent variable. Perceived leadership role distance did not significantly impact overall teamwork processes, however, both teamwork overall processes and perceived leadership role distance were significant predictors of team performance. It is important to note that the relationship between perceived leadership role distance and performance was in fact negative, such that more specialization leads to lower team performance. In terms of the direct and indirect effects, for the

direct effect, the confidence intervals did not include zero (-.01, CIs -.03, -.003); additionally, the confidence interval for the indirect effect of perceived leadership role distance did not include zero (.01, CIs .01, .05). Furthermore, the total effect of perceived leadership role distance on team performance was also significant (-.01, CIs -.02, -.001). Thus, this supports Hypothesis 4b, as there were significant indirect and direct effects. In sum, the relationship between perceived leadership role distance and team performance is partially mediated by overall teamwork processes; however, a negative relationship exists between the independent variable and dependent variable such that greater specialization of team members into unique leadership roles leads to lower team performance.

Table 14. Regression Results for the Perceived Leadership Role Distance Mediation Model

Predictor	B	(SE)	LLCI	ULCI
	Mediator Variable Model: Teamwork Overall Processes			
Constant	3.72**	(.57)	2.79	4.66
Perceived Leadership Role Distance	.08	(.05)	-.01	.17
Technology Use	-.11	(.11)	-.31	.07
	Dependent Variable Model: Team Performance			
Constant	.39*	(.08)	.27	.52
Teamwork Overall Processes	.02*	(.01)	.01	.04
Perceived Leadership Role Distance	-.01*	(.01)	-.03	-.003
Technology Use	.02	(.01)	-.01	.04

Note. * $p < .05$, ** $p < .01$, LLCI = 95% Lower Level Confidence Interval, ULCI = 95% Upper Level Confidence Interval

Mediation Effects of Teamwork: Perceived Collective Leadership

Hypotheses 5a-b, 6a-b, and 7a-b present the mediation effects of the specific teamwork process subcategories on the relationship between the two types of perceived collective leadership, distributed and collocated, and team performance. Specifically, it was expected that transition, action, and interpersonal teamwork processes would respectively partially mediate the relationships, such that there would be both a direct and indirect effect for the perceived collective leadership of structuring and planning, solving problems, and supporting the social climate on team performance. The following summarizes the results for the mediation analyses conducted using Hayes (2013) PROCESS macro for assessing mediation via bootstrapping techniques. As all hypotheses were directional and theory driven, one-tailed tests were used (Hayes, 2013; Jones, 1952, 1954; Kimmel, 1957). Additionally, the tables provided in the subsequent sections provide data for regression effects of both the collocated and distributed perceived collective leadership in a single table, as they were entered as covariates in the regression equations for one another and have the same coefficient results whether entered as a covariate or independent variable.

Structuring and Planning

In order to assess the indirect and direct effects of collocated and distributed perceived collective leadership of structuring and planning on team performance via transition processes as a mediator, bootstrapping techniques were used to generate confidence intervals for these effects. Table 15 provides the two models for assessing the influences of the independent variable and mediator variable on the dependent variable. Distributed structuring and planning network density had a positive significant impact on transition processes, but collocated structuring and planning network density was not a significant predictor. In terms of team performance,

transition processes were significantly and positively predictive of performance, but neither network density variable was significantly related. In terms of the direct and indirect effects for collocated network density, both the direct effect (.14, CIs -.01, .29) and indirect effect (-.02, CIs -.07, .003) confidence intervals included zero. Thus, Hypothesis 5a was not supported. In terms of the direct and indirect effects for distributed network density, for the direct effect, the confidence intervals did include zero (-.01, CIs -.14, .12); however, the confidence interval for the indirect effect did not include zero (.03, CIs .01, .08). Thus, this partially supports Hypothesis 5b, as there was a significant indirect but not direct effect.

Table 15. Regression Results for the Perceived Collective Leadership: Structuring & Planning Mediation Model

Predictor	B	(SE)	LLCI	ULCI
	Mediator Variable Model: Teamwork Transition Processes			
Constant	4.28**	(.87)	2.84	5.73
Structuring and Planning Perceived Network Density (Distributed)	1.68*	(.74)	.45	2.91
Structuring and Planning Perceived Network Density (Collocated)	-1.02	(.85)	-2.42	.38
Technology Use	-.32	(.17)	-.60	-.04
	Dependent Variable Model: Team Performance			
Constant	.27*	(.10)	.10	.43
Transition Processes	.02*	(.01)	.002	.04
Structuring and Planning Perceived Network Density (Distributed)	.02	(.08)	-.11	.15
Structuring and Planning Perceived Network Density (Collocated)	.12	(.09)	-.02	.27

Technology Use	.01	(.02)	-.02	.04

Note. * $p < .05$, ** $p < .01$, LLCI = 95% Lower Level Confidence Interval, ULCI = 95% Upper Level Confidence Interval

Solving Problems

In order to assess the indirect and direct effects of collocated and distributed perceived collective leadership of solving problems on team performance via action processes as a mediator, bootstrapping techniques were used to generate confidence intervals for these effects. Table 16 provides the two models for assessing the influences of the independent variable and mediator variable on the dependent variable. Distributed solving problems network density had a positive significant impact on action processes, but collocated solving problems network density was not a significant predictor. In terms of team performance, neither type of network density significantly related to team performance, but action processes did positively predict performance. In terms of the direct and indirect effects for collocated network density, both the direct effect (.13, CIs -.004, .27) and indirect effect (.03, CIs -.03, .09) confidence intervals included zero. Thus, Hypothesis 5a was not supported. In terms of the direct and indirect effects for distributed network density, both the direct effect (.02, CIs -.10, .14) and indirect effect (.03, CIs -.01, .08) confidence intervals included zero. Thus, Hypothesis 5b was also not supported.

Table 16. Regression Results for the Perceived Collective Leadership: Solving Problems Mediation Model

Predictor	B	(SE)	LLCI	ULCI
	Mediator Variable Model: Teamwork Action Processes			
Constant	1.81**	(.35)	1.22	2.41
Solving Problems Perceived Network Density (Distributed)	2.19**	(.25)	1.75	2.61

Solving Problems Perceived Network Density (Collocated)	.33	(.32)	-.19	.85
Technology Use	-.04	(.07)	-.07	.15
	Dependent Variable Model: Team Performance			
Constant	.10	(.10)	-.07	.27
Action Processes	.09**	(.02)	.05	.13
Solving Problems Perceived Network Density (Distributed)	-.15	(.08)	-.29	.01
Solving Problems Perceived Network Density (Collocated)	.13	(.02)	-.004	.27
Technology Use	.01	(.02)	-.01	.04

Note. * $p < .05$, ** $p < .01$, LLCI = 95% Lower Level Confidence Interval, ULCI = 95% Upper Level Confidence Interval

Supporting the Social Climate

In order to assess the indirect and direct effects of collocated and distributed perceived collective leadership of supporting the social climate on team performance via interpersonal processes as a mediator, bootstrapping techniques were used to generate confidence intervals for these effects. Table 17 provides the two models for assessing the influences of the independent variable and mediator variable on the dependent variable. Distributed supporting social climate network density had a positive significant impact on interpersonal processes, but collocated supporting social climate network density was not a significant predictor. In terms of team performance, interpersonal processes were significantly and positively predictive of performance, but neither network density variable was significantly related to performance. In terms of the direct and indirect effects for collocated network density, both the direct effect (.05,

CIs -.08, .18) and indirect effect (-.01, CIs -.03, .02) confidence intervals included zero. Thus, Hypothesis 7a was not supported. In terms of the direct and indirect effects for distributed network density, for the direct effect, the confidence intervals did include zero (.06, CIs -.06, .18); however, the confidence interval for the indirect effect did not include zero (.05, CIs .02, .10). Thus, this partially supports Hypothesis 7b, as there was a significant indirect but not direct effect.

Table 17. Regression Results for the Perceived Collective Leadership: Supporting Social Climate Mediation Model

Predictor	B	(SE)	LLCI	ULCI
	Mediator Variable Model: Teamwork Interpersonal Processes			
Constant	3.38**	(.76)	2.11	4.64
Supporting Social Climate Perceived Network Density (Distributed)	1.98**	(.57)	1.03	2.94
Supporting Social Climate Perceived Network Density (Collocated)	-.22	(.65)	-1.30	.87
Technology Use	-.28	(.15)	-.52	-.04
	Dependent Variable Model: Team Performance			
Constant	.28*	(.10)	.11	.45
Interpersonal Processes	.09**	(.02)	.05	.13
Supporting Social Climate Perceived Network Density (Distributed)	.01	(.07)	-.11	.14
Supporting Social Climate Perceived Network Density (Collocated)	.05	(.08)	-.08	.18

Technology Use	.02	(.02)	-.01	.05

Note. * $p < .05$, ** $p < .01$, LLCI = 95% Lower Level Confidence Interval, ULCI = 95% Upper Level Confidence Interval

CHAPTER FIVE: DISCUSSION

Our current understanding of leadership, teamwork, and team performance primarily addresses the needs of traditional face to face teams (Cannon-Bowers & Bowers, 2010). However, teams today are increasingly operating in virtual and distributed environments which place unique demands on team processes and performance. The purpose of the current study was to begin to disentangle how such context may require a different perspective regarding our understanding of how teams function. Specifically, this research offers insight regarding how distribution and virtuality may interact to impact the emergence of leadership as a team property, and how such emergent team leadership structures may in turn influence teamwork and team performance. The following discussion provides a more detailed analysis of the results from this study, highlighting first the contextual influences of virtuality and distribution, then turning to the meditational effects of teamwork on the team leadership→team performance relationship. Table 18 provides a summary of all of the hypotheses tested and degree to which support was offered based on the results.

Table 18. Summary of Hypothesis Testing Results

Hypothesis		Results
H1a	Team physical distribution configuration will negatively impact the perceived collective leadership of structuring and planning for distributed team members, such that less distributed teams will have lower perceived collective leadership of structuring and planning than more distributed teams.	Not Supported
H1b	Team physical distribution configuration will negatively impact the perceived collective leadership of solving problems for distributed team members, such that less distributed teams will have lower perceived collective leadership of solving problems than more distributed teams.	Not Supported

Hypothesis		Results
H1c	Team physical distribution configuration will negatively impact the perceived collective leadership of social climate support for distributed team members, such that less distributed teams will have lower perceived collective leadership of social climate support than more distributed teams.	Not Supported
H2a	Team physical distribution configuration will negatively impact perceived leadership role variety, such that more distributed teams will have less perceived leadership role variety than less distributed teams.	Not Supported
H2b	Team physical distribution configuration will negatively impact perceived leadership role distance, such that more distributed teams will have less perceived leadership role distance than less distributed teams.	Not Supported
H3a	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived collective leadership of structuring and planning, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.	Supported (Interaction & Virtuality Main Effect)
H3b	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived collective leadership of solving problems, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.	Supported (Interaction & Virtuality Main Effect)
H3c	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived collective leadership of solving problems, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to more dense networks for less distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect more distributed teams' network density.	Supported (Interaction & Virtuality Main Effect)
H3d	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived leadership role variety, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to greater role variety for more distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect less distributed teams' role variety.	Not Supported
H3e	Virtual tool use will moderate the relationship between team physical distribution configuration and perceived leadership role distance, such that low virtuality tool use (i.e., videoconferencing, teleconferencing) will lead to greater role distance for more distributed teams than high virtuality tool use (i.e., instant messaging), but will not affect less distributed teams' role distance.	Not Supported

Hypothesis		Results
H4a	Overall teamwork processes will partially mediate the relationship between perceived leadership role variety and team performance.	Partially Supported (Indirect Effect, Negative)
H4b	Overall teamwork processes will partially mediate the relationship between perceived leadership role distance and team performance.	Partially Supported (Direct Effect)
H5a	Transition teamwork processes will partially mediate the relationship between collocated perceived collective leadership of structuring and planning.	Not Supported
H5b	Transition teamwork processes will partially mediate the relationship between distributed perceived collective leadership of structuring and planning.	Partially Supported (Indirect Effect)
H6a	Action teamwork processes will partially mediate the relationship between collocated perceived collective leadership of solving problems.	Not Supported
H6b	Action teamwork processes will partially mediate the relationship between distributed perceived collective leadership of solving problems.	Not Supported
H7a	Interpersonal teamwork processes will partially mediate the relationship between collocated perceived collective leadership of supporting social climate.	Not Supported
H7b	Interpersonal teamwork processes will partially mediate the relationship between distributed perceived collective leadership of supporting social climate.	Partially Supported (Indirect Effect)

Virtuality and Distribution as Antecedents to Team Leadership Structure

The first set of hypotheses in this study assessed the degree to which physical distribution of team members impacted the emergence of leadership structures, and how this in turn was influenced by the type of virtual tool utilized. While there were no direct main effects of physical distribution on any of the team leadership structure variables, the interaction between virtuality and physical distribution offers several important findings. First, for all three measures of perceived collective leadership for distributed team members (structuring/planning, solving problems, supporting social climate), a similar pattern of effects emerged in regards to the influences of virtuality and distribution. As noted in Figures 5-7, for the less distributed (i.e., 3-1,

2-2) teams, the type of virtual tool used was a significant factor in predicting the degree to which distributed team members were perceived as participating in the collective execution of leadership behaviors. However, for more distributed (i.e., 2-1-1, 1-1-1-1) teams, this distinction of tool use was not present. Taken together, these results support the idea that partial distribution of teams is an especially important factor to consider in terms of its influence on the emergence of leadership structure, particularly when teams utilize less rich forms of media to communicate. When the majority of team members are collocated, it may be easier for team members to exclude isolated members from leadership processes if they are not communicating via media that conveys social presence.

This is in line with previous literature regarding the development of faultlines in teams, as distribution could be considered a dividing line that splits team members into two or more groups (Lau & Murningham, 1998). For distribution, these faultlines may lead to decrements in team processes as isolated members feel excluded from the rest of the team (Thatcher & Patel, 2011, 2012). From a team leadership perspective, the exclusion of such members may be particularly problematic given that the collocated team members may not have the capacity to perform all necessary leadership functions, leading to teamwork process decrements (Day, Gronn, & Salas, 2004). The results regarding less of an effect of virtuality for more distributed teams is not surprising, as members of teams that are more distributed are essentially all on the same level in terms of the social presence conveyed, and therefore should have more of an equal opportunity to convey social influence. As seen by the results, this relative equality in social influence results in a greater likelihood that multiple members will participate in the leadership process.

Furthermore, while not initially hypothesized, analyses did reveal a main effect of virtuality for each of the three perceived leadership network density measures for distribution. Thus, even without considering the impacts of distribution, virtuality has an impact on how leadership emerges in teams for members that are distributed. Specifically, post hoc analyses revealed that when teams communicated with instant messaging, they were less likely to perceive distributed team members as participating in leadership behaviors than when using teleconferencing and videoconferencing. Again, this result follows with the idea that the richer social presence offered by videoconferencing and teleconferencing enhances the ability of team members to convey social influence, a critical component to the leadership process (Zaccaro, et al., 2001). However, it is interesting to note that there were not significant differences for teleconferencing and videoconferencing. This may be due to a larger distinction between text based communications and audio/visual communications in terms of social presence (Daft & Lengel, 1984; Kirkman & Mathieu, 2005). This is not to say that text based communications are not as useful as teleconferencing or videoconferencing, as the ability to review communication logs can be advantageous for other team factors such as team cognition (Jimenez, 2012). However, given the social nature of leadership, being able to utilize richer media appears to be advantageous in terms of encouraging members to step into leadership roles.

Furthermore, while distribution and virtuality had significant impacts on the collective leadership conceptualizations of team leadership, there were no significant influences on the two perceived leadership role specialization indices. Therefore, it may be the case that distribution does not impact team members' abilities to pick up on member specialization into particular types of leadership roles. Alternatively, this may be due to the way in which the measure of specialization is operationalized. As previously discussed, these metrics are limited in terms of

the information they are able provide, given that the role distance metric captures the degree of specialization but does not provide information about the specific role on which the team member is specialized. Similarly, the role variety index captures the behavior perceived as being most often performed, but fails to account for the fact that a team member may be high on multiple behaviors. Thus, these deficiencies may mean that the metrics do not adequately capture the nature of the relationship between team leadership role specialization and distribution and virtuality. Further investigation into this specialization aspect in terms of how to best represent the dispersion of roles in teams is therefore warranted before final judgments can be made regarding its relationship with distribution and virtuality.

Mediating Effects of Teamwork on Team Leadership Structure & Team Performance

Moving on to the mediation analyses, several interesting patterns emerged. First, despite the acknowledged deficiencies in the measures of perceived leadership role specialization, there does appear to be an effect of role specialization on team outcomes. Specifically, expert ratings combining team transition, action, and interpersonal processes exhibited an indirect effect on the relationship between perceived role variety and team performance. However, the relationship between role variety and teamwork was negative, contrary to expectations. Additionally, there was a direct effect of perceived leadership role distance and team performance as well as an indirect effect via teamwork processes. In this case however, the relationship between teamwork and role distance was positive as expected, but the relationship between role distance and performance was negative.

In terms of an explanation for the negative relationship between role variety and teamwork, the index did account for non-leaders as part of the variety, thus teams that were highly variable could have member who did not perform any leadership function. Thus, it may

be the case that when teams did not perceive all members as performing a leadership role, they were less effective in teamwork than if multiple members were to take on the same role. This goes back to the idea that one of the benefits of sharing leadership is a sense of commitment due to involvement as a leader (Kukenberger, 2012). Thus, if one member was not perceived as leading, it may also be the case that the other members had to take on other workload requirements, leading to less effective teamwork. In terms of the negative relationship between role distance and performance, it may be the case that while team member specialization in one role as opposed to many roles is beneficial, the team members were not specializing in the correct roles. The calculation of role distance did not capture the specific behaviors in which members were specialized, therefore this is something in need of exploration, in terms of more clearly assessing the types of behaviors and degree to which members are specializing in one particular role. Again, given the discussion of the advantages and disadvantages of these role specialization indices, it is critical that future research be conducted either with the same indices or with further adaptations as our understanding of the role of specialization in team leadership expands.

Regarding the mediation effects of specific teamwork processes on the relationship between collocated/distributed perceived collective leadership and team performance, there was an overarching lack of support specifically for the influences of collocated perceived collective leadership on either teamwork processes or team performance. This is a particularly interesting finding as it was expected that both collocated and distributed collective leadership would contribute to the overall success of the team. However, it may be the case that the vast majority of collocated team members jointly worked together to perform leadership behaviors, while there was more variability in the degree to which distributed members were perceived to be

participating in leadership behaviors. A more narrow range of network density scores for collocated team members (.35 to 1.00) as compared to distributed team members (.20 to 1.00) across the three leadership variables provides some support for this idea.

However, it does appear that the degree to which distributed team members are involved in team leadership is an important factor for transition and interpersonal processes as well as team performance. The lack of a significant finding for action processes as a mediator may be due to the fact that for this particular simulation task, transition and interpersonal processes may have been more challenging than action processes, as it was a strategy intensive task requiring members to adapt and adjust plans numerous times in order to be successful. Furthermore, the complexity of operating in a virtual and distributed environment adds additional interpersonal demands, such as taking longer to develop trust and cohesion (Jarvenpaa & Leidner, 1999; O'Leary & Mortensen, 2010). Therefore, these processes may have benefitted more from leadership than action processes, explaining the lack of a mediation effect.

Theoretical Implications

Overall, this research offers several important theoretical contributions. First, it expands upon current understanding of the nuanced effects of virtuality and physical distribution on the emergence of team leadership structure. Based on this research, it appears that it is important for researchers to move beyond the dichotomizing of virtuality and distribution, and instead turn towards viewing these factors as continua whereby teams are more or less virtual as well as more or less distributed. Indeed, the present research advances Kirkman and Mathieu's (2005) call for research that moves beyond "virtual" versus "traditional" teams by incorporating multiple levels of each dimension, with unique results occurring. Furthermore, this research pushes the limited partially distributed teams literature (Humphrey, 2004; O'Leary & Mortensen, 2010) by

examining three forms of partial distribution. Subsequently, it offers a unique perspective on how team leadership structure may vary across different forms of partial distribution, especially in relation to the types of virtual tools utilized.

Second, this research provides additional empirical evidence regarding the importance of leadership as a team-level variable, especially in terms of how different operationalizations may have differential effects on processes and outcomes. Specifically, the distinction of collocated and distributed perceived collective leadership as network density appears to offer a valuable perspective on how to conceptualize the degree to which team members participate collectively in leadership for distributed environments. Furthermore, while they do not perfectly operationalize the construct, the inclusion of two conceptualizations of leadership role specializations moves beyond the current focus on understanding just the sharedness of leadership behavior, and instead pushes researchers to consider both the degree to which members are involved in leadership as well as the roles in which they serve as leaders on a team. Additionally, the breaking down of leadership into specific behaviors adds to the previous approach in social network analysis of primarily focusing on having team members rate one another on leadership as a whole (Carson, et al., 2007). This more fine grained approach offers more detail regarding the specific behaviors that need to be performed by multiple team members in order to achieve team effectiveness.

Finally, this research provides a foundation for beginning to explore the mediating mechanisms that may link team leadership and team performance, offering a better understanding as to why such collectively enacted leadership may facilitate improved performance and providing guidance regarding the specific leadership behaviors to be targeted in order to enhance teamwork processes. Previous research has linked team leadership to team

performance, but until now there has not been much attention paid to exactly how this relationship occurs. Furthermore, there has been some debate in the literature regarding whether there is truly a distinction between team leadership and teamwork; that is, if all members are participating in leading the team, is this really something more than simply good teamwork? The empirical evidence presented here provides some initial evidence towards supporting the idea that there is a difference, as team leadership behaviors significantly but not completely predicted teamwork processes. By distinguishing the particular leadership behaviors that facilitate good teamwork, this research aids in further clarifying this difference, as it appears that team leadership may in fact be a team level process comprised of specific behaviors that facilitates the successful enactment of teamwork via social influence.

Practical Implications

There are several practical considerations that can be gleaned from the results of this research. First, organizations utilizing team members who are distributed should take the form of media that they use to communicate into consideration, particularly if those team members should be involved in the leadership of teams. While text based virtual tools such as instant messaging may offer benefits for enhancing other aspects of teamwork, in order to convey social presence needed for influence, teams would benefit from the use of richer media such as teleconferencing or videoconferencing. However, this does not mean that all organizations must acquire the richest media possible, as there were not distinct differences for videoconferencing and teleconferencing. Therefore, it may be perfectly suitable for teams to continue to use teleconferencing in order to successfully convey the social presence needed for influencing others.

A second practical recommendation for organizations is to encourage the development of all team members in terms of leadership, not just a single vertical leader. Results of the present study as well as multiple previous studies show value in having multiple team members step up and take on leadership responsibilities as team needs for leadership emerge. Thus, moving towards the development of leadership in all team members may provide a distinct advantage for organizations who utilized a team based structure. Furthermore, as traditionally the focus of leadership development has remained at the individual level, it may be necessary to refine existing programs in order to encourage and reward leadership at the team level.

Furthermore, it may be worthwhile to consider the role of both assigned and emergent leadership in the workplace. As noted by Pearce and Conger (2003), having members of a team share in leadership responsibilities does not negate the role of formal, assigned vertical leaders. Instead, it may be better to consider such formal leaders as team coaches, whereby the role of such coaches is to help facilitate the active involvement of team members in the leadership process (Hackman, 2002). Indeed, Hackman and Wageman (2005) argue that team coaching involves "those interventions that inhibit process losses and foster process gains" (p. 273). If, as argued previously, successful leadership is beyond the capability of a single individual in a team, perhaps the most effective role of a formal leader is to enable and motivate other team members to step up and take on leadership functions as needs arise. Drawing upon the findings of the present study, this may mean helping the team understand how to collectively lead for a single behavior (e.g., who needs to step up at what time), and when members should be specialized in particular leadership roles.

Finally, special attention may need to be paid by organizations to ensure that the team leadership behaviors trained and developed accurately match teamwork and team performance

needs. This may be particularly true for organizations where team members are distributed, as certain types of teamwork processes (e.g., interpersonal) may be more challenging and therefore may require multiple members to be skilled in performing the necessary leadership behaviors such as setting up a supportive social climate. Furthermore, taking care to ensure that members have some degree of depth in terms of being able to specialize in a single role may be beneficial, but not to the extent that members only focus on a single leadership behavior to the detriment of others.

Limitations & Future Research

As with any study, there are several limitations that must be taken into consideration. First, this study was conducted in a controlled laboratory environment with undergraduate students, where team members utilized only one form of virtual tool use, and were only on a single team. In reality, members of distributed teams may utilize a mix of virtual tools to communicate with one another, and may be members of multiple teams simultaneously, which may all have different leadership needs. However, the findings are informative as they do begin to extract the effects of virtuality and distribution as well as the specific leadership behaviors that may be valuable to teams. Thus, future endeavors should attempt to expand this research into field settings with non-student samples to address the applicability in such contexts.

Additionally, the task performed required a high degree of interdependence among members. These types of tasks have been noted by researchers to be the most amenable to the sharing of leadership (Conger & Pearce, 2003). Thus, teams performing tasks that do not require as much interdependency may not benefit as much from the enactment of leadership at the team level. Therefore, it is important that future research be conducted to explore if the findings of the present study hold for varying levels of interdependency.

Several of the issues related to the measurement of team leadership have previously been discussed. In reiterating these points, it is also important to note that only a selected set of leadership behaviors were included in the current study. The three behaviors of structuring/planning, problem solving, and supporting the social climate were selected based on their established relationship with important performance outcomes, as well as their theoretical linkages to enhancing the specific teamwork processes (Hiller, et al., 2006; Zaccaro, et al., 2009). Furthermore, given the nature of the task performed, these behaviors appeared to be most relevant to team outcome achievement. However, there are certainly many other behaviors that may be critical to team success; indeed, Morgeson and colleagues (2010) identify 12 other leadership behaviors as important to team outcomes. Therefore, future research should continue to expand on the types of behaviors that may be valuable for effective team leadership.

Finally, while the measures included in this study all came from different sources, the perceptions of leadership ratings were assessed at the end of the performance round, requiring team members to reflect back on their overall performance period. Furthermore, the teamwork ratings also were a reflection of a global rating across the entire performance episode. Both of these formats may therefore have missed the nuances that could lead to a richer understanding of how differences in leadership structure in terms of who is responsible for what behaviors at a specific point in time may subsequently affect later teamwork processes. Thus, it is recommended that future research examine the effects of team leadership on teamwork from a temporal perspective, such as by capturing round by round changes in leadership structure. At an even more fine grained level, teamwork could also be assessed from a network perspective, enabling an even better understanding of how members may be socially influencing one another

in regards to specific leadership behaviors as well as the specialization of roles, and how this leadership may affect teamwork networks (Crawford & LePine, 2013).

Conclusion

As researchers increasingly move to collaborating within and across disciplines to produce high impact work, it is critical to take into consideration the role of leadership as a team level variable. While traditionally viewed as an individual variable, leadership at the team level appears to make a unique contribution on the effectiveness of teams. Furthermore, as working in physically distributed teams via the use of virtual tools becomes the norm of organizations and researchers alike, it is important that the impact of these contextual factors are accounted for when determining what effective leadership structures should be put into place in teams. It is hoped that the present research advances our current understanding of leadership as a team-centric construct and begins to push researchers to think more specifically about how to develop teams to meet the contextual challenges they face every day.

APPENDIX A: DEMOGRAPHIC ITEMS

Please answer the questions about yourself to the best of your knowledge. If you do not know the answer to the question or the question does not apply to you, please write "N/A" to indicate it is not applicable.

1. What is your gender:
   ☐ Male
   ☐ Female

2. What is your age?
   _____

3. UCF GPA (or high school if you haven't started classes): _____

4. SAT Score: _____
   Verbal:_____
   Math: _____

5. ACT Score: _____

6. Have you ever played the computer game Democracy 2 before?
   ☐ No

   ☐ Yes

   If Yes, please provide the last time you played:

   _____

7. Please rate how often you use each of the following types of technology, either for work/school or personal use, on the following scale:
   1: Never

   2: Less than once a month

   3: Once a month

   4: 2-3 times a month

   5. Once a week

   6: 2-3 times a week

   7: Daily

A. Instant Messaging (e.g., AIM, gChat, iChat, Skype text chat)
B. Teleconferencing (e.g., Skype phone, Google talk, regular telephone)
C. Videoconferencing (e.g., Skype video, Google Video, iChat)
D. Twitter
E. Facebook
F. Computer (Laptop or PC)
G. Smartphone
H. Video Games (e.g., Xbox, Playstation, PC games)
I. Tablet (e.g., iPad, Galaxy, Android)

APPENDIX B: LEADERSHIP BEHAVIOR SCALES

Adapted from Morgeson, F. P., DeRue, D. S., & Karam, E. P. (2009). Leadership in teams: A functional approach to understanding leadership structures and processes. *Journal of Management, 36,* 1-39.

INSTRUCTIONS: Below are a number of statements regarding specific behaviors your team members may have exhibited when you worked with them. Please indicate how often each team member exhibited the listed behaviors during your task(s).		**Team Member** _____ **How often does/did this team member perform this task?**	**Team Member** _____ **How often does/did this team member perform this task?**	**Team Member** _____ **How often does/did this team member perform this task?**
		1 = Not at all 2 = Once in a While 3 = Sometimes 4 = Fairly Often 5 = Frequently, if not Always	1 = Not at all 2 = Once in a While 3 = Sometimes 4 = Fairly Often 5 = Frequently, if not Always	1 = Not at all 2 = Once in a While 3 = Sometimes 4 = Fairly Often 5 = Frequently, if not Always
Structure and Plan				
1	Defines and structures own work and the work of the team	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
2	Identifies when key aspects of the work need to be completed	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
3	Works with the team to develop the best possible approach to its work	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
4	Develops or helps develop standard operating procedures and standardized processes	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
5	Clarifies task performance strategies	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
6	Makes sure team members have clear roles	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
Solve Problems				
1	Implements or helps the team implement solutions to problems	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
2	Seeks multiple different perspectives when solving problems	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
3	Creates solutions to problems	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
4	Participates in problem solving with the team	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤
5	Helps the team develop solutions to task and relationship-related problems	① ② ③ ④ ⑤	① ② ③ ④ ⑤	① ② ③ ④ ⑤

INSTRUCTIONS: Below are a number of statements regarding specific behaviors your team members may have exhibited when you worked with them. Please indicate how often each team member exhibited the listed behaviors during your task(s).		**Team Member** _____ **How often does/did this team member perform this task?**					**Team Member** _____ **How often does/did this team member perform this task?**					**Team Member** _____ **How often does/did this team member perform this task?**				
		1 = Not at all 2 = Once in a While 3 = Sometimes 4 = Fairly Often 5 = Frequently, if not Always					1 = Not at all 2 = Once in a While 3 = Sometimes 4 = Fairly Often 5 = Frequently, if not Always					1 = Not at all 2 = Once in a While 3 = Sometimes 4 = Fairly Often 5 = Frequently, if not Always				
Support Social Climate																
1	Responds promptly to team member needs or concerns	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
2	Engages in actions that demonstrate respect and concern for team members	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
3	Goes beyond own interests for the good of the team	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
4	Does things to make it pleasant to be a team member	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤
5	Looks out for the personal well-being of team members	①	②	③	④	⑤	①	②	③	④	⑤	①	②	③	④	⑤

APPENDIX C: TEAMWORK PROCESS BEHAVIORALLY ANCHORED RATING SCALES

MISSION ANALYSIS (TRANSITION)

Definition: Interpretation and evaluation of the team's mission, including identification of the mission's main tasks as well as the operative environmental conditions and team resources available for mission execution.

Examples:

- Identification of available resources (political capital, money, etc.) for the team
- Creating an understanding of the teams' overall mission and overarching goals (get re-elected and maintain a balanced budget) and how unique information is distributed among team members in individual handouts
- Properly identifying the main tasks and environmental contingencies (i.e. situations, prime ministers, etc.) of Democracy
- Prioritizing the mission objectives and required tasks

Scale:

Complete Skill (5) – Prior to the start of playing, team members established all of the team's roles and task responsibilities as taught by the training; they also establish their individual contribution to the overall mission. They engaged in asking questions about what should be done during the course of their mission and identified available resources.

Very Much Skill (4)

Adequate Skill (3) - Team members established their team and individual roles and task responsibilities, but did not establish how these things contributed to the overall mission. Questions asked were more procedural than evaluative. Team members were able to identify available resources but were confused as how to utilize them.

Some Skill (2)

Hardly Any Skill (1) - Team members did not establish their team and individual roles or task responsibilities; nor did they establish the individual or team's contribution to the overall mission. They had no idea what their mission objectives were, were confused, and did not ask any clarification questions to one another.

GOAL SPECIFICATION (TRANSITION)

Definition: Identification and prioritization of goals and subgoals for mission accomplishment.

Examples: -

- Developing and assigning subgoals (i.e. saying that for the first few weeks the team will get the budget in check and then focus on happiness, strategically focusing on raising the happiness of specific constituencies, etc.) that help the team accomplish mission objectives
- Developing and assigning goals for each individual in the team (i.e. watching the happiness of one's own constituents, assigning one person to monitor money, etc.)
- Prioritizing the goals developed by the team

Scale:

Complete Skill (5) – Members of the team agreed upon specific long-term and short-term goals to aid in directing the action of the team. Goals were prioritized and understood by all team members.

Very Much Skill (4)

Adequate Skill (3) - Members of the team prepared long-term and short-term goals to aid in directing the action of the team, but they were not specific or useful. Goals were not fully understood or some disagreement existed concerning whether or not the goals were useful.

Some Skill (2)

Hardly Any Skill (1) – No long-term or short-term goals were generated by the team. This caused confusion concerning what the team was trying to accomplish.

STRATEGY FORMULATION (TRANSITION)

Definition: Formulation of strategies and courses of action for mission accomplishment. This dimension includes generic planning, contingency planning, and reactive strategic adjustment.

Examples: - Developing a specific plan to gain constituents without upsetting other constituents
- Communicating the proper sequence of actions to team members
- Considering factors that might alter their mission plan (e.g., losing a prime minister, sudden change in spending)
- Recognizing and adjusting team actions or responsibilities to adapt to unexpected events (e.g., situations arising)
- Engaging in contingency planning consisting of verbally walking through "what if" scenarios which might emerge while playing

Scale:

Complete Skill (5) – Team members developed a primary course of action for achieving the team's goals and were able to detect and quickly adapt/coordinate their actions to unexpected situations with appropriate actions. The team tested and strengthened its plan using "what if" scenarios. All team members were aware of and understood how their individual task responsibilities fit into the primary and secondary courses of action.

Very Much Skill (4)

Adequate Skill (3) - Team members had difficulty developing a primary course of action for achieving the team's goals. The team briefly tested and its plan using "what if" scenarios. All team members were aware of their individual task responsibilities but might not have understood how they fit into the primary and secondary courses of action.

Some Skill (2)

Hardly Any Skill (1) –Team members did not develop a primary course of action for achieving the team's goals. Instead, they simply changed things within the game and saw what happened. The team did not plan ahead for potential scenarios which might emerge. Team members were unaware of their individual task responsibilities and how they fit into the primary and secondary courses of action.

MONITORING PROGRESS TOWARDS GOALS (ACTION)

Definition: Tracking task and goal progress toward mission accomplishment; reporting system information in terms of what needs to be accomplished for goal attainment, transmitting team goal progress to team members.

Examples: - Tracking the team's progress on goals and subgoals (e.g., increasing specific constituencies, eliminating specific situations)
- Reporting the team's progress on goals and subgoals (e.g., increasing specific constituencies, eliminating specific situations)

Scale:

Complete Skill (5) – Maintained awareness of and tracked progress on their primary and secondary goals throughout the mission. Understood which individual tasks and responsibilities were necessary for goal attainment and established benchmarks to monitor these tasks.

Very Much Skill (4)

Adequate Skill (3) - Maintained awareness of and tracked progress on their primary and secondary goal progress throughout parts of the mission. Did not understand how individual tasks and team responsibilities fit into goal attainment.

Some Skill (2)

Hardly Any Skill (1) – The team is either "monitoring everything" or hardly anything at all. There is little connection between what the team is monitoring and the goals that they should be trying to accomplish.

SYSTEMS MONITORING (ACTION)

Definition: Tracking team resources and environmental conditions as they relate to mission accomplishment. This dimension includes internal systems monitoring and environmental monitoring.

Examples: - Tracking team related factors (e.g., political capital, constituent happiness, budget, time, rounds, or anything deemed relevant to the mission by the team) and ensure that these systems are operating effectively

Scale:

Complete Skill (5) – Team members effectively monitor factors related to political capital, budget, and happiness of constituents. Additionally, team members monitor other's individual task responsibilities and any communication generated within the team.

Very Much Skill (4)

Adequate Skill (3) - Team members, to a lesser degree monitor factors related to political capital, budget, and happiness of constituents. There may be some communication generated within the team, but they do not attend to it.

Some Skill (2)

Hardly Any Skill (1) – Team members have no idea how to monitor related to political capital, budget, and happiness of constituents, each other's individual task responsibilities, and any communication generated within the team.

TEAM MONITORING AND BACKUP BEHAVIOR (ACTION)

Definition: Assisting team members to perform their tasks. Assistance may occur by (a) providing a teammate verbal feedback or coaching, (b) by assisting a teammate behaviorally in carrying out actions, or (c) by assuming and completing a task for a teammate. This dimension includes the provision of feedback and task related support and the seeking of help from teammates when necessary.

Examples: - Keeping an eye on other teammates to determine if and when they need help
- Helping teammates with their assigned roles by telling them what to do and/or how to do it
- Team members inform each other of individual progress and setbacks
- Team members offer each other feedback
- Asking for or providing help in terms of how to perform certain tasks in the game (e.g., how to raise/lower policies, how to determine the level of political capital)

Scale:

Complete Skill (5) – All team members monitor each other's specific roles and task requirements (e.g. ensuring that certain constituencies are monitored, asking the team to refer to their printed documents) to successfully complete the overall mission. Feedback and support are offered by team members and they are not afraid to ask for help if necessary.

Very Much Skill (4)

Adequate Skill (3) - Team members observe and are aware of each other's specific roles and task requirements (e.g. ensuring that certain constituencies are monitored, asking the team to refer to their printed documents). Feedback is offered by team members if necessary and they rarely ask for help.

Some Skill (2)

Hardly Any Skill (1) – Team members do not observe and are not aware of each other's specific roles and task requirements. Minimal feedback is offered by team members and they no team members ask for help when necessary.

CONFLICT MANAGEMENT (INTERPERSONAL)

Definition: Establishing conditions to prevent, control, or guide team conflict before it occurs. Working through task and interpersonal disagreements among team members.

Examples: - Making statements or offering opinions about task related issues, the way the team functions together, or personal issues, that are likely to affect subsequent team conflict.
- Attempting to work through disagreements when they arise within the team and are open to alternative ideas
- Rules are established in dealing with interpersonal conflict

Scale:

Complete Skill (5) – Team members openly discuss different approaches and strategies for the game without letting things get personal. All team members are considerate of differences and establish a pleasant and cooperative working environment. Team members are able to constructively discuss problems. If conflict does occur, team members are able to manage and contain the disagreements effectively.

Very Much Skill (4)

Adequate Skill (3) – Team members are willing to discuss different approaches and strategies for the game with relatively little ill feelings developing. Team members are sometimes considerate of differences and establish a fair working environment. Team members are able to discuss some problems and resolve most types of conflict. Some team members just "stay out" of any disagreements which may arise.

Some Skill (2)

Hardly Any Skill (1) – Team members are inconsiderate of differences; they establish an unpleasant and uncooperative working environment regarding the overall mission. Team members argue about problems in a destructive manner and often experience much conflict. They are completely unwilling to discuss the issue at hand and have no clue how to resolve the disagreement.

MOTIVATING AND CONFIDENCE BUILDING (INTERPERSONAL)

Definition: Generating and preserving a sense of collective confidence, motivation, and task based cohesion with regard to mission accomplishment.

Examples: - Members are motivated to work hard on the game and do well
- Influencing the level of task cohesion of team members with respect to the goals of Democracy
- Team members have a shared sense that they can be successful

Scale:

Complete Skill (5) – All team members exhibit a strong sense of collective efficacy. This attitude creates a positive attitude about the overall mission, and members seek to motivate one another through reinforcement and praise.

Very Much Skill (4)

Adequate Skill (3) – Team members exhibit a moderate sense of self efficacy and are motivated to do well in the game. They believe that they can "hold their own" and do not fold in the face of adversity.

Some Skill (2)

Hardly Any Skill (1) – Collective efficacy is low in the team and people seem to be "going through the motions." When faced with adversity, the team members start to give up and believe that they cannot recover.

AFFECT MANAGEMENT (INTERPERSONAL)

Definition: Regulating member emotions during mission accomplishment, including (but not limited to) social cohesion, frustration, and excitement.

Examples: - Influencing the positive and negative emotions of other members
- The members of the team are always ready to cooperate and help each other
- The members of the team stick together
- Relationships between members of the team are positive and rewarding

Scale:

Complete Skill (5) – While carrying out the mission objectives, team members effectively extinguished negative emotions and enhanced positive emotions. They were able to regulate and maintain a solid sense of emotional stability within the team.

Very Much Skill (4)

Adequate Skill (3) – While carrying out the mission objectives, team members extinguished their own negative emotions and retained some positive emotions. They were able to regulate and maintain a moderate level of emotional stability within their team.

Some Skill (2)

Hardly Any Skill (1) – While carrying out the mission objectives, team members failed to extinguish negative emotions and failed to enhance positive emotions. They were unable to regulate and maintain any sense of emotional stability within the team. If given the option, members would walk away from the entire experience.

APPENDIX D: UCF IRB HUMAN SUBJECTS PERMISSION LETTER

University of Central Florida Institutional Review Boa
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Shawn Burke** and Co-PIs: **Eduardo Salas, Stephen M. Fiore**

Date: **May 14, 2012**

Dear Researcher:

On 5/14/2012, the IRB approved the following human participant research until 5/13/2013 inclusive:

Type of Review:	IRB Continuing Review Application Form
Modification Type:	[Consent form revision, Add'n of co-inv's, Methodology Revisions, Add'n of Test Instruments, etc] (received on xx/xx/20xx) *<Delete this section if n/a>*
Project Title:	Shared Leadership: Moving Beyond Virtuality and Distribution to Build Capacity in Virtual Organizations
Investigator:	Shawn Burke
IRB Number:	SBE-10-07005
Funding Agency:	National Science Foundation
Grant Title:	
Research ID:	N/A

The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 5/13/2013, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., CF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 05/14/2012 03:29:53 PM EDT

Joanne Muratori

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