THE IMPACT OF VIRTUALITY ON TEAM FUNCTIONING: A META-ANALYTIC INTEGRATION

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THE IMPACT OF VIRTUALITY ON TEAM FUNCTIONING: A META-ANALYTIC INTEGRATION

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SUMMARY

Communication technologies have become a central characteristic of workplace functioning. The literature has suggested that the use of these technologies fundamentally changes the manner in which team members interact. The present study sought to reorganize previous research on the impact of virtuality on team emergent states and behavioral processes to elucidate how different degrees of team virtuality shape team functioning, and to investigate the manner in which these relationships differ according to team type, team membership stability, and publication year. Findings from 174 studies (total number of teams = 9204; total N approximately 26,050) suggest that there is not a strong relationship between team virtuality and emergent states and behavioral processes. However, moderator analyses revealed that a reliance on highly virtual tools may be most detrimental to action teams and ad hoc teams. Moreover, findings demonstrate that the degree to which virtuality shapes team transition and action process may be changing over time.

CHAPTER 1

INTRODUCTION

It was once believed that, in order to perform most efficiently and effectively, organizational team members needed to interact in a face-to-face environment (Olson & Olson, 2000). Without this interpersonal interaction, many scholars supported the notion that dispersed team members interacting through virtual means would be unable to work as effectively when performing interdependent tasks as face-to-face teams (Andres, 2002). Despite this resistance, working virtually has become the standard that businesses and organizations embrace. The rapid development of technology and the increase of team member dispersion brought about by globalization has led a vast array of teams and organizations to frequently interact virtually in distributed settings. This has pushed global businesses to rely on virtual means to facilitate interaction among work team members.

This reliance on virtual tools has led members to increasingly complete work-related tasks via any number of communication technologies (i.e. e-mail, teleconferencing, videoconferencing: Anderson, McEwan, Bal, & Carletta, 2007; Cramton & Webber, 2005). The extent to which team members rely on communication technology to facilitate work-related tasks is conceptualized as team virtuality (Dixon & Panteli, 2010). Due to this heightened prominence of virtuality in the workplace, it is likely that teams and organizations that fail to adapt will be unable to remain viable in today's global economy (Kirkman & Mathieu, 2005). Consequently, organizations are now faced with the challenge of embracing these rapid advances in technology so as to remain competitive in the global economy. However, this use of virtual communication

tools in the workplace fundamentally alters the manner in which team members interact, given that employees are frequently no longer able to rely on face-to-face interactions to complete tasks (e.g. Maynard, Mathieu, Rapp, & Gilson, 2012; Schweitzer & Duxbury, 2010). Therefore, in order to guide the development of effective teams in the 21st century, it is crucial that we develop a comprehensive understanding of how this trend affects team functioning.

Olson and Olson (2000) provided assertions concerning how to appropriately conduct tasks in dispersed teams as compared with collocated teams. While foundational, this perspective has become overly simplistic and outdated. For instance, Olson and Olson (2000) posited that synchronous technologies, such as teleconferencing and videoconferencing, were highly limited in their availability, cost, and quality. Moreover, they conjectured that it would be decades before these limitations were overcome. However, both the capabilities and availability of virtual communication tools have developed at rate at a rate that was not initially anticipated (Jarrahi, 2010). For instance, improved bandwidth now allows for audio and video transmissions that closely reflect face-to-face communication (Hambley, O'Neill, & Kline, 2007). These advances have come to allow employees in dispersed environments to function effectively, with a number of studies yielding positive effects of virtuality on team outcomes (e.g. Aiken & Vanjani, 1997; Balthazard, Potter, & Warren, 2004; Sole & Edmonson, 2002; Hinds & Bailey, 2003;).

In addition, qualitative reviews have indicated that the predominant trend in the empirical literature has been the investigation of dichotomous comparisons between two forms of teams (typically face-to-face versus virtual teams) and their subsequent

processes and/or outcomes (Bell & Kozlowski, 2002, Martins et al., 2004). However, teams now have the ability to collaborate using a wide variety of tools in many different capacities (Martins et al, 2004). Moreover, it is now commonplace for all teams to use some form of communication technology, regardless of team member dispersion (Mesmer-Magnus, DeChurch, Jimenez-Rodriguez, Wildman, & Shuffler, 2011). Therefore, more recent theoretical work suggests that this classification of teams as either face-to-face or virtual is no longer appropriate (Dixon & Panteli, 2010; Kirkman & Mathieu, 2005; Martins, Gilson, & Maynard, 2004).

Kirkman and Mathieu (2005) have indicated that team virtuality is best understood as the extent to which members use virtual communication tools to coordinate team interaction, the amount of informational value provided by these tools, and interaction synchronicity afforded by these tools. Each of these factors plays an essential role in shaping team virtuality (Kirkman & Mathieu, 2005), and impact how members communicate, think, and feel about their team (Mathieu et al., 2008). It follows that a given team's level of virtuality fundamentally influences not only different aspects of communication and behavioral exchanges between team members (e.g. behavioral processes: Marks, Mathieu, & Zaccaro, 2001), but also affective, motivational, and cognitive components of the interactive process (e.g. emergent states: DeChurch & Mesmer-Magnus, 2010; Martins et al., 2004). The strength of these team emergent states and behavioral processes has been demonstrated to be a critical determinant of the overall effectiveness of a team (e.g. Mathieu et al., 2008). Therefore, this information highlights the need for a comprehensive study that investigates the true scope of the impact of virtuality on team functioning, while allowing for the interpretation of these effects not as

a comparison between face-to-face and virtual teams, but according to their degree of virtuality.

Contributions of this Meta-Analysis

This study is a meta-analysis that seeks to provide a comprehensive understanding of the impact of different aspects of virtuality on team functioning. Theoretical and empirical work has indicated that virtuality impacts a wide variety of team constructs (Martins et al., 2004). For instance, team virtuality has been demonstrated to shape team planning and action processes, team affect, cognitive states, and member motivation (Mach, Dolan, & Tzafrir, 2010; Huang, Wei, Watson, & Tan, 2002; Siegel, Dubrovsky, Kiesler, & McGuire, 1986; Jessup & Tansik, 1991). The teams' literature has supported the notion of organizing these constructs in the form of inputs, processes, and outcomes (Mathieu, Maynard, Rapp, & Gilson, 2008). Consequently, the present study adopts the input-process-outcome framework to analyze the manner in which teamwork states and processes are affected by virtuality. Through accumulating the effects of virtuality on a variety of team emergent states and processes, this study aims to create a more complete depiction of how virtuality impacts team functioning. Given that virtuality provides important implications for how teams interact with each other and carry out taskwork, the degree of team virtuality is positioned as an input. The present study utilizes this framework to address two critical questions. First, how do different aspects of virtuality impact team states and processes? Second, to what extent are these relationships impacted by other variables such as team type and team membership stability?

Reviews regarding the impact of virtuality on a variety of team processes and states have increased within the last decade. Multiple studies have centered upon the

impact of communication mode on interaction processes, yielding relatively inconsistent findings. For instance, some reviews have indicated that face-to-face teams report better communication and are more ultimately effective (e.g. Fjermestad, 2004; Baltes, 2002). However, others have indicated that teams that rely on virtual communication maintain stronger communication and produce better decisions (e.g. McLeod, 1997; Rains, 2005). Mesmer-Magnus, DeChurch, Jimenez-Rodriguez, Wildman, and Shuffler (2011) sought to reconcile these differences with regard to information sharing. Information sharing can be parsed into the dimensions of uniqueness and openness: uniqueness refers to the variability in how many team members possess certain information, while information sharing openness is the extent to which all members have access to certain information (Hinsz, Tindale, & Vollrath, 1997; Mesmer-Magnus & DeChurch, 2009). Findings indicated that virtuality positively enables the sharing of unique information, which represents the variability in how many group but is detrimental to the openness of information sharing. The present meta-analysis seeks expand upon this effort, and will serve to quantitatively accumulate empirical findings regarding the relationships between team viruality and emergent states and behavioral processes.

Virtuality in Teams

Communication technology has become a central characteristic of the workplace functioning. All teams, regardless of member dispersion, now utilize communication technology to interact (Dixon & Panteli, 2010, Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002; Maznevski & Chudoba, 2002). These technologies have become embedded in the functioning of work teams and organizations (Pentland & Feldman, 2007). Therefore, it is no longer appropriate to view technology, work, and organizations

as separate entities. Rather, there is an inherent inseparability between the work conducted by teams and the technologies they employ (Orlikowski & Scott, 2008).

This synergy between technology and teamwork has fundamentally changed the manner in which members interact. Suthers (2006) proposed that different technologies have different affordances, implying that the characteristics of a given technology allow an individual to carry out certain actions. For example, videoconferencing affords individuals the ability to maintain eye contact and interpret body language while communicating. Likewise, e-mail affords its users the ability to catalogue their correspondence. According to the technology-in-practice lens, these technological affordances shape member interactions (Jarrahi, 2010). Teams develop interaction rules and norms for interaction based upon the technologies they use (Orlikowski & Scott, 2008). For instance, Poole and DeSanctis (1992) showed that users limited to interaction via group decision support systems (GDSS) experienced constraints on their ability to reach group consensus. The use of this technology led these teams to change decision-making routines. Furthermore, Zack and McKenney (1995) showed that when individuals were constrained to interacting over e-mail, they altered their consultation routine to better fit correspondence through e-mail.

While these findings support the notion that technological affordances shape team interaction norms, more recent research indicates that we need to enhance our understanding of the exact manner in which different technologies shape these interactions across settings (Orlikowski & Scott, 2008). Given that technology is developing at an exceedingly rapid rate, it is critical we understand how the affordances of different communication technologies positively or negatively impact team

functioning as they are implemented in the workplace. Early work indicated that technological affordances limited the ability of members to interact, thus hindering team functioning. The seminal review conducted by Olson and Olson (2000) posited that physical distance between team members maintains important implications for culture, time zones, geography, and language. They asserted that notable discrepancies regarding these attributes among team members could not have been fully overcome with the emerging technologies of the time. Moreover, they proposed that there were certain characteristics of face-to-face interactions that cannot be reproduced through the use of technology. This was supported largely through the assertion that human perceptual and cognitive capabilities, as well as work context, are more fluidly and effortlessly communicated through face-to-face interaction. Due to the fact that these characteristics are critical for team functioning, Olson and Olson (2000) indicated that the development of working habits and routines are more easily facilitated through consistent face-to-face interaction. Moreover, their work largely supported the notion that despite developing technologies, geographical distance among workplace team members would persist in maintaining a critical impact on how individuals interact with each other (Olson & Olson, 2000).

The Olson and Olson (2000) review also served to critique the use of virtual tools that were prominent at that time. It was specified that technology could be used in ways that benefit team interaction (e.g. allowing for the retrieval of information); however, certain technological limitations (e.g. video quality, communication delays) tended to hinder the ability of the work team to complete its tasks. They expanded upon this

critique to state that it is unlikely that these misgivings could be overcome through further technological development (Olson, Teasley, Covi, & Olson, 2002).

Current literature suggests that, while the use of virtual tools does maintain certain limitations, they also provide certain advantages for team functioning (Table 1).

Table 1.
Advantages and Disadvantages of Virtuality

Advantages	**Disadvantages**
Improved resource utilization (Kirkman & Mathieu, 2005).	Loss of meaning, mutual understanding. (Gibson & Gibbs, 2006)
Lower costs over time. (Bergiel, Bergiel, Balsmeier, 2008)	Reduced potential for cohesion, team identification (Hertel, Geister, & Konradt, 2005)
Flexible patterns of communication (Bell & Kozlowski, 2002)	Multiple time zones. (Olson & Olson, 2000)
Structuring of group discussion. (Abad, et al., 2002)	Technological breakdowns. (Bergiel et al., 2008).

Research has denoted that the use of virtual tools results in lower organization costs over time, more flexible patterns of communication amongst team members, and the potential for more structured group discussion through the use of tools such as group discussion boards (Bergiel, Bergiel, & Balsmeier, 2008; Abad, Castella, Cuena, & Navarro, 2002; Bell & Kozlowski, 2002). Therefore, evidence suggests that virtual tools can be implemented to facilitate effective team interaction.

Recent work indicates it is likely that technology has advanced more rapidly than Olson and Olson (2000) had initially anticipated (Naquin, Kurtzberg, & Belkin, 2008; Pridmore & Philips-Wren, 2011). For example, video quality, file sharing capabilities, and Internet speeds have all improved drastically over the last decade, allowing for the

improvement of virtual work (Schweitzer & Duxbury, 2010). Many scholars now posit that, if implemented appropriately, the multitude of virtual tools available to work teams today provides them with the opportunity to collaborate effectively (Maynard, Mathieu, Rapp, & Gilson, 2012; Martinez-Moreno, Zomoza, Gonzalez-Navarro, & Thompson, 2012; Pridmore & Phillips-Wren, 2011). Video conference calls, e-mail, instant messaging, and other forms of computer-mediated communication offer a number of potential benefits to teams, by fostering accessibility among team members, permitting synchronous and asynchronous coordination of work, uniting geographically distributed members, and assisting with the development and maintenance of group memory (Mesmer-Magnus et al., 2011). This lack of consensus in the literature regarding the impact of technology in the workplace signifies the need for a better understanding of the manner in which different tools shape team functioning.

Defining Virtual Teams

The definition of a virtual team has varied somewhat throughout the literature. Despite this, an investigation of the most common definitions indicates that there is notable overlap in their core aspects (Martins, Gilson, & Maynard, 2004). Moreover, previous literature had conceptualized virtuality as a strict dichotomy between virtual teams and face-to-face teams (e.g. Olson & Olson, 2000, Tang & Isaacs, 1993). However, recent work suggests that virtuality is more appropriately conceptualized as a continuum (Gibson & Gibbs, 2006; Kirkman & Mathieu, 2005; Martins et al., 2004).

Many definitions of virtual teams describe these collectives in terms of multiple dimensions (Kirkman & Mathieu, 2005). The most common dimension upon which the virtuality of a team is judged is geographical dispersion. For example, Gibson and Cohen

(2003) define the virtual team as a collective in which members use technology to interact with one another across geographic, organizational, and other boundaries. Others state that virtual teams are collectives that rely on technology-mediated communication while crossing several boundaries, such as space and time (e.g. Bell & Kozlowski, 2002; Lipnack & Stamps, 1999; Lurey & Rasinghani, 2001). However, an emphasis of geographical dispersion in the definition of the virtual team implies that face-to-face teams lack the need for using virtual means to communicate (Kirkman & Mathieu, 2005). In today's business world nearly every team implements at least one form of technology to facilitate virtual communication, even if this team is located within one centralized location. This is due to the fact that tools, such as e-mail, allow for the instantaneous transmission and retrieval of information, which is much more difficultly achieved through relying entirely on face-to-face interaction. Therefore, while geographic dispersion increases the likelihood that teams will implement virtual tools to facilitate their interactions, the presence of geographical dispersion among team members does not entirely determine its virtuality (Kirkman & Mathieu, 2005; Schweitzer & Duxbury, 2010).

Following this logic, the present study adopts the definition of virtual teams proposed by Kirkman and Mathieu (2005). In accordance with the concept that different aspects of the virtuality of a team should be judged through varying degrees, Kirkman and Mathieu (2005) asserted that team virtuality is defined through the combination of three dimensions: 1) the use of virtual tools, 2) the informational value of the virtual tools used, and 3) the synchronicity of team member virtual interaction. According to their

framework, these three dimensions interact to determine a team's given level of virtuality.

The use of virtual tools refers to the extent to which team members use virtual tools to coordinate and execute team processes. Virtual tools are defined as interaction modes where members communicate virtually (Kirkman & Mathieu, 2005). Examples of commonly used tools are communication media, such as e-mail and videoconferencing, and work tools, such as discussion boards and group decision support systems. As previously indicated, the concept of virtuality in teams has been reconceptualized to incorporate the fact that even face-to-face teams now maintain a high reliance on virtual tools. Therefore, positioning on this continuum is determined by the extent to which team members rely on virtual tools to facilitate interaction. Consequently, one end of the spectrum contains teams that operate in a collocated environment and only minimally rely on virtual tools, such as e-mail, to engage in work processes, rendering them less virtual. Likewise, the other end of the spectrum contains teams that may have never interacted in a face-to-face context and rely entirely on highly virtual tools to conduct work (Kirkman & Mathieu, 2005).

The second dimension of the Kirkman and Mathieu (2005) framework, informational value, refers to the extent to which virtual tools send or receive communication or data that are valuable for team functioning and effectiveness. Encompassed within this dimension is the concept of media richness, which is the extent to which the interaction facilitated by the implemented virtual tools is similar to face-to-face interaction. By this logic, tools such as videoconferencing would be considered rich forms of communication media, while e-mail would less rich. However, the dimension of

informational value expands upon media richness to incorporate the fact that not all technologies are implemented in the same fashion. For example, the text body of e-mail messages is commonly used to send and receive relatively short and simplistic bits of information between team members. However, the communication of richer information, such as the demonstration of product use, can be more appropriately communicated through an online video or videoconference. Therefore, informational value is the extent to which the combination of virtual tools being used conveys communication and data that are important for the team to be effective (Kirkman & Mathieu, 2005). It follows that teams that implement virtual tools that convey rich and valuable information are less virtual than teams that implement technologies that provide less valuable information.

Lastly, synchronicity is the extent to which there is a time lag regarding the sending and receiving of information between team members (Kirkman & Mathieu, 2005). Therefore, synchronous communication exchanges occur in real time, while asynchronous exchanges maintain a certain degree of time lag (Goel, Sharda, & Tanair, 2003). The literature has indicated that the use of asynchronous (e.g. e-mail, discussion boards) versus synchronous technology (e.g. teleconferencing, videoconferencing, face-to-face interaction) is contextually dependent (Anderson, Ewan, Bal, & Carletta, 2007; Wong & Burton, 2000). This is due to the fact that asynchronous information allows team members to more thoroughly process the information, providing members more time to develop a potentially more comprehensive response than could have been initially achieved through using a synchronous tool. Likewise, synchronous tools allow for the instantaneous sending and receiving of information, supporting efficient interpersonal communication (Kirkman & Mathieu, 2005). Subsequently, the predominant use of

asynchronous tools represent a greater degree of virtuality, while an emphasis of synchronous tools renders a team less virtual.

As previously indicated, the extent to which team members use virtual tools to facilitate work interactions, the informational value of the tools used, and the synchronicity of said interactions combine to determine a team's overall level of virtuality. Therefore, teams that rely heavily on less rich virtual tools (e.g. e-mail, instant messaging) to facilitate interactions would be considered high in virtuality. Likewise, teams that operate almost entirely in a face-to-face (or videoconferencing) context in communicating valuable information would be considered low in virtuality.

Through the technology-in-practice lens, these differences in synchronicity and informational value reflect differences in affordance between communication technologies. These differences in technological affordance have implications not only for the degree of team virtuality, but team functioning as well. Given that low virtuality tools have different technological affordances from high virtuality tools, low virtuality teams are likely to develop different team interaction norms from high virtuality teams. Consequently, different degrees of team virtuality manifest different sets of rules for member interaction. These differences in team norms are likely to lead to notable differences in team states and processes. Therefore, the present study seeks to investigate the manner in which varying degrees of virtuality shapes team functioning.

Proposed Framework

Major theoretical reviews of team effectiveness have supported the conceptualization of team functioning through the input-process-outcome (IPO) framework (e.g. Marks, Mathieu, & Zacarro, 2001). The Input-Process-Outcome (IPO)

model, first proposed by McGrath (1964), posits a framework for understanding team functioning. Inputs refer to stable, compositional traits manifested through individuals, teams, and organizations, such as material or human resources. Processes are defined as dynamic interactions among group members as they work on a group's task, and serve as mediating constructs that direct inputs to outcomes (Marks et al, 2001). Moreover, they typify how a team plans for and engages in a task. Lastly, outcomes refer to task and non-task consequences of a group's functioning (Marks et al., 2001; Martins, Gilson, & Maynard, 2004). Marks et al. (2001) further expanded upon the I-P-O model to differentiate between team process and team emergent states as team mechanisms. Emergent states reflect properties of a team that are typically dynamic in nature and vary as a function of team context, inputs, processes, and outcomes, while behavioral process denote interaction processes.

Studying these processes and emergent states is integral to understanding how and why virtuality impacts team relevant outcomes. Methodologically speaking, a lack of analysis of the appropriate mediating process variables does not create an accurate depiction of the input-outcome relationship at hand. As pointed out by Mathieu et al. (2008), it is overly simplistic to assume that inputs directly influence distal outcomes such as performance. Therefore, an analysis of more proximal team processes is necessary to furthering our understanding of team functioning.

As indicated, the IPO framework posits that various emergent states and behavioral processes shape team functioning. Due to the fact that the use of virtual tools fundamentally alters the way in which teams interact and function, it can be argued that virtuality impacts these team states and processes. Consequently, the present study

proposes that the constructs related to virtuality can be structured according to this framework (see Figure 1).

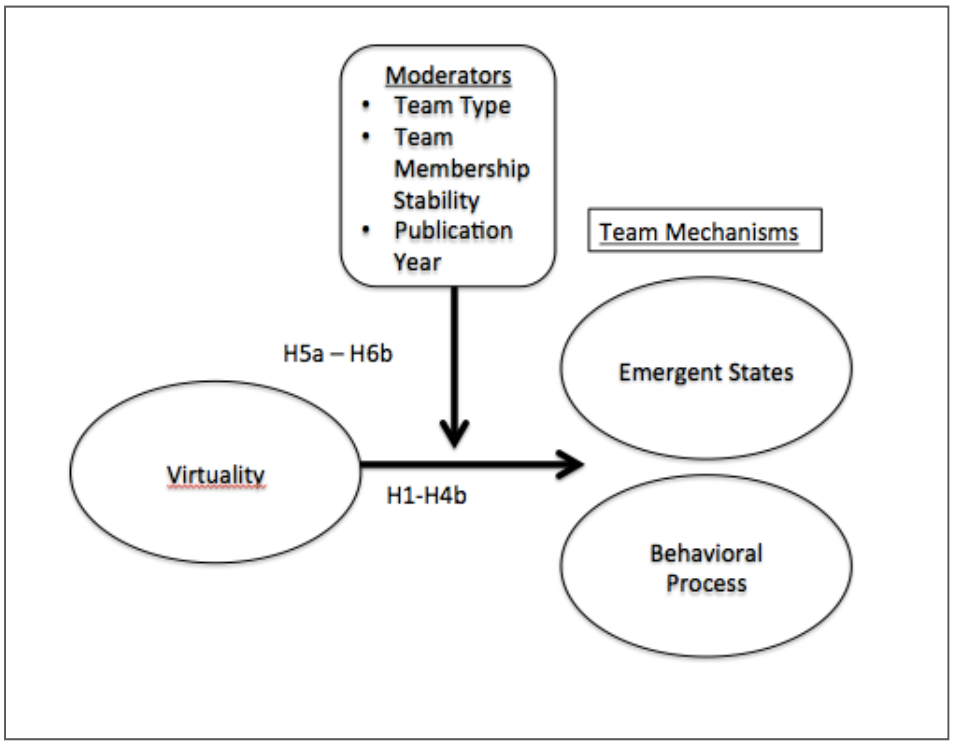

Figure 1. Proposed framework.

Affective, cognitive, and motivational emergent states, and behavioral processes are proposed to be proximal outcomes of virtuality. The present framework postulates that the degree of team virtuality is a critical determinant of team mechanisms (e.g. emergent states and behavioral processes). The following sections will delineate support for the consideration of virtuality as an essential determinant of these constructs.

Emergent States

Emergent states reflect dynamic cognitive, affective, or motivational characteristics of teams that are impacted by context, inputs, processes, and outcomes. Emergent states are indicative of what teams are thinking and feeling while engaging in a given task. Consequently, emergent states do not represent team interaction, but rather

are products of team experiences (Kozlowski & Ilgen, 2006; Marks et al., 2001; Mathieu et al. 2008; Mathieu, Gilson, & Ruddy, 2006). It is also critical to differentiate emergent states from psychosocial traits. Psychosocial traits refer to relatively enduring characteristics, while emergent states are relatively dynamic in nature as they are influenced by the surrounding context (Kerlinger, 1986; Marks et al., 2001). In the context of the present study, emergent states are positioned as proximal outcomes of virtuality. This is due to the fact that team virtuality is generally viewed as a critical determinant of a variety of emergent states (e.g. Curseu, 2006).

A review of the literature signifies that virtuality has been empirically linked with team emergent states (Martins et al., 2004). However, while each primary study provides valuable information concerning this relationship, a comprehensive review is still lacking. The majority of empirical work regarding the impact of virtuality on team emergent states has investigated the impact of one type of virtual communication tool (e.g. Curseu, 2006; Naquin, Kurtzberg, & Belkin, 2008; Sproull & Kiesler, 1986;). However, as proposed by the Kirkman and Mathieu (2005) framework, the characteristics of virtual tools vary across multiple dimensions. Therefore, it is essential that a theoretical framework be created to depict the impact of a wide variety of virtual tools on emergent states.

Affective Emergent States. Affective emergent states are collective states of emotion or feeling (Curseu, 2006). The role of affective emergent states in impacting team outcomes has been robustly demonstrated in the literature (Mathieu et al., 2008; Curseu, 2006). Historically this relationship has been investigated in the context of face-to-face teams (Pallud & Josserand, 2006). However, the incorporation of virtual tools in

team settings forces members to alter how they interact. Particularly in distributed settings, team members may rely more heavily on affective bonds such as trust and cohesion when engaging in tasks without face-to-face interaction to counteract feelings of isolation (Potter & Balthazard, 2002). Therefore, affective relationships among team members are likely to become critical determinants of the team's overall success (Pallud & Josserand, 2006).

Regarding this assertion, empirical research concerning the relationship between team virtuality affective emergent states has increased in recent years. For example, multiple studies have indicated that highly virtual teams reported lower levels of cohesion and satisfaction (e.g. Jessup & Tansik, 1991; Straus, 1996). However, other findings indicate there may be no relationship between team virtuality and affect (e.g. Bryant, Albring, & Murthy, 2009). The present study seeks to address these inconsistencies through meta-analysis. Table 2 indicates the most prominently researched affective emergent states, which will be investigated in the present meta-analysis.

Table 2.
Affective Emergent States

Affective Emergent State	Definition
Team Identity	A psychological 'merging' of the self and group that leads individuals 1) to see the self as similar to other members of the collective, 2) to ascribe group-defining characteristics to the self, and 3) to take the collective's interest to heart (Tajfel & Turner, 1985).
Team Trust	The point to which a person has confidence in another person and is prepared to act based on the words, deeds, and decisions of the other person or/and a group (Mach, Dolan, & Tzafrir, 2010).
Team Satisfaction	The extent to which team members feel content about their jobs and the groups in which they work (Vegt, G., Emans, B., & Vliert, E., 2010).
Team Cohesion	A dynamic process that is reflected in the tendency of a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs (Mach et al., 2010).
Decision Commitment	Level of consensus regarding a team decision (Dooley & Fryxell, 1999).
Decision Polarity	The tendency of individuals in a group setting to engage in more extreme decisions than their original private individual decisions (Myers & Lamm, 1976).

The relationship between team virtuality and emergent can also be viewed through the lens of Media Richness Theory. Media Richness Theory is a framework used to describe the ability of a communications tool to transmit information (Daft & Lengel, 1984). This framework posits that face-to-face interaction, or tools that closely mimic face-to-face interaction (e.g. videoconferencing) are the richest mediums of communication (Curseu, 2006; Daft & Lengel, 1984). It follows that subtle social cues that express emotions are more effectively communicated through more rich media.

Without this awareness of the collective levels of emotion within a group, it is likely very difficult to cultivate positive team affect. Therefore, according to the Kirkman and Mathieu (2005) framework, teams that are more virtual (e.g. those that rely on the frequent use of virtual tools low in media richness to facilitate work-related interactions such as e-mail) will experience lower levels of positive affect (e.g. team satisfaction, team cohesion), and will experience higher levels of negative affect (e.g. decision polarity). A review of the empirical literature indicates that this proposition is supported. Therefore, the present study proposes that:

> *Hypothesis 1: Affective emergent states will be inversely related to team virtuality such that teams who interact primarily face-to-face will have stronger affective states than will teams who interact primarily using low virtuality tools, who will in turn have stronger affective states than teams who interact primarily using high virtuality tools (i.e. cohesion (1a), decision commitment (1b), team satisfaction (1c), team identity (1d), team trust (1e)) and positively related to negative affective states (i.e. decision polarity (1f)).*

Motivational Emergent States. Motivational emergent states refer to the team's general level of investment and effort in both teamwork and taskwork (Mathieu et al., 2008). Moreover, motivational emergent states describe attraction to the team and beliefs about its capability to perform tasks. Table 3 delineates relevant motivational constructs and their associated definitions.

Table 3.
Motivational Emergent States

Motivational Emergent State	Definition
Motivation (e.g. engagement, effort, task attraction)	Member's allocation of personal and collective effort towards team goals, which may involve effort directed as performing their individual role within the team, as well as assisting the team in other ways (Chen, G., Kanfer, R., DeShon, R., Mathieu, J., & Kozlowski, K., 2009).
Collective Efficacy	A group's shared belief in its conjoint capabilities to organize and execute the course of action require to produce given levels of attainments (Bandura, 1997).

Empirical research regarding the relationship between team virtuality and these motivational emergent states has increased over the past decade. Numerous studies and reviews have indicated the relevance of these constructs to team outcomes (Beal, Cohen, Burke, McLendon, 2003; Gully, Incalcaterra, Joshi, & Beaubien, 2002; Mullen & Cooper, 1994). However, findings have yielded relatively inconsistent effects. For example, some studies have indicated that team virtuality is not related to collectively efficacy (e.g. Aiken, 2009), while others indicate that these constructs are negatively related (e.g. Strauss & McGrath, 1994). Therefore, it is essential that a comprehensive depiction of this relationship be obtained.

The literature suggests that the nature of virtual work requires that, in order to interact and perform tasks effectively, team members must behave proactively, seek continuous improvement, and search out innovative solutions to work problems (Crant, 2000; Hyatt & Ruddy, 1997). Moreover, team members who have knowledge of the relative impact of their work, as well as of the work of other members, are more likely to

engage in these behaviors (Kirkman, Rosen, Tesluk, & Gibson, 2002). However, research suggests that high virtuality teams are less aware of the type of work and the work effort put forth by other team members. This is due to the fact that member levels of work effort and engagement cannot be conveyed as comprehensively in teams that rely on highly virtual communication tools, such as e-mail, as compared to less virtual teams. For instance, members could use frequency of e-mail communication to index the level of engagement of their team members but this fails to capture the amount of effort needed to address a specific task-related issue via e-mail. Teams in less virtual settings are more likely to be aware of the direct amount of effort each member is putting forth, and how this effort impacts their resulting products due to the fact that they can more readily perceive the amount of time and effort an individual is spending on a task. Moreover, members interacting through highly virtual means may feel somewhat detached from the group, resulting in a lower level of motivation to work on behalf of the team. Therefore, the present study proposes that:

> *Hypothesis 2: Motivational emergent states will be inversely related to team virtuality such that teams who interact primarily face-to-face will have stronger team motivational states than will teams who interact primarily using low virtuality tools, who will in turn have stronger motivational states than teams who interact primarily using high virtuality tools (i.e. team motivation (2a) and team efficacy (2b)).*

Cognitive Emergent States. Cognitive emergent states are group states of task or team relevant thought. The most predominantly researched cognitive emergent state is team cognition. Team cognition is defined as the manner in which knowledge important

to team functioning is mentally organized, represented, and distributed within the team and allows members to anticipate and execute actions (Kozlowski & Ilgen, 2006). The concept of team cognition encompasses the constructs of team transactive memory and team mental models. The principal point of difference between these two constructs is centered upon knowledge distribution: team transactive memory refers to knowledge that is distributed among team members, while team mental models refers to knowledge that is in some way held in common by team members (Kozlowski & Ilgen, 2006). Team transactive memory reflects a compilational knowledge structure in that it arises from the patterning of knowledge among members in a team (DeChurch & Mesmer-Magnus, 2010). Team mental models, on the other hand, represent compositional knowledge structure as it represents the degree of similarity of cognitive representations among team members (Table 4) (DeChurch & Mesmer-Magnus, 2010).

Table 4.
Cognitive Emergent States

Cognitive Emergent State	**Definition**
Transactive Memory	A compilational knowledge structure that arises from the patterning of knowledge among members in a team (DeChurch & Mesmer-Magnus, 2010).
Shared Mental Models	A compositional knowledge structure that represents the degree of similarity of cognitive representations among team members (DeChurch & Mesmer-Magnus, 2010).

Consequently, in order to develop a strong transactive memory system, team members must be aware of each member's respective role within the team, as well as their area of expertise. Likewise, team members must be able to efficiently receive and interpret

information to form shared mental models. The extant literature has indicated that team cognition sustains a critical impact on behavioral process, motivational states, and team performance (Cannon-Bowers, & Salas, 2005; DeChurch & Mesmer-Magnus, 2010; Lim & Klein, 2006; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000).

Given that team cognition provides an essential foundation to teamwork, research concerning the impact of virtuality on team cognition has increased substantially over the last decade. Studies have suggested that virtuality is an integral determinant of team mental models and transactive memory systems (e.g. Xie, Zhu, & Wang, 2009; Yoo & Kanawattanachai, 2001). However, there seems to be a general lack of agreement concerning the nature of these effects. For instance, Xie et al. (2009) indicate that the use of virtual tools reduces linguistic and social cues, which subsequently impacts the formation of shared mental models. Likewise, Bordia (1997) argued that more virtual teams compensate by indulging is less task-irrelevant conversation, improving their ability to form shared mental models and transactive memory systems.

The present study seeks to examine the relationship between virtuality and cognitive emergent states through the lens of media richness theory. Media richness theory posits that more rich virtual communication tools (e.g. videoconferencing) aid team members in clarifying ambiguous messages or pieces of knowledge (Daft & Lengel, 1984; Pallud & Josserand, 2006). For instance, the amount of information contained within an e-mail message is limited to its text; however, in addition to verbal language transmission, face-to-face interactions also transmit social and contextual cues. These additional characteristics found in less virtual interactions provide multiple channels through which information can be transmitted and clarified. This clarification allows for

the integration of information amongst team members, which would increase the awareness of the areas of expertise of other members (e.g. strengthen transactive memory) and increase the knowledge that is common to the team (e.g. strengthen mental models) (Maruping & Argarwal, 2004). Likewise, as posited by Curseu (2006), less rich virtual communication tools (e.g. e-mail) will hinder the clarification of ambiguous messages, which will negatively impact team cognition. Therefore, the present study hypothesizes that:

> *Hypothesis 3: Cognitive emergent states will be inversely related to team virtuality such that teams who interact primarily face-to-face will have stronger team cognition than teams who interact primarily using low virtuality tools, who will in turn have stronger team cognition than teams who interact primarily using high virtuality tools.*

Behavioral Process

Behavioral process is defined as team member interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing task work to achieve collective goals (Marks et al., 2001). These processes are centered upon members' interacting with other members and their task environment. Team behavioral processes occur in cycles, referred to as episodes, while a team is engaging in a task (Weingart, 1997; Zaheer, Albert, & Zaheer, 1999). Episodes are defined as distinguishable periods of time over which performance accrues and feedback is available (Locke & Latham, 1990; Mathieu & Button, 1992). Consequently, different behavioral processes are essential at different stages of a task. The different stages of a task can be separated into transition and action phases. At times, it is essential that team

members engage in behaviors related to planning for carrying out a task (*transition phase*), while at other times team members must engage in activities directly related to carrying out a task (*action phase*) (Marks et al., 2001). Transition phases are specifically defined as periods of time when teams focus primarily on evaluation and/or planning activities to guide their accomplishment of a team goal or objective. Examples of behavioral processes that occur within transition phases include goal specification and strategy formulation (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Dickinson & McIntyre, 1997; Levine & Moreland, 1990; Prince & Salas, 1993). Action phases, on the other hand, are periods of time when teams are engaged in acts that contribute directly to goal accomplishment (Marks et al., 2001). Examples of action phase processes are coordination, backup behavior, and team monitoring (Brannick, Prince, Prince, & Salas, 1992; Dickinson & McIntyre, 1997; Jentsch, Barnett, Bowers, & Salas, 1999). As indicated, these phases occur in a cyclical fashion and impact each other.

Social impact theory provides a foundation for understanding the relationship between virtuality and action and transition phases. Social impact theory posits that changes in behavior or attitudes towards group members are a function of the strength (number and power) and distance of targets (group members; Blaskovich, 2008). Therefore, as strength and distance between members increases, detrimental group norms such as social loafing are likely to be established (Lantane, 1981). Social loafing refers to the tendency for individuals to contribute less than their full potential when working in a group (Blaskovich, 2008). Consequently, the increase of strength and distance between members likely causes group interactive processes to degrade.

This proposition directly applies to the investigation of team virtuality due to the fact that highly virtual teams are frequently physically dispersed and have little personal contact with each other, especially if less rich media is used to facilitate interaction. This can cause individuals to feel more isolated and less inclined to fully engage in work related processes (Chidambaram & Tung, 2005; Kidwell & Bennett, 1993). Accordingly, these characteristics of highly virtual teams facilitate a decrease in the social impact that team members have on one another. Effective engagement in behavioral processes, such as goal specification and coordination, require a high degree of social impact among team members. Thus, a decrease in social impact among team members will likely deteriorate behavioral processes. Therefore, the present study hypothesizes that:

Hypothesis 4: Behavioral process will be inversely related to team virtuality such that teams who interact primarily face-to-face will demonstrate stronger behavioral processes (i.e. transition (4a), action (4b)) than teams who interact primarily using low vituality tools, who will in turn demonstrate stronger behavioral processes than teams who interact primarily using high virtuality tools.

Moderators

Team Type

The teams' literature has specified that work groups can be classified into the categories of project teams, production teams, service teams, action teams, management teams, and parallel teams (Sundstrom & Altman, 1989; Sundstrom, McIntyre, Halfhill, & Richards, 2000). The present study adapted this taxonomy to focus on the impact of team type on the relationship between virtuality and team states and processes. Specifically, in

order to accurately depict the types of teams that implement virtual tools to facilitate their functioning, the present study focuses on the moderating impact of three team types put forth by Sundstrom et al. (2000): action, project, and management.

Action teams are highly skilled specialist teams cooperating in unpredictable circumstances (e.g. sports teams, military regiments) (Sundstrom, et al., 2000). These groups conduct complex, time-sensitive tasks in typically challenging environments. Furthermore, team members of action teams are highly interdependent (Sundstrom & Altman, 1989). Management teams are relatively permanent in structure, are comprised of members of varying specializations, and are responsible for upper-level operations such as budgeting (e.g. corporate executive teams). These teams coordinate subordinate work units through joint planning, policy-making, budgeting, staffing, and logistics (Cohen & Bailey, 1997; Sundstrom et al., 2000). Furthermore, management teams are generally more autonomous than other team types (Hackman, 1987). Project teams are groups of white-collar professionals that collaborate on assigned or original projects (e.g. research and development teams) (Sundstrom, Meuse, & Futrell, 1990). These teams are typically ad hoc in nature, and are comprised of cross-functional members brought together for the purposes of a specific task (Ancona & Caldwell, 1992; Sundstrom et al, 2000). Table 5 provides further description and examples of each of the team types.

Table 5.
Team Types (adapted from Sundstrom et al.,1990)

Team Type	**Examples**	**Typical Output**	**Definitional Info**
Management	Corporate exec teams, regional steering committees, middle management teams.	Budgeting, staffing, logistics, joint planning.	Team considered permanent but with frequent changes in members due to transfers/ promotions; moderately specialized as no other team in the org does the same thing; self-designing.
Project/Development; Task forces	Research groups, planning teams, architect teams, engineering teams, development teams, task forces.	Plans, designs, investigations, presentations, prototypes, reports, findings.	Work cycles typically differ for each new project, one cycle can be team life span; have highly specific tasks to do within definite time periods; they disband after finishing tasks; usually cross-functional w/ members coming from different departments/units/expertise.
Action/Negotiation	Sports teams, entertainment groups, expeditions, negotiating teams, surgery teams, cockpit crews, military tank crews, firefighters, rescue units.	Combat missions, expeditions, legal contracts, concerts, surgical operations, competitions.	Brief performance events, often repeated under new conditions requiring extended training and/or preparation; groups that conduct complex, time-limited performance events involving audiences, adversaries, or challenging environments; members are usually specialists.

Action teams require a substantial amount of rich and synchronous interaction to facilitate functioning (Dyer, 1984; Foushee, 1984). In most instances, it is not feasible for action teams to carry out their relevant task through the use of highly virtual tools (e.g. e-mail). This is likely due to the fact that action teams rely on a high degree of interdependence to perform task work. For instance military tank crews, negotiating teams, and surgery teams all perform highly time-sensitive tasks that necessitate immediate and synchronous interactions. Therefore, the use of highly virtual tools to facilitate the interaction of action team members may be detrimental to team functioning. Similarly, project teams are also likely to be negatively impacted by a reliance on highly virtual tools. This is largely due to the fact that the majority of project teams are ad hoc. Empirical work has demonstrated that previously unacquainted members brought together from different departments or units to collaborate exclusively on a given project are likely to struggle in using virtual tools to facilitate team interaction (Hertel, Geister, & Konradt, 2005; Munkvold & Zigurs, 2007). Management teams, on the other hand, are less likely to be hindered by the use of highly virtual tools. Tasks such as policy making, budgeting, and logistics can be carried out through a variety of means ranging from face-to-face interaction to asynchronous e-mail exchanges. Consequently, their tasks are likely to be less negatively affected by the use of highly virtual tools. Therefore, the present study posits that:

> *Hypothesis 5a: Team type will moderate the relationship between team virtuality and team emergent states such that team virtuality is more strongly negatively related to emergent states in action teams than in project and management teams.*

Hypothesis 5b: Team type will moderate the relationship between team virtuality and team behavioral processes such that team virtuality is more strongly negatively related to behavioral processes in action teams than project and management teams.

Team Membership Stability

Team membership stability refers to whether a given team is newly formed or was previously established (Salas, DiazGranados, Klein, Burke, & Stagl, 2008). Intact teams are comprised of members who have a shared history as a result of a commonly held assignment to a given collective operating inside an organization, while ad hoc teams are strangers purposively assembled to work in a contrived setting (Salas et al., 2008). Consequently, in comparison to ad hoc teams, intact teams tend to have relatively stable membership and are not assembled solely to work on a given task (Salas et al., 2008). Ad hoc teams, unlike intact teams, are likely to experience the challenges of establishing group norms through the stages of group development delineated by Tuckman (1965). Therefore, ad hoc teams are more likely to experience miscommunications or inefficiencies while carrying out a task than intact teams, as they cannot rely on pre-established group norms to guide their interactions. It follows that emergent states and behavioral processes will be more unstable in ad hoc teams. Moreover, ad hoc teams will likely have less experience using virtual tools to communicate with the respective members of their new team, which will hinder informational integration (Hollingshead, McGrath, & O'Connor, 1993; Munkvold & Zigurs, 2007). It follows that ad hoc teams will likely struggle in managing the use of virtual tools to facilitate task-related

interactions in comparison to intact teams who have pre-established work group norms. Therefore, the present study proposes that:

Hypothesis 6a: Team membership stability will moderate the relationship between team virtuality and team emergent states such that team virtuality is more strongly negatively related to emergent states in ad hoc teams than in intact teams.

Hypothesis 6b: Team membership stability will moderate the relationship between team virtuality and team behavioral processes such that team virtuality is more strongly negatively related to behavioral processes in ad hoc teams than in intact teams.

CHAPTER 2

METHOD

One hundred and seventy-four independent studies reported in 168 manuscripts (total number of teams = 9,204; total N = 26,050) examining the relationship between virtuality and emergent states and processes were included in this meta-analysis.

In order to obtain these effects, an all-inclusive search was conducted to identify all empirical studies reporting effect sizes between virtuality and affective emergent states (e.g. cohesion, team identity), motivational emergent states (e.g. team efficacy, team motivation), cognitive emergent states (e.g. team cognition), and behavioral process variables (e.g. transition, action process). To ensure a comprehensive search, the following strategies were implemented: (a) computerized key-word search of GoogleScholar, PsychInfo, Buisness Source Premier, and Dissertation Abstracts International using the terms listed in Table 6, (b) reverse citation searches in GoogleScholar on relevant seminal articles (Table 7), and (c) obtain the databases of previously conducted and relevant meta-analyses (Table 7). Studies were only included if virtuality was assessed in a collective setting, and sufficient information was provided to compute a correlation between virtuality and the construct of interest (e.g. emergent state or behavioral process). In instances when studies reported findings from multiple samples, those effects were analyzed separately. All empirical studies between the years of 1950 and 2010 were included.

Table 6.
Search Terms

virtuality + teams	distibuted+teams+cohesion	virtual team + cohesion	co-located teams
virtuality + performance	distributed+teams+cohesiveness	virtual team + viability	distributed teams
virtuality	virtual + group + viability	virtual team + shared perception	geographic distribution
virtual + teams	virtual+teams+viability	virtual team + successful outcomes	geographically distributed
virtual + organization	virtual+organizations+viability	virtual team + social identity	geographic dispersion
virtuality + organization	dispersed+organizations+viability	telecommuting + commitment	geographically dispersed
computer-mediated + team	dispersed+teams+viability	virtual group + success	virtual teams
computer-mediated + group	distributed+teams+viability	virtual group + efficacy	factual structural features of teams
distributed teams	distributed+organizations+viability	virtual group + cohesion	cross cultural communication
distributed teams + performance	virtual+organization+satisfaction	virtual group + successful outcomes	same time, different place communication
dispersed organizations	dispersed+organizations+satisfaction	virtual group + s.i.	functional distance
dispersed organizations + performance	dispersed+teams+satisfaction	group support systems	global teams

Table 6 (ctd.).
Search Terms

distributed organizations + performance	distributed+teams+satisfaction	media use + team	computer mediated communication
virtual + teams + performance	distributed+organizations+satisfaction	media use + group	murder mystery and distributed teams
virtual + organizations + performance	distributed+organizations+effort	media use + organization	hidden profile and distributed team
virtual + group + performance	virtual+organizations+effort	real-time interaction + team	
virtual + teams + cohesion	Virtual+teams+effort	real-time interaction + group	
virtual + organizations + cohesion	geographically distributed+ teams	asynchronous interaction + team	
virtual + organizations + cohesiveness	geographically dispersed + teams	asynchronous interaction + group	
virtual + teams + cohesiveness	remote+teams+performance	synchronous interatction + team	
dispersed + teams + cohesiveness	telework	synchronous interatction + group	
dispersed + organizations + cohesiveness	telecommuting	groupware	
distributed + organizations + cohesiveness	virtual team + success	internet telephony	
distributed+organizations+cohesion	virtual team + efficacy	media richness theory	

Note. Search terms were entered into GoogleScholar, Business Source Premier, PsycInfo, and Dissertation Abstracts International.

Table 7.
Reverse Citation Searches and Meta-Analytic Databases

Reverse Citation Searches	Meta-Analytic Databases
Jarvenpaa, S.L., & Leidner, D.E. (1999). Communication and trust in global virtual teams. *Organization Science*, *10*, 791-815.	Baltes, B.B., Dickson, M.W., Sherman, M.P., Bauer, C.C., & LaGanke, S. (2002). Computer-Mediated Communication and Group Decision Making: A Meta-Analysis. *Organizational Behavior and Human Decision Processes*, *87*, 156-179.
Straus, S.G., & McGrath, J.E. (1994). Does the medium matter? The interaction of task type and technology on group performance and member reactions. *Journal of Applied Psychology*, *79*, 87-98.	Websters & Staples. (2006). Comparing virtual teams to tradition teams: An identification of new research opportunities. *Research in Personnel and Human Resources Management, 25*, 181-215.
Hinds, P.J., Bailey, D.E. (2003). Out of sight, out of sync: Understanding conflict in distributed teams. *Organization Science*, *14*, 615-632.	Raghuram, S., Tuertscher, P., & Garud, R. (2008). Mapping the field of virtual work: A co-citation analysis. Information Systems Research.
Chidambaram, L. & Jones, B. (1993). Impact of communication medium and computer support on group perceptions and performance: A comparison of face-to-face and dispersed meetings. *MIS Quarterly*, *17*, 465-491.	Watson-Manheim, M.B., & Crowston, K., & Chudoba, K.M. (2000). A new perspective on "Virtual": Analyzing discontinuities in the work environment. Academy of Management Conference.
Cramton, C.D. (2001). The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science*, *12*, 346-371.	Connaughton, S.L., & Shuffler, M. (2007). Multinational and multicultral distributed teams: A review and future agenda. *Small Group Research,* 38, 387-412.
Powell, A., Piccoli, G., & Ives, B. (2004). Virtual teams: A review of current literature and directions for future research. ACM SIGMIS Database, 35, 3-36.	Mortensen, M., Caya, O., & Pinsonneault. (2009). Virtual teams demystified: An integrative framework for understanding virtual teams and a synthesis of research. MIT Sloan School Working Paper.
Bell, B.S., & Kozlowski, S.W.J. (2002). A typology of virtual teams: Implications for effective leadership. *Group and Organization Management, 27*, 14-49.	Lin, C., Standing, C., & Liu, Y.C. (2008). A model to develop effective virtual teams. *Decision Support Systems*, *45*, 1031-1045.
Martins, L.L., Gilson, L.L., & Maynard, M.T. (2004). Virtual teams: What do we know and where do we go from here? *Journal of Management*, *30*, 805-835.	

Coding Procedure

Each study was coded for the following data: total sample size, number of teams included, sample characteristics, team type, and team size. A review of the empirical literature indicates that team virtuality is typically studied as a direct comparison between forms of high virtuality teams (e.g. e-mail, chat) and low virtuality teams (e.g. face-to-face, videoconferencing). In order to appropriately classify these varying comparisons, operationalization of the construct of virtuality for each primary study was coded as (a) a direct comparison between a face-to-face and a high virtuality team, (b) a direct comparison between a face-to-face and low virtuality team, (c) a direct comparison between a low virtuality team and a high virtuality team, or (d) a continuous measure of virtuality. In instances where studies reported a continuous measure of virtuality, reliability estimates were coded as well.

Virtuality. In order to capture the degree of virtuality within each team, team conditions within each study were coded as face-to-face, low virtuality, or high virtuality (Table 8). Face-to-face teams rely almost entirely on collocated interactions to facilitate workgroup functioning. Low virtuality teams rely on tools that closely mimic face-to-face interaction, and can transmit interpersonal subtleties, such as tone and facial expressions. High virtuality teams principally rely on tools that do not have the capacity to communicate multiple forms of rich information (e.g. facial expressions, tone). These operationalizations were based upon the framework of team virtuality posited by Kirkman & Mathieu (2005). Table 8 further elucidates these differences.

Table 8.
Degrees of Virtuality

Virtuality	**Characteristics**	**Example Operational Definitions**
Face-to-Face	• Collocated • Use of virtual tools – rare, typically e-mail if anything • Synchronous communication • Informational value – high	• "Approximately half of the groups completed the case FtF in a conference room, using a single shared computer to complete the task.' (Blaskovich, 2008) • "FtF, which is unmediated and proximal, and afforded participants full access to each other's verbal and nonverbal behavior." (Burgoon et al., 2002) • "F2F groups met together in a conference room." (Cappel & Windsor, 2000)
Low Virtuality	• Reliance on tools that closely mimic face-to-face interaction • Largely synchronous communication • Informational value – High in capacity to transmit rich information	• "Members of groups were seated in a meeting room and could communicate via videoconference during the problem-solving session." (Barkhi, 2005)

Table 8 (ctd.).
Degrees of Virtuality

Virtuality	Characteristics	Example Operational Definitions
High Virtuality	• Use of virtual tools – high reliance on tools that do not mimic face-to-face interaction • Typically asynchronous communication • Informational value – Low in capacity to transmit rich information	• "Half of the teams completed it using synchronous computer-mediated chat software with members dispersed in different rooms." (Alge et al., 2003) • "Members of DGDSS groups were physically separated and did not have FTF contact." (Barkhi, 2005) • "Experimental groups used an asynchronous text-based computer-mediated communication system. The system features e-mail and computer conferencing enhanced with software features to support specific academic activities." (Benbunan-Fich et al., 2002) • "The remaining half completed the case from individual computers in separate conference rooms. These VC groups communicated solely through a text-chat window provided on the same screen as the case materials." (Blaskovich, 2008)

The primary communication medium was also coded (e.g. face-to-face, e-mail, chat, videoconference). Teams that relied on face-to-face interaction were classified as face-to-face, teams that principally implemented teleconferencing or videoconferencing were classified as low virtuality teams, and teams that predominantly utilized e-mail, chat, textual information (e.g. list serves), or group decision support systems (GDSS) were classified as high virtuality teams. This specific communication tool classification system was developed for the purposes of the present study. In order to validate these categorizations, a Q-Sort task was conducted with subject matter experts (SMEs). The Q-Sort task has been implemented across a variety of settings to examine individual perspectives on a given topic (Adams, 1983; Chatterji & Mukerjee, 1986).

Ten SMEs were given a list of these eight tools, along with relevant definitional information. SMEs were also given definitions of the three virtuality categories (face-to-face, low virtuality, and high virtuality). They were then instructed to place each of the eight tools into the most appropriate category. These instructions are contained in the Appendix. Each of these individuals maintained extensive experience in using virtual tools to facilitate team collaboration. Agreement percentages are indicated in Table 9. Findings indicate strong support for the virtuality classification maintained in the present study.

Table 9.
Summary of SME agreement for Q-Sort validation task.

Virtual Tool	% Agreement	Virtuality Degree
F2F	100	Face-to-Face
Teleconference	100	Low
Videoconference	100	Low
E-mail	100	High
Chat	90	High
Textual Information	100	High
Group Decision Support System	90	High

Note. Agreement percentages are based upon the ratings of 10 subject matter experts. The Virtuality Category indicates that classification chosen by the majority of the subject matter experts.

Emergent States. Three forms of team emergent states were coded: affective, motivational, and cognitive. The constructs that were coded under each category are conveyed in Tables 2-4. The correlation between virtuality and the emergent state of interest was coded. It should be noted that the affective, motivational, and cognitive labels are simply used for conceptual purposes, and each construct under each of these classifications was coded and analyzed independently. If reported, the reliability estimate of the measure was coded as well.

Behavioral Processes. Two general categories of behavioral process were examined in the primary studies: transition process and action process. Behaviors were classified into the category of transition process when they represented behaviors related to planning for engaging in a task (e.g. process remarks, discussion of task procedures, goal setting, goal clarification, mission analysis, assessing consequences of solutions), while behaviors corresponding to the team directly engaging in a task were be coded as action process (e.g. coordination, feedback about progress/performance, team member backup behavior, and monitoring progress). As with emergent states, the correlation

between virtuality and the behavioral process of interest was coded, as well as the reliability of the measure.

Team type and team membership stability moderators. The present study also coded for the potential moderating impact of team type and team membership stability on the relationship between virtuality and emergent states and behavioral processes. To code for team type, teams were classified as action teams, management teams, or project teams (Table 5). To code for team membership stability, teams were also coded as either ad hoc or intact. Teams that were newly formed and brought together for the purposes of engaging in the task at hand were classified as ad hoc. Teams that had been collaborating for a period of time that preceded the relevant task were classified as intact.

Reliability. In order to ensure coding consistency and construct validity, an additional researcher participated in the coding process. All coders were trained according to the coding scheme. The researchers coded primary studies independently, and the degree of inter-coder agreement was assessed as an estimate of inter-rater reliability. Initial inter-coder agreement is represented in Table 10. Disagreement regarding specific codings was resolved through discussion.

Table 10.
Summary of coder reliability for key study variables.

Variable	% Agreement
Sample Size	100
Number of Teams	100
Construct Operationalization	98.4
Primary Communication Medium	100
Use of Virtual tools	100
Informational Value	100
Synchronicity	100

Primary Study Characteristics

The majority of the studies included in the meta-analytic database were conducted in laboratory settings (81%), and were conducted within student populations (83%). The average team size was 4.27, and ranged from 3-20. The types of teams present in the primary studies included action teams (5%; e.g. pharmaceutical sales representatives), project teams (78%; e.g. undergraduate teams performing a class project), and management (7%; e.g. MBA students performing a board of directors task). In addition, the majority of teams were ad hoc (82%), while 14% were intact. The teams in the primary studies performed tasks including brainstorming tasks, decision-making tasks, and idea generation tasks. Approximately half of the primary studies were published since the year 2000 (55%). Various communication technologies were used in the primary studies including face-to-face interaction (66%), chat (30%), group decision support systems (15%). videoconferencing (10%), and teleconference (9%).

Analytic Approach

The methods of meta-analysis outlined by Hunter and Schmidt (2004) were implemented in the present study. These methods allow for comprehensive analysis of relevant effects regarding the impact of virtuality on team emergent states and behavioral processes across primary studies, while enabling appropriate corrections. Corrections were be made for sampling error, artificial dichotomization of the virtuality construct, and measurement error. Due to the fact that reliability estimates of relevant measures seem to be reported rather sporadically, the Hunter and Schmidt (2004) methods of artifact distribution were implemented. Corresponding analyses for each hypothesized relationship are indicated in Table 11.

Table 11.
Hypothesized Relationships and Corresponding Analyses

Hypothesis	Analysis
Hypothesis 1: Team virtuality will be negatively related to positive affect and positively related to negative affective states.	*Meta-analysis.* The presence of 0 outside the 80% credibility interval (CV) will indicate a significant relationship. ρ will indicate the direction and magnitude of a given relationship.
Hypothesis 2: Team virtuality will be negatively related to team motivational states/collective efficacy.	Same as Hypothesis 1.
Hypothesis 3: Team virtuality will be negatively related to team cognition.	Same as Hypothesis 1.
Hypothesis 4: Team virtuality will be negatively related to both transition and action phase behavioral processes.	Same as Hypothesis 1.
Hypothesis 5a: Team type will moderate the relationship between team virtuality and team emergent states such that team virtuality is more strongly negatively related to emergent states in action teams than in project and management teams.	*Subgroup Analysis.* A full meta-analysis is conducted. If resulting variance remains unaccounted for, data is then separated into groups defined by the moderator of interest. The aforementioned meta-analytic techniques and methods of corrections are then implemented.
Hypothesis 5b: Team type will moderate the relationship between team virtuality and team behavioral processes such that team virtuality is more strongly negatively related to behavioral processes in action teams than project and management teams.	Same as Hypothesis 5a.

Table 11 (ctd.).
Hypothesized Relationships and Corresponding Analyses

Hypothesis	Analysis
Hypothesis 6a: Team membership stability will moderate the relationship between team virtuality and team emergent states such that team virtuality is more strongly negatively related to emergent states in ad hoc teams than in intact teams.	Same as Hypothesis 5a.
Hypothesis 6b: Team membership stability team structure will moderate the relationship between team virtuality and team behavioral processes such that team virtuality is more strongly related to behavioral processes in ad hoc teams than in intact teams.	Same as Hypothesis 5a.
Publication Year	*WLS Multiple Regression.* Both the moderator and relevant effect size are linearly transformed by weighting each by the sample size (N).

Artificial Dichotomization. As previously mentioned, team virtuality is most appropriately conceptualized as a continuum (Kirkman & Mathieu, 2005). However, a vast majority of primary studies have dichotomized this construct when investigating its relationship with emergent states and behavioral processes. This artificial dichotomization results in an attenuation of the point biserial correlation, when compared to the correlation resulting from a continuous operationalization (Hunter & Schmidt, 2004). Consequently, the methods of correction delineated by Hunter & Schmidt (2004) were utilized.

Due to the fact that a majority of relevant primary studies manipulated virtuality, resulting in a comparison between degrees of team virtuality, many studies reported subgroup comparisons (means/SDs, t-tests, etc.) rather than correlation coefficients.

Accordingly, Hunter and Schmidt (2004) conversion procedures were implemented to transform all effects to the common metric of correlation coefficients. Table 12 indicates reported statistics and their respective comparison formulas.

Table 12.
Formulas and Procedures for Converting Study Statistics to r

Statistic to be Converted	Formula for Transformation to r	Notes
t	$r = \sqrt{\frac{t^2}{t^2 + df}}$	Paired or unpaired t-tests
F	$r = \sqrt{\frac{F}{F + df\,(e)}}$	One-way ANOVA
X^2	$r = \sqrt{\frac{(Fa * dfa)}{(Fa * dfa) + (Fb * dfb) + (Fab * dfab) + df\,(e)}}$	**Fa** = Main effect of Interest **dfa** = df for A **fb** = Second Main Effect **dfb** = df for B **fab** = Interaction effects **dfab** = Interaction df **df (e)** = error df
d	$r = \sqrt{\frac{d}{d^2 + \frac{4\,(N - 2)}{N}}}$	**d** = Cohen's d **N** = combined sample sizes

Sampling Error. A review of the relevant empirical literature indicates that primary study sample sizes tend to be somewhat small and vary across a variety of settings. This indicates that validity estimates found in each of the primary studies are likely subject to a certain degree of sampling error, which suggests that their resulting validities may not be truly representative of the population values. Consequently, correction methods described by Hunter & Schmidt (2004) were applied.

Measurement Reliability. Measurement unreliability in the independent or dependent variable has an attenuating impact on observed effects (Hall & Brannick, 2002). Hunter and Schmidt (2004) describe methods to estimate the variance in true validities after measurement unreliability has been accounted for. Unfortunately, due to the fact that reliability estimates in the primary studies of interest are not consistently reported, the Hunter and Schmidt (2004) methods of artifact distribution were implemented. This method allowed for the compilation of artifact information (e.g. measurement reliability) across studies to generate a distribution for that artifact. This distribution allowed for the calculation of an average attenuation factor, which was then used to correct for measurement error across primary studies.

File-drawer Analysis. Previous research has posited the possibility that present results are likely to be impacted by a file-drawer effect. This implies that meta-analytic results are likely to be biased which posits that significant findings are more likely to be published than non-significant findings (Rosenthal, 1979). Accordingly, a file drawer-analysis was conducted in order to estimate the number of null effects needed to lower corrected correlation below a pre-determined significance threshold. The present study used $\rho = .05$ as this threshold.

CHAPTER 3

RESULTS

Tables 13 through 19 contain results for the impact of virtuality on states and processes (Tables 13-16), as well as the impact of moderating variables on this relationship (Tables 17-19). The number of correlations (*k*), and total number of groups (*N*) across all primary studies are reported for a particular analysis. For each analysis, the sample size weighted mean observed correlation (*r*), and the sample size weighted standard deviation of the observed correlations (*SDr*) are reported. These values reflect the uncorrected correlation coefficient and corresponding standard deviation weighted by sample size for a given analysis. Furthermore, the sample size weighted mean observed correlation corrected for unreliability in both measures (ρ), and the corresponding standard deviation of ρ (SD_ρ), is reported. The values are weighted by sample size and reflect measurement reliability corrections achieved through the method of artifact distribution delineated by Hunter and Schmidt (2004).

The 80% credibility interval around ρ (80% CV) and 90% confidence interval around ρ (90% CI) are also reported. The credibility interval (CV) indicates the range in which 80% percent of the related validities are likely to occur across the primary studies (Hall & Brannick, 2002). Accordingly, wide CVs indicate the potential presence of a moderating variable, and CVs that don't include zero convey that the relevant effects generalize across studies (Bobko & Roth, 2008). Likewise, the confidence interval (CI) reflects that, if infinite validities were obtained, the population mean validity would fall in this interval 90% of the time (Hall & Brannick, 2002). Therefore, the CI serves an indication of the accuracy of the estimation of ρ (Whitener, 1990). Consequently, the

present study interprets CIs as meaningfully different from each other when an estimate (mean rho) does not fall in the CI of another estimate (Mesmer-Magnus et al., 2011).

Lastly, the percent variance due to sampling error (%SEV), the percent variance due to all corrected artifacts (%ARTV), and the file drawer *k* (FDk) are reported. As previously indicated, the file drawer k represents the estimated number of studies reporting non-significant findings needed to lower the corrected correlation below ρ = .05.

Magnitude of the Impact of Virtuality

Hypotheses 1 through *Hypothesis 4b* were tested using analytic techniques explained by Hunter and Schmidt (2004). Separate types of effects are reported for each relationship. For studies reporting a continuous measure of virtuality, a direct correlation between degree of virtuality and an emergent state or behavioral process is reported. Analyses also reflect instances in which primary studies manipulated virtuality, which resulted in a direct comparison between different levels of virtuality. As previously indicated, studies were coded as comparisons between face-to-face and low virtuality teams, face-to-face and high virtuality teams, and low virtuality and high virtuality teams. The corresponding ρ for each of these comparisons is also reported for a given construct. In all instances, the resulting ρ is be used to indicate both the degree and magnitude of a given relationship between virtuality and the emergent states or behavioral process of interest. A negative correlation coefficient indicates that higher levels of virtuality are detrimental to the construct of interest. Significance is demonstrated when the credibility interval does not contain zero.

Given that the focus of the present study is to assess the impact that different degrees of virtuality have on emergent states and behavioral processes, the subsequent sections report findings regarding comparisons between face-to-face, low virtuality, and high virtuality teams. However, Tables 13-16 also contain results that are reflective of a comparison between face-to-face and virtual teams as a reference. Corrected rhos are reported in each of the subsequent sections. Uncorrected rhos are reported in Tables 13-19 for reference.

Affective Emergent States. *Hypothesis 1* posited affective emergent states would be inversely related to team virtuality such that face-to-face teams would exhibit stronger affective states than would low virtuality teams, which would, in turn, exhibit stronger affective states than would high virtuality teams. Table 13 presents the meta-analytic effect sizes needed to test this relationship with team cohesion, team trust, team satisfaction, team identity, decision commitment, and decision polarity. These findings are graphically displayed in Figure 2.

Table 13.
Virtuality – Affective Correlates

Meta-Analyses	*k*	*N*	*r*	SD_r	ρ	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD_k
Cohesion	25	2376	-.20	.33	-.25	.40	-.77/.26	-.39/-.11	8.90	8.98	100
Face-to-Face (FF) v. Virtual Teams	14	1173	-.20	.45	-.25	.55	-.95/.45	-.50/.00	5.55	5.57	56
FF v. Low Virtuality	7	529	-.06	.51	-.08	.63	-.89/.73	-.50/.34	5.09	5.10	4
FF v. High Virtuality	7	644	-.32	.35	-.40	.42	-.94/.15	-.67/-.13	7.26	7.35	49
Low Virtuality v. High Virtuality	3	95	-.01	.13	-.01	.00	-.01/-.01	-13/.11	100	100	---
Degree of Virtuality	8	1108	-.21	.15	-.27	.15	-.46/-.08	-.38/-.16	32.27	32.94	35
Decision Commitment	17	831	-.10	.32	-.12	.36	-.59/.34	-.27/.03	20.21	20.22	24
Face-to-Face (FF) v. Virtual Teams	16	792	-.09	.34	-.11	.38	-.60/.38	-.28/.06	18.53	18.54	19
FF v. Low Virtuality	6	351	-.23	.33	-.29	.38	-.78/.20	-.57/-.01	14.39	14.39	29
FF v. High Virtuality	10	441	.03	.29	.04	.31	-.37/.44	-.24/.16	28.29	28.29	---
Low Virtuality v. High Virtuality	2	58	.02	.07	.02	.00	.02/.02	-.10/.06	100	100	---
Degree of Virtuality	---	---	---	---	---	---	---	---	---	---	---
Satisfaction (Team)	63	3304	-.11	.27	-.14	.29	-.51/.23	-.21/-.07	28.06	28.13	113
Face-to-Face (FF) v. Virtual Teams	45	1554	-.14	.35	-.18	.39	-.69/.32	-.29/-.07	24.39	24.46	117
FF v. Low Virtuality	17	723	-.21	.31	-.27	.35	-.72/.18	-.43/-.11	23.70	23.92	75
FF v. High Virtuality	28	831	-.08	.38	-.10	.41	-.63/.43	-.25/.05	26.05	26.08	28
Low Virtuality v. High Virtuality	10	513	-.09	.20	-.12	.19	-.36/.13	-.26/.02	47.13	47.20	14
Degree of Virtuality	9	1309	-.11	.12	-.14	.11	-.28/.00	-.22/-.06	46.05	46.29	16

Note. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

Table 13 (ctd.).
Virtuality – Affective Correlates

Meta-Analyses	*k*	*N*	*r*	SD_r	ρ	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD_k
Team Identity	13	584	-.13	.28	-.16	.00	-.16/-.16	-.32/.00	100	100	29
Face-to-Face (FF) v. Virtual Teams	9	245	-.13	.37	-.16	.00	-.16/-.16	-.41/.09	100	100	20
FF v. Low Virtuality	4	75	-.30	.40	-.38	.40	-.90/.14	-.80/.04	35.18	35.31	26
FF v. High Virtuality	5	170	-.06	.33	-.07	.00	-.07/-.07	-.35/.21	100	100	2
Low Virtuality v. High Virtuality	1	16	-.56	---	---	---	---	---	---	---	---
Degree of Virtuality	5	362	-.12	.22	-.14	.21	-.41/.13	-.33/.05	29.41	29.41	9
Team Trust	29	1794	-.04	.22	-.05	.23	-.34/.24	-.13/.03	34.28	34.29	---
Face-to-Face (FF) v. Virtual Teams	20	890	-.07	.23	-.09	.21	-.36/.18	-.20/.02	43.22	43.23	16
FF v. Low Virtuality	10	460	-.08	.27	-.10	.27	-.45/.24	-.28/.08	31.61	31.62	20
FF v. High Virtuality	10	430	-.06	.19	-.07	.13	-.24/.09	-.19/.05	69.58	69.58	4
Low Virtuality v. High Virtuality	5	243	.25	.20	.32	.19	.08/.56	-.51/-.13	45.18	45.20	27
Degree of Virtuality	7	559	-.11	.13	-.15	.09	-.26/-.03	-.26/-.04	70.78	71.44	14
Decision Polarity	15	403	.16	.33	.21	.32	-.21/.62	.03/.39	35.19	35.19	48
Face-to-Face (FF) v. Virtual Teams	13	302	.22	.32	.27	.31	-.13/.67	.09/.45	39.84	39.84	57
FF v. Low Virtuality	5	160	.34	.17	.07	.05	-.36/.49	-.27/.59	93.70	93.70	38
FF v. High Virtuality	8	142	.07	.39	.09	.38	-.39/.57	-.20/.38	39.11	39.11	6
Low Virtuality v. High Virtuality	5	135	.13	.33	.16	.32	-.25/.57	-.14/.46	36.05	36.06	11
Degree of Virtuality	---	---	---	---	---	---	---	---	---	---	---

Note. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

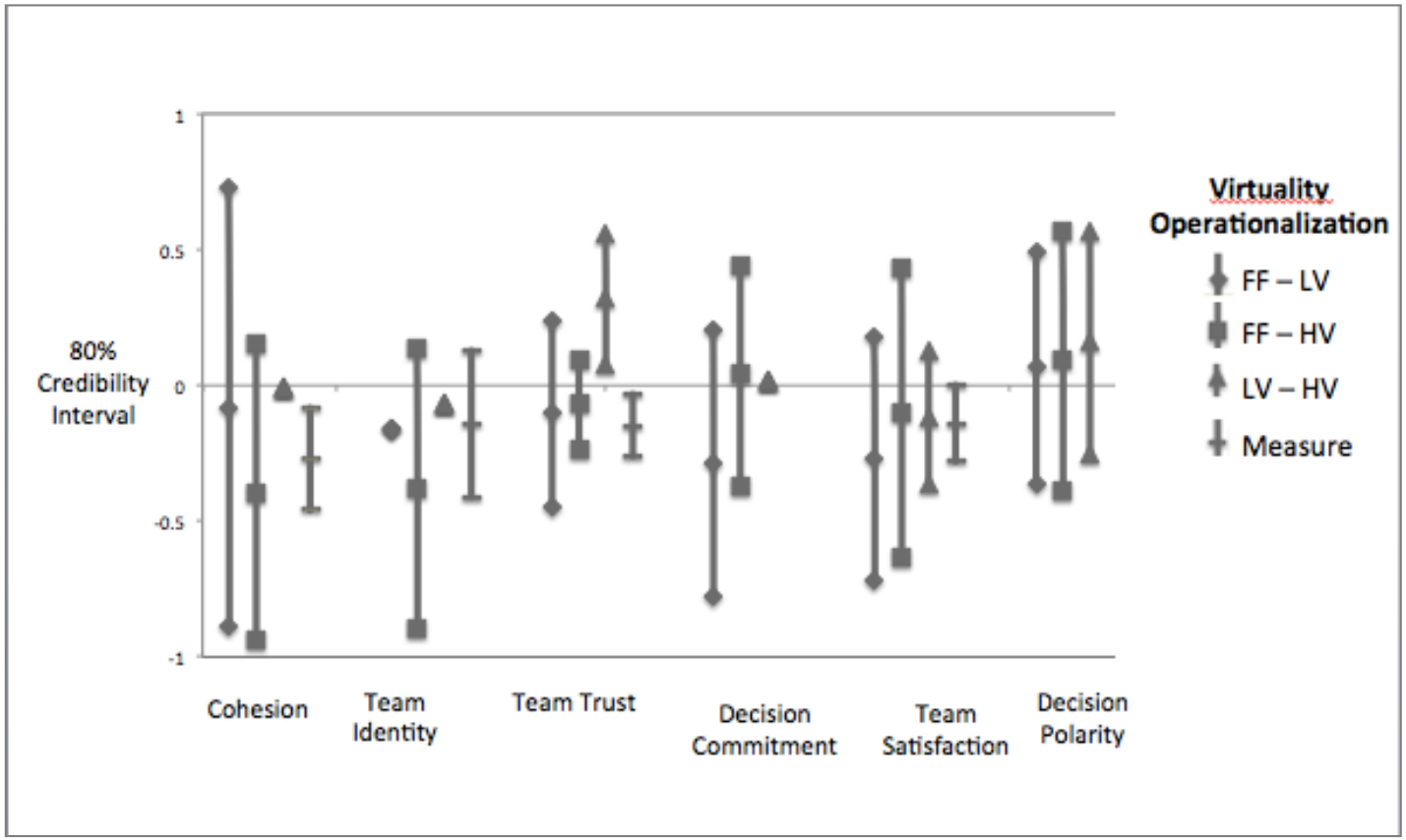

Figure 2. Results regarding the impact of team virtuality on affective emergent states are displayed. 80% Credibility intervals and associated corrected mean rhos are presented for meta-analyses of comparisons between degrees of virtuality (Face-to-Face vs. Low Virtuality, Face-to-Face vs. High Virtuality, Low Virtuality vs. High Virtuality), and for meta-analyses of studies that reported continuous measures of team virtuality. In general, findings demonstrate that team virtuality is not significantly related to affective emergent states. Select operationalizations of virtuality are related to team cohesion (Measure), team identity (Face-to-Face vs. Low Virtuality; Low Virtuality vs. High Virtuality), and team trust (Measure).

Hypothesis 1a stated that cohesion would be inversely related to team virtuality such that face-to-face teams would exhibit stronger cohesion than low virtuality teams, who would in turn exhibit stronger cohesion than would high virtuality teams. Examining the results in Table 13 finds partial support for H1a. Cohesion did not differ according to level of team virtuality. There were no differences in cohesion between low virtuality and high virtuality teams (ρ = -.01. k = 3, the credibility interval includes zero), face-to-face and low virtuality teams (ρ = -.08, k = 7, the credibility interval includes zero), and face-to-face and high virtuality teams (ρ = -.40, k = 7, the credibility interval includes zero). However, results indicate a negative relationship between virtuality and cohesion when considering primary studies that implemented a continuous measure of virtuality (ρ = -.27, k = 8).

Hypothesis 1b proposed that decision commitment would be inversely related to team virtuality such that face-to-face teams would demonstrate stronger decision commitment states than low virtuality teams, who would in turn demonstrate stronger decision commitment than high virtuality teams. Examining the results in Table 13 yields no support for H1b. Decision commitment did not vary according to level of team virtuality. There were no differences in the decision commitment of face-to-face and low virtuality teams (ρ = -.29, k = 6, the credibility interval includes zero), face-to-face and high virtuality teams (ρ = .04, k = 10, the credibility interval includes zero), and low virtuality and high virtuality teams (ρ = .02, k = 2, the credibility interval includes zero). No studies reported the relationship between a continuous measure of virtuality and decision commitment.

Hypothesis 1c stated that team satisfaction would be inversely related to team virtuality such that face-to-face teams would demonstrate stronger team satisfaction states than low virtuality teams, who would in turn demonstrate stronger team satisfaction than high virtuality teams. Findings in Table 13 demonstrate that results are not consistent with H1c. Results suggest that there is no difference in team satisfaction for face-to-face and low virtuality teams (ρ =-.27, k = 17, the credibility interval includes zero), face-to-face and high virtuality teams (ρ = -.10, k = 28, the credibility interval includes zero), and low virtuality and high virtuality teams (ρ = -.12, k = 10, the credibility interval includes zero). Additionally, there was not a significant relationship between the degree of team virtuality and team satisfaction for studies reporting a continuous measure of virtuality (ρ = -.14, k = 5, the credibility interval includes zero).

Hypothesis 1d predicted that team identity would be inversely related to team virtuality such that face-to-face teams would demonstrate stronger team identity states than low virtuality teams, who would in turn demonstrate stronger team identity than high virtuality teams. Results in Table 13 demonstrate partial support for H1d. Findings suggest that face-to-face teams demonstrate stronger team identity than high virtuality teams (ρ = -.07, k = 5), while there is no difference for face-to-face and low virtuality teams (ρ = -.38, k = 4, the credibility interval includes zero). Insufficient information was provided to allow for a comparison of team identity in low virtuality and high virtuality teams. There was not a significant relationship between the degree of team virtuality and team identity for studies reporting a continuous measure of team virtuality (ρ = -.14, k = 5, the credibility interval includes zero).

Hypothesis 1e projected team trust would be inversely related to team virtuality such that face-to-face teams would demonstrate stronger team trust than low virtuality teams, who would in turn demonstrate stronger team trust than high virtuality teams. Examining the results in Table 13 finds partial support for H1e. Studies reporting a continuous measure of virtuality signify there is a negative relationship between the degree of team virtuality and team trust (ρ = -.15, k = 7). However, dichotomous comparisons between face-to-face and low virtuality (ρ = -.10, k = 10, the credibility interval includes zero) and face-to-face and high virtuality (ρ = -.07, k = 10, the credibility interval includes zero) demonstrate no differences in team trust. In addition, contrary to *Hypothesis 1e*, results indicate that levels of team trust are stronger in high virtuality teams than in low virtuality teams (ρ = .32, k = 5).

Hypothesis 1f postulated that decision polarity would be inversely related to team vituality such that face-to-face teams would demonstrate less decision polarity than low virtuality teams, who would in turn demonstrate less decision polarity than high virtuality teams. The results in Table 13 yield no support for H1f . Findings indicate there are no differences regarding decision polarity for face-to-face and low virtuality teams (ρ = .43, k = 5, the credibility interval includes zero), face-to-face and high virtuality teams (ρ = .09, k = 8, the credibility interval includes zero), and low virtuality and high virtuality teams (ρ = .16, k = 5, the credibility interval includes zero). No studies reported continuous measures of team virtuality.

Motivational Emergent States. *Hypothesis 2* stated that motivational emergent states would be inversely related to team virtuality such that face-to-face teams would have stronger team motivational states than low virtuality teams, and low virtuality teams

would have stronger motivational states than high virtuality teams. Table 14 presents evidence regarding the relationship between virtuality and motivational emergent states. These findings are displayed in Figure 3.

Table 14.
Virtuality – Motivational Correlates

Meta-Analyses	*k*	*N*	*r*	SD_r	ρ	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD*k*
Motivation	11	816	-.59	.48	-.74	.59	-1/.02	-1/-.44	2.53	2.57	152
Face-to-Face (FF) v. Virtual Teams	9	757	-.64	.47	-.80	.57	-1/-.07	-1/-.48	1.96	2.01	135
FF v. Low Virtuality	6	274	-.22	.41	-.28	.47	-.88/.33	-.63/.07	12.22	12.23	28
FF v. High Virtuality	3	483	-.87	.31	-.81	.38	-1/-.61	-1/-.66	0.38	0.38	57
Low Virtuality v. High Virtuality	4	216	-.06	.13	-.08	.00	-.08/-.08	-.22/.06	100	100	2
Degree of Virtuality	1	18	-.22	---	---	---	---	---	---	---	---
Team Efficacy	17	1008	-.12	.26	-.15	.28	-.50/.20	-.28/-.02	25.25	25.27	34
Face-to-Face (FF) v. Virtual Teams	11	612	-.21	.27	-.26	.29	-.63/.12	-.43/-.09	22.42	22.53	46
FF v. Low Virtuality	6	373	-.12	.29	-.14	.32	-.55/.27	-.37/.09	18.66	18.69	11
FF v. High Virtuality	5	239	-.36	.16	-.45	.11	-.59/-.31	-.60/-.30	66.78	66.78	40
Low Virtuality v. High Virtuality	2	158	-.05	.15	-.07	.09	-.19/.05	-.31/.17	69.96	69.96	1
Degree of Virtuality	4	238	.07	.13	.08	.04	.04/.13	-.20/.04	95.30	95.30	2

Note. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

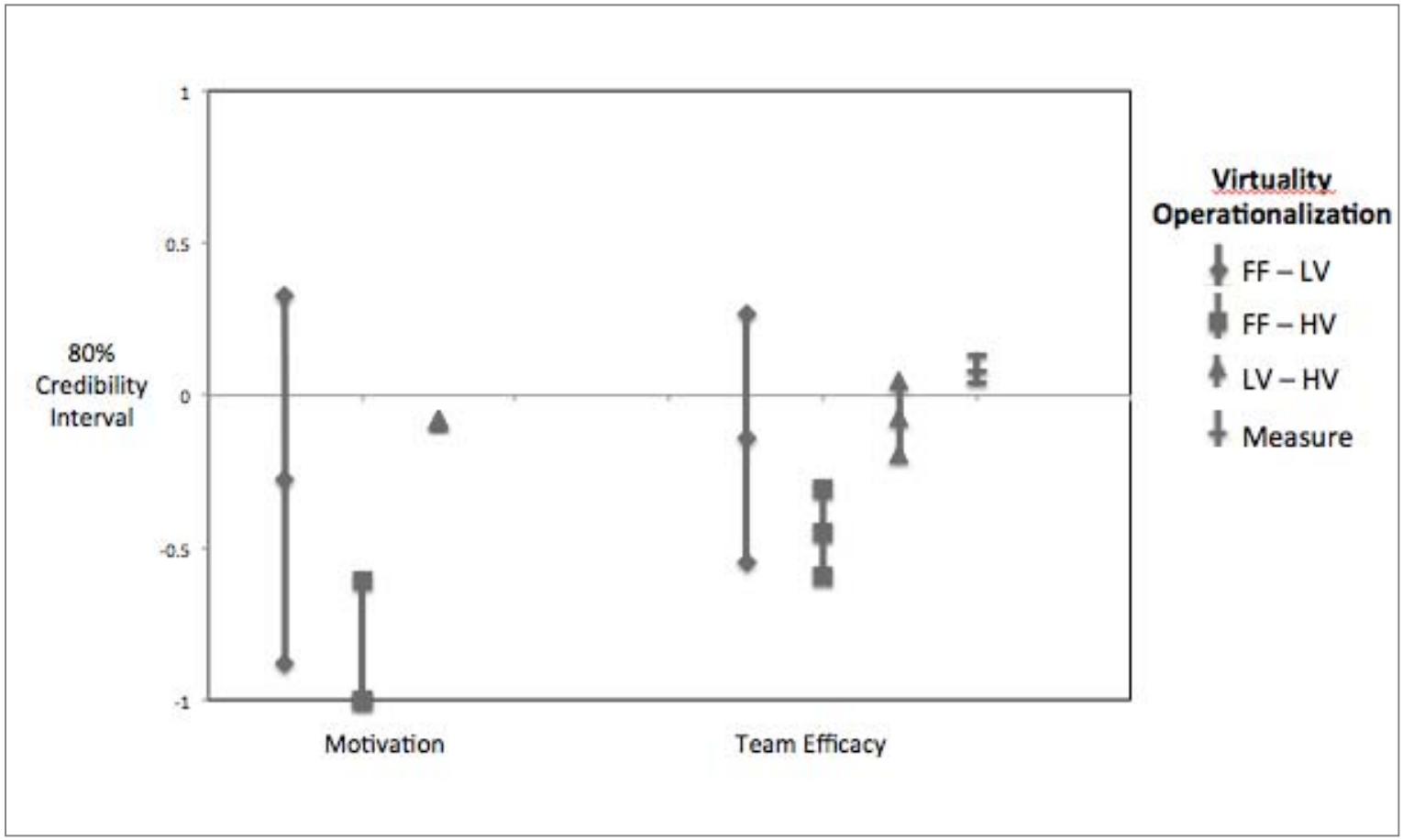

Figure 3. Results regarding the impact of team virtuality on motivational emergent states are displayed. 80% Credibility intervals and associated corrected mean rhos are presented for meta-analyses of comparisons between degrees of virtuality (Face-to-Face vs. Low Virtuality, Face-to-Face vs. High Virtuality, Low Virtuality vs. High Virtuality), and for meta-analyses of studies that reported continuous measures of team virtuality. Results demonstrate that select operationalizations of virtuality are related to motivation (Face-to-Face vs. High Virtuality; Low Virtuality vs. High Virtuality) and team efficacy (Face-to-Face vs. High Virtuality; Measure).

Hypothesis 2a postulated that team motivation would be inversely related to team virtuality such that face-to-face teams would exhibit stronger team motivation than low virtuality teams, who would in turn exhibit stronger team motivation than high virtuality teams. The results in Table 14 demonstrate support for H2a. Findings reveal that face-to-face teams are more motivated than high virtuality teams (ρ = -1, k = 3). Moreover, findings demonstrate that low virtuality teams are more highly motivated than high virtuality teams (ρ = -.08, k = 4). However, there is no difference in team motivation between face-to-face and low virtuality teams (ρ = -.28, k = 6, the credibility interval includes zero). Insufficient information was reported to enable an assessment of the relationship between continuous measures of team virtuality and team motivation.

Hypothesis 2b proposed that team efficacy would be inversely related to team virtuality such that face-to-face teams would exhibit stronger team efficacy than low virtuality teams, who would in turn exhibit stronger team efficacy than high virtuality teams. The results in Table 14 yield partial support for H2b. Results reveal that face-to-face teams exhibit higher levels of team efficacy than high virtuality teams (ρ = -.45, k = 5). However, there is no difference in team efficacy between face-to-face and low virtuality teams (ρ = -.14, k = 6, the credibility interval includes zero), or between low virtuality and high virtuality teams (ρ = -.07, k = 2, the credibility interval includes zero). Additionally, a slightly positive relationship between team virtuality and team efficacy was found for studies reporting continuous measures of virtuality, (ρ = .08, k = 4).

Cognitive Emergent States. Table 15 displays meta-analytic data concerning the relationship between virtuality and cognitive emergent states. Due to an insufficient sample size (k), studies reporting effect sizes for shared mental models and transactive

memory systems were collapsed into the category of team cognition. *Hypothesis 3* proposed that team cognition would be inversely related to team virtuality such that face-to-face teams would have stronger team cognition than low virtuality teams, who would in turn have stronger team cognition than high virtuality teams. The results in Table 15 reveal partial support for H3. Findings demonstrate that face-to-face teams exhibit stronger team cognition than low virtuality teams (ρ = -.32, k = 2). It should be noted that the analysis was based upon one study of shared mental models, and one study of transactive memory systems. To enable meta-analysis, these effects were collapsed under the category of team cognition. However, the small sample size indicates the possibility of second order sampling error. Insufficient information was reported to allow an analysis of the relationship between face-to-face teams and high virtuality, low virtuality teams and high virtuality teams, or the impact of continuous measures of virtuality on team cognition.

Table 15.
Virtuality – Cognitive Correlates

Meta-Analyses	*k*	*N*	*r*	SD_r	ρ	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD*k*
Team Cognition	4	142	-.26	.21	-.32	.16	-.53/-.11	-.53/-.11	59.22	59.36	22
Face-to-Face (FF) v. Virtual Teams	3	134	-.30	.10	-.39	.00	-.39/-.39	-.51/-.27	100	100	20
FF v. Low Virtuality	2	81	-.25	.10	-.32	.00	-.32/-.32	-.47/-.17	100	100	11
FF v. High Virtuality	1	53	-.38	---	---	---	---	---	---	---	---
Low Virtuality v. High Virtuality	---	---	---	---	---	---	---	---	---	---	---
Degree of Virtuality	1	8	.50	---	---	---	---	---	---	---	---

Note. Due to the small sample size ($k = 4$), effect sizes for shared mental models and transactive memory systems were collapsed into the overall construct of team cognition. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

Behavioral Processes. Table 16 displays meta-analytic findings regarding the relationship between team virtuality and behavioral processes. These findings are displayed in Figure 4.

Table 16.

Virtuality – Behavioral Correlates

Meta-Analyses	*k*	*N*	*r*	SD_r	ρ	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD*k*
Team Process (Action)	16	603	.05	.18	.06	.00	.06/.06	-.15/.03	100	100	3
Face-to-Face (FF) v. Virtual Teams	14	366	.10	.52	.12	.00	.12/.12	-.15/.39	100	100	20
FF v. Low Virtuality	7	160	.10	.45	.12	.49	-.51/.76	-.22/.46	22.70	22.70	10
FF v. High Virtuality	7	206	.09	.57	.12	.00	.12/.12	-.35/.59	100	100	10
Low Virtuality v. High Virtuality	2	37	.15	.30	.19	.23	-.11/.49	-.25/.63	60.78	60.78	6
Degree of Virtuality	1	218	-.07	---	---	---	---	---	---	---	---
Team Process (Transition)	16	965	-.15	.22	-.19	.21	-.45/.08	-.30/-.08	38.10	38.13	45
Face-to-Face (FF) v. Virtual Teams	13	442	-.27	.29	-.34	.29	-.71/.03	-.51/-.17	35.68	35.68	75
FF v. Low Virtuality	9	378	-.29	.28	-.37	.30	-.76/.02	-.57/-.17	27.30	27.30	58
FF v. High Virtuality	4	64	-.14	.28	-.18	.00	-.18/-.18	-.48/.12	100	100	10
Low Virtuality v. High Virtuality	3	68	-.22	.09	-.27	.00	-.27/-.27	-.37/-.17	100	100	13
Degree of Virtuality	3	512	-.05	.04	-.06	.00	-.06/-.06	-.11/-.01	100	100	1

Note. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

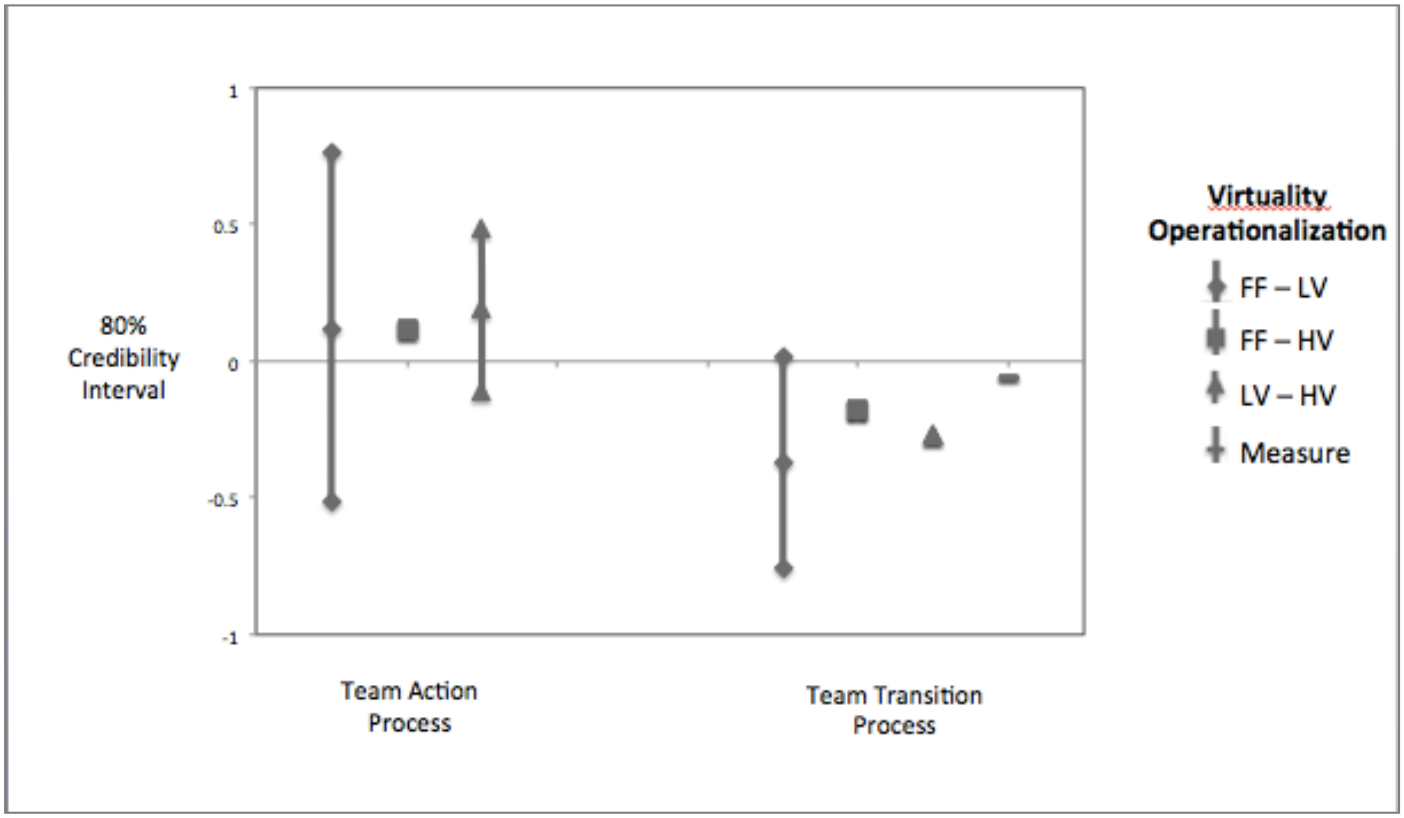

Figure 4. Results regarding the impact of team virtuality on behavioral processes are displayed. 80% Credibility intervals and associated corrected mean rhos are presented for meta-analyses of comparisons between degrees of virtuality (Face-to-Face vs. Low Virtuality, Face-to-Face vs. High Virtuality, Low Virtuality vs. High Virtuality), and for meta-analyses of studies that reported continuous measures of team virtuality. Results demonstrate that select operationalizations of virtuality may be related to team action process (Face-to-Face vs. High Virtuality) and team transition process (Face-to-Face vs. High Virtuality; Low Virtuality vs. High Virtuality; Measure).

Hypothesis 4a stated that transition process would be inversely related to team virtuality such that face-to-face teams would demonstrate stronger transition process than low virtuality teams, who would in turn display stronger transition process than high virtuality teams. Results contained in Table 16 reveal that H4a is partially supported. Findings indicate that face-to-face and low virtuality teams exhibit higher levels of transition process than high virtuality teams (ρ = -.18, k = 4; ρ = -.27 k = 3, respectively). Moreover, a slightly negative relationship between team virtuality and transition process was found for studies reporting continuous measures of virtuality (ρ = -.06, k = 3). However, no differences were found between face-to-face and low virtuality teams (ρ = -.37, k = 9, the credibility interval includes zero).

Hypothesis 4b stated that action process would be inversely related to team virtuality such that face-to-face teams would demonstrate stronger action process than low virtuality teams, who would in turn yield stronger action process than high virtuality teams. The results in Table 16 do not support H4b. Findings show that there are no differences between face-to-face and low virtuality teams (ρ = .12, k = 7, the credibility interval includes zero), or between low virtuality and high virtuality teams (ρ = .19, k = 2, the credibility interval includes zero). Contrary to the hypothesis, high virtuality teams demonstrated stronger action process than face-to-face teams (ρ = .12, k = 7). Insufficient studies reported effects based upon continuous measures of virtuality.

Moderation

Hypothesis 5a through *Hypothesis 6b*, regarding the moderating impact of team type and team membership stability, was tested using subgroup analyses. Subgroup analyses were conducted by the procedures described by Hunter and Schmidt (2004). The

first step in this procedure involved conducting the full meta-analysis. If a significant proportion of the variance remained unaccounted for, the data was then separated into groups defined by the moderator of interest. This was indicated by the presence of zero in the credibility interval surrounding the corrected rho. The aforementioned meta-analytic techniques and methods of corrections were then implemented. A given relationship was only examined for the potential presence of moderators if sufficient information was reported to enable subgroup analysis. For instance, in order to allow a team type moderator analysis for a given relationship, zero must be present in the credibility interval of the direct effect, and sufficient effect sizes for action, project, and management teams must be provided. Significance for moderation is demonstrated when the corrected mean rho for a given effect is not contained in the confidence interval of another effect.

Team type. Table 17 contains sub-group analysis results regarding the potential moderating impact of team type on the relationship between team virtuality and select variables. These findings are presented in Figure 5.

Table 17.
Team Type Moderator w/ Select Variables

Meta-Analyses	*k*	*N*	*r*	SD_r	*ρ*	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD*k*
Cohesion											
Action	2	304	.22	.49	.27	.58	-.48/1.00	-.43/.97	2.50	2.51	9
Project	18	1610	-.29	.26	-.38	.31	-.78/.01	-.51/-.25	14.34	14.59	119
Management	3	124	-.09	.35	-.12	.39	-.61/.38	-.56/.32	20.40	20.42	4
Satisfaction (Team)											
Action	3	154	-.32	.15	-.45	.11	-.59/-.31	-.65/-.25	71.49	71.49	24
Project	48	1817	-.11	.30	-.16	.34	-.59/.28	-.26/-.06	30.41	30.44	106
Management	6	223	-.21	.40	-.29	.49	-.92/.34	-.66/.08	16.36	16.42	29
Team Process (Action)											
Action	1	218	-.07	---	---	---	---	---	---	---	---
Project	12	341	.19	.46	.26	.00	.26/.26	-.04/.56	100	100	51
Management	3	44	-.49	.49	-.62	.56	-1/.09	-1/-.03	18.14	18.14	34

Note. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

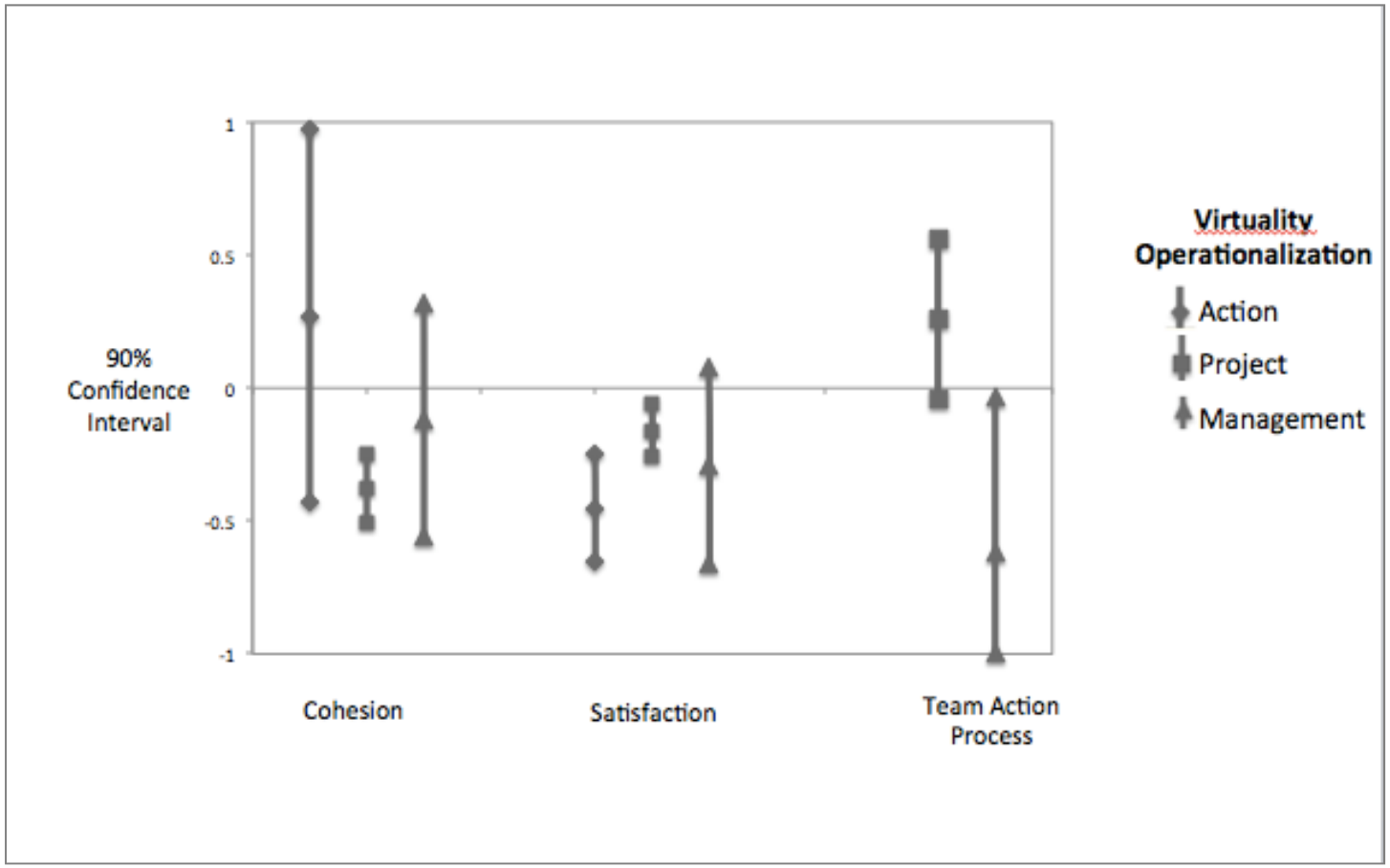

Figure 5. Results regarding the moderating impact of team type on the relationship between virtuality and emergent states, and the relationship between virtuality and behavioral process are displayed. 90% Confidence intervals, and associated corrected mean rhos, are presented for action, project, and management teams. Findings demonstrate that team type moderates the relationship between team virtuality and cohesion, satisfaction, and action process.

Hypothesis 5a proposed that team type would moderate the relationship between team virtuality and team emergent states such that team virtuality would be more strongly negatively related to emergent states in action teams than in project and management teams. Sufficient information was provided to investigate the moderating impact of team type on the relationships between team virtuality and team cohesion, and between team virtuality and team satisfaction. The direction of the results is partially consistent with the hypothesis. In interpreting these results, we find that that the team virtuality-team satisfaction relationship is most strongly negative in action teams (ρ = -.45, k = 3), while it is weaker in both project and management teams (ρ = -.16, k = 48 and ρ = -.29, k = 6, the confidence intervals overlap considerably). On the other hand, effects regarding the impact of team virtuality on team cohesion are not in the expected direction. Results demonstrate that the relationship for virtuality and team cohesion is positive for action teams (ρ = .27, k = 2), but negative for project and management teams (ρ = -.38, k = 18, and ρ = -.12, k = 3, respectively; the confidence intervals overlap considerably).

Hypothesis 5b posited that team type would moderate the relationship between team virtuality and team behavioral processes such that team virtuality would be more strongly negatively related to emergent states in action teams than in project and management teams. Findings suggest that team virtuality is negatively related to action process in management teams (ρ = -.62, k = 3), but positively related in project teams (ρ = .26, k = 12). Insufficient information was reported to investigate this moderating effect for team transition process.

Team membership stability. Table 18 contains sub-group analysis results regarding the potential moderating impact of team membership stability on the

relationship between team virtuality and select variables. These results are presented in Figure 6.

Table 18.

Team Membership Stability Moderator Analyses for Select Variables

Meta-Analyses	*k*	*N*	*r*	SD_r	ρ	SD_ρ	80%CV	90%CI	%SEV	%ARTV	FD*k*
Cohesion											
Ad Hoc	20	1581	-.22	.41	-.28	.49	-.92/.35	-.47/-.09	7.12	7.18	92
Intact	4	560	-.16	.06	-.21	.00	-.21/-.21	-.27/-.15	100	100	13
Satisfaction (Team)											
Ad Hoc	55	1856	-.12	.33	-.16	.38	-.65/.33	-.26/-.06	27.98	27.99	121
Intact	4	914	-.09	.12	-.12	.13	-.29/.04	-.25/.01	31.66	31.73	6
Team Trust											
Ad Hoc	22	1154	.02	.25	.02	.28	-.33/.38	-.07/.11	31.55	31.55	---
Intact	5	467	-.14	.01	-.19	.00	-.19/-.19	-.20/-.18	100	100	14
Team Identity											
Ad Hoc	7	220	-.10	.37	-.14	.00	-.14/-.14	-.46/.18	100	100	13
Intact	5	346	-.08	.11	-.10	.00	-.10/-.10	-.20/.00	100	100	5
Team Process (Action)											
Ad Hoc	11	235	-.17	.38	-.23	.00	-.23/-.23	-.48/.02	100	100	40
Intact	4	361	.16	.32	.22	.42	-.32/.75	-.14/.58	10.97	11.04	14
Team Process (Transition)											
Ad Hoc	12	420	-.32	.25	-.43	.25	-.74/-.12	-.59/-.27	43.69	43.93	91
Intact	3	428	-.02	.04	-.02	.00	-.02/-.02	-.06/.02	100	100	---

Note. Positive correlations indicate greater virtuality resulted in greater values on each construct. k = number of correlations meta-analyzed; N = total number of groups; r = sample size weighted mean observed correlation; SD_r = sample size weighted standard deviation of the observed correlations; ρ = sample size weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80%CV = 80 percent credibility interval around ρ; 90%CI = 90% confidence interval around ρ; %SEV = percent variance due to sampling error; %ARTV = percent variance due to all corrected artifacts; FDk = file drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.

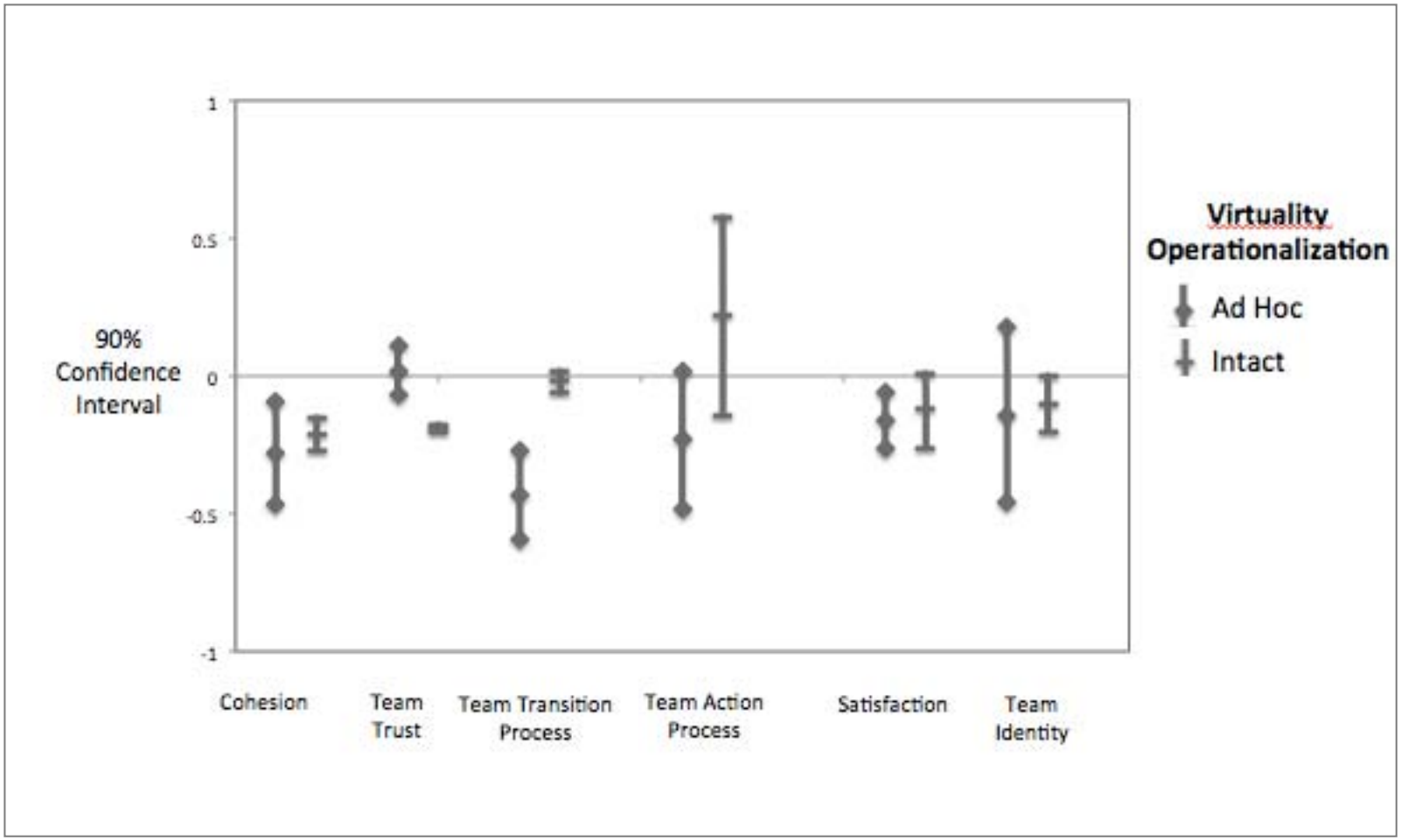

Figure 6. Results regarding the moderating impact of team membership stability on the relationship between virtuality and emergent states, and the relationship between virtuality and behavioral process are displayed. 90% Confidence intervals, and associated corrected mean rhos, are presented for ad hoc and intact teams. Findings suggest that team membership stability moderates the relationship between team virtuality and team trust, team cohesion, team transition process, and team action process.

Hypothesis 6a posited that team membership stability will moderate the relationship between team virtuality and team emergent states such that team virtuality would be more strongly negatively related to emergent states in ad hoc than in intact teams. Results partially support this proposition. Analyses indicate that team virtuality is more strongly and negatively related to cohesion (ad hoc: ρ = -.28, k = 20; intact: ρ = -.21, k = 4). However, team virtuality is more strongly and negatively related to team trust in intact teams than ad hoc teams (ρ = -.19, k = 5 and ρ = .02, k = 22, respectively).

Hypothesis 6b posited that team member stability will moderate the relationship between team virtuality and team behavioral processes such that team virtuality would be more strongly negatively related to behavioral processes in ad hoc than in intact teams. Results are in support of this hypothesis. Findings indicate that team virtuality is negatively related to action process in ad hoc teams (ρ = -.23, k = 11) but positively related in intact teams (ρ = .22, k = 4). Moreover, team virtuality is more strongly related to transition process in ad hoc teams than intact teams (ad hoc: ρ = -.43, k = 12; intact: ρ = -.02, k = 3).

Year of publication. Year of publication was also investigated as a potential methodological moderator. The characteristics of communication technology tools are dynamic and have changed considerably over time. These changes affect how the tools are implemented in team settings, as well as how the tools impact team dynamics. It follows that the virtual tools that were available during the time the research was conducted impacted the observed effects in each study. Consequently, the investigation of the potential moderating influence of publication year sought to elucidate whether the

effects of virtuality on states and processes are increasing or decreasing as technology evolves.

The moderating impact of publication year was investigated using WLS multiple regression. This method is most appropriate for continuous variables (Hausknecht, Halpert, di Paolo, & Gerrard, 2007; Steel & Kammeyer-Mueller, 2002). It requires that both the effect size and moderator be weighted by sample size (N) (Hunter & Schmidt, 2004). This method is performed to account for the fact that the spread of the effect sizes is likely not uniform across all correlation levels due to unequal sample sizes (Steel & Kammeyer-Mueller, 2002). Previous research has noted that the probability values for the determination of significance are incorrect in common statistical software (Lipsey & Wilson, 2001). This is due to the fact that the weighting procedure assumes that the weights represent different numbers of subjects, which is incorrect when conducting meta-analyses. Therefore, z-tests were calculated to determine the significance of the regression coefficients. Given that there was a large sample size for each analysis, the determination of significance was $p \leq .001$.

Table 19 displays the WLS regression results. Findings demonstrate that publication year moderates the relationship between virtuality and team motivation ($\beta = -.74$, $p < .001$). Figures 7 and 8 indicate that, on average, the effect size for the relationship between virtuality and team motivation has shifted from slightly positive to negative over time. Publication year also moderated the relationship between virtuality and team transition process ($\beta = .40$, $p < .001$) and action process ($\beta = -.31$, $p < .001$), respectively. Figures 8 through 12 suggest that the effect size for each respective relationship has shifted from negative to no relationship over time.

Table 19.
WLS Regression Analyses for the Moderating Effect of Publication Year

Construct		Publication Yr Range	*k*	*N*	*β*	SE_b	Z-Score
Affective Emergent States							
	Cohesion	1990-2010	23	2218	.11	.00	.00
	Team Identity	1992-2008	15	623	-.08	.01	-.54
	Team Trust	1992-2009	34	2152	-.26	.01	-2.67*
	Team Satisfaction	1990-2010	89	4788	.13	.00	.00
	Decision Commitment	1989-2006	25	1124	-.11	.02	-1.40
	Decision Polarity	1986-2008	18	437	-.04	.01	-.23
Motivational Emergent States							
	Team Motivation	1991-2008	23	1589	-.74	.02	12.81**
	Collective Efficacy	1994-2009	20	1412	.36	.01	2.75*
Cognitive Emergent States							
	Team Cognition	2004-2009	4	182	-.43	.10	2.13*
Behavioral Processes							
	Transition Process	1992-2010	24	1122	.40	.01	3.35**
	Action Process	1994-2010	18	639	-.31	.02	-3.12**

Note. Effect Size was regressed onto publication year, weighted by sample size (N). In conducting this analysis, the statistical analysis software assumes the weights represent different numbers of subjects, resulting incorrect output related to statistical significance testing (Lipsey & Wilson, 2001). Therefore, the significance of regression coefficients was determined by calculating a corrected standard error and subsequently inputting it into a z-test. * = Z-scores exceeding +/- 1.96 (p = .05); ** = Z-scores exceeding +/- 3.09 (p=.001). Unstandardized betas, corrected standard error of beta, and associated z-scores are reported.

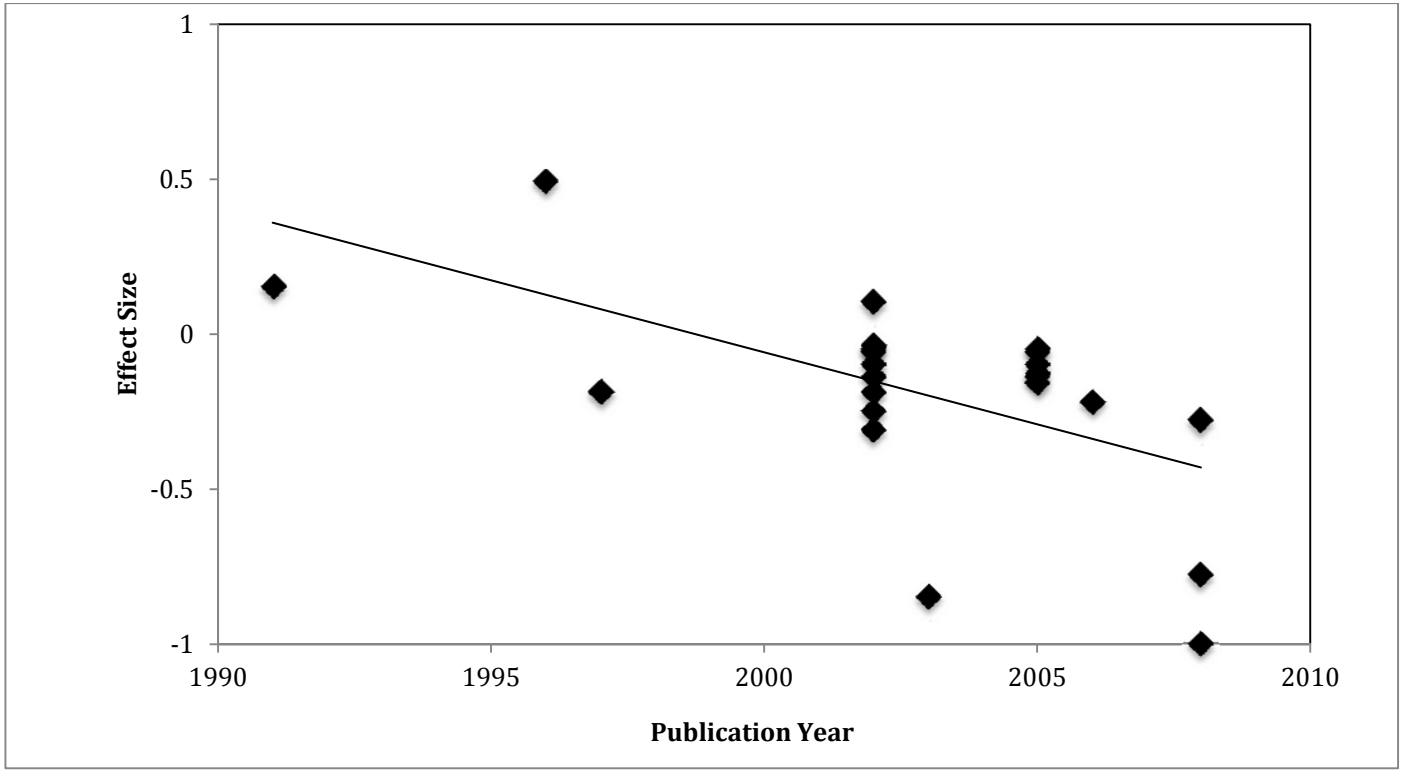

Figure 7. Results depicting the moderating impact of publication year on the relationship between team virtuality and team motivation are displayed. Findings suggest that the direction of the relationship between virtuality and team motivation has become negative over time.

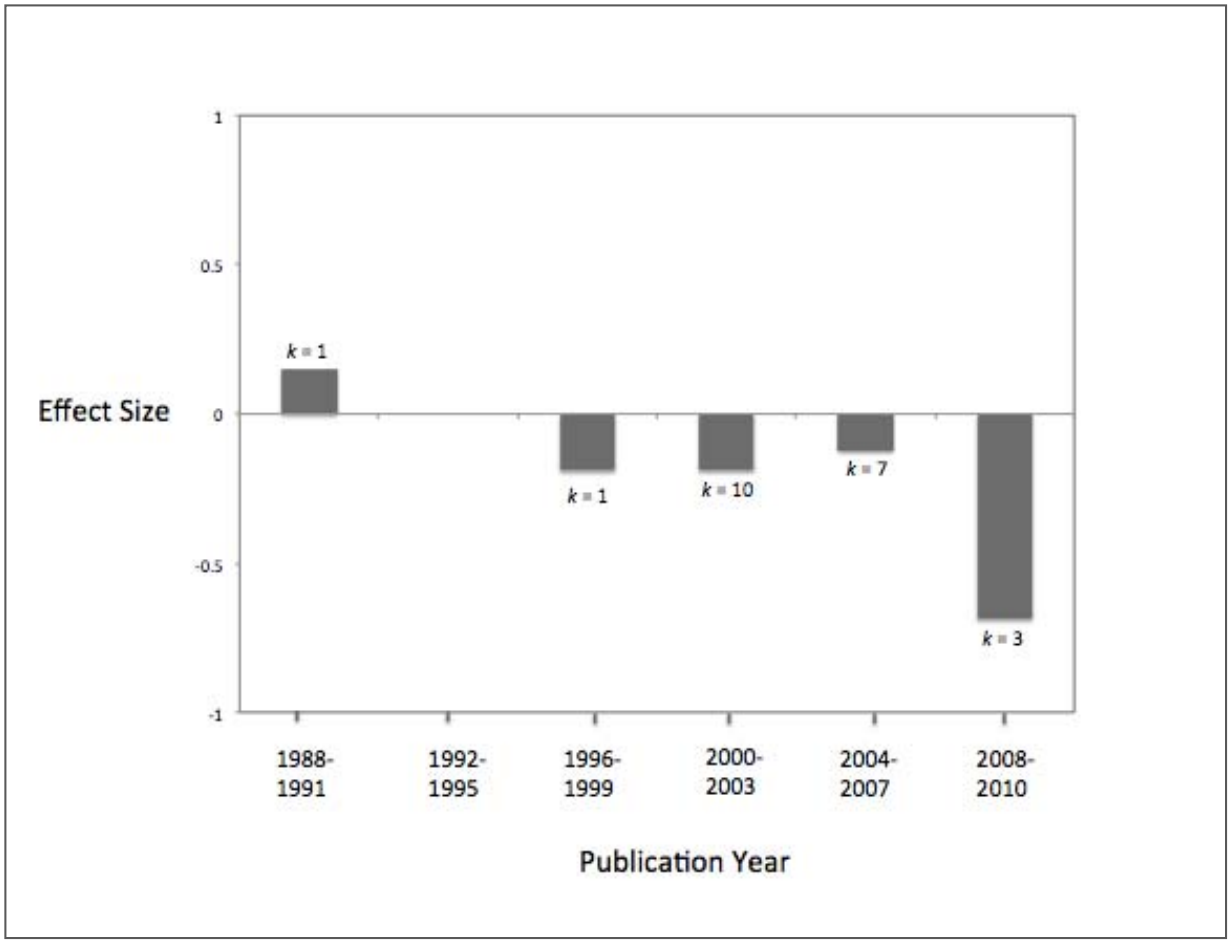

Figure 8. Results depicting the moderating impact of publication year on the relationship between team virtuality and team motivation are displayed. Findings suggest that the direction of the relationship between virtuality and team motivation has become negative over time. While WLS regression was conducted for this analysis, the present histogram is included simply to facilitate interpretation.

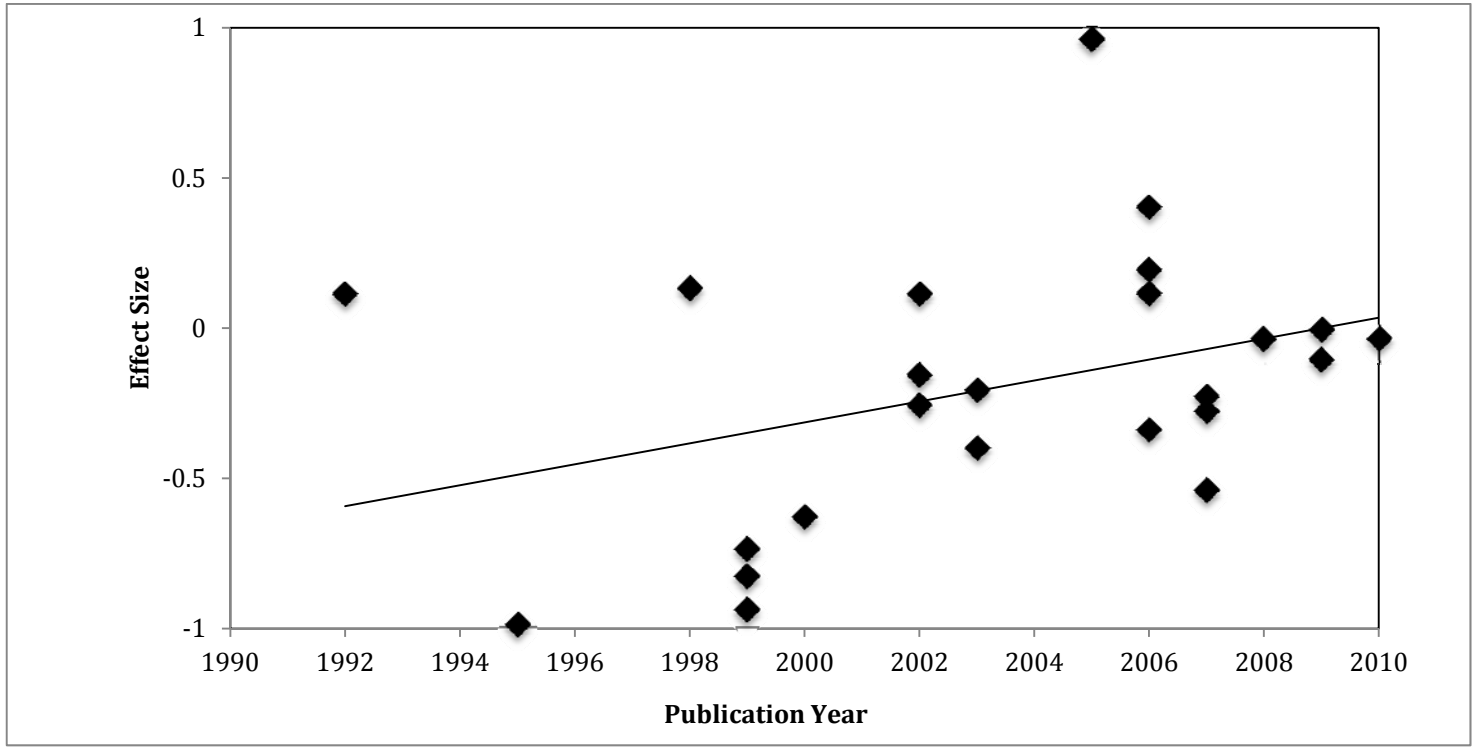

Figure 9. Results depicting the moderating impact of publication year on the relationship between team virtuality and team transition process are displayed. Results demonstrated that the relationship between virtuality and transition process has shifted from negative to no relationship over time.

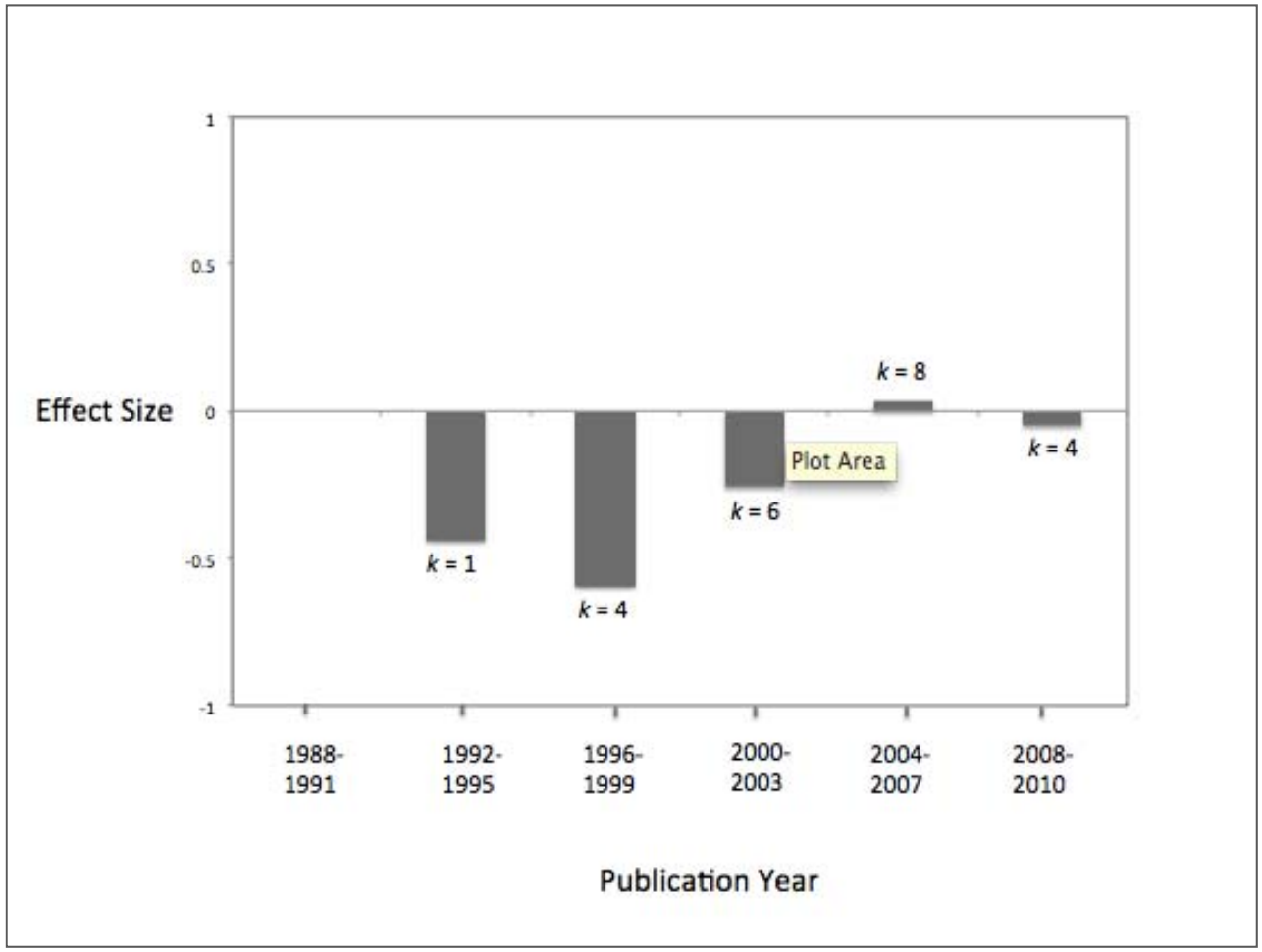

Figure 10. Results depicting the moderating impact of publication year on the relationship between team virtuality and team transition process are displayed. Results demonstrated that the relationship between virtuality and transition process has shifted from negative to

no relationship over time. While WLS regression was conducted for this analysis, the present histogram is included simply to facilitate interpretation

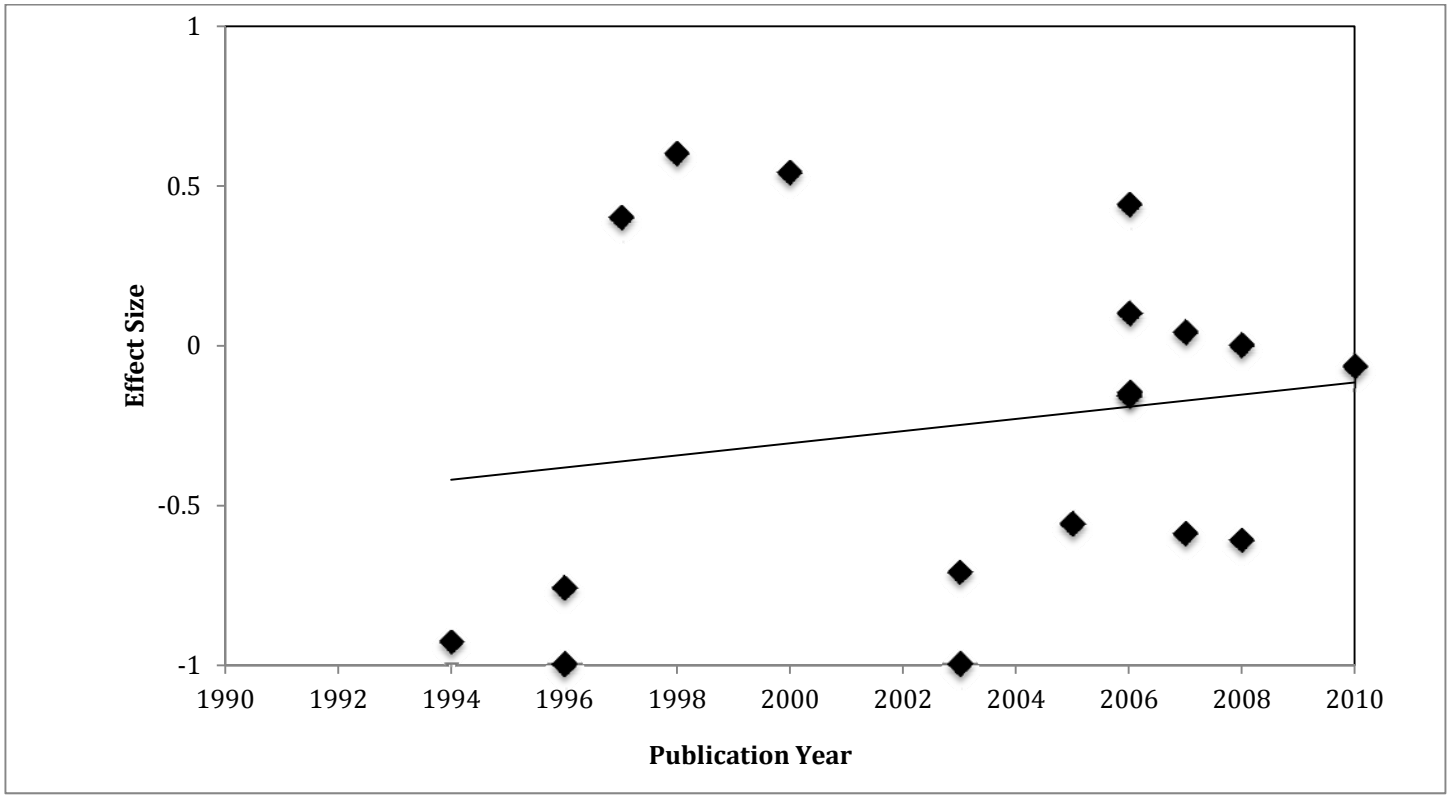

Figure 11. Results depicting the moderating impact of publication year on the relationship between team virtuality and team action process are displayed. Results demonstrated that the relationship between virtuality and action process has become less negative over time.

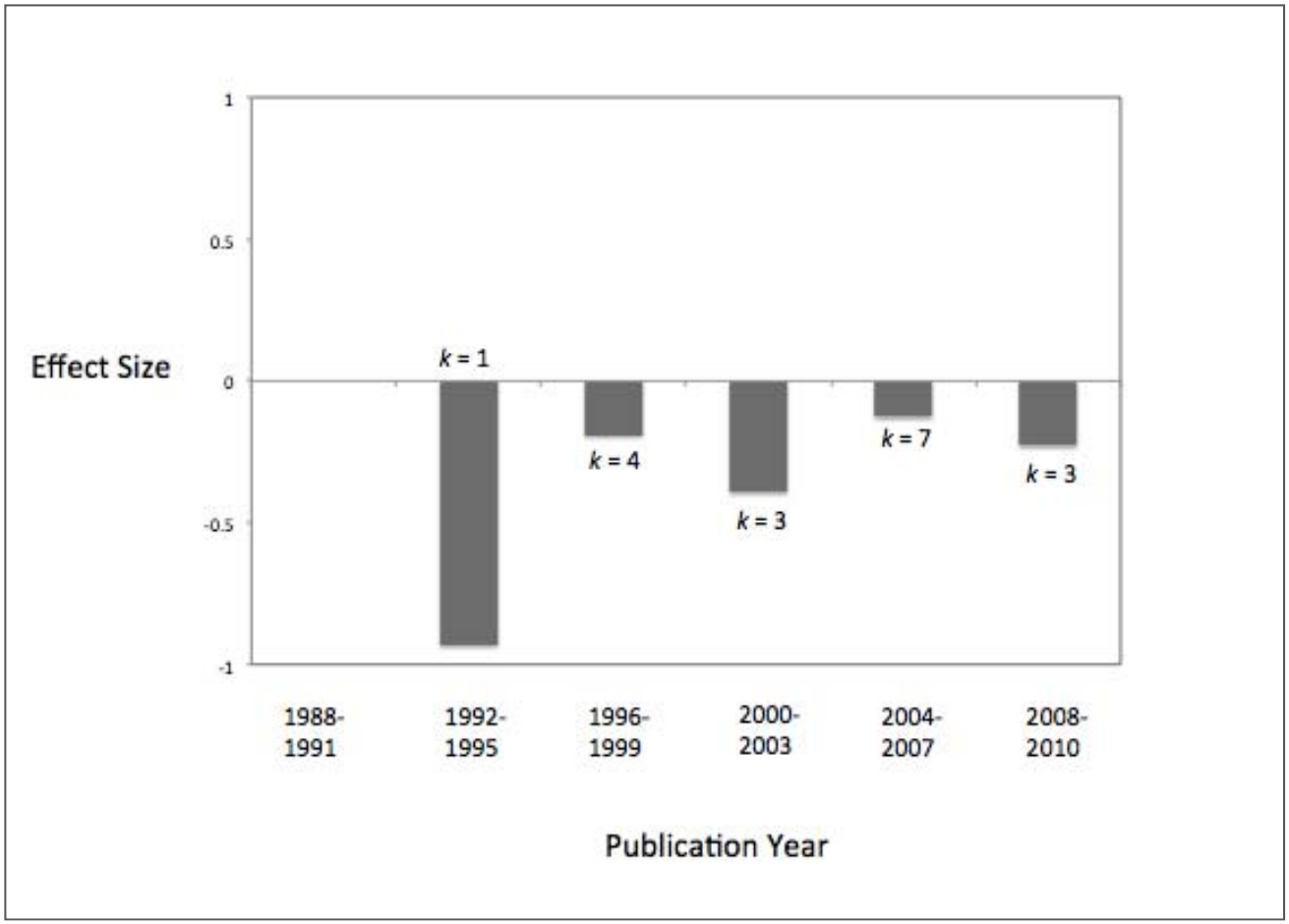

Figure 12. Results depicting the moderating impact of publication year on the relationship between team virtuality and team action process are displayed. Results demonstrated that the relationship between virtuality and action process has become less negative over time. While WLS regression was conducted for this analysis, the present histogram is included simply to facilitate interpretation.

CHAPTER 4

DISCUSSION

Virtual communication tools have become embedded in the workplace, such that there is an inherent inseparability between the work conducted by teams and the technologies they use to complete this work (Orlikowski & Scott, 2008). E-mail, videoconferencing, instant messaging and many other forms of communication technology afford team members the ability to interact in many ways. However, despite the fact that virtual interactions have become the norm for many organizations, there is still much to understand pertaining to the manner in which these virtual tools shape team interactions (Mesmer-Magnus et al., 2011). Through leveraging the literatures concerning team virtuality and technological affordances, the present study sought to reorganize previous research on the impact of virtuality on team emergent states and behavioral processes to elucidate how different degrees of team virtuality shape team functioning, and to investigate the manner in which these relationships differ according to team type, team membership stability, and publication year. These meta-analytic findings uncover new insights into the true nature of these relationships, as well as expose avenues for future research.

Theoretical Contributions

Prior work has produced mixed conclusions regarding the impact of virtuality on team functioning. Initial work suggested that the use of virtual tools is largely detrimental (e.g. Olson & Olson, 2000), while more recent work has indicated that virtuality can enhance team functioning if the tools are utilized appropriately (e.g. Bergiel et al., 2008, Abad et al., 2002, Bell & Kozlowski, 2002). The principle theoretical contribution of this

study is that a reliance on highly virtual work may not be as detrimental to team functioning as initially believed. Drawing upon media richness theory and social impact theory, Hypotheses 1-4b proposed that virtuality would negatively impact team emergent states and behavioral processes. In general, results revealed that there is not a strong relationship between team virtuality and states and behaviors. These findings indicate that the extent to which teams establish beneficial states and behaviors is not necessarily contingent upon where the team falls along the virtuality continuum.

The first set of hypotheses examined the manner in which team virtuality impacts affective emergent states. Results indicate that team virtuality is not indicative of team decision commitment, team satisfaction, and decision polarity. Analyses based upon primary studies that manipulated virtuality were not significant for either cohesion or trust. However, analyses did suggest that virtuality negatively shapes both team cohesion and team trust in studies that implemented continuous measures of virtuality. These findings highlight the possibility that team cohesion and team trust are more strongly hindered by the reduced ability of high virtuality tools to communicate multiple forms of social information (e.g. tone, facial expressions) which are instrumental in determining the extent to which members have confidence in their team members and the extent to which members feel the are part of a unified collective (Martins et al., 2004).

The second set of hypotheses sought to investigate the relationship between team virtuality and motivational emergent states. Results imply that there is not a strong relationship between virtuality and motivational emergent states. There were no differences in motivation or team efficacy between face-to-face and low virtuality teams, and no differences in team efficacy between low and high virtuality teams. However,

analyses from studies that manipulated virtuality do suggest that face-to-face teams may exhibit stronger team motivation and collective efficacy than high virtuality teams. These specific findings may demonstrate the difficultly in establishing both collective effort and a collective belief in a team's ability to perform a task when interacting in highly virtual settings. According to social impact theory, team member knowledge of the relative impact of each individual's work is a key factor in shaping team motivational states, given that this knowledge serves as a form of process feedback (Kirkman et al., 2004). These findings intimate that this information may be more comprehensively communicated through more rich media and face-to-face interactions than interactions through high virtuality tools. This is likely due to the fact that members interacting via high virtuality tools are not able to receive rich social information (e.g. tone, body language) that is instrumental in the feedback process (Kirkman et al., 2004). These members may feel more isolated, and consequently less motivated, as they are not able to receive this information. This corroborates previous research indicating that the nature of highly virtual work places constraints on the communication of feedback, a key factor in the maintenance of member motivation (Geister et al., 2006). However, these findings are based upon a small number of studies ($k = 3$ and $k = 5$, respectively), highlighting the possibility of second order sampling error. Therefore, future research should investigate this relationship to further evaluate the validity of these assertions.

The third hypothesis investigated the extent to which team cognition is negatively shaped by virtuality. Four studies total have investigated this relationship thus far, which limited meta-analyses to the comparison between the team cognition of face-to-face teams and low virtuality teams. Findings from this analysis suggested that virtuality

negatively shapes team cognition. However, only two studies were included in this particular analysis. Janssen (2008) found that face-to-face undergraduate project teams experienced greater transactive memory regarding team member roles than teams that relied on instant messaging. Likewise, results from Kring (2004) suggested that face-to-face student project teams experienced greater shared mental models with regards to their mission goals than teams that interacted through e-mail. Future research should seek to expand upon this work to investigate the manner in which virtuality shapes both shared mental models and transactive memory systems.

The fourth set of hypotheses focused upon the manner in which team virtuality shapes team transition and team action processes. Results signify that there is not a strong relationship between virtuality and motivational emergent states. No differences were found for transition or action process between face-to-face and low virtuality teams, or for action process between low virtuality and high virtuality teams. However, findings from studies that manipulated virtuality suggest that face-to-face teams are more effective at planning for tasks than high virtuality teams, while high vituality teams may engage in tasks more effectively than face-to-face teams. Social impact theory would posit that strength and distance between members decreases in teams that rely on face-to-face interaction or virtual tools that closely mimic face-to-face interaction (e.g. low virtuality tools), which is likely to benefit collective engagement in planning processes such as goal specification and coordination (Blaskovich, 2008; Kidwell & Bennett, 1993). These processes are critical for the establishment of effective transition process. Accordingly, face-to-face may exhibit stronger transition process behaviors than high virtuality teams.

Likewise, high virtuality tools may allow for better coordination and team monitoring due to their information storage capabilities, and the ability for members to contribute according to their own schedules (Bikson & Eveland, 1990; Jessup & Tansik, 1991; Kirkman & Matheiu, 2005). Virtual tools such as e-mail and group decision systems provide team members with a platform through which they can organize and monitor task-relevant information as it is exchanged (Townsend et al., 1998). The asynchronous nature of these tools likely allows each team member to appropriately process information specific to executing the task at hand prior to each respective contribution. Therefore, high virtuality teams may demonstrate stronger action process than face-to-face teams. However, these findings were based upon a relatively small number of primary studies (action process: $k = 7$; transition process $k = 4$), and may be subject to second order sampling error. Therefore, future research should further examine the manner in which team virtuality shapes both transition and action behavioral processes.

A second purpose of this study was to test for moderators of the relationships between virtuality and aspects of team functioning. The wide credibility intervals, many of which include zero, suggest there are indeed moderators of these effects. This thesis tests team type, team membership stability, and publication year as moderators of these relationships.

Findings suggest that the extent to which virtuality affects team functioning depends in part on the nature of the work being performed by the team. Higher degrees of virtuality are more detrimental to team satisfaction in action teams than in either project or management teams. This corroborates previous propositions that action teams are most

effective when engaging in rich and synchronous interaction (Dyer, 1984; Klein, Ziegert, Knight, & Xiao, 2006). Thus, it can be inferred that the degree to which action team members are satisfied with their collective will be hindered when more asynchronous and highly virtual tools are used. On the other hand, project and management teams are likely to rely less on rich media to function, therefore it is logical that their satisfaction levels would be relatively unaffected regardless of the means of interaction. Contrary to prediction, the impact of virtuality on team cohesion was found to be positive for action teams but negative for project teams. A potential explanation for this finding could be the fact that a reliance on high virtuality tools in action teams could result in a reduced opportunity for conflict. The empirical literature has indicated that the more team members interact with one another, the more likely they are to experience various forms of conflict (Mathieu et al., 2008). Accordingly, action teams likely have less opportunity to interact in a face-to-face setting when interacting via highly virtual tools, and therefore may experience diminished levels of conflict.

Moreover, results suggest that virtuality positively impacts action process in project teams, but upholds a negative impact for management teams. This may be due to the fact that the use of highly virtual tools in project teams allows for a greater degree of member autonomy when carrying out a task. Managers, on the other hand, likely require more rich media to perform job-related tasks (e.g. conducting interviews, firing employees). However, it should be noted that the number of effect sizes incorporated into these analyses for action and management teams was quite small. Therefore, findings should serve to indicate the potential presence of a moderating relationship, and ought to be investigated in future research.

The present study also investigated the moderating impact of team membership stability. Findings suggest that virtuality is more strongly and negatively related to cohesion in ad hoc compared to intact teams. These results validate the proposition that ad hoc teams are likely to negatively impacted by the fact that they have not properly engaged in the stages of team development, and thus do not have norms to guide their interactions.

However, results also suggest that virtuality negatively impacts team trust in intact teams, but is not related to trust in ad hoc teams. This insinuates that established and stable teams experience lower levels of trust when engaging in more highly virtual means of interaction. The literature has indicated that ad hoc teams may display the ability to develop high trust through embracing a swift trust model over the traditional method of trust development (Jarvenpaa & Leidner, 1999; Powell, Piccoli, & Ives, 2004). Swift trust indicates that, in ad hoc teams, team members may assume that other members are trustworthy given that they do not have ample time to slowly build trust (Meyerson, Weick, & Kramer, 1996). Findings from the present study would support the idea that, due to the formation of swift trust, virtuality might not impact trust levels in ad hoc teams. However, given that intact teams are more likely to engage in traditional means of trust development, their trust levels may be negatively impacted by the use of more highly virtual tools (Jarvenpaa, Knoll, & Leidner, 1998).

In addition, findings propose that the relationship between virtuality and both transition and action process is negative for ad hoc teams. However, in intact teams, virtuality positively shapes action process, but is unrelated to transition process. A possible explanation for this is that ad hoc teams don't have established norms for

planning of a task (e.g. mission analysis, goal setting) or carrying out a task (e.g. coordination, backup behavior). In order to engage in these behaviors, it can be argued that ad hoc teams require the ability to exchange information in a rich, comprehensive manner due to the absence of these interaction norms. Therefore, they may struggle to exhibit effective transition and action process behaviors if relying solely on asynchronous and less media-rich technology in a high virtuality setting.

Intact teams, on the other hand, are more likely to have established norms for transition and action processes (Salas et al., 2008). As suggested by these findings, their ability to plan for a task may remain the same regardless of their means of interaction. Moreover, their ability to actually engage in a task may be enhanced by the use of high virtuality tools. Previous research supports this proposition. Ramesh and Dennis (2002) suggested that established teams could enhance coordination by leveraging high virtuality technology through decoupling team members and decreasing the need to work via entirely synchronous means. It has been suggested that intact teams have implicit coordination norms, and thus may not have as strong of a need to carry out tasks in a face-to-face, synchronous context (Salas et al., 2008). Therefore, due to these established norms, intact teams may have the ability to utilize highly virtual tools, such as e-mail and databases, to efficiently carry out a task via asynchronous means.

A central assumption of the present study is the communication technology impacts the manner in which individuals interact. Consequently, the use of different forms of communication technology will yield fundamentally different interactions. This is due to the fact that tools vary in terms of their synchronicity and media richness (Kirkman & Mathieu, 2005). It follows that these differences are not only present among

different tools in a given setting, but are also likely to be present when examining the use of different communication tools over time. Communication technology has developed rapidly in recent decades, which has likely led to a marked impact on team dynamics (Orlikowski & Scott, 2008). Consequently, recent research has suggested that the direction and strength of virtuality-relevant effects may have changed over the past two decades (Mesmer-Magnus, et al., 2011). To test this proposition, the present study also conducted an exploratory analysis to investigate the potential moderating impact of publication year on the relationship between team virtuality and emergent states and behavioral processes.

Findings suggest that the direction of the relationship between virtuality and team motivation has become negative over time. This could be due to a combination of factors. Employees have become much more adept at implementing many types of virtual tools in the workplace (Elias, Smith & Barney, 2012). Moreover, the capabilities and types of tools have expanded rapidly over the last decade (Dixon & Panteli, 2010; Rico, Bachard, Sanchez-Manzanares, & Collins, 2012). This development is especially true for low virtuality tools, which are now available to any organization and more closely mimic face-to-face interaction than ever before. It could be proposed that employees have come to rely on these low virtuality tools to facilitate teamwork. It is plausible then that when employees are restricted to seemingly less-advanced high virtuality technologies such as e-mail, they become demotivated because they are not exposed to the interpersonal cues necessary for the maintenance of work effort, which are more likely to be present in interactions over rich media (Kirkman et al, 2004).

Results demonstrated that the relationship between virtuality and both transition process and action process has shifted from negative to very little relationship over time. The information organization and transmission capabilities of both high and low virtuality tools have developed substantially over the last two decades (Elias et al., 2012). For instance, improved bandwidth now allows for audio and video transmissions that closely reflect face-to-face communication (Hambley, O'Neill, & Kline, 2007). Likewise, highly virtuality tools, such as e-mail, have benefitted from advancements in storage and informational organization capabilities (Dixon & Panteli, 2010). Therefore, it is plausible that these advancements now allow teams to effectively implement all types of virtual communication tools in planning for and carrying out tasks.

Managerial Implications

The vast array of communication technologies available to managers has the potential to improve work efficiency, decrease travel costs, and decrease redundancies between team members (Kayworth & Leidner, 2000). However, certain virtual tools may appear impersonal in nature, and, if implemented incorrectly, may be detrimental to team functioning (Curseu, 2006). Therefore, managers must be aware of the advantages and limitations of relying on different forms of communication technology, and the settings in which these tools should be implemented.

Accordingly, the present study provides many important managerial implications. Generally speaking, findings indicate that virtuality does not play a critical role in shaping team states and behaviors. Therefore, managers can consider implementing both high and low virtuality tools in a given team setting (e.g. hybrid teams: Mesmer-Magnus et al., 2011). Managers should also be cognizant of the manner in which the

characteristics of team shape the impact virtuality has on team interactions. Findings from the present study suggest the team type has notable implications for the use of virtual tools in team settings. Namely, managers of action teams should rely on high virtuality tools in order to enhance team cohesion and action process. Likewise, managers of project teams should implement low virtuality tools or face-to-face interaction to improve cohesion and action process. On the other hand, if managers wish to augment team satisfaction, low virtuality tools should be used in project or management teams, while high virtuality tools should be employed in action teams.

An increasingly common trend among today's organizations is the creation of ad hoc teams to comprehensively address a given task through bringing together individuals with distinct areas of expertise (Salas et al., 2008). This meta-analysis allowed for a comparison of the impact of virtuality on team functioning between these newly formed teams and previously established collectives. Results from the present study can be used to guide a manager's selection of which type of team structure is best suited to implement virtual toocls to facilitate taskwork. For instance, results suggest that managers of ad hoc teams should implement less virtual tolls to facilitate transition and action behavioral processes, but that managers of intact teams should utilize highly virtual communication tools to enhance team trust.

Limitations

While the present meta-analysis provides notable contributions to the collective identity literature, several limitations should be acknowledged. To begin with, while there are no specific guidelines concerning the minimum number of studies required to conduct a meta-analysis, some of these meta-analyses raise concerns of potential second-order

sampling error (Hunter & Schmidt, 2004). This is due to the fact that the estimates of meta-analyses based upon a small number studies tend to be impacted by sampling error. However, it is important to note that the standard deviation is more likely to be impacted than mean rhos (Hunter & Schmidt, 2004). Regardless, in these instances, the purpose of these analyses was to gain insight into the general direction of the relationship of interest. Accordingly, the findings should be used to guide future research aimed at examining the impact of varying degrees of virtuality on team functioning.

Specific to the meta-analyses regarding the relationship between virtuality and cognition, the number of primary studies that had investigated this relationship was particularly low ($k = 4$). Theoretically, transactive memory systems and shared mental models are distinct concepts, reflecting compilational and compositional cognitive structures, respectively (DeChurch & Mesmer-Magnus, 2010). This would indicate that each structure would necessitate its own analysis. However, the small sample size required that these constructs be collapsed under the same meta-analysis. While these findings should be interpreted as a potential representation of the relationship between virtuality and team cognition overall, future research should seek to parse out these constructs.

A third limitation regards the design of the primary studies included in our meta-analyses. A variety of scales were used to assess many of the attitudinal and behavioral correlates, indicating general lack of consistency regarding the conceptualization and operationalization of the construct of interest. In general, we were able to reliably code each construct based upon its scale items, regardless of the label given in the primary study.

A fourth limitation pertains to the exploratory moderation analyses. The present study sought to investigate the possibility that the direction and strength of virtuality-related effects have changed over time. In order to investigate this relationship, the present study conducted WLS regression analyses with publication year serving as a proxy for the development of technology. However, it could be argued that a lag between data collection and primary study publication persists. Thus, it is possible that publication year may not exactly represent the state of technology at during the specified year. However, these analyses were exploratory in nature and simply sought to investigate the potential existence of such moderating effects. Future research should seek to further investigate this relationship in light of other temporal variables.

Future Research

These findings exposed multiple avenues for future research. The present study categorized teams as either fully face-to-face, low virtuality, or high virtuality. This approach allowed for the isolation of varying degrees of virtuality, and the subsequent investigation of how these degrees shape team functioning. However, it is likely that present-day teams use a variety of means of interaction, reflecting a combination of face-to-face, low virtuality, and high virtuality communication technologies (Mesmer-Magnus et al., 2011). Therefore, a logical next step in this line of research would be to examine the manner in which combinations of different forms of communication technology across these varying degrees of virtuality shape interactions. Previous research has demonstrated that both face-to-face and virtual interaction maintain unique benefits to work teams (Dixon & Panteli, 2010; Martins et al., 2004; Kirkman & Mathieu, 2005 Schweitzer & Duxbury, 2010). Moreover, recent empirical work has suggested that

teams which use a mix of face-to-face and virtual interactions (hybrid teams) benefit from better information sharing capabilities (Mesmer-Magnus et al., 2011). Consequently, it is plausible that a balance of both forms of tools is necessary to achieve optimal team states and behaviors.

In the same vein, the operationalization of the construct of virtuality in the primary studies only permitted comparisons among three degrees of team virtuality. However, the literature has generally supported the conceptualization of team virtuality as a continuum (Gibson & Gibbs, 2006; Kirkman & Mathieu, 2005). Unfortunately, only a small subset of studies included in the present meta-analysis embraced this operationalization. The present study maintains a notable contribution to the literature in that it moved beyond the simplistic comparision of face-to-face compared to virtual teams in examining multiple degrees of virtuality. However, in order to more appropriately capture the interplay between team virtuality and emergent states and behavioral processes, future research should further consider implementing continuous measures of team virtuality.

A number of relatively wide credibility intervals were found in the analyses regarding the direct impact of virtuality on emergent states and behavioral processes. This was particularly true for a number of face-to-face versus low virtuality comparisons (e.g. cohesion, motivation, team action process). These findings indicate a relatively large degree of variability exists in the primary studies that investigated these relationships. Current results suggest that three variables, team type, team membership stability, and publication year, serve as moderators that further enhance our understanding of how virtuality shapes team interactions. However, arguments can be made for the existence of

other potential moderators. For instance, previous work has proposed that team member experience with technology may play an important role in their implementation of technology (Griffith, Sawyer, & Neale, 2003; Kayworth & Ledier, 2000). It could be argued that perhaps less experienced individuals would need to use tools that more closely mimic face-to-face work to ease their transition into virtual work. Accordingly, future research could investigate the match between technological experience and communication tool usage.

Task interdependence may also be a key moderator from the relationship between virtuality and team states and behaviors. Recent empirical work has demonstrated that task interdependence plays a critical role in determining the effectiveness of virtual teams (Bodiya, 2011; Hertel, Konradt, & Orlikowski, 2004). It is plausible that the degree to which a team is interdependent impacts the manner in which members implement various virtual tools. For instance, more interdependent teams may benefit from implementing lower virtuality tolls to facilitate synchronous, fast-paced interaction. However, perhaps less task interdependent teams are better suited by the use of high virtuality tools based upon the autonomous nature of their work.

The present study examined the degree to which virtuality shapes prominent emergent states and behavioral processes. These behaviors and states were investigated given that they have been robustly studied in the literature and are theoretically tied to team functioning (Martins et al., 2004). However, as the use of virtual tools fundamentally changes the manner in which individuals interact, their use may also alter the manifestation of these states and behaviors. Recent efforts have sought to conceptualize constructs specific to the use of virtual tools (e.g. technological means

efficacy: Laver, George, Ratcliffe, & Crotty, 2012). Future research should investigate the development of additional virtuality-related mechanisms.

The literature has posited that teams develop according a series of phases (Johnson, Suriya, Yoon, Berrett, & La Fleur, 2002; Joy-Matthews & Gladstone, 2000). One of the most prominently supported models is the Kozlowski, Gully, Nason, and Smith (1999) Team Compilation Model. This model proposes that teams develop through engaging in team formation, task compilation, role compilation, and team compilation. Each of these phases depicts a fundamentally stage of developing team and task norms. It follows that the team states and behaviors will manifest differently depending upon the team's stage of development. Accordingly, future research should embrace a longitudinal perspective regarding how the degree to which virtuality shapes team interactions changes over time.

Findings from the present study would also suggest that the manner in which team virtuality is studied maintains a marked difference in how the impact of virtuality is manifested. Field studies have typically been centered upon subjective perceptions of how much a given individual relies on certain forms of virtual communication tools over others. Lab studies, on the other hand, have typically constrained individuals to interacting via one principal means of communication. Therefore, lab studies likely assess the manner in which certain tools impact team functioning regardless of preference or technological expertise; however, field studies tap into the extent to which individuals prefer to use certain tools to others. This opens up multiple avenues for future research. For instance, what factors impact an individual's choice to use certain communication tools? What role does this preference play in shaped team emergent states and behavioral

processes? Do individuals vary in terms of their perceptions of virtuality? Addressing these questions will provide a more comprehensive depiction of how the impact of virtuality is shaped.

Lastly, the investigation of virtuality should also be extended to multiteam system (MTS) research. MTSs are defined as "two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals" (Mathieu, Marks, & Zaccaro, 2001, p. 290). A principle focus of this literature is the manner in which between team states and processes differ from within team processes (Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005). Therefore, an interesting research avenue would be how virtuality shapes between team compared to within team states. It would also likely be highly fruitful to investigate which communication tools members choose to implement in between team communication versus within team communication.

Conclusion

Olson et al. (2002) posited, "In spite of all the new ways to connect remote teams – e-mail, chat, videoconferencing, shared whiteboards, and the others – it is still the case that there is nothing quite so humanly effective collocated" (p. 113). Just ten years later, the present study demonstrates that while certain aspects of virtual tool use fundamentally alter the manner in which team members interact, virtuality may not be as detrimental to team functioning as initially thought. However, as the demands of the workplace change, so to must the scope of future research in this field. In order to capture the increasing complexity of teamwork in today's organizations, we must further our understanding of

not only how different combinations of virtual tools shape team interactions, but also how these interactions manifest as teams develop over time.

APPENDIX A

PARTICIPANT INSTRUCTION FORM FOR Q SORT VALIDATION

TASK

You have received a spreadsheet containing a list of eight communication tools. These tools represent eight different ways teams communicate in the workplace. Below is an explanation of each of the tools:

- Face-to-Face Interaction
- E-mail
- Chat/IM
- Teleconference
- Videoconference
- Textual Information (list serves; informational databases)
- Group Decision Support System (typically contain chat, whiteboard, and file sharing capabilities)

Please place each virtual tool into one of three virtuality categories by indicating 1, 2, or 3 in the attached spreadsheet. When completing these ratings, please consider your own experience with using these tools.

The virtuality categories are defined as:

1) Face-to-Face Interaction

- Colocated (e.g. located in the same place)
- No/rare use of virtual tools
- Synchronous communication

2) Low Virtuality

- Closely mimics face-to-face interaction
- Very short delay in communication (if any)
- High capacity to transmit interpersonal subtleties (e.g. verbal content, tone, facial expressions)

3) High Virtuality

- Typically delayed sending and receiving of information
- Less closely mimics face-to-face interaction
- Low capacity to communicate interpersonal subtleties (e.g. facial expressions, verbal content, tone etc.)
- Less ability to ensure others have understood what you've said

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