Special Issue

Hype or Help? A Longitudinal Field Study of Virtual World Use for Team Collaboration

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Abstract

Despite increasing organizational interest and investment in virtual worlds (VWs), there is a lack of research on the benefits of VWs. When and how does the use of VW systems engender better organizational outcomes than traditional collaborative technologies? This paper investigates the value of VWs for team collaboration. Team collaboration is particularly relevant in studying VWs given the rich interactive nature of VWs and an increasing organizational reliance on virtual teamwork. To understand the value of VW use for team collaboration, we examine the relationship between a team's disposition toward IT, their general disposition (personality) and VW use in influencing team cohesion and performance. We conducted a field study that compares two collaborative technology systems – one that is based on a traditional desktop metaphor and one that is grounded in the principles of a virtual world. We tracked the use of the systems for one year. We analyzed data at the team level and the results generally support our model, with agreeableness, conscientiousness, extraversion, openness, and computer self-efficacy interacting with time and technology type to positively influence team technology use. We also found that the use of the virtual world system positively influenced the relationship between technology use and team cohesion, which, in turn, predicts team performance. The model explains 57 percent, 21 percent, and 24 percent of the variance in team technology use, team cohesion, and team performance, respectively.

Keywords: Virtual Worlds, Team Collaboration, Cohesion, Personality, Disposition, Computer Self-Efficacy, Personal Innovativeness in IT, Computer Playfulness.

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1. Introduction

In recent years, excitement has arisen over the use of virtual worlds in organizations. Virtual worlds (VWs) are multi-dimensional, computer-mediated "spaces" in which users interact with each other and the virtual environment by way of a graphical representation of themselves (called "avatars") (Hendaoui, Limayem, & Thompson, 2008). The Gartner Group (2007) estimates that as much as 80 percent of Fortune 500 companies will have a presence in a VW by 2011. The growing investments in VWs reflects this growing interest. In 2009, $1.38 billion was invested worldwide in over 87 companies with virtual goods (Sherman, 2009). Despite this growing interest and investment, evidence for the organizational benefits of VWs is sorely lacking. Organizations have yet to see a return on investment in VWs (Terdiman, 2010), and some organizations have ceased their VW projects, including Google's Lively (Google, 2008) and Oracle's Darkstar (Takahashi, 2010) projects, because of concern about insufficient evidence for VWs' value. "Nine out of ten business forays into virtual worlds fail within 18 months but their impact on organizations could be as big as that of the Internet" (Gartner Group, 2008, p. 1). Indeed, organizations continue to invest resources into VWs based on the promise that they represent the next evolution in social media. Fortune 500 companies represented in VWs include Walmart, Proctor & Gamble, IBM, and Cisco Systems. The U.S. Government, along with many of its agencies, such as the Centers for Disease Control and Prevention, the Department of Homeland Security, and the National Science Foundation, has also established a presence in VWs (Pellerin, 2007). Given the uncertainty surrounding the benefit of VWs for businesses, it behooves researchers to explore the potential applications and downstream outcomes of VW use in the organizational setting.

VWs are different from previous communication media because they afford users a stronger sense of presence by providing three-dimensional (3D) representation through avatars, relatively complex movement (such as hand gestures and facial expression), and synchronous voice transmission. This sense of presence has been found to be an important aspect of immersive engagement with a technology (Coelho, Tichon, Hine, & Wallis, 2006). Presence is the "perceptual illusion of nonmediation" that occurs when the communication medium is no longer acknowledged or perceived by the user—that is, they "feel like they are there" with their communication partners (Lombard & Ditton, 1997). Research has linked this sense of presence to behavioral outcomes. For instance, Yee and Bailenson (2007) found that participants assigned to more attractive avatars engaged in greater self-disclosure, whereas those assigned to taller avatars behaved more confidently in a negotiation task. VWs have also been found to increase learning (Suh & Lee, 2005), notably group-oriented learning, sense of group presence, and process engagement (Franceschi, Lee, Zanakis, & Hinds, 2009). In light of this prior research, we explore the use of VWs in a group-oriented setting that is particularly relevant to the business context – that is, team collaboration. VWs are noted for their rich interactive facilities and devoted user communities (Franceschi et al., 2009), and research shows that they can influence group processes. However, a clear gap exists in our understanding of how organizations can leverage these benefits to help foster teamwork. Despite growing interest and investment in VWs, we lack an understanding of the factors impacting its use and the effects on interpersonal interaction in organizational teams. To evaluate the potential value of VWs for organizations, we need to better understand the antecedents of VW use and the resulting impact of VW use on team performance. By doing so, we will advance our understanding of the use of VW technologies and its influence on team collaboration.

To address these gaps in the literature, we examine the role of VWs in the context of organizational team performance by integrating the literature on teams, personality, and technology design. Specifically, we explore the dispositional factors that may contribute to VW use and the downstream effects on team collaboration. Because the purported "value-add" of VWs are the unique benefits it affords interpersonal interaction, we examine the impact of VW use on team cohesion. Team cohesion has been established as an important predictor of team performance (Evans & Dion, 1991; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000; Warkentin, Sayeed, & Hightower, 1997) and team member satisfaction – particularly in computer-mediated collaborations (Chidambaram, 1996; Warkentin et al., 1997). Thus, it represents a theoretically well-suited aspect of team interaction

that can be useful in understanding the role of technology in team performance. Dispositional factors should also be useful in understanding the role of technology in team performance. Prior research has demonstrated that dispositional factors – both personality and specific dispositions toward a particular activity – are important drivers of behavior. In the management literature, a renewed focus on the "big five" or five factor model of personality (FFM) – that is, agreeableness, conscientiousness, extraversion, neuroticism, and openness to experience – has found that these personality traits are associated with a wide array of organizational processes, behaviors, and outcomes (Barrick & Mount, 1991; Barrick, Mount, & Judge, 2001; Bono & Judge, 2004; Judge, Heller, & Mount, 2002). Additionally, recent work in the information systems (IS) literature has found support for the FFM predicting technology acceptance and use (Devaraj, Easley, & Crant, 2008; McElroy, Hendrickson, Townsend, & DeMarie, 2007), with calls for research linking personality to the use of information technology (IT) in team settings (Devaraj et al., 2008). Other work in the IS literature points to the importance of IT-specific dispositions, including computer self-efficacy (Compeau & Higgins, 1995), personal innovativeness with IT (Agarwal & Prasad, 1998b), and computer playfulness (Webster & Martocchio, 1992), in driving the adoption and use of IT. Research has found that these dispositions toward IT can induce cognitive absorption, which is similar to the experience of flow (Agarwal & Karahanna, 2000). Flow is believed to be particularly important in driving the adoption of immersive technologies, such as VWs (Holsapple & Wu, 2007; Hsu & Lu, 2004).

This research examines the role of VWs in facilitating team performance. To do this, we explore the dispositional antecedents and downstream consequences of VW use in teams. As such, we:

(1) developed a model of the dispositional factors – both general and IT-specific – that contribute to team technology use to understand how these relationships are affected over time by the technology design; and

(2) empirically tested the model in a year-long longitudinal field study using two collaborative systems – one based on a traditional desktop metaphor and the other on a virtual world metaphor.

We leveraged the literature on teams, personality, and technology design to build a model that predicts team performance by way of individual differences, VW use over time, and team cohesion. Using one of two collaborative technology systems, we conducted a year-long field study of 91 teams to test the model. This research contributes to the literature in three important ways. First, it contributes to the literature on VWs by clarifying the dispositional factors that influence the adoption of VW systems. Understanding this process can better assist researchers who seek to explain and predict the factors that result in successful organizational initiatives that involve VWs. Researchers must keep pace with these new social media and explore the varied and nuanced effects they have on interpersonal relationships if we are to offer meaningful prescriptions to practitioners. Second, it contributes to the literature on technology-enabled teamwork by exploring the antecedents of team cohesion, which includes the use of particular technologies. This exploration situates the IT artifact firmly in the center of our understanding of team collaboration. Such an approach broadens our understanding of how technology-enabled teams are affected by the communication technologies on which they rely. Third, it contributes to the IS literature on the capabilities of collaborative systems by extending prior research on design and use over time (Carte & Chidambaram, 2004; Maruping & Agarwal, 2004).

2. Theoretical Foundation

2.1. Virtual Worlds

VWs have captured researchers' interest in recent years because they bring greater verisimilitude to technology-mediated interaction. VWs represent a technology in need of further exploration by IS researchers because they embody unique characteristics that have been shown to influence user behavior (Walsh & Pawlowski, 2002). These characteristics include greater immersiveness, media richness, interactivity, and sense of presence (Suh & Lee, 2005; Walsh & Pawlowski, 2002). For example, virtual environments facilitate a much richer sense of presence by providing users with

synchronous voice transmission and a bodily representation through their avatar,. This sense of presence has been found to be an important aspect of immersive engagement with a technology (Coelho et al., 2006). Further, both immersion and presence have been found to be predictors of task performance and to contribute to positive intragroup relationships (Slater, Linakis, Usoh, Kooper, & Street, 1996; Slater, Sadagic, Usoh, & Schroeder, 2000). Moreover, while further research is needed to investigate the relationship between VW characteristics and team outcomes, some early progress provides insight into the rich capabilities that VWs afford. For example, Schroeder et al. (2001) found that team performance was equivalent across teams that used a virtual environment and teams that met face-to-face compared with the more poorly performing teams that used a less-immersive, desktop-based environment. Such findings suggest that VWs are capable of providing an environment that effectively simulates interaction in the real world.

While still in its nascent stages, extant research offers some insight into the impact of VWs. Research on VWs has primarily investigated individual and intra-individual behaviors, especially in the context of virtual learning environments, with little research at the team level. However, research at the individual level has important implications for organizations (Jäkälä & Pekkola, 2007). Research has found that individuals interacting in virtual environments report feeling more comfortable expressing themselves (Kim, 2000). Similarly, a recent study showed that avatar realism increased individuals' willingness to share information with others (Bailenson, Yee, Merget, & Schroeder, 2006). Information sharing and disclosure are behaviors critical to both teamwork and organizational performance, especially in a virtual context that lacks sustained personal contact (Rafaeli & Ravid, 2003). At the team level, research has showed that VW use leads to higher group-oriented learning and process engagement (Franceschi et al., 2009; Jarmon, Traphagan, & Mayrath, 2008), in addition to spontaneous and opportunistic conversations that are integral to building more intimate social connections (Meyer & Swatman, 2009). VWs have also been found to interact with leadership style to influence perceptions of support from leaders, which leads to higher group cohesion and group efficacy (Huang, Jestice, & Kahai, 2009).

2.2. Team Cohesion

We define team cohesion as "the resultant of all the forces acting on the members to remain in the group" (Festinger, 1950, p. 274). Research shows cohesion to be an important determinant of team performance (Evans & Dion, 1991; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000; Warkentin et al., 1997) and team member satisfaction (Chidambaram, 1996; Warkentin et al., 1997). Cohesion improves team performance by increasing the team's commitment to the task and increasing individuals' efforts toward success (Hackman & Vidmar, 1970). Interestingly, technology-mediated teams are found to initially report lower levels of cohesiveness, but research finds that they are capable of exchanging enough information over time to develop strong levels of cohesion and social integration (Chidambaram, 1996; Chidambaram & Bostrom, 1993; Harrison, Price, Gavin, & Florey, 2002; Walther, 1995). However, this is not to say that developing cohesion is as easy for technology-mediated teams as it is for those who meet face-to-face. Because technology-mediated teams sometimes work apart from one another, they have fewer opportunities for informal communication. Research shows that these teams are less likely to share personal information and communicate informally, behaviors linked to bonding and cohesion (Lebie, Rhoades, & McGrath, 1996).

Although the impact of VW use on team collaboration remains unclear, research on media richness may shed some light on how VW use impacts team cohesion. For example, Hambley, O'Neill, and Kline (2007) found that technologies higher in media richness contribute to greater cohesiveness. In their study, teams using a symbol-rich video-conferencing system employed a more constructive team interaction style and thus had higher levels of cohesion compared to teams using a leaner, text-based chat system. Other studies have found similar results (Straus & McGrath, 1994; Warkentin et al., 1997), with the underlying theory that communication technologies that more closely approximate face-to-face interaction evoke behaviors that are germane to in-person interaction (O'Conaill, Whittaker, & Wilbur, 1993).

2.3. Disposition: General and IT-Specific Traits

Extant research has acknowledged the lack of and need to study individual disposition, both personality and IT-specific traits, in the context of both IT use and technology-mediated teamwork (Devaraj et al., 2008; Holton, 2001; McElroy et al., 2007; Thatcher & Perrewe, 2002). Individuals' attitudes, beliefs and cognitions with respect to technology are, in part, determined by their personality. Personality is defined as "a dynamic and organized set of characteristics possessed by a person that uniquely influences his or her cognitions, motivations and behaviors in various situations" (Ryckman, 2004, p. 5). Although there are many conceptualizations of specific personality traits, one of the most widely-used is the FFM (Ajzen, 2005). The FFM consists of five broad, superordinate traits that constitute personality: Agreeableness, defined by characteristics such as cooperative, good-natured, and trustful; conscientiousness, defined by characteristics such as orderly, responsible, and dependable; extraversion, defined by characteristics such as talkative, assertive, and energetic; neuroticism, defined by characteristics such as anxiety, hostility, and impulsiveness; and openness to experience, defined by characteristics such as intellectual, imaginative, and independent-minded (John & Srivastava, 1999). Numerous researchers have used these traits togetheras predictors of outcomes in a wide variety of fields, including psychology, organizational behavior, and IS (Barrick & Mount, 1991; Barrick et al., 2001; Devaraj et al., 2008; Digman, 1990; John & Srivastava, 1999; McElroy et al., 2007).

In IS research, personality has been integrated with several models to predict various outcomes, such as adoption intention (Devaraj et al., 2008), Internet use (McElroy et al., 2007), computer anxiety (Thatcher & Perrewe, 2002), and systems-related social networks (Sykes, Venkatesh, & Johnson, 2007). For example, Devaraj et al. (2008) integrated the FFM with the well-established technology acceptance model (TAM). He observed that the relationship between perceived usefulness and intention to use a technology was stronger for people who were more agreeable, conscientious, and extraverted, and that the relationship between subjective norms and intention was stronger for those who were more agreeable and extraverted. Other research by McElroy et al. (2007) found that personality – and not cognitive style – predicted Internet use, with openness to experience positively influencing general Internet use and neuroticism positively influencing buying and selling online.

In addition to general personality, we examine IT-specific variables. IS researchers have explored a variety of variables related to an individual's interaction with IT, including computer playfulness, computer self-efficacy, personal innovativeness with IT, computer anxiety, and cognitive absorption (for a review, see Sun & Zhang, 2006) – of these, we focus on computer self-efficacy (CSE), personal innovativeness with technology (PIIT), and computer playfulness (CP). We define CSE as the an individual's judgment of their own capability to use a computer (Compeau & Higgins, 1995, p. 192). We define PIIT as "the willingness of an individual to try out any new information technology" (Agarwal & Prasad, 1998b, p. 206). And we define CP as "the degree of cognitive spontaneity in microcomputer interactions" (Webster & Martocchio, 1992, p. 204). We chose these specific variables for three primary reasons.

First, they represent enduring dispositions and thus are in line with our focus on traits, which are enduring characteristics that are relatively stable across situational stimuli. Traits are often contrasted with states, which refer to affective or cognitive responses to situational stimuli and are likely to change over time (Webster & Martocchio, 1992). Thus, traits should have a lasting and noticeable impact on team interaction. Although prior literature has clearly defined PIIT and CP as traits in prior literature (Sun & Zhang, 2006), recent research acknowledges that CSE has been considered both as a state and a trait (Claggett & Goodhue, 2011). In keeping with the original conceptualization (Compeau & Higgins, 1995) that traces its definition to the work of Bandura (1997), we treat CSE as a trait.

Second, we selected CSE, PIIT, and CP as key IT-specific traits due to the weight of their influence on technology acceptance in extant IS research. Each of these variables are found to positively influence technology adoption (Agarwal & Prasad, 1998b; Thatcher, Loughry, Lim, & McKnight, 2007; Venkatesh, 2000), in part because they help to reduce computer-related anxiety and boost intrinsic

motivation (Agarwal & Prasad, 1998b; Venkatesh, 2000; Webster & Martocchio, 1992), which results in greater persistence during system learning and use (Venkatesh, 1999; Venkatesh & Speier, 1999).

Third, we chose these variables because they are traits from technology adoption papers that are among the most highly cited (Agarwal & Karahanna, 2000; Venkatesh, 2000) and thus represent variables that are of considerable interest to IS researchers.

2.4. Time

The importance of time in the development of organizational theory as a means to enrich theory and explain behavior has received increasing attention (Ancona, Goodman, Lawrence, & Tushman, 2001; George & Jones, 2000). Although there are several ways to conceptualize time, prior IS research has considered three manifestations: (1) anticipation of a target behavior (distal versus proximal), (2) the amount of experience with the target behavior, and (3) how often the behavior is performed (episodic versus repeated) (Venkatesh, Maruping, & Brown, 2006). We conceptualize time here as the amount of experience with the target system, which is in line with the second manifestation listed above (see Venkatesh, Morris, Davis, & Davis, 2003). Research on the role of time in shaping individuals' behavior emphasizes a strong connection between past and present behaviors because present behavior is based on prior experience performing it (George & Jones, 2000). This is borne out in research that finds that experience with a technology strengthens the relationship between behavioral intention and technology use (Venkatesh et al., 2006). Further, with increasing experience, an individual's cognitions and attitudes are more predictive of behavioral intention to use the system compared with subjective norms (Karahanna, Straub, & Chervany, 1999). Each cumulative behavior reveals new information about the necessary requirements of the behavior, which reduces uncertainty and reinforces the behavior. Thus, in the hypotheses development below, we theorize about how the relationship between general and IT-specific dispositions and team technology use are affected by the nature of system in use and how this is reinforced over time – that is, with increasing experience using the system.

3. Hypotheses Development

Before discussing the hypotheses, we note some boundaries of our model. First, we do not hypothesize relationships between general and IT-specific dispositions. There is some preliminary evidence that general dispositions influence IT-specific dispositions. For example, openness to experience has been linked to PIIT and CP (Nov & Ye, 2008; Woszczynski, Roth, & Segars, 2002), and neuroticism has been shown to influence PIIT (Davis, Lee, & Yi, 2007) and CSE (Thatcher & Perrewe, 2002). However, our interest lies in exploring how these dispositions interact with technology type to influence team technology use and team cohesion, and not in how they interact with and influence each other. Thus, for the sake of model parsimony and a sharper focus on the outcomes of interest, we examine the direct effects of general and IT-specific dispositions on team technology use, as well as their interaction with technology type. Second, research shows that studying situation-specific dispositions yields better predictive validity than generalized or abstract dispositions (e.g., Bem, 1970; Goldsmith & Hofacker, 1991; Leonard-Barton & Deschamps, 1988). This raises the question: Why not exclusively study IT-specific dispositions? General dispositions are studied because they are theoretically important to the context of teams and they capture aspects of individual differences that are not captured by IT-specific dispositions. We examine both general dispositions and IT-specific variables because, together, they capture two important elements underlying team technology use: inclinations toward one's wider environment, which includes other people, and inclinations toward IT. Figure 1 shows the research model.

3.1. General Dispositions

Agreeableness is expected to positively influence team technology use. A recent meta-analysis of personality research suggests that agreeableness has strong predictive validity in team-oriented settings and situations that require cooperation and helping behaviors. In addition, agreeable individuals are more likely to focus on the positive aspects of a collaborative experience (Devaraj et al., 2008), which thus leads to greater acceptance and use of the technology. Although not the

strongest predictor of an individual's intention to use a technology, agreeableness certainly plays a role, especially when moderated by other variables (e.g., Venkatesh & Morris, 2000). This mechanism is likely to underlie the behavior of agreeable individuals, who are more sensitive to the thoughts and opinions of others (John & Srivastava, 1999).
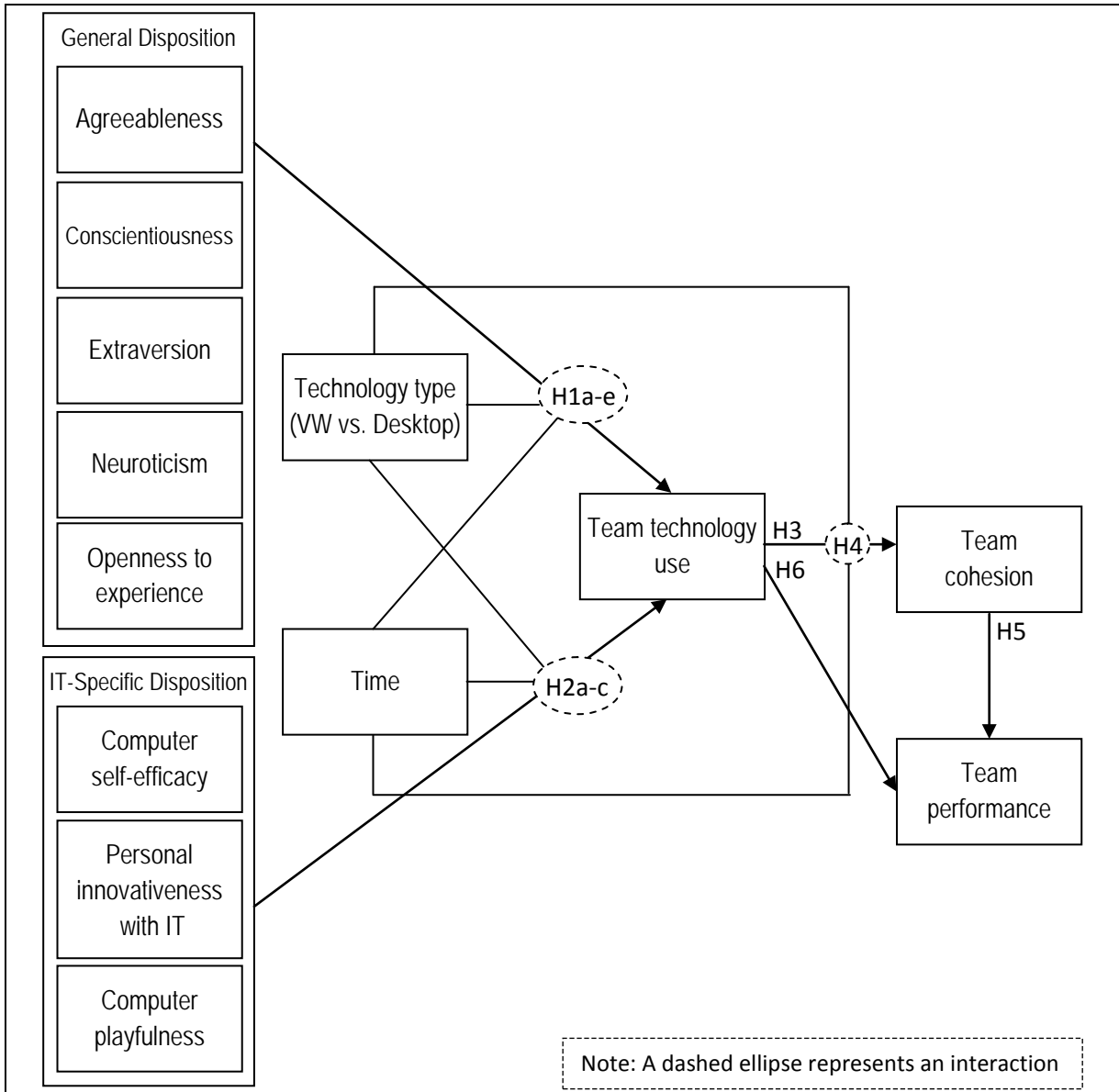
Figure 1. Research Model

A VW system's availability is expected to strengthen the relationship between agreeableness and team technology use. Research shows that, due to a heightened sense of presence and immersion in the VW technology, social pressure is stronger than it would be when using a leaner communication medium (Blascovich, 2002). Richer communication media are capable of transmitting more cues that can be used to exert influence (e.g., tone of voice, spatial proximity, member status), which enables more avenues for communicating social pressure. Because agreeable individuals are driven by social conformity and their desire to maintain a positive social climate, they will be more affected by the stronger social pressures inherent in VWs. Thus, the use of VWs should have a stronger influence on agreeable individuals' use of the team technology.

Time is expected to reinforce this effect. Consistent with the social identity approach (Turner, 1991), research shows that, over time, group norms and pressures to conform increase as prototypical patterns of communication emerge and a group identity is established (Postmes, Spears, & Lea, 2000). Because agreeable individuals are particularly sensitive to group norms, time should strengthen the relationship between agreeableness and team technology use. This effect will be particularly strong for those teams using VW technologies due to the heightened sense of social pressure. Thus, we hypothesize:

> **H1a:** *Technology type and time will moderate the positive relationship between agreeableness and team technology use; for those teams that are high in agreeableness, the strength of the relationship will increase with a VW system's availability and over time.*

Conscientiousness is expected to positively influence team technology use. Psychologists have described two aspects of conscientiousness – that is, responsibility and volition (Barrick et al., 2001). Volition involves willpower and describes individuals who are driven by a need to achieve, are self-disciplined, and are persevering. For these reasons, conscientious individuals are more likely to be workaholics (Clark, Livesley, Schroeder, & Irish, 1996) and expend a great deal of effort in pursuit of a performance goal (Barrick, Stewart, & Piotrowski, 2002). Collaborative technologies enable individuals to work regardless of time or physical location, which caters to the conscientious individual's tendency to maintain a higher workload. Thus, to the extent that the team's collaborative technology represents a tool to enable communication, knowledge sharing, and collaboration, conscientious individuals will likely embrace the use of such technologies so that their team will perform better. Indeed, research finds that teams that score high in conscientiousness are more concerned with the success of the team (Zander & Forward, 1968). In terms of dependability or responsibility, conscientious individuals are more attentive to and feel a stronger obligation to uphold social contracts, such as work arrangements (Barrick et al., 2001). This is likely to encourage the use of collaborative technology because it allows members to actively participate in distributed tasks by way of monitoring others' work, overseeing progress toward goals, and organizing the exchange of work in an efficient way. This enables conscientious individuals to manage their contributions and the contributions of others.

Availability of a VW technology is expected to strengthen the relationship between conscientiousness and team technology use. People who are highly conscientious are more likely to carefully consider the ways in which the use of a technology can help them to perform their work more effectively (Devaraj et al., 2008). As richer communication media, VWs have a higher degree of immediacy of feedback (i.e., synchronicity), support for multiple communication cues and language variety (i.e., video, text, voice) and parallelism (i.e., multiple simultaneous conversations) (Dennis, Fuller, & Valacich, 2008). Conscientious individuals are more likely to view these attributes of a VW positively because they help them to communicate more efficiently and effectively with their teammates. Additionally, as mentioned, conscientious individuals are more attentive to social pressure and feel a stronger obligation to uphold social contracts (Barrick et al., 2001). Because social pressure is stronger in a richer communication environment (Blascovich, 2002), a VW system is likely to increase conscientious individuals' use of the collaborative system. Conscientious individuals may view relationship building as a necessary aspect of teamwork that contributes to knowledge sharing, productivit,y and efficiency, and thus should be driven to use the system to attain these results. This view is in line with research that finds conscientious individuals engage in more cooperative and helping behaviors compared to those who are lower in conscientiousness, which results in less social loafing and free riding (Morgeson, Reider, & Campion, 2005).

Time is expected to reinforce judgments about the value of VW technologies for enhancing collaboration and performance. Research shows that, over time, attitudes toward a technology are governed almost solely by instrumentality beliefs (Karahanna et al., 1999) and that early perceptions are a significant determinant of later beliefs (e.g., Nickerson, 1998; Tversky & Kahneman, 2000). Due to early beliefs about the value of VWs influencing later beliefs, we expect that, over time, the use of VW technologies will strengthen the relationship between conscientiousness and team technology

use. Furthermore, because conscientious individuals are performance-driven (Barrick et al., 2001; Barrick et al., 2002), they are more likely to be motivated by the need and desire to build positive relationships with their teammates to facilitate smooth and efficient performance. Over time, this may become more critical as teams increase their reliance on one another, which results in an increased need to use the VW system. Thus, we hypothesize:

> **H1b:** *Technology type and time will moderate the positive relationship between conscientiousness and team technology use; for those teams that are high in conscientiousness, the strength of the relationship will increase with a VW system's availability and over time.*

Extraversion is expected to negatively influence team technology use. Extraverts are highly sociable and derive pleasure and energy from interacting with others (Digman, 1990). Computer-mediated communication generally constrains interpersonal interaction by filtering out certain verbal and non-verbal cues (Walther, 1995). This is likely to frustrate extraverts, who are lively and highly animated (Wiggins, 1996), by suppressing their natural communication preferences. Indeed, research suggests that, compared with introverts, extraverts prefer face-to-face interaction, spend less time, and are less likely to perceive a sense of presence in a virtual environment (Hertel, Schroer, Batinic, & Naumann, 2008; Landers & Lounsbury, 2006; Sas, O'Hare, & Reilly, 2004). Other research examining different types of Internet use, which include information searching and social and leisure activities, suggests that extraverts use the Internet for leisure activities, but tend not to use it for social activities (Hamburger & Ben-Artzi, 2000).

A VW technology's availability is expected to weaken the relationship between extraversion and team technology use, which thereby increases the likelihood that extraverts will use the system. Compared to traditional collaborative systems, a VW represents a richer communication medium because it offers immediate feedback or synchronicity, a greater number of cues and channels, variety in language, and a greater focus on the recipient of a message (see Daft & Lengel, 1986). By providing multiple modalities for exchange, VWs more closely approximate face-to-face interaction and should be less likely to constrain the communication preferences of extraverts. Indeed, research shows that, compared to introverts, extraverts prefer communication media with high levels of richness (Hertel et al., 2008) and achieve higher performance than do introverts when using a rich collaborative environment (Sas et al., 2004). In addition to multi-modality, VWs offer users a greater sense of immersion and presence (Suh & Lee, 2005; Walsh & Pawlowski, 2002). This should be particularly attractive to extraverts, who enjoy higher levels of stimulation, interactivity, and engagement with others (Hertel et al., 2008).

Time is expected to reinforce the impact of VW technologies on the relationship between extraversion and team technology use. We can explain extraversion and time using social networks as a theoretical lens. Extraverts are particularly interested in social relationships and their social relationships develop over time. Teams represent a social network of actors who share information and advice, develop friendships, and assist other members (Kilduff & Tsai, 2003). Because they place a high value on interpersonal relationships, extraverts work to establish ties and bridge gaps so that they become a central player in the team's social network. Research finds that extraverts do tend to occupy central positions in team networks and thus often emerge as informal team leaders (Neubert & Taggar, 2004). Because social networks are built on communication, the team's collaborative technology represents an important tool through which extraverts can influence their social network. Thus, over time, extraverts are likely to leverage the capabilities of a VW technology to shape and reinforce their image and role as a central member of the team. To maintain this position in the team, extraverts are likely to use the VW technology because it suits their communication preferences and facilitates the display of their central network position. Thus, we hypothesize:

> **H1c:** *Technology type and time will moderate the negative relationship between extraversion and team technology use; for those teams that are high in extraversion, the strength of the relationship will decrease with a VW system's availability and over time.*

Neuroticism is expected to negatively influence team technology use. People with neurotic personalities exhibit emotional instability and have tendencies toward negative affectivity (Digman, 1990). Thus, they are likely to negatively view technology and unfavourably view the use of technology when interacting with others because the use of technology in a team setting allows others an opportunity to monitor one's work and observe one's work habits. This is problematic for neurotic individuals because they tend to be more insecure and have a higher need for privacy and control (Tuten & Bosnjak, 2001). Research also shows that neurotic individuals have lower perceptions of technology's usefulness (Devaraj et al., 2008) and tend to use Internet technologies less than those who have higher emotional stability (Tuten & Bosnjak, 2001). Further, due to their inherent mistrust of others, they then limit the amount of information they exchange online, and thus believe that they receive less social support (Swickert, Hittner, Harris, & Herring, 2002).

A VW technology's availability is expected to strengthen this relationship between neuroticism and team technology use. Research finds that neurotic individuals prefer leaner communication media (Hertel et al., 2008). VW systems represent a richer technology, which include support for synchronous interaction and a greater number of communication channels (i.e., audio, video, text). Neurotic individuals should avoid technologies with such capabilities because synchronicity and multiple channels decrease the amount of control over an exchange. Asynchronicity provides more control because it allows individuals to analyze the situation in a safe and non-threatening atmosphere, which facilitates opportunities to carefully compose and rehearse messages (Maruping & Agarwal, 2004; Walther, 1996). This is important for neurotic individuals because they have a more difficult time managing stressful situations (McElroy et al., 2007). Fewer channels result in greater control over others' perceptions and protect neurotic individuals from the experience of negative or disparaging feedback from others (Stritzke, Nguyen, & Durkin, 2004).

Time is expected to reinforce tendencies to avoid VW use because early attitudes about the technology influence later behaviors (Nickerson, 1998; Tversky & Kahneman, 2000). Neurotic individuals are more likely to experience negative moods (Costa & McCrae, 1980), and negative moods during the early stages of technology use are known to have persistent, long-term negative effects on both intrinsic motivation and intention to use a technology (Venkatesh & Speier, 1999). In turn, the negative moods frequently experienced by neurotic individuals will have long-term effects on their attitudes toward the use of VWs. Thus, we hypothesize:

> **H1d:** *Technology type and time will moderate the negative relationship between neuroticism and team technology use; for those teams that are high in neuroticism, the strength of the relationship will increase with a VW system's availability and over time.*

Openness to experience is expected to positively influence team technology use. Individuals with a high degree of openness exhibit flexibility of thought and a willingness to embrace different ways of thinking because they value the stimulation brought about by a variety of experiences (McCrae & Costa, 1997). Rapid and evolving change is an enduring aspect of technology due to constant innovation and updates that aim to improve efficiency. Thus, individuals who are more open to new experiences should value the opportunity to explore technologies and adapt to their constantly changing structures. Extensive prior research has established that perceived usefulness and perceived ease of use are the *de facto* predictors of an individual's intention to use a technology and that most other variables operate through their impact on these constructs (see Venkatesh et al., 2003). However, recent research has challenged this by finding that openness to experience has a direct impact on intention to use a technology (Devaraj et al., 2008). Unlike the other four personality dimensions, the impact of openness on an individual's intention to use a technology is not mediated by perceived usefulness or perceived ease of use. This illustrates the strength of this particular personality trait in influencing technology use behavior, the power of curiosity, and the need for experimentation in motivating use. Other research that has found that openness to experience directly influences Internet use (McElroy et al., 2007; Swickert et al., 2002; Tuten & Bosnjak, 2001).

A VW technology's availability should strengthen the relationship between openness to experience and team technology use. Unlike traditional collaborative software, VWs present an opportunity to explore a much richer environment that is more responsive to user input and manipulation (Franceschi et al., 2009; Suh & Lee, 2005). The ability to manipulate one's environment and appearance allows individuals to experiment with the "digital world" in a way that is not possible with other tools: They can explore new ways of interacting with others, presenting themselves, and presenting information and ideas. For example, VW technologies facilitate simulations, models, and artifacts to be created and modified quickly, which enables users to learn by changing the boundaries and attributes of their creations in the VW (Bartle, 2003). This should appeal to the creativity and curiosity of open individuals. Further, VWs often incorporate elements of play and fantasy into their design (Bartle, 2003), which should appeal to the imaginativeness of open individuals and their tendency to seek out various forms of adventure.

Time is expected to strengthen the relationship between openness to experience and team technology use. With increasing experience using a technology, individuals can identify different opportunities for exploration and extension of its use, and become more reliant and involved in the pleasurable experience of using the technology, thus increasing use. Research shows that cognitive absorption influences intention to explore the technology in later stages of use (Magni, Taylor, & Venkatesh, 2010). VWs provide more opportunities for experimentation and creative engagement, thus providing a variety of opportunities for exploration. Thus, we hypothesize:

> **H1e:** *Technology type and time will moderate the positive relationship between openness to experience and team technology use; for those teams that are high in openness to experience, the strength of the relationship will increase with a VW system's availability and over time.*

3.2. IT-Specific Dispositions

Computer self-efficacy (CSE) is expected to positively influence team technology use. Extant research has demonstrated the link between CSE and use of a variety of technologies. CSE is linked to greater technology use both directly (Compeau & Higgins, 1995; Yi & Hwang, 2003) and indirectly through its influence on heightened enjoyment, lower computer anxiety (Compeau & Higgins, 1995), and higher perceptions of ease of use (Agarwal & Karahanna, 2000; Agarwal, Sambamurthy, & Stair, 2000; Lewis, Agarwal, & Sambamurthy, 2003; Venkatesh & Davis, 1996). Based on this body of research, we expect CSE to lead to greater team technology use.

The availability of a VW system is expected to strengthen the relationship between CSE and team technology use. Bandura's (1997) extensive work on self-efficacy shows that individuals rely on their state of emotional arousal in forming attitudes about their level of anxiety and stress. Thus, emotional arousal is a key source of information through which self-efficacy functions. This is demonstrated in Compeau and Higgins' (1995) work that shows that positive affect (enjoyment) helps to explain the relationship between CSE and use. VWs' support for hedonic elements of play and fantasy, as well as interactivity, presence, and immersion (Hendaoui et al., 2008; Holsapple & Wu, 2007; Suh & Lee, 2005) support an environment that should be more conducive to positive feelings of enjoyment. In addition, the ability to manipulate one's environment, control self-presentation, and transmit more social cues (Bartle, 2003) should afford users a stronger perception of control over their interactions with others, which reduces feelings of anxiety that may interfere with the CSE-use relationship. In sum, these a VW capabilities should strengthen the relationship between CSE and team technology use by contributing to feelings of enjoyment and perceptions of control.

Time is expected to positively influence the relationship between CSE and team technology use when a VW system is available. Prior research shows that CSE can increase over time with greater experience using a system (Venkatesh & Davis, 1996), which leads to increased use. Further, over time, enjoyment using the system becomes a more important determinant of ease of use, a key predictor of behavioral intention to use a technology (Venkatesh, 2000). Because enjoyment becomes more important over time, and because CSE and enjoyment are tightly coupled (Compeau

& Higgins, 1995; Yi & Hwang, 2003), experiencing a more enjoyable system should bolster the positive relationship between CSE and team technology use, and thus lead to a stronger relationship over time. Thus, we hypothesize:

H2a: *Technology type and time will moderate the positive relationship between computer self-efficacy and team technology use; for those teams that are high in computer self-efficacy, the strength of the relationship will increase with a VW system's availability and over time.*

PIIT is expected to positively impact team technology use. Individuals who score higher on PIIT are more likely to accept risk associated with using a technology (Agarwal & Prasad, 1998b). Thus, they are exposed to more opportunities to use the system because they have a higher tolerance for the uncertainty associated with its use. This should result in greater team technology use by those who are high in PIIT. PIIT has been shown to influence intention to use technology through a variety of factors, including perceived ease of use (Davis et al., 2007; Lewis et al., 2003; van Raaij & Schepers, 2008), perceived usefulness (Lewis et al., 2003), cognitive absorption (Agarwal & Karahanna, 2000), computer anxiety and CP (Davis et al., 2007; van Raaij & Schepers, 2008). It has also been shown to moderate the relationship between perceptions of compatibility and intention to use a technology (Agarwal & Prasad, 1998a, 1998b).

A VW system's availability should strengthen the relationship between PIIT and team technology use. Extant research shows that those who are innovative are more likely to seek out information for developing ideas (Rogers, 1995) and are more willing to search for novel solutions beyond their existing mental framework (Goldsmith, 1984). VWs represent a much richer environment (Franceschi et al., 2009; Suh & Lee, 2005) with more sophisticated tools, including support for simulations, modeling, and creating three-dimensional artifacts (Bartle, 2003). Thus, those who are higher in PIIT should be more likely to use a system if it embodies tools that cater to their tendency to try out new technologies in search of information and novel solutions. Moreover, research shows that innovative individuals are more interested in experiencing a stimulating environment than they are in realizing utilitarian outcomes (Venkatraman, 1991), which should further increase the likelihood that VWs will influence the relationship between PIIT and team technology use.

Time is expected to attenuate the relationship between PIIT and team technology use, but this attenuation is expected to occur more slowly when a VW system is available. With increasing experience, the need to explore a technology decreases (Berlyne, 1960), and interaction becomes more routinized (Jasperson, Carter, & Zmud, 2005; Limayem, Hirt, & Cheung, 2007). This process should occur more slowly when VWs are employed because they provide more opportunities for experimentation and thus prolong the exploratory period. However, once the technology has been adequately explored, individuals high in PIIT will shift their attention to different technologies that can satisfy their need to experiment. Indeed, recent research shows that, over time, PIIT has a diminishing impact on behavioral intention to explore a technology (Magni et al., 2010). Thus, we hypothesize:

H2b: *Technology type and time will moderate the positive relationship between personal innovativness with IT and team technology use; for those teams that are high in personal innovativeness with IT, the strength of the relationship will increase with a VW system's availability and decrease over time.*

CP is expected to have a positive relationship with team technology use. Those higher in CP tend to be more spontaneous, inventive, and imaginative in their computer interactions (Webster & Martocchio, 1992). This reflects a more constructive stance toward the use of computers. Moreover, research shows that CP is associated with a variety of positive outcomes, including lower computer anxiety, positive attitudes and mood, greater satisfaction, computer involvement, and learning (Webster & Martocchio, 1992). In addition, CP is found to induce cognitive absorption, which relates to a state of flow where individuals are absorbed in their activities and experience a sense of control over their environment (Agarwal & Karahanna, 2000). Given these positive associations, we expect that those higher in CP will use the team technology more.

The availability of a VW system should strengthen the relationship between CP and team technology use. The unique characteristics of VWs should cultivate an environment that allows users to indulge their CP as they engage with the system, thus strengthening this relationship. For example, part of this environment might be a heightened ability to enter into a state of flow. Compared to traditional collaborative systems, VWs are higher in immersiveness and telepresence (Suh & Lee, 2005; Walsh & Pawlowski, 2002), two key components of the experience of flow (Csikszentmihalyi, 1990). Additionally, the novelty and sophisticated toolset offered by VWs is likely to peak users' curiosity, another key factor involved in flow (Csikszentmihalyi, 1990). Indeed, research finds that users who experience flow in a VW have higher satisfaction with VWs (Hassell, Goyal, Limayem, & Boughzala, 2009).

While those higher in CP should be more likely to seize on the opportunity to indulge in a rich interactive experience, we expect this to dissipate over time, albeit more slowly for teams using a VW system. This is because, with increasing experience, system use becomes more routinized, habitual, and less challenging, which reduces the arousal caused by the discovery process (Venkatesh, 2000). Challenge and arousal are key components of an intrinsically motivating activity (Malone, 1981), and, as they decrease over time, those high in CP are less likely to enjoy using the system. VWs should maintain elements of challenge and arousal longer than traditional systems because they offer more opportunities for immersive engagement and interaction. Thus, we hypothesize:

> **H2c:** *Technology type and time will moderate the positive relationship between computer playfulness and team technology use; for those teams that are high in computer playfulness, the strength of the relationship will increase with a VW system's availability and decrease over time.*

A team's collaborative system represents a powerful communication tool that can organize the team and establish a shared knowledge base of the inputs and outputs of the team's activities. Due to its substantial role in technology-enabled teamwork, communication and its impact on interpersonal relationships has been the focus of much research in the literature on technology-enabled teams (Powell, Piccoli, & Ives, 2004). When teams are unable to establish a shared knowledge base, multiple problems ensue, which include a failure to communicate, an uneven distribution of information, and a difficulty understanding the salience of information and meaning of silence (Cramton, 2001). Research finds that the frequency and predictability of communication improves communication effectiveness, which enhances interpersonal relationships among team members (Jarvenpaa, Knoll, & Leidner, 1998; Jarvenpaa & Leidner, 1999; Kayworth & Leidner, 2000; Maznevski & Chudoba, 2000). In sum, greater use of a team's collaborative technology should improve cohesion because it enhances communication effectiveness and interpersonal relationships. Thus, we hypothesize:

> **H3:** *Team technology use will positively influence team cohesion.*

In addition to Hypotheses 3, we expect time and technology type to moderate the positive relationship between technology use and cohesion, such that the relationship will be stronger over time with the availability of a VW system. Technologies higher in media richness are thought to be better suited for affect management processes in teams (Maruping & Agarwal, 2004). Affect management is an integral component of team cohesion because cohesion can be derailed when frustration or conflict are not appropriately addressed (Marks, Mathieu, & Zaccaro, 2001). Maruping and Agarwal (2004) suggest that one affect management strategy for technology-mediated teamwork is the use of communication media that is high in immediacy or synchronicity so that conflict or frustration can be addressed before it leads to dysfunctional behavior. VWs that support virtual meeting spaces and real-time voice transmission facilitate a high degree of synchronous communication. Further, the exchange of personal, non-work related communication, including jokes and personal anecdotes, can help to dispel tension and build social bonds among team members (Mechanic, 1991). Compared to traditional technologies, technologies that provide a richer sense of presence are more likely to facilitate cohesion because they provide an atmosphere where team members may feel more immersed in an interaction and are thus more likely to share personal information. Indeed, research finds that the realism afforded by a VW increases tendencies toward self-disclosure (Bailenson et al., 2006) and spontaneous and opportunistic conversations (Meyer & Swatman, 2009).

Time is expected to reinforce the positive relationship between team technology use and team cohesion for those teams using a VW system. Channel expansion theory argues that, over time, an individual's perception of the richness of communication channel or medium can increase (Carlson & Zmud, 1994, 1999). With increasing experience, an individual's knowledge base about a communication medium grows and they are able to participate in increasingly rich communication. For example, over time, an individual may develop a better understanding for how to use and appropriate the various capabilities of a medium to convey more nuanced emotions or complex ideas. In the team context, this concept extends beyond the knowledge acquired about the specific communication medium to include knowledge of the communication styles and idiosyncrasies of fellow team members. Over time, individuals develop a knowledge base to draw on for communicating with their team members. They employ cues that are relevant to a particular person or group of people and draw on shared experiences or terminologies that have richer meaning for communication partners. Such communication approaches are developed through ongoing interactions with one's team members to generate individuating knowledge about others (Walther, 1992, 1995, 1996). In sum, over time, the influence of team technology use on team cohesion is expected to increase because the technology becomes richer in the eyes of the users. Thus, we hypothesize:

> **H4:** *Technology type and time will moderate the positive relationship between team technology use and team cohesion; for those teams that have high in team technology use, the strength of the relationship will increase with a VW system's availability and over time.*

3.3. Outcome Criterion: Team Performance

In extant research, cohesion has been found to improve performance (Evans & Dion, 1991; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000; Warkentin et al., 1997). This link is included in our model to provide completeness to the nomological network. Cohesion is an important antecedent of team performance because it increases the team's commitment to their tasks and elevates their efforts directed at success (Langfred, 1998). From an interpersonal perspective, cohesion results in group members exchanging information with less inhibition and reduces the need to monitor others' work, which thus allows the team to coordinate their actions with greater ease and effectiveness (Gully, Devine, & Whitney, 1995). When teams are more cohesive, members are inclined to subjugate their individual interests for the team's interest, and are thus more likely to act in ways that benefit the team's performance (Harrison et al., 2002). Thus, we hypothesize:

> **H5:** *Team cohesion will positively influence team performance.*

The preceding hypotheses suggest that technology use positively influences cohesion (H3) and that cohesion positively influences team performance (H5). Beyond this, we expect that technology use will influence performance through its impact on cohesion – that is, a mediated effect. Research shows that collaborative technology use can improve team performance (Easley, Devaraj, & Crant, 2003). There are a number of reasons for this finding. Use of a collaborative technology engenders less domination by particular members of the group, which thus ensures greater equality of participation (Dubrovsky, Kiesler, & Sethna, 1991; Straus, 1997). Other research demonstrates that increased use of a system allows team members to develop relationships by exchanging personal information as the team works together over time (Chidambaram, 1996). Such mechanisms are likely to play a part in improving performance by ensuring greater cohesion because each team member feels that they have a voice on the team and are personally and socially bonded with others on the team. Consequently, team members are likely to engage in greater knowledge sharing and to coordinate their actions more smoothly (Gully et al., 1995), and thus result in higher performance. Thus, we hypothesize:

> **H6:** *Team cohesion will mediate the impact of team technology use on team performance.*

4. Methodology

4.1. Sample

We conducted the study in a firm in the entertainment and broadcasting industry. The company had locations in several different cities in the US. We used two types of systems for team collaboration. The first system, which we term TRADSYS, was the current version of a leading commercially available collaborative tool to facilitate interaction. The second system, which we term VWSYS, was an in-house system built to support virtual world collaboration. The organization identified two sites (cities) for a pilot system. Each site used one of the two systems.

The organization chose the study participants randomly to represent a range of functional areas. They were almost all knowledge workers. The sampling was also done to ensure heterogeneity in terms of gender, age, and organizational position. The sample at site one comprised 380 participants. Of these, 301 participants (38 percent women; average age 38.68, s.d. 7.80) provided usable responses in all phases of our study for a response rate of 79 percent. The sample at site two comprised 355 participants. Of these, 282 individuals (40 percent women; average age 38.12, s.d. 7.46) provided usable responses in all phases of our study for a response rate of 79 percent. There were no demographic differences between the sampling frame and those included in the sample. One aspect worth noting is the high response rate in both sites for which there are several important, interrelated reasons: first, there was a strong organizational push to deploy the systems and facilitate virtual work; second, given that the participants had been hand-picked by the organization, the participants were more likely to participate; and, third, because the survey was administered immediately following a training session, the response rate was quite high. The 583 participants were organized into 91 teams, with 47 teams using the TRADSYS and 44 teams using the VWSYS. The average team size was about 6.5 members.

4.2. Description of Systems

As noted earlier, the first system – that is, TRADSYS – was the current version of a leading, commercially available collaborative tool for the Windows environment. This system's key purpose was that it allowed for collaboration from any remote location. The functionalities included messaging, group discussion, calendaring/scheduling, database management, electronic forums, and workflow. The system was compatible with most desktop software applications, which offered full advantage of the desktop metaphor capability whether working from home or other locations. The system worked seamlessly with desktop productivity software, such as Microsoft Office, to allow users to create and edit documents (both independently and together), participate in text-based group discussion forums, and send messages. The system also included audio and video conferencing support along with an interactive white board. Further, the system provided remote access to each user's files on different servers and their own computer(s) at work and home. Thus, the system provided the opportunity for employees to interact with each other to conduct business, which supported interpersonal communication and virtual teamwork.

The organization designed the second system – that is, VWSYS –with the same goals in mind. It used a web-based graphical user interface, but with the intent of creating a VW based on the actual office environment. The organization designed the system with the objective of creating a maximal, seamless illusion of working in the actual office environment. This was accomplished by leveraging the metaphor of physical space and virtual reality in the same manner as other popular VW applications, such as Second Life. Specifically, the system re-created the physical look and feel of the office building and offices at the actual office location. This included the office corridors, individual offices, and work areas of the participants. Users could navigate the virtual representation of the building and perform various actions – for example, knocking on a door – in the virtual environment. Thus, for instance, "going to work" acquired the meaning of traversing the virtual hallways to reach one's office and "attending team meetings" meant accessing a virtual conference room. In all cases, "rooms" provided a strong sense of presence because of the re-creation of the physical space in the VW. Further, the provision of video support for all audio communication, which included images of the

participants, strengthened the system's VW aspect. The system also minimized obtrusiveness of the medium. This is consistent with Held and Durlach (1992) who argue that, to create the illusion of non-mediation, technology should be constructed in such a way as to not remind the participant of the mediation. In sum, VWSYS re-created a workplace in virtual space while providing seamless access to the actual workplace and other employees. Although both TRADSYS and VWSYS offered similar features, the two systems presented substantially different views of the virtual office to the users.

4.3. Procedure

We deployed the systems concurrently in both sites. Site one used TRADSYS and site two uses VWSYS. A one-day training program introduced the participants to the system. In order to keep the number of attendees manageable, trainers conducted four training sessions over a two-week period. The trainers initially conducted the training and all the chosen participants attended the training session. The same team of trainers – that is, two lecturers and five aides – conducted all training sessions. The authors did not participate in the conduct of the training but observed the training programs to ensure that different training sessions were equivalent in terms of the informational content. Following the training program, participants completed a questionnaire.

All employees participating in the training already had a computer at home with a hardware and software setup identical to their workplace – that is, identical images. Regardless of the location, each employee had a broadband connection at home to provide enough bandwidth to support the video with high fidelity and immediacy consistent with goals of the virtual work systems. Using a caching algorithm, often-accessed and non-changing video was stored locally on the workers' home PC once it had been downloaded in order to facilitate faster response time and lower bandwidth use. We measured use via system logs for one year following the training.

We collected data at two points in time from members of standing teams. The first point of data collection was at the time of the initial training when a survey that included the various traits was administered to the members of various teams. One year after the initial survey, data were collected about technology use, team cohesion, and team performance.

4.4. Measurement

We measured all constructs, with the exception of time and team technology use, by adapting previously validated scales. We assessed the five factor model of personality using five separate 4-item scales from Costa and McCrae (1992), which were measured on a 7-point Likert-type agreement scale. A sample item for agreeableness is: "I try to be courteous to everyone I meet". We assessed computer self-efficacy using a 9-item measure (Venkatesh, 2000) based on Compeau and Higgins (1995) and a 7-point Likert-type agreement scale. A sample item is: "I could complete the job using [SYSTEM] if there was no one around to tell me what to do as I go". We assessed oersonal innovativeness with IT using a 4-item measure from Agarwal and Prasad (1998b) on a 7-point Likert-type agreement scale. A sample item for this measure is: "If I heard about a new information technology, I would look for ways to experiment with it". We assessed computer playfulness with a 7-item measure from Webster and Martocchio (1992) using a 7-point Likert-type agreement scale. A sample item for this measure is: "I am spontaneous when I interact with [SYSTEM]".

We conceptualize time as the amount of experience with the target system. We operationalize this as experience using the TRADSYS OR VWSYS as measured in number of months of prior system use. This approach is consistent with prior literature that has conceptualized time in terms of experience with a target behavior (Venkatesh et al., 2006; Venkatesh et al., 2003). We captured team technology use as actual time logged on to the system. An automatic logout after five minutes of idle time (no keystrokes) ensured a more accurate measure of actual use. When a user idled past 5 minutes, the system stored a snapshot of the user's work for retrieval upon re-login to prevent loss of unsaved work; the system continued to record conversations that the user was part of for later perusal. Such an auto-logout helped effectively use server resources and maximize response time for active users. We assessed team cohesion using four of the six items of Bollen and Hoyle's (1990) scale and a 7-point Likert-type agreement scale. A sample item is: "I feel a sense of belonging to my team". Finally,

we assessed team performance using a 4-item measure and a 7-point Likert-type agreement scale adapted from prior research (Hoegl & Gemuenden, 2001). A sample item is: "The work that this team is doing is of high quality". Appendix A provides the items.

We measured all items at the individual level and aggregated them to the team level. Aggregating individual-level scales to garner team-level metrics is consistent with prior research, both in IS (e.g., Rai, Maruping, & Venkatesh, 2009) and psychology (e.g., Ilies, Wagner, & Morgeson, 2007). For team cohesion and team performance, sufficiently high intraclass correlation coefficients (ICC) justified aggregation, which demonstrates that a proportion of total variance in a given variable could be accounted for by group membership (ICC1), and that the group means were reliable (ICC2) (Bliese, 2000). For the disposition variables, including the FFM variables, CSE, PIIT, and CP, we averaged items across team member scores. Although an appropriate level of reliability is necessary for team outcome variables, this is not the case with dispositional variables and thus they can be aggregated without demonstrating reliability (LePine, 2003; van Vianen & De Dreu, 2001). LePine (2003, p. 33) uses this approach to measuring team personality, and notes that it is "an additive form of aggregation and is appropriate when team members can compensate for one another with respect to task-focused contributions". In addition to LePine (2003), others have used this method of aggregating the FFM variables to the team level (e.g., de Vries, van den Hooff, & de Ridder, 2006; van Vianen & De Dreu, 2001).

5. Results

We analyzed data using partial least squares (PLS), with SmartPLS version 2.0 (Ringle, Wende, & Alexander, 2005) being the software used. PLS is well suited for examining complex models with many latent variables, as was the case with the model presented here. With PLS, the measurement model and structural model are estimated simultaneously, which allows for an assessment of both the psychometric properties and the structural results. We assessed the measurement model first to determine the validity and reliability of the measures. Tables 1 and 2 show the item loadings and cross-loadings, and Tables 3 and 4 show the correlations and descriptive statistics. Tables 1 and 2 show that all item loadings are greater than .65, which supports convergent validity. Tables 3 and 4 show that all internal consistency reliability (ICR) values are greater than .70, which supports reliability (Chin, 1998; Chin, Marcolin, & Newsted, 2003). We assessed discriminant validity by comparing the square root of the average variance extracted (AVE) to the inter-construct correlations. Discriminant validity is supported if the square root of the AVE is larger than the inter-construct correlations (Fornell & Larcker, 1981). As Tables 3 and 4 show, this is indeed the case.

Table 5 presents the results of the structural models (Appendix B shows the results in graphical form). We employed a bootstrap procedure using 1,000 iterations to estimate the t-values and corresponding p-values. With the exception of neuroticism, PIIT, and CP, all interactions were significant in predicting team technology use with the VWSYS, whereas none of the interactions were significant in predicting team technology use of the TRADSYS. Agreeableness and time interacted to positively influence technology use when the VWSYS is used, which supports H1a. For conscientiousness, the interaction with time was positive and significant for VWSYS use, which supports H1b. In terms of H1c, we hypothesized a negative relationship between extraversion and team technology use, and this relationship was not significant. However, the interaction term for time and extraversion was significant for the VWSYS, which indicates that time and technology type strengthen the relationship between extraversion and team technology use, which partially supports H1c. The interaction term for neuroticism and time with VWSYS use was not significant; thus, H1d is not supported. The relationship between openness and team technology use is positive and significant for teams using the VWSYS and time increases the strength of this relationship, which supports H1e.

Table 1. Loadings and Cross-Loadings for VWSYS

	AGR	CON	EXT	NEU	OPN	CSE	PIIT	CP	COHS	PERF
AGR1	**.75**		.44		.44				.44	
AGR2	**.75**		.42						.43	
AGR3	**.70**								.41	
AGR4	**.76**		.41						.42	
CON1	.44	**.75**								
CON2		**.80**								
CON3		**.84**			.48					
CON4		**.73**								
EXT1	.44		**.80**		.43				.42	
EXT2	.43		**.80**						.50	
EXT3	.46		**.84**							
EXT4	.47		**.75**							
NEU1				**.78**						
NEU2				**.80**						
NEU3				**.70**						
NEU4				**.71**						
OPN1	.42				**.75**					
OPN2					**.75**					
OPN3					**.70**					
OPN4					**.71**					
CSE1						**.84**	.42			
CSE2						**.84**				
CSE3						**.88**				
CSE4						**.80**				
PIIT1						.48	**.75**	.44		
PIIT2						.44	**.80**	.42		
PIIT3						.43	**.71**	.49		
PIIT4						.48	**.73**	.51		
CP1					.44	.42	.42	**.74**		
CP2					.48	.43	.43	**.73**		
CP3					.51	.41	.50	**.70**		
CP4					.41	.44	.48	**.75**		
COHS1	.41		.44						**.75**	
COHS2	.44		.51						**.76**	.48
COHS3	.49								**.75**	.44
COHS4	.43								**.70**	
PERF1		.46							.44	**.75**
PERF2		.44	.42						.42	**.80**
PERF3		.47								**.74**
PERF4		.51	.43							**.80**

Notes: AGR: Agreeableness, CON: Conscientiousness, EXT: Extraversion, NEU: Neuroticism, OPN: Openness, CSE: Computer self-efficacy, PIIT: Personal innovativeness with IT, CP: Computer playfulness, COHS: Team cohesion, PERF: Team performance. Cross-loadings lower than .40 are not shown to improve readability.

Table 2. Loadings and Cross-Loadings for TRADSYS

	AGR	CON	EXT	NEU	OPN	CSE	PIIT	CP	COHS	PERF
AGR1	**.80**		.47		.45				.43	
AGR2	**.75**		.44							
AGR3	**.73**								.44	
AGR4	**.70**		.43						.50	
CON1		**.71**								
CON2		**.77**								
CON3		**.71**			.49					
CON4		**.77**								
EXT1	.47		**.75**		.46				.44	
EXT2	.42		**.70**						.52	
EXT3	.44		**.71**							
EXT4	.45		**.74**							
NEU1				**.73**						
NEU2				**.73**						
NEU3				**.71**						
NEU4				**.75**						
OPN1	.48				**.80**					
OPN2	.44				**.71**					
OPN3	.43				**.73**					
OPN4					**.71**					
CSE1						**.84**				
CSE2						**.80**				
CSE3						**.80**				
CSE4						**.88**				
PIIT1						.45	**.70**	.47		
PIIT2						.50	**.70**	.46		
PIIT3							**.71**	.50		
PIIT4						.44	**.73**	.53		
CP1					.49	.45	.47	**.71**		
CP2					.44	.46	.44	**.77**		
CP3					.52	.44	.47	**.73**		
CP4					.46	.47	.48	**.70**		
COHS1	.44		.47						**.75**	
COHS2	.45		.44						**.71**	.49
COHS3	.47		.43						**.70**	.44
COHS4	.44								**.77**	
PERF1		.48							.45	**.72**
PERF2		.45	.45							**.71**
PERF3		.45	.43							**.73**
PERF4		.48	.45							**.84**

Notes: AGR: Agreeableness, CON: Conscientiousness, EXT: Extraversion, NEU: Neuroticism, OPN: Openness, CSE: Computer self-efficacy, PIIT: Personal innovativeness with IT, CP: Computer playfulness, COHS: Team cohesion, PERF: Team performance. Cross-loadings lower than .40 are not shown to improve readability.

Table 3. Means, Standard Deviations, and Correlations for VWSYS; n = 44

Variable	ICR	Mean	S Dev	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Average age	–	37.5	6.90	–													
2. Team size	–	6.51	1.81	.32***	–												
3. Agreeableness	.71	4.41	1.20	.17**	-.15*	**.86**											
4. Conscientiousness	.71	4.38	1.27	.20**	-.19**	.13*	**.85**										
5. Extraversion	.72	4.80	1.34	-.07	.04	.14*	.17**	**.89**									
6. Neuroticism	.75	2.19	0.54	.04	.03	.03	.08	.05	**.80**								
7. Openness	.80	3.98	1.54	.08	.08	.08	.04	.04	.04	**.78**							
8. CSE	.84	5.41	0.95	-.20**	.05	.10	.14*	-.08	.04	.08	**.84**						
9. PIIT	.73	3.75	1.62	-.24***	.04	.07	.15*	-.05	.02	.15*	.19**	**.88**					
10. CP	.74	3.87	1.59	.26***	.02	.05	.07	-.03	.05	.17**	.20**	.24***	**.82**				
11. Time	–	0.50	0.50	.00	.10	.02	.03	.07	.05	.02	.05	.02	.03	–			
12. Technology use	–	13.05	4.81	-.15*	.07	.17**	.23***	.05	-.03	.30***	.20**	.10	.20**	.23***	–		
13. Team cohesion	.75	4.75	1.32	.13*	.05	.15*	.20**	.04	-.02	.26***	.17**	.08	.17**	.28***	.35***	**.89**	
14. Team performance	.74	5.28	1.07	.07	-.13*	.16*	.15*	.08	-.10	.14*	.07	.08	.10	.15*	.39***	.46***	**.83**

Note: ***p<.001; **p<.01; *p< .05; Square root of the average variance extracted is shown in bold on the diagonal. ** p < .01; * p < .05; ICR: Internal consistency reliability; CSE: Computer self-efficacy; PIIT: Personal innovativeness with IT; CP: Computer playfulness.

Table 4. Means, Standard Deviations, and Correlations for TRADSYS; n = 47

Variable	ICR	Mean	S Dev	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Average age	–	38.5	6.42	–													
2. Team size	–	6.50	1.95	.30***	–												
3. Agreeableness	.74	4.47	1.28	.15*	-.16*	.80											
4. Conscientiousness	.75	4.30	1.20	.17**	-.20**	.14*	.84										
5. Extraversion	.77	4.75	1.28	-.05	.05	.15*	.20**	.75									
6. Neuroticism	.84	2.01	0.47	.03	.03	.05	.05	.04	.77								
7. Openness	.80	3.75	0.52	.05	.08	.04	.03	.04	.05	.75							
8. CSE	.75	5.17	0.97	-.17**	.04	.08	.15*	-.05	.05	.08	.74						
9. PIIT	.78	3.84	1.40	-.20**	.02	.05	.15*	-.05	.04	.17**	.20**	.80					
10. CP	.70	3.29	1.65	-.24***	.07	.04	.05	-.07	.05	.20**	.21**	.23***	.84				
11. Time	–	0.50	0.50	.00	.04	.04	.02	.07	.03	.05	.02	.03	.04	–			
12. Technology use	–	11.25	4.80	-.13*	.02	.20**	.24***	.20**	-.05	.31***	.22***	.08	.20**	.17**	–		
13. Team cohesion	.74	4.08	1.49	.14*	.01	.19**	.20**	.17**	-.04	.28***	.20**	.05	.19**	.20**	.20**	.84	
14. Team performance	.79	4.48	1.20	-.10	-.15*	.14*	.14*	.05	-.07	.13*	.05	.05	.07	.14*	.32***	.47***	.80

Note: ***p<.001; **p<.01; *p<.05; Square root of the average variance extracted is shown in bold on the diagonal. ** p < .01; * p < .05; ICR: Internal consistency reliability; CSE: Computer self-efficacy; PIIT: Personal innovativeness with IT; CP: Computer playfulness.

Table 5. Structural Model Results

Dependent variable	Team Technology Use				Team Cohesion				Team Performance	
	VWSYS main effects	VWSYS moderating effects	TRADSYS main effects	TRADSYS moderating effects	VWSYS main effects	VWSYS moderating effects	TRADSYS main effects	TRADSYS moderating effects	VWSYS	TRADSYS
Average age	-.12*	.03	.13*	.13*	.12*	.10	.13*	.10	.07	-.10
Team size	.04	.02	.04	.04	-.07	-.04	-.08	-.05	-.13*	-.15*
Agreeableness (AGR)	.12*	.04	.15**	.15**	.03	.02	.08	.14*		
Conscientiousness (CON)	.16**	.02	.18**	.18**	.11*	.01	.13*	.13*		
Extraversion (EXT)	.04	.07	.12*	.12*	.02	.03	.07	.10		
Neuroticism (NEU)	.02	.02	.02	.02	.01	.01	.01	.01		
Openness (OPN)	.20***	.03	.24***	.24***	.15*	.02	.17**	.20***		
CSE	.15*	.05	.17**	.17**	.08	.01	.10	.15**		
PIIT	.02	.04	.04	.04	.01	.02	.01	.02		
CP	.12*	.02	.13*	.13*	.05	.01	.04	.08		
Time		.07		NS	.05	.02	.03	.02		
AGR x Time		.38***		NS						
CON x Time		.35***		NS						
EXT x Time		.27***		NS						
NEU x Time		.04		NS						
OPN x Time		.28***		NS						
CSE x Time		.21**		NS						
PIIT x Time		.03		NS						
CP x Time		.02		NS						
TTU					.28***	.13*	.12*	.12*	.10	.08
TTU X Time						.21***		NS		
Team cohesion									.46***	.47***
R^2	.40	.57	.44	.44	.17	.25	.10	.12	.24	.25

Note: ***p<.001; **p<.01; *p<.05; CSE: Computer self-efficacy; PIIT: Personal innovativeness with IT; CP: Computer playfulness; TTU: Team technology use; NS: Non-significant and dropped from analysis.

For the IT-specific dispositions, the interaction between CSE and time was significant and positive for the VWSYS, which supports H2a. In contrast, the interaction terms for PIIT and time and for CP and time was not significant in predicting team technology use for either technology. Thus, H2b and H2c are not supported. H3 predicted that team technology use would positively influence team cohesion and this is supported. For both VWSYS and TRADSYS, the coefficients were positive and significant but the relationship was much stronger for the VWSYS than it was for the TRADSYS. H4 predicted that time and technology type would moderate the relationship between team technology use and team cohesion. Results show that time increased the strength of the relationship between team technology use and team cohesion in the case of the VWSYS, but not in the case of the TRADSYS. Thus, H4 is supported. H5 predicted that team cohesion would positively influence team performance and this was supported for both VWSYS and TRADSYS. Finally, H6 predicted that team cohesion would mediate the influence of team technology use on team performance. A Sobel test (Sobel, 1982) of the indirect effects suggests full mediation. Thus, H6 is supported. For the VWSYS, the model explains about 57 percent of the variance in team technology use, 25 percent of the variance in team cohesion, and 24 percent of the variance in team performance.

Because our measures are self-reported, to further validate our results we tested for the possibility common method bias using the marker-variable technique (Lindell & Whitney, 2001; Malhotra, Kim, & Patil, 2006). According to this approach, variables that are theoretically unrelated to at least one other variable in the data can act as a marker for common method variance (CMV). This technique assesses the model for CMV by adjusting the path coefficients for CMV and examining the CMV-adjusted coefficients and explained variance. If the CMV-adjusted coefficients and explained variances are substantially different, then CMV may be a concern. We estimated the CMV-adjusted coefficients using a CMV-adjusted correlation matrix that is generated by selecting the second smallest positive correlation among constructs as a conservative estimate of CMV. Our results show that the path coefficients did not change by more than .02. The explained variance in team technology use, cohesion, and performance changed by no more than .01. Thus, we conclude that common method variance is not a major concern in our study.

6. Discussion

Our study provides evidence for the value of a VW-based design of a team collaborative system in fostering use of the system andincreasing team cohesion. It also provides evidence that team dispositional factors, including both general and IT-specific dispositions, are important factors that influence team technology use and that this influence is impacted by both time and technology type. Time and technology type strengthen the relationship between team technology use and agreeableness, conscientiousness, extraversion, openness to experience, and CSE. In other words, for teams that used the VW system, those high in agreeableness, conscientiousness, extraversion, openness, and CSE were more likely to use the technology, with use increasing over time. In addition, consistent with our theorizing, team technology use was positively related to team cohesion. We observed this relationship to be stronger over time for teams that used the VW system. Thus, we found strong evidence in support of the superiority of outcomes in the context of a VW-based team collaborative system.

6.1. Theoretical Contributions

This work contributes to the literature on VWs, technology-enabled teamwork, and technology use. VWs as a topic of business interest has emerged and researchers in different fields are seeking theoretically grounded investigations of their value in business contexts (Hendaoui et al., 2008). This work fills this void because, previously, it was unclear just how VW systems can contribute value to organizations in terms of supporting teamwork. We show that VWs can be an important support mechanism affecting team cohesion – a pivotal factor relating team interaction to team performance (Evans & Dion, 1991; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2000; Warkentin et al., 1997). These findings represent important leverage points for researchers exploring the factors that contribute to the success of organizational initiatives involving VWs. Few studies have compared user performance outcomes using VWs with the performance of those using more traditional systems, and fewer still have been conducted in an organizational team context. In examining the relative impact of

a system based on the traditional desktop metaphor versus one grounded in the principles of virtual reality, this study sheds light on how and why a VW system generates more value for collaborative exchange than many traditional collaborative technologies that are currently used.

By grounding this study in the context of technology use in teams, we also contribute to the growing literature on technology-enabled teamwork. We respond to calls for research on individual differences and its role in technology adoption in teams and on newer forms of social media in facilitating teamwork (Devaraj et al., 2008; McElroy et al., 2007). In exploring the dispositional factors that contribute to team technology use, we shed light on individual differences in technology-mediated teamwork. The results point to the pivotal role of experience with the system and the design of the system in enhancing the relationship between dispositional factors and team technology use. In particular, they suggest that research on teams should perhaps consider the team members' dispositional traits in influencing technology use. Further, we situate the IT artifact firmly in the center of our investigation and show that richer, more immersive technologies are particularly attractive to teams with members who are highly agreeable, conscientious, extraverted, open, and who have a high computer self-efficacy. In doing so, we further our understanding of how team member characteristics affect technology use and how teams are affected by the technology they rely on to coordinate their work. Our findings suggest that newer media that are more experiential and social in nature can play a key part in facilitating team performance by improving cohesion.

We also contribute to the IS literature on technology design, particularly for collaborative technologies. The design of systems and leveraging the design as an intervention to produce positive outcomes related to IS implementations is important (Venkatesh & Bala, 2008). By demonstrating empirical evidence in favor of a specific design – that is, based on principles related to VWs – and providing theoretical justification for why these characteristics are important, we contribute to research on design of IS. Further, by incorporating an examination of both the design of the communication medium and the role of time, we contribute to prior literature on the importance of these factors in the selection and use of collaborative technologies (Carte & Chidambaram, 2004; Maruping & Agarwal, 2004). We extend such work to consider a different aspect of time (i.e., experience, rather than distal vs. proximal stages of team development) and a technology with different capabilities (i.e., immersive, highly interactive, stronger sense of presence).

In addition to the theoretical contributions, this work sparks several interesting future research directions. This work demonstrates the impact of a VW platform, but researchers could examine the specific human-computer interaction principles involved in producing the positive outcomes observed. For instance, GUI design factors, such as color, have been shown to impact decision-making speed (Benbasat & Dexter, 1986). In different contexts, researchers have identified various principles of design that contribute to IS success (e.g., Venkatesh & Agarwal, 2006). We also outline several theoretical mechanisms by which VWs influence the relationship between personality, IT-specific dispositions, and team technology use – these mechanisms bear testing (Shroff, Vogel, & Coombes, 2008). Additionally, alternative models of system use that have been proposed in the literature, such as the technology acceptance model (Venkatesh, Davis, & Morris, 2007) and the unified theory of acceptance and use of technology (Venkatesh et al., 2003; Venkatesh, Thong, & Xu, 2012), could be tested and compared to this model that positions individual differences as important antecedents and team cohesion as a key outcome. In recent research, the role of habit has also been recognized as an important part of IT acceptance and use (Limayem & Hirt, 2003; Limayem et al., 2007; Venkatesh et al., 2012). The current work would benefit from an examination of how habit plays a part in VW use, and, in particular, of its impact on the perception of how stimulating the VW environment is as its novelty diminishes. Although interpersonal relationships play an implicit role in our theorizing, we do not focus on the social network among people. Recent research finds that such network effects can positively or negatively contribute to technology use (Sykes, Venkatesh, & Gosain, 2009; Sykes, Venkatesh, & Rai, 2011; Venkatesh, Zhang, & Sykes, 2011) and other outcomes, such as job performance (Sykes, Venkatesh, & Johnson, forthcoming). Future research could explore how these effects play out in the context of teams using newer forms of social media. Moreover, recent research on technology-enabled teamwork points to the role that communication media mix (i.e., proportion of computer-mediated versus face-to-face communication) plays in influencing team creativity and

diversity perceptions (Thatcher & Brown, 2010; see also Zhang & Venkatesh, forthcoming). Given the elements of play and fantasy that are characteristic of VWs, it would be interesting to examine VW use on these team factors.

6.2. Limitations

Just as the theoretical contributions of this work suggest possible future research directions, so too do its limitations. One limitation is the omission of variables that may be important in explaining additional variance in our dependent variables or account for some of our non-significant results. Although we were primarily interested in individual traits related to technology use, researchers have observed several cognitive and affective factors that influence technology adoption and use. Perceived ease of use, perceived usefulness, computer anxiety, mood, and cognitive absorption are just a few of these factors (see Sun & Zhang, 2006, for a review). Future research could incorporate these variables to examine both their direct and mediating effects on technology use. In addition to IT-specific traits, IS researchers would benefit from exploring other general individual differences that may account for variance in technology use and performance. For example, in the context of teams, empathy (Davis, 1983) may be a useful lens through which to examine team members' ability to connect to and share the emotions of their dispersed teammates.

A scoping decision that we noted earlier is the second limitation of this work – we did not consider the interrelationships among the personality and IT-specific dispositions. Prior research has shown that general dispositions can influence IT-specific dispositions, as in the case of openness to experience being linked to PIIT and CP (Nov & Ye, 2008; Woszczynski et al., 2002). Such complexities require consideration if we are to continue to expand our understanding of technology use and its relationship with performance.

A third potential limitation is the size of our sample. Although we had a large number of individuals participate in the study (n = 582), and a moderate number of teams (n = 91), the model is tested separately in the context of each of the two systems, which further reduces the sample size (n = 44 for VWSYS; n = 47 for TRADSYS). Thus, the potential for type II error is a concern. This is alleviated to some extent by our findings. Nine of our twelve hypotheses were supported (eight fully supported and one partially supported), which suggests that we were able to detect effects even with these sample sizes. The non-significant findings may be a result of low power or some idiosyncrasy inherent in our sample. Such possibilities may also account for our surprising finding that extraversion predicts use in the case of the TRADSYS, but not in the case of the VWSYS. Replication and extension will be necessary to investigate these possibilities.

6.3. Practical Implications

Broadly, this work provides empirical support for the notion that VW technologies can have positive implications for organizations. In particular, we demonstrate that a VW-based system can foster positive team outcomes in the longer-term. This provides a clear and prescriptive solution for improving the cohesiveness and overall team-based work experience of employees, and is an encouraging result for organizations that are considering investments in VWs. From a broader social perspective, the ability to cultivate an engaging technology-mediated experience represents a positive step toward initiatives aimed at globally distributed teamwork and telecommuting. A VW-based collaborative system appears to provide teams with a system that facilitates richer and more positive interaction. Much work remains in exploring how VW technologies contribute to team outcomes, but this current work provides some evidence that team cohesion can be improved by leveraging richer experiential technologies that promote use. Further, the results help provide some prescriptive solutions for matching the design or composition of the team with the design of the system the team uses. Organizations may want to consider composing teams of individuals high in agreeableness, conscientiousness, extraversion, openness, or CSE when first adopting VW technologies to help build a culture of positive attitudes and experiences with VWs.

Designers of collaborative systems can also benefit from the results of this work. In the absence of a complete adoption of a VW system, IS developers and designers may be well advised to explore the

capabilities of VW technologies and look for ways to integrate them into existing collaborative systems. Although firms have produced various types of collaborative systems, most, if not all, have relied almost exclusively on the traditional desktop metaphor. However, the time has clearly come to think beyond this metaphor. In a world that is filled with virtual reality games that provide rich experiences to users, it is likely that the next generation of workplace tools need to better mimic the reality to which people have become accustomed. As today's teenagers enter the workforce, such systems may be the only ones that will be embraced and used.

7. Conclusion

VW technology holds great promise for generating organizational value, yet our understanding of the impacts of this technology in various organizational contexts is still in its nascent stages. The current work represents a step toward a better understanding of how and why VWs may be leveraged for team collaboration. Provision of a richer, more engaging experience via VWs is a means by which organizations can facilitate a more effective collaborative experience, which leads to greater team technology use. We find that the downstream consequence of this is an overall improvement in team cohesion and team performance. In explicating the dispositional mechanisms by which use of VWs lead to positive team outcomes over time, we hope that this research will contribute to efforts made to gain insight into design features of information systems, their use and, ultimately, their contributions to organizational success.

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Appendices

Appendix A: Survey Items

Five-Factor Model of Personality
Personality was assessed using the NEO-PI-R scales developed by Costa and McCrae (1992). The NEO-PI-R is a proprietary scale and thus is not reprinted.

Computer Self-Efficacy
I could complete the job using [SYSTEM]…
CSE1. If there was no one around to tell me what to do as I go.
CSE2. If I had never used a package like it before.
CSE3. If I had only the software manuals for reference.
CSE4. If I had seen someone else using it before trying it myself.
CSE5. If I could call someone for help if I got stuck.
CSE6. If someone else had helped me get started.
CSE7. If I had a lot of time to complete the job for which the system was provided.
CSE7. If I had just the built-in help facility for assistance.
CSE8. If someone showed me how to do it first.
CSE9. If I had used similar packages before this one to do the same job.

Personal Innovativeness with IT
PIIT1. If I heard about a new information technology, I would look for ways to experiment with it.
PIIT2. Among my peers, I am usually the first to try out new information technologies.
PIIT3. In general, I am hesitant to try out new information technologies.*
PIIT4. I like to experiment with new information technologies.

Computer Playfulness
CP1. I am spontaneous when I interact with the [SYSTEM].
CP2. I am unimaginative when I interact with the [SYSTEM].*
CP3. I am playful when I interact with the [SYSTEM].
CP4. I am flexible when I interact with the [SYSTEM].
CP5. I am uninventive when I interact with the [SYSTEM].*
CP6. I am creative when I interact with the [SYSTEM].
CP7. I am unoriginal when I interact with the [SYSTEM].*

Team Cohesion
COHS1. I feel a sense of belonging to the team.
COHS2. I feel that I am a member of the team.
COHS3. I see myself as part of the team.
COHS4. I am enthusiastic about the team.

Leader-Rated Team Performance
PERF1. This team is doing a good job.
PERF2. The work that this team is doing is of high quality.
PERF3. I am satisfied with this team's work.
PERF4. Overall, this team is functioning effectively.

Note: 1. * denotes reverse-coded items; 2. All items are measured on a 7-point Likert-type scale where 1 represents complete disagreement and 7 represents complete agreement.
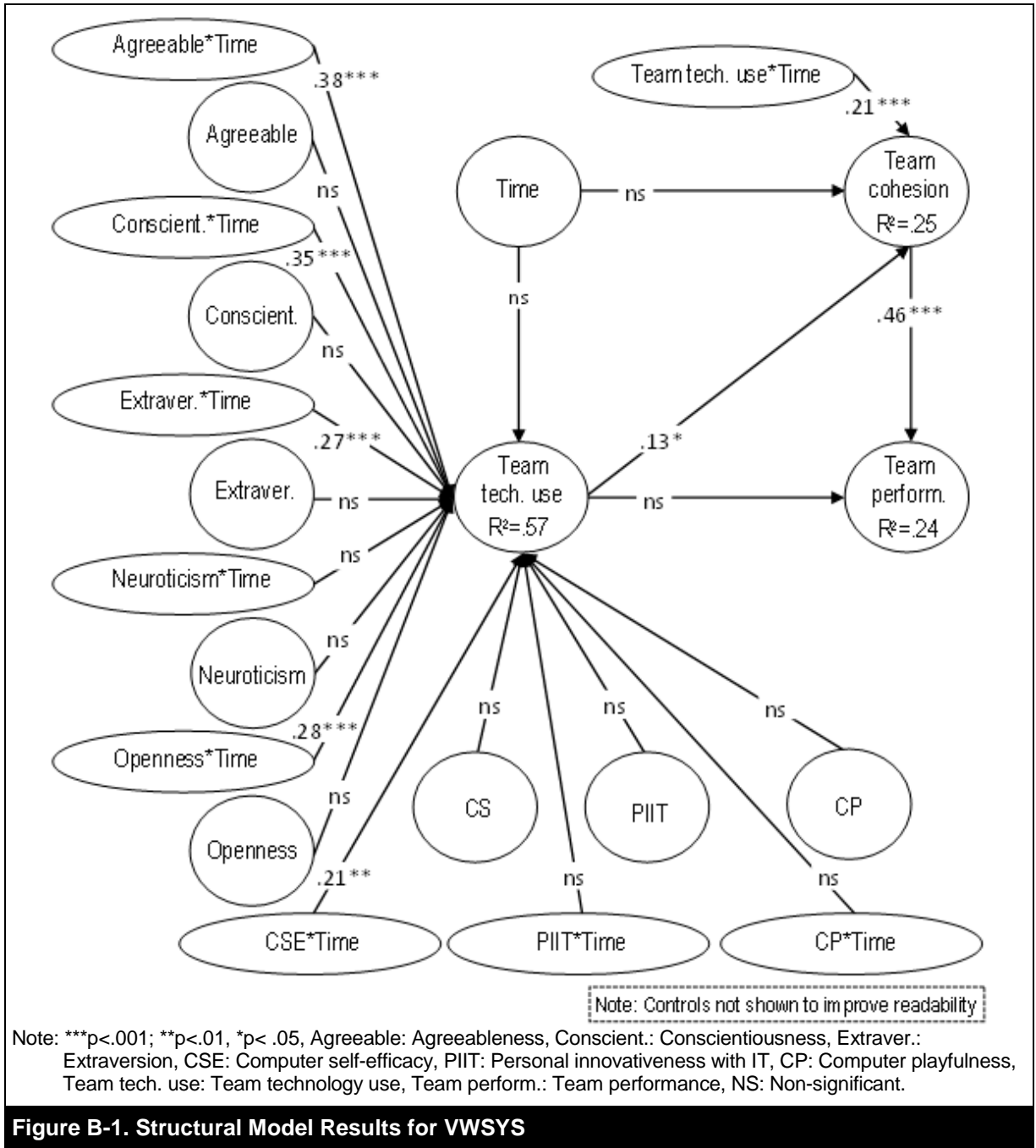
Appendix B

Figure B-1. Structural Model Results for VWSYS

Note: ***p<.001; **p<.01, *p< .05, Agreeable: Agreeableness, Conscient.: Conscientiousness, Extraver.: Extraversion, CSE: Computer self-efficacy, PIIT: Personal innovativeness with IT, CP: Computer playfulness, Team tech. use: Team technology use, Team perform.: Team performance, NS: Non-significant.

Note: ***p<.001; **p<.01; *p< .05, Agreeable: Agreeableness, Conscient.: Conscientiousness, Extraver.: Extraversion, CSE: Computer self-efficacy, PIIT: Personal innovativeness with IT, CP: Computer playfulness, Team tech. use: Team technology use, Team perform.: Team performance, NS: Non-significant.
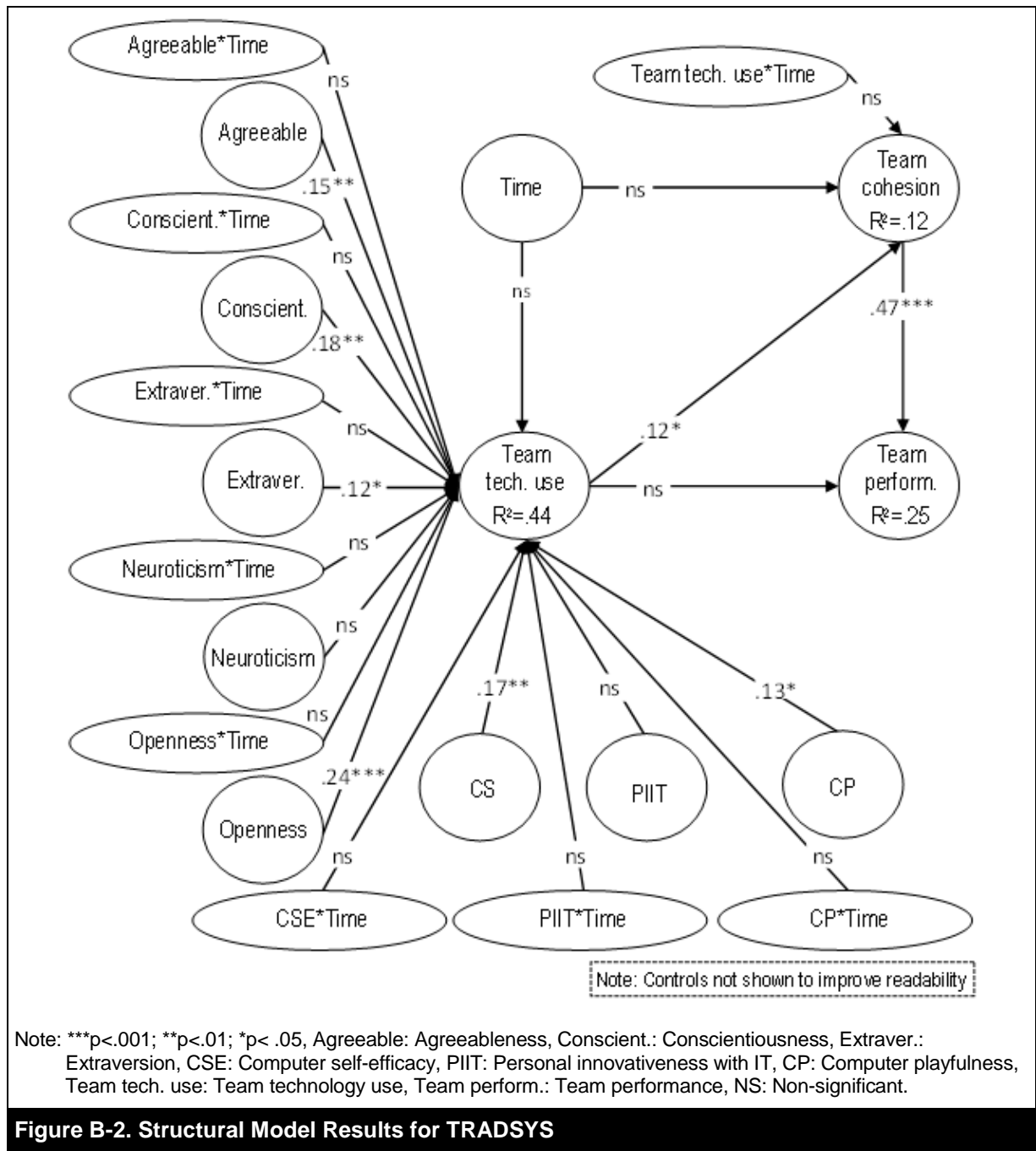
Figure B-2. Structural Model Results for TRADSYS

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