

Frank Siebdrat

**Virtual Teams – Understanding their Dynamics and Leveraging their Performance**

An Empirical Study of Software Development Teams



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To My Parents



## **Extended Summary**

Distance in work teams has become a cornerstone of today's business world as well as a fundamental research area. It has also become a prevalent team design factor that enables managers to combine the knowledge and skills of far-flung employees together in one team and, thus, to leverage their performance. However, it is not yet clear whether and how distance affects intra-team dynamics and performance. This dissertation addresses this fundamental research gap and explores the consequences of distance in teams and how virtual teams can overcome the burdens of virtual collaboration. More precisely, there are three burning issues addressed with regard to dispersed team dynamics: the perception of distance versus proximity, virtual teamwork processes, and the impact of the team context. In practice, it has been shown that the inadequate management of these issues plays a crucial role when virtual teams fall behind managers' expectations. However, practitioners to date have only limited knowledge how to handle these factors of virtual team performance effectively, due to the severe research gaps associated with these issues. Accordingly, this study's approach to explaining virtual team performance is built on these three focused elements of virtual collaboration.

Adopting this research focus, the empirical part of this work is structured into four research papers that empirically investigate whether and how perceived distance, team processes, and the team context may become critical for virtual team performance and the extent to which practitioners can build on these three success factors to optimize distributed work. The empirical analyses to these questions are based on a sample consisting of 161 software development teams with varying degrees of geographic dispersion.

The results presented in this dissertation clearly show that team processes, the perception of distance, and the team context matter for virtual team effectiveness. The research results of this study revealed team processes to be the key drivers of virtual team performance. In fact, virtual teams with high-level collaborative team processes are able to outperform their co-located counterparts, even those with the same quality of team processes. Teams with poor team processes, in contrast, suffer heavily from dispersion and underperform co-located teams with the same (low) levels of these processes. Thus, the effect of dispersion is not necessarily detrimental to team performance but rather depends on the quality of task-related team processes.

The analyses further show that it seems not (only) to be the actual degree of geographic dispersion that affects virtual team dynamics but rather the perceived level of distance between the members of a team. By exploring its antecedents, distance perceptions turned out to be mental states that emanate from complex and more socially-based constructions of the reality and are significantly affected by team members' national heterogeneity. This finding illustrates the need to include the social aspects of dispersion in future research on dispersed team functioning. For executives, this finding offers new opportunities how to reap the benefits of virtual collaboration without efforts of bringing team members together face-to-face.

A third antecedent of virtual team dynamics turned out to be the organizational context. The organizational context has been shown to affect virtual team performance more indirectly by changing the conditions in which team members collaborate. In this dissertation, two paths have been identified of how the organizational context impacts virtual team functioning. First, organizational context variables such as the degree of formalization facilitate the perception of proximity even for team members being geographically strongly dispersed. Second, the organizational context can facilitate virtual team performance by creating an environment for superior dispersed collaboration quality. These context-related findings show that the larger organizational environment can help distributed teams to cope with the liabilities of distance more effectively. In particular, there are distinct and manageable attributes of the organizational context that can be addressed to help team members developing perceptions of interpersonal closeness as well as to perform high-level dispersed teamwork.

The results of this dissertation offer both considerable contributions to the extant literature on virtual team dynamics and guidance for the formulation of best-practices in virtual team management. In the end, all presented theoretical models and corresponding research results help to learn more about virtual teams – especially about their dynamics and the antecedents of their performance.



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## Acronyms

e.g.	Exempli gratia (for example)
Email	Electronic mail
etc.	Et cetera (and so forth)
HLM	Hierarchical linear modeling
HRM	Human resource management
i.e.	Id est (that is)
ICC	Intra-class correlation
Lab	Laboratory
Log	Logarithm (natural)
N	Number of observations in the sample at the respective level of analysis
OTS	Organizational team support
P-value	Probability value
R	Correlation
R&D	Research and development
$\chi^2$	Chi-square



*“New ideas will spread faster, leaping borders. Entire electorates will learn things that once only a few bureaucrats knew. Small companies will offer services that previously only giants could provide. Poor countries will have immediate access to information that was once restricted to the industrial world and traveled only slowly, if at all, beyond it. In all of these ways, the communications revolution is profoundly democratic and liberating, leveling the imbalance between large and small, rich and poor. The death of distance, overall, should be welcomed and enjoyed.” (Cairncross, 2001: 6)*

*“Even if you are on the other side of the cafeteria, you are in another sphere of influence. Outside of that range, the next major jump is across a different time zone.”  
“YOU make the same mistakes if the distance is 4,000 miles or 10. You still tend to turn to the person in front of you for the answer. I respond more to people I see more often.” Two manager appraisals cited by Armstrong and Cole (2002a: 171).*

## **1 Introduction**

### **1.1 VIRTUAL TEAMS: RELEVANCE AND DEFINITION**

Distance and proximity between people have been the subjects of social science research for decades (Kiesler & Cummings, 2002). This long line of studies began mostly in non-work (i.e., social, residential, and educational) settings to control for various influences on specific dependent variables. These studies dealt primarily with how short distances and physical barriers (e.g., file cabinets, partitions, and walls) between people negatively affected their dyadic interactions (e.g., Blake, Head, Wedge, & Mouton, 1956; Byrne & Buehler, 1955; Maisonneuve, Palmade, & Fourment, 1952; Stewart, 1942). These and other studies in the same tradition (Athanasίου & Yoshioka, 1973; Kahn & McGaughey, 1977; Newcomb, 1961) demonstrated a positive association between physical proximity, interpersonal liking, and communication frequency. Festinger and colleagues (1950), for instance, found that graduate students and their families who were randomly assigned to housing near one another were more likely to become friends. Similarly, Gullahorn (1952) demonstrated within a controlled office situation that although interaction between office personnel was significantly reduced by the presence of filing cabinets separating rows or sub-groups, the interaction within sub-units was increased. While this early work proved quite clearly that ‘distance matters,’ it did so in mostly experimental, dyadic, non-organizational, and/or non-work contexts (Van den Bulte & Moenart, 1998). Furthermore, it did so with distances mostly measured in feet not miles or kilometers, hence the

description of these studies as “proximity” not “distance” research (O’Leary & Cummings, 2007).

In the 1970s, researchers began to demonstrate the importance of distance in work settings and to extend the distances in question. Some of the most influential works in this line of research are the studies in which Allen (1977) demonstrated that the frequency of work-related technical communication between pairs of co-located co-workers decreases rapidly as distance between those co-workers increases. In Allen's data, for example, about 25% of the subjects whose offices were next door (less than 5 meters apart) talked to each other about technical topics at least once per week; if their offices were 10 meters apart, this figure dropped well below 10%. After this sharp decline, the curve asymptotes at approximately 30 meters, so that subjects 30 meters apart and those several miles apart would have nearly the same low probability of talking to each other at least once per week. More than any other works, Allen’s (1977) research brought the group research on proximity and distance into an organizational context. His studies still largely represent the standard in that regard. In fact, as Rice and Gattiker (2001: 558) have noted, “few researchers other than Allen (1977) have seriously considered the ways in which physical structures constrain or facilitate organizational communication.” At the level of specific floor plans within the organization, Allen’s field-based quasi-experiments with different office layouts have led many companies (e.g., Apple, BMW, and Chrysler) to re-design their facilities to enhance communication and, thus, performance (Becker & Steele, 1995).

However, while the basic principles of this ‘proximity research’ are still valid, they do not fully apply with the current situation in teams, especially in new product development teams. Within the last 25+ years, teamwork in research and development (R&D) has changed remarkably (Gassmann & Zedtwitz, 2003). Today, firms increasingly move towards smaller, more numerous, and more decentralized units that suit the increasingly complex and information-rich nature of new product development, so that different floor plans no longer capture the more complex reality. Employees involved in the development of new products often reside locally in pockets of excellence in the national company network or even around the world (Brockhoff & Medcof, 2007; Leenders, van Engelen, & Kratzer, 2003). In addition, the formation of alliances, joint ventures, and international subsidiaries further nourishes the trend towards larger distances in team designs (Prasad & Akhilesh, 2002).

One reason for the increasing use of virtual teams is the trend toward expanding business activities around the globe and matching team design accordingly. For most companies, the imperative to 'go global' is absolute due to their need to access markets and human resources, to localize products, or exploit diverse capabilities and expertise (Prasad et al., 2002). Managers have increasingly realized that organizational and geographic boundaries no longer need to prevent employees from working on the same project. If internationalization as a business pull is one reason for the proliferation of dispersed teams, the technology push is another. The advent of new communication technologies – from the simple such as emailing to the more sophisticated such as audio and video-conferencing – has significantly helped people overcome the barriers of distance and time (Dewett & Jones, 2001; Maruping & Agarwal, 2004). The new wave of digital technologies as well as the strategic and operational need to internationalize businesses has led to virtual team structures becoming commonplace.

According to recent figures (Conlin, 2005), about 12% of the US workforce can be described as distributed. In urban areas, the estimate is 15% and it is predicted that 40% of the workforce will be distributed by 2012. Increasingly, US federal and state governments have encouraged this work arrangement through the introduction of legislation (e.g., Department of Transportation and Related Agencies Appropriations Act of 2000; US Office of Personnel Management, 2005). Outside the United States, a survey of 254 senior-level executives revealed that staff in two-thirds of their global firms were involved in distributed work (Gajendran & Harrison, 2007). At some companies, like IBM, 40% of the workforce is already working virtually. At Sun Microsystems, nearly 50% of employees are allowed to work from home, drop-in centers, and other locations. Finally, Intel reports that over 70% of their global workforce is considered as working 'virtually' (Hymowitz, 2006).

*But what defines a virtual team and what are the key differentiating characteristics between these teams and their traditional counterparts?* An in-depth look at the literature reveals much confusion regarding the definition of virtual teams (Arling, 2007; Dubé & Paré, 2004). They are variously defined as diverse members working remotely, electronically dependent, geographically dispersed, or dynamic, and often referred to as 'virtual teams,' 'dispersed teams,' 'distributed teams,' or 'telecommuting teams' (Bell & Kozlowski, 2002; Gibson & Cohen, 2003; Griffith, Sawyer, & Neale, 2003; Kirkman & Mathieu, 2005; Martins, Gilson, & Maynard, 2004). While the commonly used label 'virtual team' suggests a binary distinction between virtual teams and non-virtual teams – specifically in prior research (Gibson & Gibbs, 2006) – virtuality

or dispersion is acknowledged as a dimensional construct in this dissertation. In their case study analysis, Majchrzak et al. (2000: 574) describe a team that can be regarded as an exemplary current development team:

*“Two members were located in different ends of the same building, three other members were each one mile away in different buildings; one member of a second organization was located 100 miles away; and two members of the third organization were located 1,000 miles away in different buildings. ... [Team] members limited their travel since they were involved in many different teams within their company. As a result, all members were together only once – at the end – although there were three other formal meetings held in which some members attended ...”*

This example of a dispersed development team illustrates that it is not sufficient to map virtuality as a distinct variable, differentiating virtual from co-located teams. Rather, for most teams, being virtual is a matter of degree. At one extreme, a team is completely virtual in that its members are geographically and temporally fully dispersed and communication is maintained solely through electronic means. This structure rarely arises in organizational environments. Even in highly dispersed project teams with specialists scattered across the world, chunks of the work are often done by individuals located in the same building or at the same site (Leenders et al., 2003). While virtuality in new product development has undoubtedly increased and will continue to increase (Gajendran et al., 2007), the fully virtual R&D team is still scarce. The other extreme, the conventional, fully co-located R&D team in which all specialists live under the same physical roof and all communication occurs face-to-face is also increasingly unlikely (Leenders et al., 2003). In reality, attributes of virtuality can be assigned to any team, regardless of its level of dispersion, particularly as also fully co-located teams may have the characteristics of a ‘virtual’ team (Griffith & Neale, 2001; Sessa, Hansen, Prestridge, & Kossler, 1999). Co-located teams, for instance, also use communication technologies such as email, telephone, and voicemail – sometimes as often as virtual teams do (Mortensen & Hinds, 2001). Furthermore, being located in two different rooms on the same floor may be as detrimental to interpersonal communication as being hundreds of miles apart (Allen, 1977; O’Leary et al., 2007). Thus, the degree of virtuality or distance is more continuous, and the decision regarding the co-location versus dispersion of team members is not a matter of choosing between two discrete dichotomous alternatives, “but rather one of discerning among the many shades of gray between these two extremes” (Hoegl, Ernst, & Proserpio, 2007a: 162).

Although most researchers have recently agreed that teams' virtuality is continuous, they referred to conceptually different sub-dimensions of this overall construct (Kirkman et al., 2005; Watson-Manheim, Chudoba, & Crowston, 2002). The number and complexity of the dimensions vary from one conceptual framework to another. Cohen and Gibson (2003b), for instance, include two dimensions: electronic dependence and geographic dispersion. Griffith, Sawyer, and Neale (2003) posit that team virtualness can be defined along three dimensions: the distribution of the physical locations occupied by team members, the percentage of work that the team performs with its dispersed members, and the level of technological support used by the team. Martins, Gilson, and Maynard (2004) developed four dimensions: geographical dispersion, use of computer-mediated communication, temporality, and diversity. Chudoba et al. (2005) suggest a virtuality index which includes geography, time zone, organization, national culture, work practices, and technology as respective dimensions.

In this dissertation, distributed teams are considered as differing from traditional teams in only two respects: members are separated by distance and forced to rely on technology to mediate their communication and collaborative work (Hinds & Bailey, 2003a). At first glance, this approach may appear to rule out other properties that might distinguish a distributed team from a co-located one. However, in this dissertation, it is assumed that all other traits that may be associated with geographical distribution derive from distance or technology mediation. For example, some, but not all, distributed teams may experience incongruent temporal rhythms because members work in different time zones (Rutkowski, Saunders, Vogel, & van Genuchten, 2007), but different time zones occur as a result of distance. Likewise, members of a distributed team may have members pertaining to different cultures. Beyond the impact of distance, distributed teams are no more or less likely than co-located teams to have members with culturally diverse backgrounds. Moreover, the effects of technology mediation are distinct from those of distance. Although distributed team members must rely on technologies because of their distance, technology mediation is also common in co-located team settings with subsequent consequences for their collaboration (Mortensen et al., 2001). Among the many characteristics that might distinguish geographically distributed teams from co-located ones, separation by distance and reliance on mediating technologies are the only two factors that hold true for all distributed teams (Hinds et al., 2003a).

Adopting geographic dispersion and technological mediation as the main characteristics for specifying virtual teams, virtual teams are defined in this dissertation as *small collections of*

*people with a common purpose, who carry out interdependent tasks across distance, regard themselves and are regarded by others as a team, and rely on information technologies to communicate, collaborate, and coordinate work* (Cramton, 2001; Lipnack & Stamps, 1997; Saunders & Ahuja, 2006). Thus, in this dissertation, the terms ‘virtual team’ and ‘dispersed team’ both indicate that a team is comprised of members from different locations who use some sort of technology for their interaction. As is the prevailing practice in current research, the labels ‘dispersed team’ and ‘virtual team’ are therefore used interchangeably throughout this dissertation (McDonough, Kahn, & Barczak, 2001). Likewise, the subsequent use of differentiations such as ‘co-located’ versus ‘dispersed’ teams does not indicate an underlying dichotomous view, but instead, a polarization between the two extremes on a continuous dispersion scale.

## **1.2 RESEARCH GAP, RESEARCH QUESTIONS, AND CONTRIBUTION**

Given their increasing emergence, virtual teams have been the subject of considerable research attention, which has yielded initial insights into the mechanisms of dispersed team collaboration. Researchers have, for instance, investigated the effect of factors such as trust (Kanawattanachai & Yoo, 2002; Paul & McDaniel Jr, 2004), conflict (Kankanhalli, Tan, & Kwok-Kee, 2006; Mortensen et al., 2001), identification (Fiol & O’Connor, 2005), knowledge transfer (Boh, Ren, Kiesler, & Bussjaeger, 2007a; Caya & McGill, 2008a), and shared norms of IT use (Majchrzak et al., 2000) regarding the output quality of virtual teams. Others have studied the influence that geographic dispersion has on individual-level outcomes such as team member satisfaction (Warkentin & Beranek, 1999), attitudes (Staples & Cameron, 2004), and commitment (Powell, Galvin, & Piccoli, 2006). More recently, virtual team research has also addressed widely neglected, more historic, traditional team research topics such as team member familiarity and friendship development (Espinosa, Slaughter, Kraut, & Herbsleb, 2007c), individual learning (O’Leary, Woolley, & Mortensen, 2008), team role disagreement (Mortensen & Beyene, 2008), and leadership (Hoegl & Muethel, 2007b; Mehra, Smith, Dixon, & Robertson, 2006).

Despite this increasing body of research on the dynamics of distributed work, the conceptual and empirical understanding of virtual teams is still underdeveloped. While scholars increasingly include a measure of geographic dispersion in their studies, dispersion itself has almost been a black box for researchers. It has been a domain-defining condition rather than a variable



of direct interest. The fact that dispersion has been taken for granted is due to at least five factors. First, research on geographically dispersed teams is still in its infancy and the domain is still being mapped (O'Leary et al., 2007). Second, the majority of research on geographically dispersed teams has been done in laboratory or controlled field settings with teams lacking an organizational history and without an anticipated future (Hertel, Geister, & Konradt, 2005; Scott, 1999). Consequently, variations in dispersion have actually been controlled away in an attempt to focus on other factors of interest. In this laboratory research, the dominant view of dispersion is still dichotomous – teams are either dispersed or not, with little gray area in between (Arling, 2007). Third, frameworks with which to characterize degrees of geographic dispersion in work teams are lacking, nor is there a clear theoretical basis for understanding the role of geographic dispersion in teams. Instead, the available evidence from virtual teams operating in organizational contexts tends to have been gathered inductively, with an emphasis on practical matters (Hinds & Mortensen, 2005). Fourth, most research has focused on student teams, and only a few studies have investigated dispersed teams in organizations (Martins, Gilson & Maynard, 2004; Webster & Staples, 2006). In addition, most studies use samples with limited variation in geographic dispersion. This variance restriction in dispersion measures as predictors of team dynamics complicates the drawing of conclusions from the specific influence of distance. And finally, previous research has tended to lump various features of 'virtuality' together without examining the possible independent, differential, and perhaps even unintended, effects of each characteristic (Gibson et al., 2006).

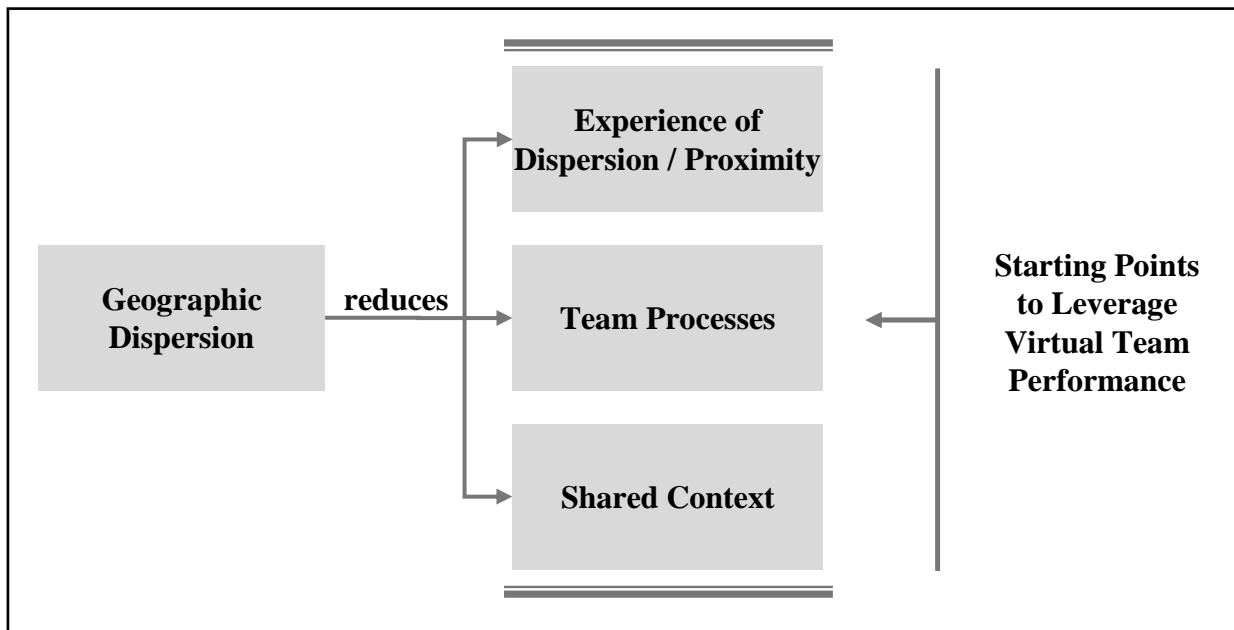
In addition to the conceptual and empirical shortcomings, research has to date revealed inconsistent results regarding the effects of distance on team performance (Martins et al. 2004). While researchers have found that virtual teams achieve the same performance levels as co-located teams, or even outperformed them, most others have reported lower outcomes for dispersed teams (Martins et al., 2004; Powell, Piccoli, & Ives, 2004; Webster & Staples, 2006). In trying to explain these inconsistent results in respect of virtual team performance, researchers have not only pointed to the above raised shortcomings of prior research, but also to the indirect, more ambivalent influence of distance (Kiesler et al., 2002). This ambivalence of distance-related effects has led some authors to conclude that working with virtual teams is double-edged (Kiesler et al., 2002; O'Leary et al., 2007). On the one hand, virtual collaboration makes obtaining access to diverse knowledge and skills possible in a flexible and cost efficient manner and is therefore an increasingly important source of competitive performance (Doz, Santos, &

Williamson, 2001). On the other hand, collaboration across boundaries such as time, space, and culture has been proven to be harmful to a wide set of different dimensions of teamwork (Chudoba et al., 2005; Hinds & Kiesler, 1995; Hoegl & Proserpio, 2004a).

The methodological shortcomings as well as the inconsistent findings of prior research on the antecedents of virtual team performance present managers with a puzzle regarding how virtual team performance should be leveraged. While choosing and managing the right collaboration mode seems to be highly critical, companies still have little guidance in making these decisions. The level of empirical insight into multinational group dynamics is not sufficiently advanced to predict with any precision how and why the balance of advantages and disadvantages shifts across teams. As Hambrick et al. (1998: 193) noted: “we must be particularly concerned with the question of why some MNGs (multinational groups) are very effective, while others are very ineffective.” Armstrong and Cole (2002a: 183) likewise contended that “some work groups are more effective than others, even if their memberships span a greater geographic distance and encompass more time zones and cultures than other, less effective groups.” To date, it is not even clear whether and how team performance is instantaneously affected by dispersion, additionally affected by various confounds (such as national diversity), or indirectly influenced through intermediate team processes (Espinosa, DeLone, & Lee, 2006b). Taking exception to much of the previous research on the influence of distance on communication, Van den Bulte and Moenaert (1998: 3), for instance, claimed that “previous research does not allow one to conclude confidently that distance is a major barrier to communication in R&D settings.” Furthermore, other authors question whether dispersion is at all critical for team performance (Schunn, Crowley, & Okada, 2002; Singh, 2008). Performance may depend more on the way in which dispersion influences team processes and on how these processes are managed.

As a response to this research gap, the present work addresses the fundamental, yet not sufficiently addressed, research question ‘*how to optimally leverage dispersed team’s performance*’ by overcoming the methodological and conceptual shortcomings of prior research. Given the already mentioned ‘double-edged’ nature of geographic dispersion, virtual team performance can generally be leveraged by increasing the opportunities and/or reducing the liabilities of virtual work. The opportunities of virtual collaboration (e.g., access to diverse markets and expertise) are apparently intertwined with the dispersed nature of virtual teams and invariant after managers have chosen this team design. A feasible way of increasing virtual team per-

formance is, however, to escape the liabilities of distance. Owing to this argumentation, virtual team performance strongly depends on teams' ability to cope with the liabilities of distance. Thus, distance leads to reduced performance only in those teams that are not able to overcome the burdens of distance. Starting with the above research question, this study is therefore aimed at identifying ways in which virtual teams can overcome or at least mitigate the liabilities of dispersion, and thus leverage performance.



*Figure 1-1: Responses to Dispersion and Starting Points to Leverage Virtual Team Performance (adapted from Kiesler & Cummings, 2002)*

*But what are the liabilities of virtual team collaboration?* According to Kiesler and Cummings (2002), geographic distance has three primary liabilities from which other, more indirect, consequences are derived. These liabilities are (1) less social presence (i.e., the experience of distance or proximity), (2) impaired team processes (e.g., infrequent face-to-face contact and spontaneous communication), and (3) reduced shared context. Consequently, the present research adopts these three elements as the primary liabilities of geographic distance as well as possible starting points for virtual teams to overcome distance (see Figure 1-1). Effectively managing these three liabilities would therefore not only mean helping team members to cope with the dark side of dispersion but also to increase virtual team performance.

As a first response, increasing distance between team members has been shown to reduce the social presence of others – a sense of being with another induced by technological mediation (Biocca, Harms, & Burgoon, 2003; Short, Williams, & Christie, 1976). Accordingly, it has been

widely assumed that there is a one-to-one relation between physical distance and team members' experience of distance (Harrison-Hill, 2001). However, the perception of distance has recently been proposed as more than just a mental representation of its physical value. Instead, perceived distance is assumed to be a subjective appraisal and, in addition, a more proximal, yet neglected, predictor of virtual team dynamics and performance (Wilson, O'Leary, Metiu, & Jett, 2008). It is in line with the most prominent behavioral theories that the idiosyncratic *perception* of a stimulus affects complex team processes more than the stimulus' mere physical presence (Stroh, Northcraft, & Neale, 2002). Virtual team success may likewise be more strongly affected by team members' *perception* of distance than by their actual physical distribution. Despite of this apparent potential to predict, explain, and understand virtual team effectiveness more precisely, scholars to date have largely ignored the subjective component of physical distance in their research. To date, there is no profound knowledge available for subjective distance as a new construct of virtual team research, nor for its antecedents or for its consequences (Wilson et al., 2008). The present research therefore addresses this research gap and includes team members' proximity perceptions as a first proposed starting point for increasing virtual team performance.

Second, team processes such as informal communication and coordination are instantaneously affected by distance, as it is more difficult to get all team members in one place or to speak personally (Allen, 1977; Jarvenpaa & Leidner, 1999; Moenaert, Caeldries, Lievens, & Wauters, 2000). Allen's (1977) already outlined study results further demonstrate that personal communication is significantly complicated by even short distances. In addition, distance places significant constraints on the functioning of a team's social system, so that interpersonal processes like trust and cohesion hardly evolve (Hoegl et al., 2004a). Teams' collaboration quality is therefore most likely to be a second driver of virtual team performance, since sound team processes are necessary for virtual teams to exploit their diverse knowledge (Cummings, 2004; Van der Vegt & Bunderson, 2005; Zhu & Cummings, 2008). However, research to date has predominantly focused on the direct link between dispersion and performance and, thus, leaves a considerable research vacuum with regard to the identification of processes that may help virtual teams to overcome distance and to leverage their inherent potential (Cummings, 2007). Consequently, the present study addresses this research gap and includes team processes as a second potential starting point to leverage virtual team performance.

Third, dispersed team members do not share the same social setting (e.g., laboratory or office), which fosters the development of divergent behavioral norms, mental schemas, and expectations (Kiesler et al., 2002). Interaction across distance carries too little information about other team members' context to compensate for this lack of shared context. Consequently, the sparse availability of contextual cues impedes team members' ability to regulate interaction, express information, and monitor feedback, thus negatively impacting the establishment of mutual understanding (Cramton & Webber, 2005b; Kraut, Fussell, Brennan, & Siegel, 2002; Sproull & Kiesler, 1986). An organizational context conducive for dispersed teamwork, however, is often assumed to be of particular importance in virtual teams (Joshi & Roh, 2008). An organization with an international human resource management (HRM) promoting a global mindset, for instance, seems to be more likely to foster virtual team processes than a local operating company without such practices. While the surrounding context may be essential for explaining virtual team dynamics, as has been often reported in case studies on dispersed teams (e.g., Armstrong et al., 2002a), the decisive impact of the organizational context on virtual team collaboration is still a black box in current research (Martins et al., 2004; Zellmer-Bruhn & Gibson, 2006). It is not yet clear, to what extent virtual team collaboration is affected by the surrounding organizational context nor whether context has different effects on dispersed and co-located team members. Consequently, the present work addresses this fundamental gap in virtual team research and includes the organizational context as a third starting point to leverage virtual team performance.

Overall, there are three burning issues for practitioners to be addressed when aiming at leveraging virtual team performance: perceived proximity, team processes, and team context. In practice, the inadequate management of these issues is likely to play the crucial role when virtual teams fall behind managers' expectations. However, practitioners to date have only limited knowledge how to handle these leverage points effectively, due to the severe research gaps associated with these issues. Accordingly, this study's approach to explaining virtual team effectiveness is built on these three points of leverage. In the empirical part of this dissertation, it will be evaluated whether and how perceived distance, team processes, and the team context may become critical for virtual team performance; and the extent to which practitioners can build on these three success factors to optimize distributed work.

Acknowledging that the three antecedents of virtual team performance are – at least in part – interdependent, a more comprehensive picture will be drawn by highlighting and empirically

testing the interrelations between and contingencies of these variables. In respect of the organizational context, it can be specifically assumed that its influence does not directly affect team performance, but that the contextual influence is – at least partially – mediated by teams' emergent states or processes (Hinds et al., 2003a; Hinds et al., 2005; Kiesler et al., 2002). Consequently, cross-level influence on teams' processes and perceptions will be empirically investigated rather than organizational context elements' direct impact on virtual team performance. Departing from the overriding research question of how to leverage virtual team performance and the three proposed levers to do so, the following – more specific – research questions arise as the main issues of this study:

- How does objective distance translate into perceived distance, are both distinct, and if so, which is more predictive of virtual team processes and, thus, performance?
- Are virtual teams able to overcome the burdens of geographic distance, possibly even outperforming co-located teams, if they manage to achieve high-level teamwork?
- Does the organizational context impact virtual team dynamics? Which characteristics are significant for the development of proximity perceptions? Which context elements foster or inhibit the development of high-level dispersed teamwork?

In order to explore these research questions, the team will be the focal unit of investigation rather than the individual, since most virtual work in organizations is done in teams (Edmondson, 2002; Gully, 2000). Given that the consequences of geographic dispersion may even be more dramatic for work teams than for individuals due to the coordination required to accomplish a set of tasks, the team-level analysis is further justified (Cummings, 2007). Consequently, this study does not address any individual-level outcomes such as individual learning or personal success.

Given also this study's focus on the success factors of virtual team collaboration, teams' technological equipment would have been another very obvious variable for consideration, since technological mediation is a definitional characteristic of virtual teams (see chapter 1.1). However, teams' access to communication technology is one of the best studied variables in virtual team research and prior research suggests that even superior technology is not a panacea for virtual team effectiveness (Kiesler et al., 2002; Kozlowski & Ilgen, 2006; Olson & Olson,

2000). In addition, interviews with project managers before the data collection of this study commenced revealed that teams in this sample predominantly use the same technological tools for their remote interaction. Hence, technological equipment does not appear to be an essential success factor for virtual team collaboration and is therefore not included in this study. The perceived *extent* of technological mediation is, however, assumed to differ considerably between the teams in this sample and is included as one aspect of team members' perception of distance. Furthermore, there are additional starting points to virtual team performance discussed in the literature such as face-to-face meetings (Crowston, Howison, Masango, & Eseryel, 2007) and leadership style (Cummings, 2007). However, these approaches affect virtual team performance more indirectly through their impact on team processes and mental states, which are focus variables of this research. Consequently, concepts like virtual team leadership are not included in the empirical analyses of this work but considered in the discussion of results and managerial implications.

Using this conceptual framework to examine the presented research questions, the *main contributions* of this work to the extant research on virtual teams are threefold:

- (1) This research employs the newly formulated construct 'perceived distance' (Wilson et al., 2008) and empirically investigated its yet unexplored antecedents and consequences. The consideration of perceived distance does not only enrich the conceptualization of dispersion, but also helps to open up the black box of what it means to be dispersed. Perceived distance can therefore be assumed to represent a critical, though missing link to understanding dispersed team dynamics and performance. Perceived distance can furthermore be assumed to help reconcile conflicting claims about the impact and importance of distance, as well as explaining the contradictory empirical findings of the research to date (Wilson et al., 2008).
- (2) Prior research extensively explored the relationship between dispersion and many different team processes, but it did so by testing the direct relationship between dispersion and one or few selected team processes. While offering interesting insights in the effects of distance on teamwork, this research leaves open, which team processes are most critical for virtual teams to harness their full potential (e.g., Paul et al., 2004). This study therefore considers a broad set of team process variables and their contribution to explain virtual teams' ability to overcome distance and to use

the potential inherent in virtual work for superior performance. In so doing, this study provides fuller insight into the mechanisms of how dispersion might be harnessed and why some virtual teams are more effective than others (Armstrong et al., 2002a).

- (3) There is still a sizable gap in researchers' knowledge of the role that contextual factors play in shaping virtual team processes and performance (e.g., Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Kozlowski & Bell, 2003). While context provides the purpose, resources, social cues, and norms for team processes (Jackson, Joshi, & Erhardt, 2003), it is not yet clear whether and how virtual team dynamics are affected by their surrounding context. This research makes a first step toward empirically testing of how organizational context variables influence team processes as well as team members' perception of distance and, thus, virtual team performance. In this regard, the present study contributes to open the black box of the organizational context for virtual team dynamics and goes well beyond the taken-for-granted assumptions of prior research (Joshi et al., 2008; Mortensen et al., 2008).

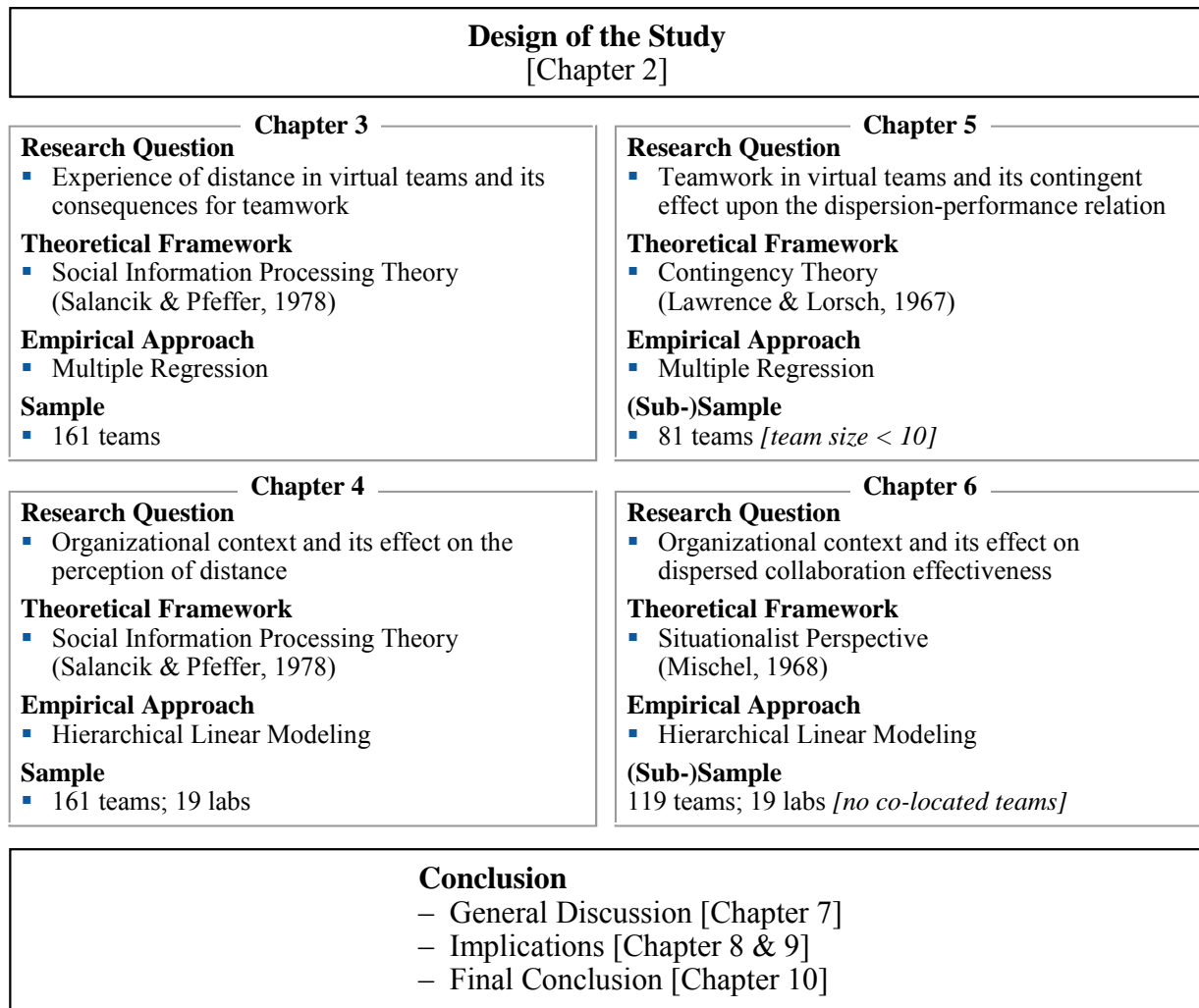
To achieve these conceptual contributions, this research investigates all hypothesized associations by employing state-of-the-art measures of team dispersion, differentiating between geographic, temporal, and configurational aspects. The more detailed assessment of various aspects of dispersion goes well beyond prior research (e.g., Cramton et al., 2005b) and helps to disentangle effects that can be primarily attributed to geographic distance from other confounded effects (Espinosa et al., 2006b). Furthermore, all hypothesized relations in this research are developed based on a strong theoretical foundation. The findings revealed in this work will help to confirm, reconcile, and expand the used theoretical models and to evaluate their significance for explaining virtual team dynamics. In particular, this research draws predominantly on micro theories that have been designed to describe intra-team dynamics, such as social information processing theory (Salancik & Pfeffer, 1978), social presence theory (Short et al., 1976), and the faultline model for sub-group dynamics (Lau & Murnighan, 1998). In the end, the presented research results should help develop implications for future theory building and derive clear-cut propositions of how practitioners can optimally design virtual work in order to leverage dispersed team performance.



### 1.3 OUTLINE

The remainder of this dissertation is structured into nine chapters that correspond to three larger sections. Figure 1-2 provides an overview of this study's outline and shortly summarizes descriptive information about the chapters in the empirical section. In the next chapter (chapter 2), the design and sample of the study are described, which have been laid out for this study's purpose. The subsequent four chapters make up the main section of this dissertation and empirically examine this study's research questions. These four chapters are organized according to the three hypothesized success factors of virtual team performance (perception of distance, team processes, and organizational context). As the first chapter of the main part, chapter 3 motivates and introduces the concept of perceived distance and explores its antecedents as well as its consequences for the team-level analysis. Building on these findings, chapter 4 moves from the team level to the organizational level and examines whether the organizational context exerts a significant influence on team members' perception of distance, and, in turn, on their performance. Chapter 5 focuses on team processes as the next hypothesized predictor of virtual team performance and pursues the question whether the dispersion-performance link is contingent upon teams' level of collaboration quality. Confirming team processes as highly critical for virtual team performance, Chapter 6 also moves to the organizational level of analysis and investigates to what extent the organizational context can support or constrain dispersed collaboration effectiveness.

Each of these chapters addresses one research question and is structured as an empirical research paper. After a short abstract that highlights the intention as well as the main findings, each of the chapters begins with an introduction, continues with theoretically derived hypotheses, shortly describes the empirical methodology, including the sample and measures, reports results, and concludes with a discussion of the findings. This division into four paper-structured chapters has been chosen to depict the different perspectives on virtual teams required by the presented research questions of this study. While some redundancies are inevitable in these empirical chapters, especially in the methodological part, it should be noted that the four chapters deal with different research questions, utilize different analysis methods, and partly rely on different sub-samples (Figure 1-2).



*Figure 1-2: Outline of the Present Study*

The last section concludes this dissertation, drawing common themes from the four studies, highlighting key contributions for the understanding of virtual team dynamics, and pointing towards promising areas of future research. In this final section, an emphasis is placed on issues that still remain to be explored in order to open up the black box of virtual team dynamics.

## **2 Design of the Empirical Study**

### **2.1 PROCEDURE**

This study was planned and constructed to meet all the requirements that emerge from the presented research questions. To ensure that all relevant constructs are included in the study design, a detailed analysis was conducted of the existing literature and exploratory interviews undertaken with managers from different companies and industries. The literature review as well as the manager interviews confirmed the significance of the research questions and helped to identify the relevant variables for this study. This preceding analysis further showed up the need to conduct a large-scale empirical study on real business teams. The literature review, specifically, revealed that prior research into the antecedents of virtual team performance were limited with regard to sample characteristics. These limitations encompass prior studies' focus on management-oriented or conceptual research, largely based on a small number of case studies, and the use of student samples, or marginally dispersed business teams. Thus, there was a strong need for a large-scale empirical study that would allow managerial recommendations, backed by empirical data from real business teams, to be derived.

The interviews with executives from different industries further revealed that the software industry suits the aim of the present study optimally. In particular, the following four reasons motivated this study's reliance on software development teams:

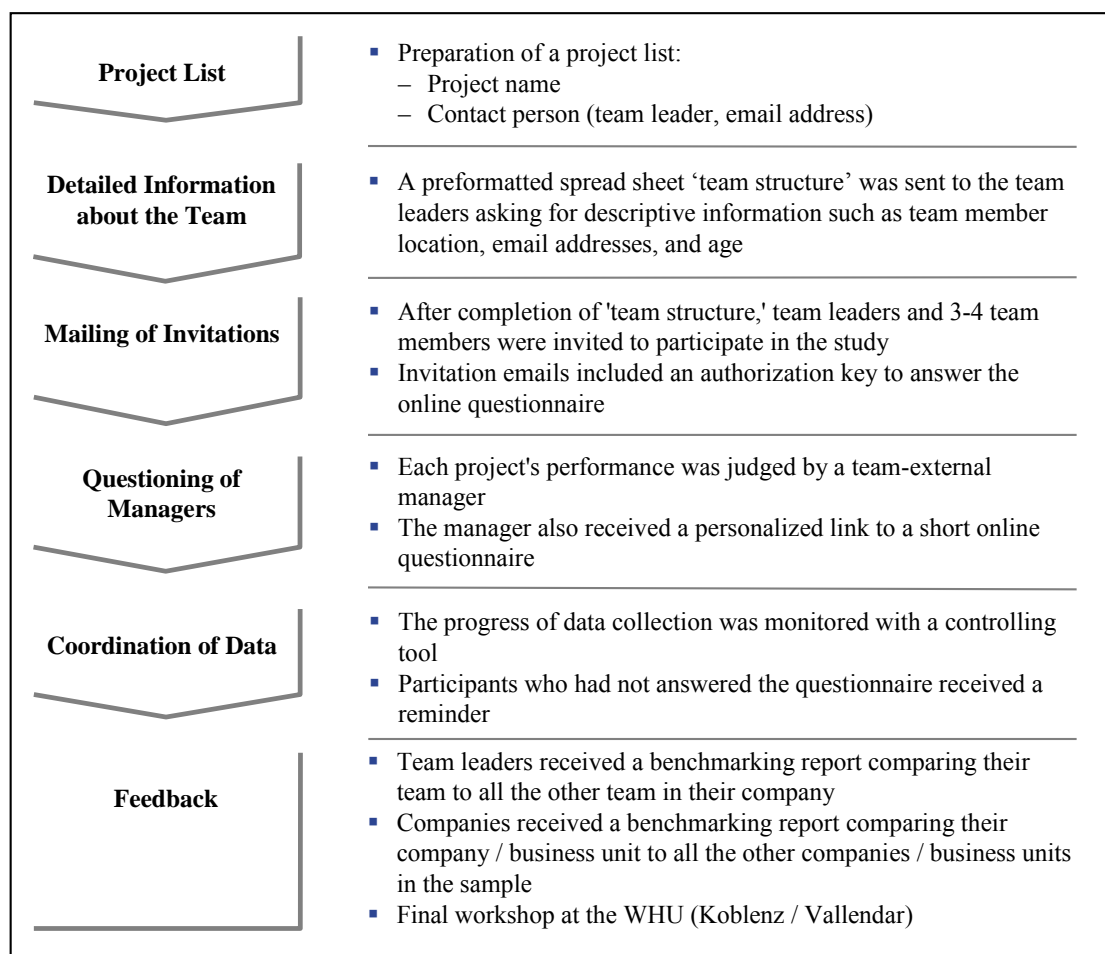
- (1) Compared to other industries, the software development industry is quite homogeneous, which helps to reduce the within-sample variance in attributes for which the study does not account.
- (2) Owing to its digital outputs, the software development industry typically has a higher degree of dispersion than other businesses and therefore guarantees enough variance in the focal variable for subsequent statistical analyses (Espinosa & Carmel, 2004).
- (3) The performance criteria can be defined more specifically to meet the idiosyncratic requirements of the software developing industry than when various industries are represented in the sample.

- (4) The software industry is one of the leading business sectors in Europe and provides a sufficient data pool from which to draw a large-scale business sample.

Having chosen the industry focus for this study, a preliminary questionnaire was constructed for trial interviews with representatives from three different software companies (not included in the final sample). These interviews revealed the need to match the selection and wording of some of the study variables with the specific requirements of this industry, leading to various items being revised or newly generated. After this industry-specific adaptation, a web-based survey was constructed, offering employees the possibility to access the questionnaire from their international office locations.

All constructs considered in this questionnaire refer to the team as the unit of analysis. Accordingly, all measures pertaining to this questionnaire were specified on the team level. The respondents were therefore asked to evaluate the properties and behaviors of the team as a whole. The questionnaire was administered in German and English. A pretest of the online questionnaire was conducted with seven members of a software development team at a Swiss consulting and engineering company. Following this pretest, the wording of some items and the layout of the online questionnaire were refined for later use in the main study. Nearly all the items were drawn from published scales and anchored as 1, “strongly disagree” to 5, “strongly agree.”

For the acquisition of participating teams, only larger software development companies were addressed, providing the possibility of nominating several teams to take part in this study; a procedure that helps to reduce the number of companies and, hence, the amount of company-specific variance in the final data set. As an incentive to participate in the study, companies were offered a benchmarking report showing the relative performance of their company or business unit in comparison to anonymized benchmarking partners in this sample. In addition, company representatives received recommendations on how to improve the collaboration in their development teams in terms of a final report and a post-study workshop.



*Figure 2-1: Detailed Procedure of Data Collection with Online Questionnaire*

After the companies had confirmed their participation, the data collection procedure was initiated and structured into a number of consecutive steps. As depicted in Figure 2-1, in a first step, the participating companies produced a list of projects, as well as the names and contact information of the respective team leaders. In the second step, the team leaders were provided with additional information about the present study and asked to complete a pre-defined spreadsheet with descriptive details about the team and all the team members. In addition, in personal kick-off meetings with all the participating team leaders, it was established that 'real' teams or 'core teams' has been selected. Consequently, a group of software developers was only regarded as a 'team' or 'core team' if all the members collaborated regularly and were not only informed via mailing lists about the project's status. This team leader instruction was very important for the present study, as it became apparent that software development is frequently organized in multi-team projects with considerable degrees of dispersion. However, team member collaboration was found to predominantly occur in smaller sub-teams of these multi-team constructs, partially in respect of tasks worked on in co-located team settings. Thus, in order to

make valid and comparable statements about the effects of dispersion, only teams with close collaboration between the team members were included in the study.

Owing to the comparatively great effort required by the team leaders to provide the descriptive information on their project, motivating and monitoring team members' participation, and, finally, to fill out the online questionnaire, each team leader was offered an additional personalized, team-specific benchmarking report. This report benchmarked each team, showing its performance in comparison to the average of all other teams pertaining to the respective company or business unit.

Finally, the team leaders and team-external managers as well as randomly chosen team members were contacted and asked to complete the online questionnaire. The respondents' participation in this study was strictly voluntary and all were invited by means of an email containing a link to the online questionnaire. The study includes software development projects that were completed within 12 months prior to data collection and that were worked on by 'teams.' In the invitation email, a brief description was given of this study's purpose together with some descriptives of the software development project on which the recipients would be questioned, such as its name, as well as the name of the team leader and team members who had been involved. This information should ensure that all the participants were clear about the project to which the subsequent questions refer and help them to recall their project experiences as well as possible. Following the individualized link, each respondent was immediately forwarded to the online questionnaire. This questionnaire had been preceded by a front page explaining fundamentals of the subsequently following questions and ensuring the confidentiality of all responses. The completion time for the questionnaire was about 30 minutes for team leaders, 15 minutes for team members, and two minutes for managers. To be included in the final data set, the team leader, the team-external manager, and at least two team members of each team had to have completed the questionnaire.

After all the questionnaire data has been collected, an interview-based, follow-on study was conducted to gather information on the organizational context of the laboratories in which the teams had resided. This information was necessary for cross-level analyses of the impact of higher level organizational characteristics on dependent variables on the team level. The organizational-level data were gathered in individual phone interviews by the author of this dissertation with respective site managers, using a fully standardized questionnaire. The questionnaire

includes descriptive information about the lab (e.g., year of foundation) and several specific organizational variables such as the level of formalization and questions on the organizational culture. All constructs in this questionnaire were adapted from existing scales and anchored as 1, “strongly disagree” to 5, “strongly agree.” The overall data collection of this study began in June 2006 and was completed in October 2007.

## 2.2 SAMPLE

Five international software developing companies participated in this research with four headquartered in Germany and one headquartered in the USA. The development work of the participating companies was managed by 19 different software laboratories (labs). All the software labs are dedicated to the development, testing, and adaptation of basic software programs. While most software labs are proficient in the whole value chain of software development, some labs are specialized in certain functionalities or development processes such as banking or retail software solutions. Descriptive information on the 19 labs was collected in follow-on interviews with the site managers and is summarized in Table 2-1. As the variables ‘number of developers’ and ‘number of current teams’ show, the labs differ largely in size. While the smallest lab employed only three teams, the largest lab had more than 2,000 teams. Interestingly, while this sample consists of companies headquartered in Europe and North America, the lab sizes in India, Belarus, Israel, and China are considerably large, with around 4,000 employees in one development center in Bangalore (India), for instance. In addition, labs in this sample show noteworthy differences in the average age of their developers. While developers’ average age in West-European labs is around 40 years and above (with the exception of one lab in France), it averages 30 years and sometimes below in eastern, less developed countries such as Israel, China, and India. This finding reflects the trend of European and American software companies to globally expand their development capacities in order to leverage their know-how as well as to obtain savings in product costs and development budget (Carmel, 1999). The figures in Table 2-1 also confirm the usefulness of the software industry for the purpose of this study. While there is a considerable variance in the extent that software development is done virtually (the proportion of virtual teams to all teams varies between 5% and 100%), the average prevalence of virtual teams is much higher than reported for other industries (Boh, Slaughter, & Espinosa, 2007b; Espinosa et al., 2007c).

Laboratory	1	2	3	4	5	6	7
Foundation	1985	1976	1975	1990	1990	1986	1990
Location (country) <sup>1)</sup>	DE	DE	NL	UK	FR	I	DK
Number of developers	200	16	900	20	200	68	160
Number of teams	30	3	80	7	50	5	100
% of virtual teams	100%	100%	80%	75%	85%	80%	80%
Average length of projects	8	5	6	12	6	8	5
Average age of employees	41.6	40.9	37.6	-	37.4	43.5	33.0
Number of teams in sample	9	10	9	3	5	7	1

Laboratory	8	9	10	11	12	13
Foundation	1993	1999	1993	1997	2000	1972
Location (country) <sup>1)</sup>	BY	IND	DE	DE	DE	DE
Number of developers	2000	2600	130	4500	300	650
Number of teams	40	600	5	2000	20	120
% of virtual teams	100%	100%	5%	33%	25%	80%
Average length of projects	36	6	14	12	12	18
Average age of employees	33.8	31.8	38.1	44.5	39.3	35.6
Number of teams in sample	10	2	8	2	13	37

Laboratory	14	15	16	17	18	19
Foundation	1998	2004	1992	1998	1966	2002
Location (country) <sup>1)</sup>	IND	IL	CN	FR	DE	I
Number of developers	4000	850	800	170	5469	30
Number of teams	250	30	10	5	600	3
% of virtual teams	20%	5%	10%	40%	5%	10%
Average length of projects	6	6	5	12	12	12
Average age of employees	28.9	32.6	29.6	31.2	40.7	42.9
Number of teams in sample	16	3	3	3	16	4

1) Locations are indicated via country codes: DE: Germany; NL: Netherlands; UK: United Kingdom; FR: France; I: Italy; DK: Denmark; BY: Belarus; IND: India; IL: Israel; CN: China

*Table 2-1: Selected Descriptives of this Sample per Laboratory*

Overall, this study's analyses are based on a total of 856 responses from 161 team leaders, 161 managers, 515 team members, and 19 site managers (head of laboratory). The response rate of team leaders, managers, and site managers was 100%, and of team members 68%. In comparison with similar studies on real business teams, this is an extremely high response rate, especially when taking into account that any information on projects and employees is usually



treated extremely confidentially. The major reasons for the high response rates can be seen in the detailed feedback that all the participants received together with the elaborate and time-consuming data collection process and the relevance that virtual collaboration currently has in practice.

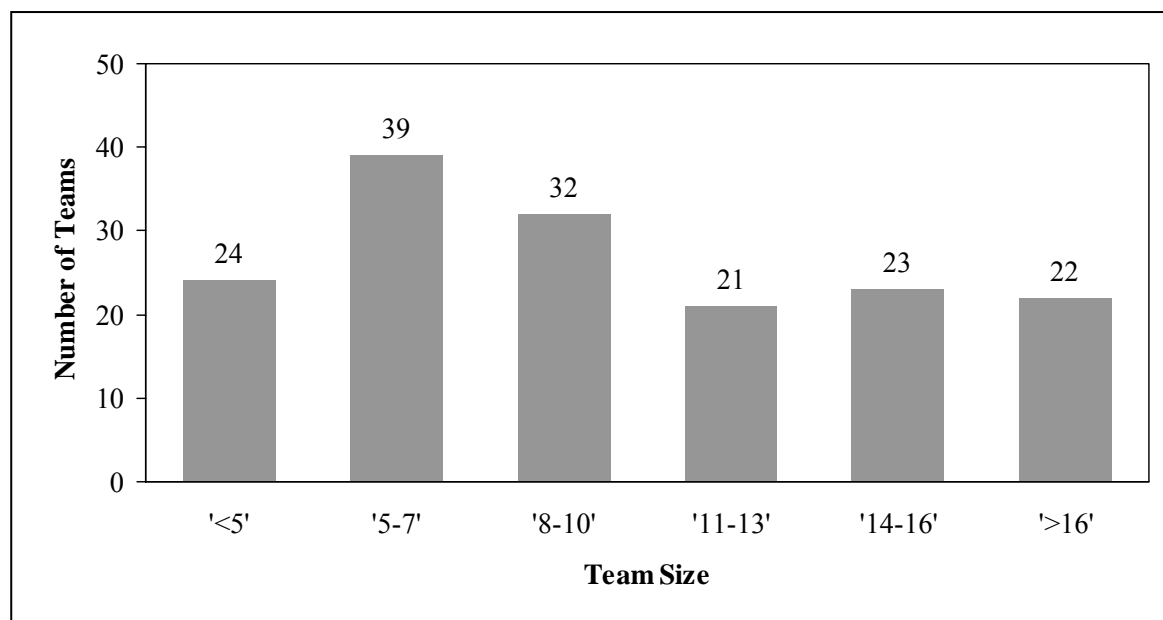


Figure 2-2: Distribution of Team Sizes;  $N = 161$  Teams

This sample contains 23% female team leaders and 23% female team members. The average age of the all team members is 35.9 years (standard deviation = 8.5). As shown in Figure 2-2, teams in this sample are, in comparison to studies on traditional teams, larger with an average of 10.8 members per team (median = 9.5). These higher team sizes are frequently reported in studies on virtual teams, as the virtual communication between dispersed team members does not limit the number of interaction partners to the same extent as personal interaction would (e.g., Ahuja & Galvin, 2003; Finholt & Sproull, 1990; Kirkman, Rosen, Tesluk, & Gibson, 2004; Riopelle et al., 2003).

Since team dispersion is a central subject of this research, the acquisition of teams with highly varying degrees of team member dispersion has been emphasized. To illustrate the geographical spread in this sample, Figure 2-3 depicts the distribution of teams according to an ordinal distance measure. While a continuous measurement of dispersion is advocated in this dissertation, Figure 2-3 offers a very vivid illustration of the level of team dispersion along seven meaningful categories. According to this figure, 62 teams in this sample are regarded as

co-located, of which 47 teams work in the same room, 9 in the same building, and 6 at the same site. The remaining 99 teams are distributed across the borders of the same site, with team members of 8 teams distributed within the same city, 19 within the same country, 20 within the same continent, and another 52 distributed across different continents.

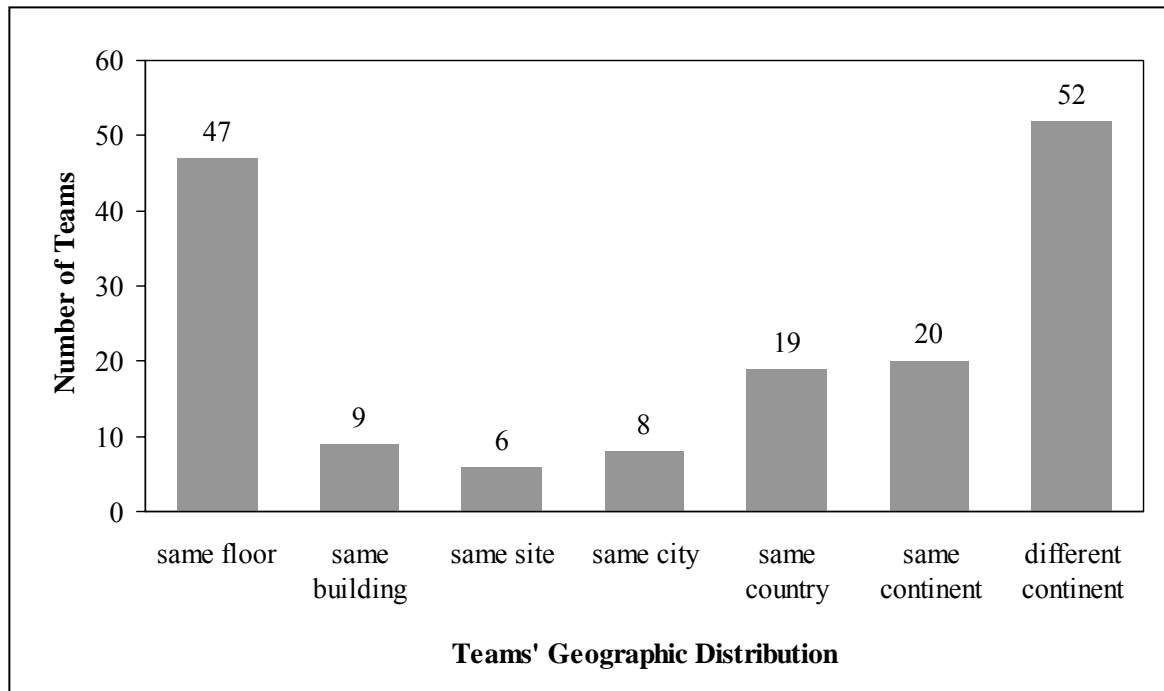


Figure 2-3: Distribution of Teams' Geographic Distance Levels;  $N = 161$  Teams

For a more visual impression of the geographic distribution, Figure 2-4 shows the office locations of all team members (and not only the respondents of this study) of the 161 teams in this sample on a world map. The geographic distribution of team members once again underlines the increasing prevalence of software hubs in Asia and their significance for today's software development. Together with the information from Figure 2-3, it seems that when choosing a virtual team format, managers prefer locations on a different continent rather than locations in adjacent cities or countries. This internationality of the sample is further highlighted by the team members being made up of as many as 38 different nationalities. The inclusion of national diversity as a study variable in this research is therefore a required step to disentangle its influence from the effects of this study's target variable 'dispersion.'

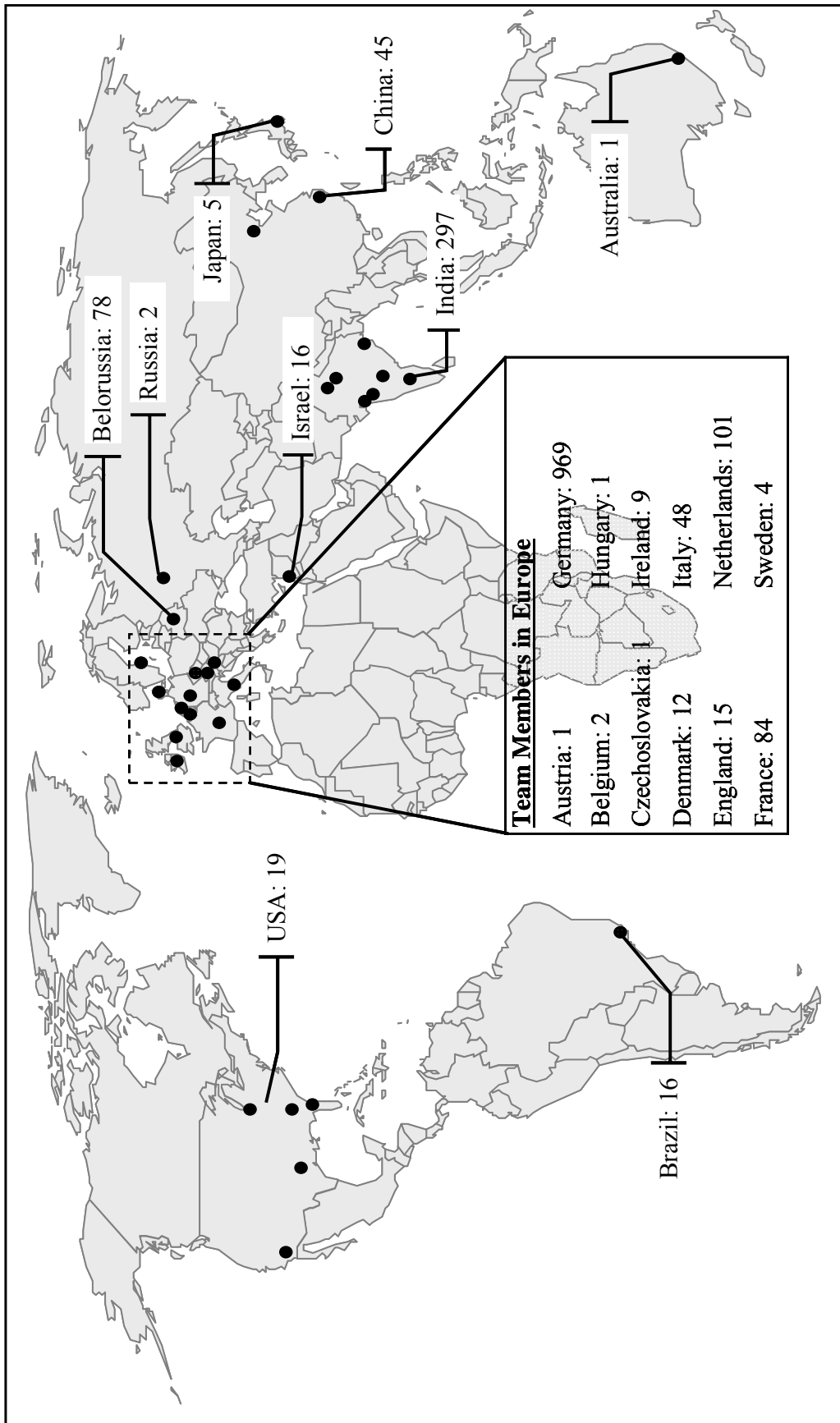


Figure 2-4: Geographical Distribution of Team Members (N = 1728 Team Members, not Respondents!)

### **3 Perceived Distance in Distributed Teams: Modeling and Empirical Evidence**

#### ABSTRACT

Distance in work teams has become a cornerstone of today's business world as well as a fundamental research area. Most of this research defines distance as merely physical distance (e.g., feet or kilometers) and acknowledges such objective measures as a proxy for its subjective representation. This paper challenges conventional wisdom that objective distance translates directly and fully into subjective distance. Drawing on social information processing theory (Salancik et al., 1978), we argue that subjective distance – a team's shared perception of other team members' distance – is likely to predict important team outcomes better than objective distance. Responses from 678 team leaders and team members pertaining to 161 new product development projects in the software industry were used to analyze the antecedents and consequences of subjective distance. Our results show that the perception of distance is more due to team members' national diversity than to their physical distance or configurations across sites. On testing physical and perceived distance's outcome relevance, we found that the perception of distance is significantly related to task and socio-emotional team processes, with objective distance having no distinct impact. Our results indicate that the decisive issue in virtual teams does not seem to be their physical separation per se, but the way distance is perceived, interpreted, and managed by members of the team. As such, our investigation of subjective distance in dispersed teams offers a way of reconciling competing claims in virtual team research and of predicting under what circumstances objective distance is likely to have the greatest effects.

Key words: Perceived Distance, Team Processes, National Diversity.

### 3.1 INTRODUCTION

Research on virtual teams has matured within the last decade. An online search within the EBSCO research database identifies more than 140 peer-reviewed articles, published between 2000 and 2007, with ‘virtual team’ in the title. There are dozens of papers that explore the causes, effects, mechanisms, mediators, and moderators of virtuality in teams and as many articles that provide suggestions on how to deal with dispersed project teams. However, despite this multitude of studies on the topic, we still know amazing little about what it means to be dispersed (Wilson et al., 2008). Several researchers have recently agreed that dispersion or a team’s virtualness is multi-dimensional and that merely differentiating teams’ level of dispersion in spatial terms is not sufficient (Espinosa et al., 2006b; Kiesler et al., 2002; O’Leary et al., 2007; Wilson et al., 2008). Usually, scholars have referred to the different dimensions of dispersion which are more or less a direct result of physical distance, such as team members’ time zone separation (Espinosa, Cummings, & Pickering, 2006a), travel time between sites (Harrison-Hill, 2001), proximity to team leaders (Antonakis & Atwater, 2002), or walking distance according to a floor plan (Rice & Aydin, 1991). With only a few exceptions, researchers from the field of organizational behavior have largely ignored the psychological dimension of dispersion. They have specifically ignored the possibility that distance may be perceived differently and have simply assumed that dispersion is directly associated with its mental representation.

This assumption is at odds with conventional wisdom in the cognitive psychology domain that even traditionally objective concepts, such as money (Mitchell & Mickel, 1999) and time (Ancona, Goodman, Lawrence, & Tushman, 2001), have important subjective dimensions. Lawrence (1988), for example, demonstrated that people do not always perceive the timing of typical events in the same way, but develop an individual sense of time and their own timing norms. A 1-year period may seem short to some individuals and long to others. Distance, too, is likely to not only be an objective measure of physical space between two or more spots, but rather a psychological reflection perceived, experienced, and understood in different ways. We already know from research in other domains and / or other levels of analysis that the perception of distance does not increase linearly with objective distance (Hansen & Lovas, 2004). In fact, scholars from geographical research have reported findings showing that ‘cognitive distance’ estimates differ significantly from actual distance measures and that *cognitive distance* seems to be a psychological representation of actual distance shaped by an individual’s social,

cultural, and general life experiences (Harrison-Hill, 2001). In their conceptual paper on the interrelation between proximity and localization, Torre and Rallet (2005: 49), for instance, contend that “proximity is not only an objective data, ... [but rather] proceeds from a *judgement* made by individuals on the nature of the geographical distance that separates them.” Similarly, Dow (2000: 61) in his study on export market selection decisions showed that “though geographic distance is a highly significant predictor, its impact is largely distinct from that of *psychological distance*” [emphasis added]; consequently, using geographical distance “as the sole indicator of psychological distance would be severely flawed.” In their analysis of inter-company relations, Ganesan et al. (2005) found that nearly all the effects of geographic proximity are contingent upon the intensity of relational ties between companies, and that one needs to consider both geographic closeness and relational closeness to understand inter-firm behavior.

Nonetheless, in the organizational behavior domain, scholars have to date not appropriately explained the subjectivity of dispersion, or the more complex, multiple, and dynamic ways in which individuals and teams construct their perceptions of distance. Some researchers have already acknowledged this research vacuum. Wilson et al. (2008: 2), for example, noted that “although researchers have started to refer to the importance of perception of proximity [...], none have defined the construct or developed a model of the factors that affect it.” Likewise, O’Leary and Cummings (2007: 448) emphasized the importance of distinguishing between objective and subjective distance and claimed that “future research should explore the relationship between objective aspects of dispersion and people’s perceptions thereof.”

In this study, we respond to this research gap and examine the relationship between the objective and subjective dimensions of dispersion between team members. More specifically, our study addresses three fundamental research questions: (1) To what extent can subjective distance be explained by objective distance? (2) Assuming that these two dimensions of dispersion are not fully interrelated, which other structural team-level attributes affect the perception of distance between team members? (3) We question whether the generally negative impact of dispersion on team processes is caused by either the subjectively perceived dispersion of team members, or by the physical distance between team members’ locations.

By addressing these research questions, we provide two prominent contributions to the extant research on virtual team dynamics. First, we identify the relative importance of ‘subjective

distance' beyond 'physical distance,' and disentangle the effects of both dimensions of dispersion on team processes. We thus challenge common practice in virtual team research that only accounts for objective distance measures when examining team outcomes such as team processes. Broadening the conceptualization of dispersion by means of its subjective dimension does not only help scholars to better predict virtual team effectiveness and to demonstrate that distance matters but also to explain *why* distance matters. In this respect, our result might be used in future team research to reconcile the inconsistent and conflicting findings with regard to the effect of distance on team processes and performance (Wilson et al., 2008).

Second, we provide a better understanding of team-level factors that shape the perception of distance. We present empirical evidence that helps to explain the paradox that team members with low levels of proximity sometimes feel distant from one another, while others, who are physically distant, feel close (Wilson et al., 2008). This far-but-close paradox has important implications for future research since influential group theories are based on the assumption that physical proximity is a necessary precondition for communication and the development of interpersonal relationships (e.g. Festinger, 1951; Newcomb, 1961). In addition, our research on the perception of distance has significant implications for more current theorizing in virtual team research such as the faultline model (Lau & Murnighan, 2005). Future research, for instance, may show that it is not (only) the objective division of team members across locations that impairs team functioning (e.g., Polzer, Crisp, Jarvenpaa, & Kim, 2006) but rather the perception of distance or friction that explains related effects. Future models of virtual team dynamics can be build on our research and include subjective elements of distance into their studies, hence refining their approach to dispersion and gaining more insight into the black box of dispersion-related team processes. To test our hypotheses, we use data from 678 team members and leaders pertaining to 161 software development teams.

### **3.2 PERCEIVED DISTANCE IN VIRTUAL TEAMS**

In their conceptual study, Wilson et al. (2008: 4) define 'perceived distance' as a dyadic construct which describes individuals' perception of "how close or how far another person is." The individual judgment of distance or proximity is an appraisal that can differ widely from objective measures of distance, since it is based on people's daily activities, work experiences, and the overall social context (Torre et al., 2005). Torre and Rallet (2005) emphasize that individuals' judgments regarding the nature of the geographical distance that separates them do not only

follow from objective data, but also from individual characteristics such as age, gender, and social background. The observation that individual judgments have a subjective component is in line with information processing theory presumptions, which hold that job perceptions do not depend exclusively on the actual job context's objective characteristics, but instead on the social constructions of the information available to workers at the time they make their judgments (Salancik et al., 1978). This social reality construction process (Salancik et al., 1978) is shaped by a person's openness to experience on the individual level (Wilson et al., 2008), by the number of sites to which team members belong on the team level (Hinds et al., 2005), and by the interdepartmental connectedness with other companies or business units in the team context (Jaworski & Kohli, 1993).

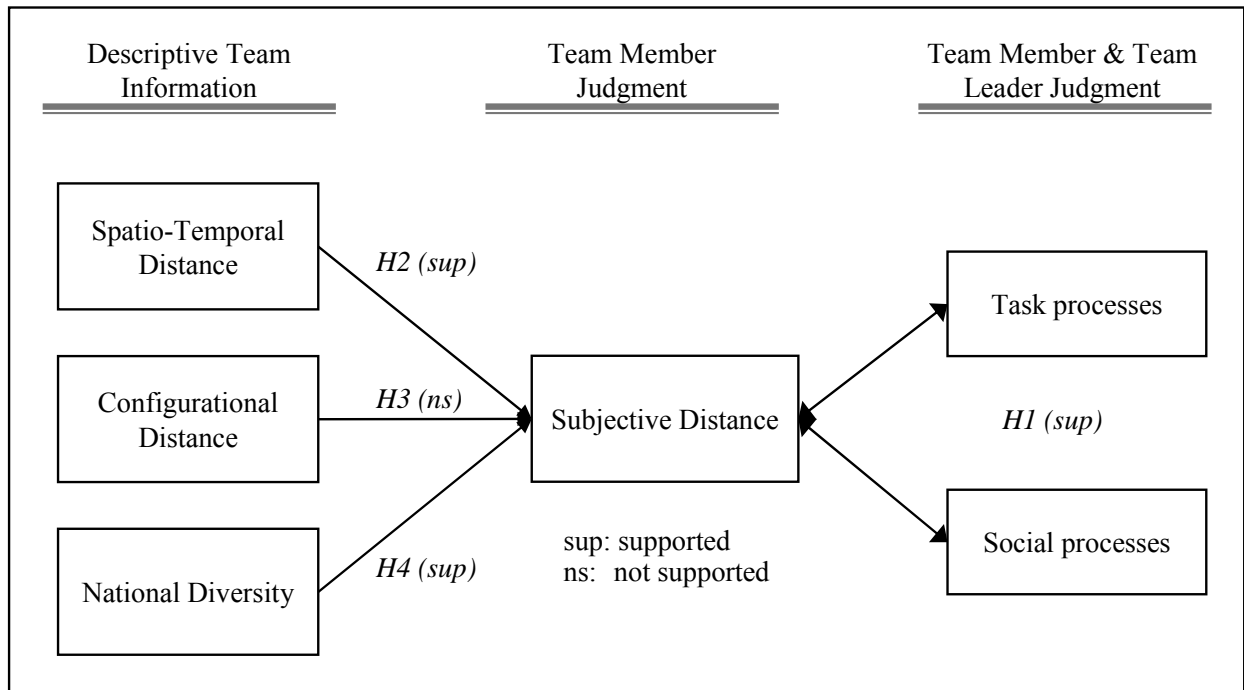


Figure 3-1: Conceptual Framework of this Research

In our study, we model antecedents and consequences of perceived distance on the team level. Drawing on social information processing theory, we presume that characteristics such as the team's configurational dispersion and national diversity shape the experience of distance as an emergent state, which, in turn, is directly linked to team-level outcomes such as task and socio-emotional processes (see Figure 3-1). While we assume that the perception of distance is first and foremost an individual judgment, in this study, we assess the perception of distance on the team level of analysis and provide two reasons for our approach. First, dispersed work mainly takes place in teams rather than dyads and, accordingly, it is the perception of distance



shared by all the team members which is most critical. Likewise, Espinoza et al. (2002: 9) claimed with regard to the appropriate level of analysis that “what often matters is the level of dispersion within the team rather than the physical distance between any pair of members.” Second, we know from social information processing theory that individuals also use their own behavior to construct reality through a ‘social enactment process’ (Salancik et al., 1978). Since most behaviors are strongly interactive, this backward loop is likely to be affected by the entire team’s dynamics and therefore suggests a team-level focus. Consequently, we adapt our conceptualization of perceived distance to the team level and define ‘perceived distance’ as a team’s shared cognitive and affective representation of spatial distance between team members.

In respect of the consequences of subjective distance (the right-hand side of our relational model in Figure 3-1), we investigate whether distance perceptions are directly intertwined with team interaction processes and whether this relationship persists beyond objective distance’s influence. In our study, we distinguish between task-related and socio-emotional team processes as dependent variables, since prior research on virtual teams has discovered that the two process bundles can have different result patterns in dispersed teams (e.g., Siebdrat, Hoegl, & Ernst, 2008). Prior research on virtual teams revealed a predominantly negative relation between objective measures of distance and team processes (Martins et al., 2004; Powell et al., 2004). We also hypothesize that subjective distance has a negative relation to team processes. In keeping with Wilson et al. (2008), we presume that a high level of perceived distance between team members leads to increased categorization processes and less salience of other team members’ behaviors and affects. In turn, this should lead to lower levels of team-internal interaction processes.

Conversely, at lower levels of interaction processes, the behavior of other team members is less predictable and understandable, which increases uncertainty, reduces the common ground, thus leading to feelings of distance. Communication, for example, stimulates the perception of proximity because it enhances the salience of the communication partners’ significance, helps to envision their context, and reduces uncertainty regarding their behavior (Wilson et al., 2008). Both, the negative impact of perceived distance on team processes and the reverse effect of lower team processes on perceived distance let this connection become bidirectional as indicated in Figure 3-1.

In addition to our assumed negative relation between perceived distance and team processes, we suggest that the perception of distance is a more proximal predictor of team processes than objective distance. In line with most behavioral theories, we argue that it is generally the perception rather than the mere presence of a physical stimulus that affects complex team processes (Stroh et al., 2002). With the exception of simple stimulus-response patterns in the tradition of behaviorism (e.g. Watson, 1913), most behavioral theories explicitly include intermediate states and / or processes to explain how a stimulus (such as objective dispersion) translates into behavior (Stroh et al., 2002). One of the most influential of such approaches is the ‘theory of planned behavior,’ which describes attitudes, subjective norms, perceived behavioral control, and the resulting intention as intermediate steps towards action (Ajzen, 1985). Further support for the recognition of cognitive processes in the perception of dispersion – the focal stimulus of our study – was recently provided by an experiment by Bradner and Mark (2002). They showed that participants who *believe* that their interaction partner (a confederate in an adjacent room using video conferencing and instant messaging) is located in a distant city are more likely to deceive, are less persuaded by, and initially cooperate less than participants who assume that their interaction partner is close. Thus, it seems possible to stimulate distance-related behaviors under experimental conditions in which the physical stimulus is not present. In summary, behavioral theories as well as results from related empirical research provide support for our notion that the cognitive and/or affective representation of distance plays a pivotal role in the shaping of behavior. Hence, we posit:

*Hypothesis 1: Subjective distance is negatively related to task (1a) and socio-emotional (1b) team processes, holding even beyond the objective distance’s impact.*

### **3.3 ANTECEDENTS OF PERCEIVED DISTANCE IN VIRTUAL TEAMS**

We initially motivated the discourse on subjective distance with the observation that people perceive and experience distance differently. Since perception is an active process, it is susceptible to a variety of internal and external influences, including the characteristics of the object of perception (objective distance), as well as the context in which the perception occurs (Stroh et al., 2002). Consequently, objective distance should be an important antecedent of subjective distance, since it is probably an important stimulus from which the perception of distance is derived. In a recent study, O’Leary and Cummings (2007) showed that the objective distance between team members has spatial, temporal, and configurational elements.

The spatial element is most commonly used in research on virtual teams and also the one that instantly comes to people's minds. It is measured in physical units like feet, miles or kilometers. The second element of objective distance is temporal distance. Temporal distance captures the extent to which members of a team are separated in terms of time zones, or depicts the degree to which their normal working hours overlap. Both elements of objective distance are assumed to have strong inter-correlations, especially in a highly dispersed sample with most team members separated in an east-west direction. The configurational element of objective distance captures the pattern or arrangement of members across sites, regardless of the spatial-temporal distances between them. This element is comprised of three sub-indices and accounts for the various clustering of members across certain sites. It recognizes that, regardless of the geographic or temporal distance between team members, their configuration across sites may have a distinct impact on group functioning. Since O'Leary and Cummings (2007) argue that "different processes, emergent states, and other team outcomes are differentially related to [these] dimensions of dispersion," we investigate their individual influences on perceived distance in our model.

Another predictor of subjective distance – which is conceptually distinct from the above-mentioned predictors - is the team members' diverse nationalities. From diversity research, we have learned that demographic dissimilarity within a team can lead to 'social distance,' which can, in turn, lead to psychological distance (Williams & O'Reilly, 1998). There were three reasons for selecting national diversity for this study rather than a multitude of other diversity constructs. First, national diversity is very likely to matter in a sample of highly dispersed teams. In comparison to other diversity constructs such as gender and age, differences in team members' nationality could become salient if the degrees of dispersion vary (Earley & Mosakowski, 2000). Second, team members' different configurational distribution is likely to activate 'fault-lines' – hypothetical dividing lines that split a group into subgroups – that impair team functioning and may have significant interdependencies with configurational elements of objective distance (Cramton & Hinds, 2005a; Polzer et al., 2006). Third, national diversity has proven to be a potent factor in explaining individual differences in psychological attributes and behaviors. Even in comparison to other dimensions of demographics, "nationality [...] emerged as an explanation for far more variation in the data than any of the respondents' other characteristics" (Laurent, 1983: 201) and is therefore likely to be a potent predictor of subjective distance. In

the following, we will describe these potential antecedents in more detail and theoretically derive mechanisms which may translate them into a perception of distance.

### 3.3.1 Geographic and Temporal Distance

Conventional wisdom holds that “we feel closest to others who are in close physical proximity to us” (Wilson et al., 2008: 979). There is a long tradition of such propinquity research, which supports this ground rule of social psychology (Festinger, 1951; Newcomb, 1961). In today’s business reality, teams are not only separated by walls or stairways, but also by country and continent borders. However, the mechanisms responsible for the interrelation between propinquity and experience of interpersonal closeness are likely to be the same. Visibility seems to be the pivotal variable for team members’ interpretation of their physical work environment, and, in particular, for their perception of dispersion (Haner, 2005). Most communication between team members separated by distance and / or time must be carried out via communication technologies, which leads to a reduction in social presence. Social presence refers to the other person’s degree of salience in an interaction and the salience of the interpersonal relationship generated by that interaction (Kiesler et al., 2002). Thus, face-to-face interaction exhibits more social presence and fosters team members’ feeling of “being there” with their interaction partners (Short et al., 1976). According to social presence theory (Short et al., 1976), remote interaction is considerably more constrained than co-located interaction (Burke, Aytes, Chidambaram, & Johnson, 1999) and, as a direct consequence, geographic and temporal virtualness diminishes the degree to which members of a team feel close (Montoya-Weiss, Massey, & Song, 2001). In a similar vein, authors of media richness and reduced contextual cue theories argue that media vary according to the amount of social information that can be conveyed. They furthermore maintain that reduced social information can negatively impact feelings of interpersonal closeness (Cummings, 2007). Consequently, we hypothesize:

*Hypothesis 2: Spatio-temporal distance is positively related to the level of perceived distance in virtual teams.*

### 3.3.2 Configurational Distance

Configurational dispersion describes the distribution of team members across sites, irrespective of the spatio-temporal distance between them. Configurational distance is therefore anchored at one extreme by fully co-located teams in which all members reside at the same location and at the other extreme by fully dispersed teams in which every member is at a different

site (Griffith et al., 2001; Polzer et al., 2006). Between these extremes lies a wide variety of ‘partly dispersed’ or hybrid configurations, which, according to O’Leary and Cummings (2007) is best described by means of three dimensions of configurational dispersion. They combine (1) the number of locations across which the team is distributed (site index), (2) the percentage of isolated team members (isolation index), and (3) the unevenness of membership across sites (imbalance index) into a multi-dimensional profile of the team’s configurational dispersion. Accordingly, we consider each dimension of configurational dispersion as having a distinct impact on subjective distance and derive our hypotheses from social presence theory (Kiesler et al., 2002; Montoya-Weiss et al., 2001), categorization theory (Turner, 1987), and the faultline hypothesis of Lau and Murnighan (1998).

The most straightforward relationship between configurational dispersion and perceived distance probably results from team members’ isolation. Owing to the isolation of the distributed team member, he or she is likely to feel differently about the group, its processes, and its outcomes than the other group members (Burke et al., 1999). While communication between all co-located team members occurs face-to-face as well as being mediated by electronic media, isolated team members (if they do not travel) are completely reliant on virtual media to communicate with the rest of the team. Isolation hinders the awareness of other members’ activities (O’Leary et al., 2007), reduces spontaneous discussions, and informal interaction (Cooper & Kurland, 2002). This lack of ‘social presence’ is qualitatively different from that of pure geographic distance in that isolated members feel less part of the group, have little identification with the team norms, consequently feeling more distant from the core team than non-isolated team members (Cooper et al., 2002).

Conversely, for the remaining two dimensions of configurational distance, ‘number of sites’ and ‘imbalance of team member allocation,’ we argue that their effect is not (only) due to a lack of social presence but merely a result of social categorization processes (Turner, 1987). As Polzer et al. (2006) recently pointed out, team members’ residing at different sites is a significant basis for perceptually grouping people together and, thus, qualifies as a dimension of diversity. For instance, when team members are engaged in face-to-face meetings “an immediately apparent social category is the one that divides the team into those who are physically present and those who are not” (Polzer et al., 2006: 680). This perceptual subgrouping of distributed team members is amplified in more balanced group membership across sites. According to the faultline hypothesis of Lau and Murnighan (1998), teams will experience more intense subgrouping

if the team members within subgroups are similar but different across subgroups. This is especially true for team size as a very salient team property. Teams which are divided into two or more equally sized ('balanced') subgroups should therefore have the strongest faultline dynamics (Earley et al., 2000; Lau et al., 1998; Polzer et al., 2006). Consequently, teams' imbalance across locations should weaken the salience of subgroups, reduce the friction between team members and, thus, be negatively associated with the perception of distance.

The logic of the faultline model can be similarly applied to explain the effect of the number of sites ('site index'). In alignment with the assumptions of Cramton and Hinds (2005a), we expect stronger categorization effects if the team is split between only a few locations. More locations increase the likelihood that demographic attributes and other important affiliations will cut instead of align across sites (Cramton et al., 2005a). A recent study by Polzer et al. (2006) has provided preliminary support for the social categorization effects stemming from both the arrangement across different sites ('site index') and the imbalance of distribution ('imbalance index'). In their study, Polzer et al. (2006) divided student teams in three experimental conditions with varying degrees of configurational dispersion. Their results suggest that teams composed of team members divided into fewer equally sized subgroups experience the most harmful faultline effects, providing support for the notion that both a small number of sites and an even distribution of team members across sites elicit group faultline dynamics. Once such location-based faultlines have been activated, they increase subgrouping, polarization, making people in another location feel more distant (Cramton et al., 2005a).

In sum, all three elements of configurational dispersion could play an essential role in the perception of distance. In the empirical investigation of Hinds and Mortensen (2005), these elements are referred to as 'psychological distance,' accordingly. The ways in which team members are configured across sites is likely to intensify or collapse any linearity or similarity in geographic dispersion and its experience. Therefore, we argue that each of the dimensions of configurational dispersion has a unique impact on perceived dispersion, and posit:

*Hypothesis 3: Configurational distance is related to the level of perceived distance beyond spatio-temporal distance in that its component dimensions' site index (3a, negative), isolation index (3b, positive), and imbalance index (3c, negative) have a distinct influence.*

### 3.3.3 National Diversity

Teams that consist of distant team members from different sites are more likely to include members who represent different nationalities than teams with co-located members (Duarte & Snyder, 1999). The nationalities represented in a group are only relevant for the subjective distance level to the extent that they affect the members' mutual perception. To date, research suggests that national diversity affects team members' mutual perceptions in two different ways. First, the level of national diversity has proven to directly affect team members' values, demeanors, and cognitive schemata (Bachmann, 2006; Hambrick et al., 1998). For instance, individuals' value orientation of dimensions – like individualism versus collectivism (e.g. England, 1975) – and their perception of emotional stimuli (Mesquita & Frijda, 1992) are shaped by their specific nationality. With regard to the perception of distance, Harrison-Hill (2001) showed that people's sense of distance in terms of travel time was strongly affected by their nationality.

Second, as already discussed in respect of configurational distance, national diversity is another very salient cue in dispersed teams to determine who belongs into an in-group and who is categorized into an out-group. As an outcome of self-categorization, team members identify with their own subgroup and feel – in part regardless of the real distance – closer to the members of their own subgroup than to members of other subgroups (Wilson et al., 2008). The above described faultline dynamics across locations are likely to further this categorization process due to team members within sites tending to be more homogeneous with regard to their nationality than team members across sites (Polzer et al., 2006). As a categorization mechanism, nationality indirectly facilitates social division between subgroups and therefore increases the perception of interpersonal distance towards team members who belong to another nationality, thus to another subgroup (Mannix & Neale, 2005). Cramton and Hinds (2005a: 234) call this bias towards the own subgroup 'ethnocentrism' and describe the subgrouping effect "along cultural and geographic faultlines ... [as] a natural but detrimental tendency in internationally distributed work."

In sum, both the direct and indirect influences of nationality may be at work in dispersed, multi-national teams, increasing the mutual perception of distance in such teams. As the study of Earley and Mosakowski (2000) revealed, the above-described mechanisms of social categorization into subgroups are present in nationally diverse teams regardless of their level of dispersion. The physical separation of team members from different national backgrounds is inclined to fuel the tendency to regard other members of the team as separate from oneself.

Consequently, we regard national diversity as an important predictor of perceived distance, even beyond objective distance, and hypothesize:

*Hypothesis 4: National diversity is positively related to the level of perceived distance, independently of the actual level of spatio-temporal distance.*

## **3.4 METHODS**

### **3.4.1 Data Collection**

Our sample consists of a total of 161 software development teams from 37 different labs worldwide pertaining to five software developing companies. Each laboratory employs between 20 and 5,500 software developers (median = 600). Software development projects that were completed within 12 months prior to the data collection and that were worked on by ‘teams’ were included in the study. Overall, we collected 676 responses from 161 team leaders and 515 team members. The responses were gathered via a web-based survey. Descriptive details about the team and all team members were provided by the team leaders within a pre-defined spreadsheet. The team members were contacted randomly and asked to complete the online questionnaire. The respondents’ participation in this study was, however, strictly voluntary. For each team included in the final data set of this study, we have responses from the team leader and at least two team members. Our sample contains 23% female team leaders and team members. Teams in our sample have an average of 10.9 members (median = 10, standard deviation = 7.1) who are on average 35.9 years old (median = 35.0, standard deviation = 8.5).



Variables	Items
Control	<i>Team-external Interdependence</i> : ‘1’ an isolated teamwork with only little interaction with other teams / projects (e.g. for some requests), ‘2’ an isolated teamwork with significant interaction with other teams / projects in at least one project phase, ‘3’ a teamwork with a continuous need for interaction with several other teams / projects, ‘4’ a multi-team project, in which your team’s work output integrated into a larger software-solution causing significant and continuous need for coordination
Subjective Distance	I could easily visit most team members with whom I collaborated. <sup>(t)</sup> It was easy to get the team members together in one place for spontaneous meetings (e.g. for discussions and decisions). <sup>(t)</sup> In this team we had frequent face-to-face meetings with all team members. <sup>(t)</sup> To which % has team communication been channeled through virtual tools (Phone, Email, Tele-Conferencing etc.)?

Notes. Please note that while all items are measured on a five-point Likert scale we measured the virtuality of communication (subjective distance) in percent and retransformed the scale into the same range as the other scales. Items with an <sup>(t)</sup> are reverse coded.

*Table 3-1: Selected Survey Items Used in This Research*

### 3.4.2 Measures

All constructs considered in this investigation refer to the team as the unit of analysis. Accordingly, all measures were specified on the team level. The respondents were therefore asked to evaluate properties and behaviors of the team as a whole. The questionnaire was administered in German and English. A pretest was conducted, which included 7 members of a software development team at a Swiss consulting and engineering company. Following this pretest, the wording of some items and the layout of the online questionnaire were refined for later use in the main study. Nearly all the items were drawn from published scales and anchored as 1, “strongly disagree” to 5, “strongly agree.” The items were also discussed with the company representatives before the questionnaire went online. To ensure content validity and to avoid a possible common source bias, data from different respondents were used to measure the different variables. That is, subjective distance was rated by the team members and its antecedents were derived from the descriptive information about the team and team processes as outcomes, which were assessed using team leader judgments.

#### *Antecedents*

To measure our different dimensions of geographic distribution, we used the team information provided by team leaders to identify each team member’s office location. A detailed description of how to calculate the different indices of objective dispersion can be found in O’Leary and Cummings (2007). As O’Leary and Cummings (2007) motivate researchers to make conscious decisions about which dimension to select, we combined geographical and

temporal dispersion's standardized values (after log transformation of spatial distance) in one index since both dimensions are highly correlated ( $r = .76$ ;  $p < .001$ ). In the following, we refer to this combined measure of geographic dispersion as 'spatio-temporal' dispersion. We calculated Blau's index (1977) to measure the level of national diversity based on the team leaders' descriptive data on each team member's nationality. This index is an appropriate way of measuring variation in team member characteristics (Harrison & Klein, 2007).

### *Subjective Distance*

We assessed subjective distance with four items (see Table 3-1), ascertaining the perceived ease with which dispersed team members could be visited, the effort required to get them in one place for a meeting, the perceived virtuality of communication, and the perceived frequency of face-to-face meetings during the project (Cronbach's alpha = 0.76). We reasoned that the subjective ease with which distant team members can be visited / met is not only a question of linear travel time, but merely depends on individuals' perception of how distant other team members are (Harrison-Hill, 2001). We furthermore considered other team members' level of 'visibility', or 'salience' as a central element of the experience of physical work environments and, hence, of the perception of distance (Crowston et al., 2007; Haner, 2005; Kiesler et al., 2002).

It should be pointed out that we also advocate the proposition forwarded by Wilson et al. (2008) that subjective distance should be measured as the cognitive or affective reflection of how close team members regard one another. For this study, we used a different measure because we wanted to distinguish clearly between perceived proximity and our dependent variables such as cohesion (one facet of socio-emotional team processes), which also captures the felt closeness of individuals and consists of a cognitive as well as an emotional component (Dion, 2000). To justify the aggregation of perceived distance to the team level, we calculated interrater agreement, using the multiple-item estimator for within-group interrater reliability (IRR) as proposed by James, Demaree, and Wolf (1984a). We found a strong agreement between raters (team members) across all teams ( $r_{wg} = .90$ ). This offers support for using team-level responses as reliable databases for further analysis. In an effort to verify the two-dimensional structure of objective and subjective distance, we used an exploratory factor analysis, which was further supported by a corresponding confirmatory factor analysis (CFA). A varimax rotation clearly grouped the indices into two distinct factors, which, due to their differ-

entiation between the five objective indicators of geographic dispersion and the four items representing subjective distance (68% variance explanation), were theoretically strongly justified.

### *Outcomes*

Teamwork processes are the outcome variables of this study. These processes are assessed by making a distinction between socio-emotional and task-related processes as the functional perspective of teams suggests (Wittenbaum et al., 2004) and several authors have conceptually proposed (e.g. Gladstein, 1984; Guzzo & Dickson, 1996). In accordance with the work of Rousseau, Aubé, and Savoie (2006), we conceive task and social-related team processes as higher order constructs comprised of more specific teamwork dimensions as facets. For ‘task-related processes,’ we follow the conceptualization of Hoegl and Gemuenden (2001) and conceive teams’ effort, balance of contribution, mutual support, quality of communication, and task coordination as indicators (Chronbach’s  $\alpha = .90$ ). Likewise, with reference to Powell, Piccoli, and Ives (2004), we conceive the team’s level of cohesion, trust and identification as indicative of ‘socio-emotional processes’ (Chronbach’s  $\alpha = .77$ ). Since we conceptualize lower-level team processes as indicators rather than definitive elements of either task or social-related teamwork, we aggregated corresponding items instead of corresponding constructs. The scales used to measure mutual support, effort, balance of contribution, and cohesion consist of two to four items each, all of which were derived from Hoegl et al. (2004b) and had already been successfully employed in the context of a longitudinal study in the automotive industry. The three items measuring task coordination were derived from scales by Hoegl et al. (2004b) and Espinoza, Cummings, and Pickering (2006a). Trust was measured using four items from Jarvenpaa and Leidner (1998), who designed their trustworthiness scale for the virtual team context. This scale has been successfully employed in several studies (e.g. Powell et al., 2006). To represent two dimensions of trust equally – a cognitive (e.g., to judge the trustworthiness of teammates) as well as an affect-based dimension (e.g., having an emotional bond to teammates) (McAllister, 1995) – we added one item measuring benevolence from Levin and Cross (2004). In order to capture team identification, we used 5 items from Mael and Ashforth’s (1992) identification scale. The measure’s validity was shown in several studies in the team context and the measure incorporates cognitive as well as affective facets of team identification (Riketta, 2005).

### *Control Variables*

We controlled for several variables that are theoretically relevant to our hypothesized relationships. These are team size, project length, team-external interdependence, and the organizational context. Team size was included in the study's analysis since several studies underline its significance for many different intragroup dynamics (Voelpel, Eckhoff, & Förster, 2008). As some researchers have shown that the team's longevity (the time its members have been together) is positively associated with the degree to which group members share perceptions (Burke et al., 1999; Hambrick, 1994), we assessed project length in terms of months from the beginning of the team's work to its conclusion and included it after a log transformation as a control variable. A third control variable accounts for the various ways in which teams are organized, which generally exert strong influence in team settings (Hackman, 1987). In-depth interviews with R&D managers from different labs prior to our data collection revealed that especially the level of team integration into the overall project organization is a key characteristic of virtual team collaboration in the software development industry. We therefore assessed whether teams performed their tasks in one of four organizational settings: (1) more or less in isolation (14%), (2) significant interaction with other teams (21%), (3) continuous interaction with other teams (28%) or (4) the team was part of a multi-team project with strong and continuous interaction and high coordination effort (37%) (see Table 3-1). Finally, given that this study includes data from several different software development companies, the study controlled for possible organizational effects in the analysis by including dummy variables for the respective country organization. We controlled for the country organization and not the laboratory or the corporate organization in order to find the right balance between identifying the team's specific context and preventing an inflation of dummy variables.

## **3.5 RESULTS**

In this study, we assumed that subjective distance is more than a cognitive representation of objective distance. Consequently, we hypothesized that configurational distance as well as national diversity have a unique influence on the perception of distance. An inspection of the descriptive statistics in Table 3-2 provides initial support for our notion, as objective distance and subjective distance share only about 27% of their variance ( $r = .52$ ;  $p < .01$ ). This result is in line with the findings of Coshall and Potter (1987), who showed that physical proximity explains no more than half of a person's perception of subjective distance. Nevertheless, the sig-

nificant bivariate correlation between subjective and objective dispersion provides support for our hypothesis 2 that objective and subjective distance are significantly related.

To test our other hypotheses addressing antecedents and outcomes of subjective distance, we used hierarchical multiple regression analysis and assessed the significance of main effects after all control variables had been entered into the models. In the theoretical part of this article, we hypothesized that both configurational dispersion and national diversity will retain their distinct association with subjective distance beyond spatio-temporal distance's positive main effect. The results illustrated in Table 3-3 show that only national diversity is significantly related to the perception of distance. This provides support for hypotheses 4. Neither the imbalance of team membership across sites, nor the number of isolates has an effect on subjective distance beyond physical and temporal distance, thus contradicting hypotheses 3b and 3c. Only the 'site index' is marginally linked to the perception of distance, but – contrary to our hypothesis – with a positive beta-coefficient (see Table 3-3) providing no support for hypothesis 3a. Interestingly, when all predictors are considered in our regression model, the bivariate relation between spatio-temporal distance and subjective distance disappears. Hence, perceived distance seems to be more strongly affected by social factors such as national diversity than by our assessed physical elements of distance.

Variables	Informant <sup>1)</sup>	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
(1) Team size	D	10.85	7.06												
(2) Team-External Interdependence	D	2.89	1.06	.25											
(3) Project length	D	1.17	0.27	.18	.15										
(4) Task interdependence	TL/TM	4.31	0.58	.26	.28	.08									
(5) Shared Context	TL/TM	3.78	0.49	-.01	-.22	-.23	-.14								
(6) Spatio-Temporal Distance	D	0.00	0.94	.16	.22	-.05	.21	-.30							
(7) Site Index	D	2.32	1.66	.20	.12	.08	.16	-.12	.53						
(8) Isolation Index	D	0.09	0.18	-.15	-.09	-.08	.07	-.07	.27	.63					
(9) Imbalance Index	D	0.13	0.13	.27	.04	-.16	.11	-.08	.45	.26	.14				
(10) National diversity	D	0.00	0.25	.05	.11	.04	.16	-.27	.67	.35	.17	.18			
(11) Subjective distance	TM	2.91	0.87	.03	.16	-.14	.00	-.25	.52	.45	.27	.26	.43		
(12) Task-related processes	TL/TM	3.90	0.34	-.02	-.26	-.16	.07	.59	-.05	.07	.05	.00	-.02	-.14	
(13) Social processes	TL/TM	3.86	0.30	.11	-.06	-.01	.18	.34	.02	.05	-.01	-.01	-.03	-.17	.66

Note.  $r > 0.17$ ,  $p < 0.10$ ;  $r > 0.21$ ,  $p < 0.05$ ;  $r > 0.30$ ,  $p < 0.01$ .

<sup>1)</sup> This study used different informants for different levels of analysis: D = Descriptive information about the team; TL = Team Leader Judgment; TM = Team Member Judgment.

Table 3-2: Descriptive Statistics and Correlations (N= 161 teams)

Variables [N = 161 teams]	Subjective Distance
Company (c)	10 dummy variables included
Team size (c)	-.04
Team-external Interdependence (c)	.09
Project length (c)	-.12 <sup>+</sup>
Spatio-Temporal Distance	.15
Site Index	.17 <sup>+</sup>
Isolation Index	.01
Imbalance Index	.07
National diversity	.26**
F	8.74**
R <sup>2</sup>	.53**

Notes. <sup>+</sup>p < 0.10, \*p < 0.05, \*\*p < 0.01. Independent variables were mean-centered before they were entered into the model. The dummy variables for companies are not included in this table. (c) = Control variable. Subjective Distance was judged by team members (excluding team leaders) and all other measures are calculated based on descriptives as provided by team leaders. Included in the table are standardized beta-coefficients.

*Table 3-3: Results of Multiple Regression Analysis Predicting Subjective Distance*

In addition to the identification of meaningful team-level predictors of subjective distance, we also investigated the relevance of perceived distance to explain team processes. To empirically analyze this relationship, we included subjective distance and all its antecedents in a regression model. Since we found the same pattern of results irrespective of whether team processes were judged by the team leaders or by the whole team, we present the results of all team members (including team leaders). The results in Table 3-4 reveal that team members' perceptions of distance are negatively related to both teams' task-related ( $\beta = -.26$ ;  $p < .05$ ) as well as their socio-emotional processes ( $\beta = -.28$ ;  $p < .05$ ). In contrast, neither spatio-temporal nor configurational distance (the elements of configurational distance not reported in Table 3-4 for parsimony) is significantly associated with our outcome variables. Thus, our findings provide support for hypothesis 1 that subjective distance seems to be a more proximal predictor of task as well as socio-emotional team processes.

Variables \ Models	Task-related Processes	Socio-emotional Processes
Company (c)	10 dummy variables included	10 dummy variables included
Team size (c)	.14 <sup>+</sup>	.08
Team-external Interdependence	-.22*	-.11
Project length	-.14	.05
Spatio-Temporal Distance	.02	.13
National Diversity	.06	-.03
Subjective Distance	-.26*	-.28*
F	2.42**	1.14
R <sup>2</sup>	.21*	.11*
Notes. <sup>+</sup> p < 0.10, *p < 0.05, **p < 0.01.		

Table 3-4: Results of Multiple Regression Analysis predicting Team Processes (N = 161 teams)

### 3.6 DISCUSSION

In this paper, we have built on social information processing theory and argued that team members' reactions to workplace stimuli such as 'dispersion' are more influenced by their perceptions of these stimuli than merely by their physical properties. In alignment with this theory's presumptions, we found that team members' perceptions of distance do not primarily stem from the extent of their objective distance. Instead, subjective distance emanates from a more complex and socially based construction of reality which we found to be significantly affected by team members' national heterogeneity. In further support of social information processing theory, our analysis revealed that subjective distance as a psychological state is more predictive of social and task-related team processes than spatio-temporal distance or any form of configurational distance.

In the theoretical part of this paper, we argued that spatio-temporal distance, configurational distance, and national diversity maintain their unique influence on the perception of distance. Interestingly, in our study, national diversity plays the pivotal role in explaining team members' perception of distance. It seems that teams in which the majority of members share the same nationality – on average – feel closer to one another, irrespective of their actual level of geographic, temporal or configurational dispersion. Our finding corresponds to the observation by



Armstrong and Cole (1995: 210) that “national and organizational cultures are experienced as dimensions of distance in distributed work groups, along with kilometer and time zones.” In our hypothesis on the relation between national diversity and perceived distance, we suggested that national diversity has a direct effect on the perception of distance, due to diversity in values and beliefs, and an indirect effect, which originates from the significance of social categories and corresponding faultlines. To shed more light on this issue and to evaluate both theoretical approaches’ relative importance in explaining our results, we added two additional post-hoc analyses.

First, to identify a direct effect of cultural distance, some researchers convincingly argue that the differences between nationalities are not binary as much as continuous (Hambrick et al., 1998). A team consisting of Americans, Australians, and Canadians is likely to be less diverse than a group consisting of Chinese, Americans, and Austrians. Our measure of national diversity with Blau’s (1977) index of variation might be a proxy for cultural distance, but since it does not distinguish between different nationalities, we ran a further analysis based on the cultural distance between different nationalities. We calculated the cultural distance along the nine GLOBE dimensions as a broad and state-of-the-art measure of a team’s cultural profile. We then used these scores as a measure of cultural values (should be) and cultural practices (as-is) (Javidan, House, Dorfman, Hanges, & De Luquet, 2006) in two different regression models. To obtain comparable indices of cultural distance across teams of different sizes, we used the calculation proposed by Kogut and Singh (1988) and assessed the average distance between each possible pair of team members, averaged across all nine cultural dimensions and corrected for the variances within each dimension. Using the average cultural distance in teams as an antecedent of subjective distance, we observed no additional explanation power beyond spatio-temporal and configurational distance in our analyses. This finding is non-intuitive, given that cultural distance seems to be conceptually directly intertwined with the perception of distance, while social categorization processes only indirectly stimulate such distance perceptions. It may be that once team members categorize their counterparts as members of an out-group about which they have very generalized or stereotypic knowledge, they base their impressions of those team members merely on categorization. Based on our data, we conclude that the categorization processes underlying the effect of national diversity seem to be more relevant in a virtual team context than differences in cultural values. Further research is, however, needed to

shed more light on the dynamics underlying the effect of national diversity on the level of perceived distance.

In accordance with the described categorization effect, we had reasoned in the theoretical part of this paper that the activation of faultlines may intensify social stereotyping towards an ethnocentrism when team members' nationality aligns with their geographic location, i.e. their site, and when teams are split equally across locations. We addressed this hypothesis in a second post-hoc analysis and calculated a 'faultline index' that obtains high values if team members are highly nationally diverse, are equally spread over sites, and when nationalities align with sites (based on standardized scores of all included variables). We found no support for the proposed three-way interaction of nationality, sites, and imbalance (faultline index) ( $\beta = .12$ ;  $p > .10$ ), nor for any of the two-way interactions. Polzer et al. (2006), however, found significant faultline effects (more conflicts, lower trust) when teams were divided into two equally sized subgroups of co-located members and when these subgroups were homogeneous in term of nationality of their group members. Our non-significant finding with regard to the presence of group faultlines may be due to the fact that Polzer et al. (2006) tested their hypotheses in a controlled design with only one group size of six student members working on the same educational exercise, in a small number of geographic locations, and with a temporary team membership of only seven weeks. Especially the comparatively short team membership in their study may have increased the probability that demographic faultlines became salient, as extended tenure enables team members to find initial stereotype-based impressions to be false (Van Knippenberg & Schippers, 2007a), thus making faultlines based on surface-level attributes like nationality and location less significant.

Overall, our post-hoc analyses show that categorization processes seem to play an important role in explaining perceived distance in dispersed teams. While we did not find support for any location-based faultlines in our data, we cannot rule out the possibility that faultlines explain several of our confirmed relationships. In research to date, faultlines have been identified in quasi-experimental settings with fixed inter-group differences (e.g. Lau et al., 2005; Li & Hambrick, 2005; Polzer et al., 2006). In field settings with continuously distributed team attributes and considerable length of team membership, the effects of faultlines are likely to be weakened and/or more difficult to detect. Larger team sizes and several faultline-relevant attributes are especially likely to inflate the possibilities of subgroup formation and to make faultlines more blurry. There is initial and promising research addressing the measurement of faultlines based

on Euclidean distances (Thatcher, Jehn, & Zanutto, 2003), which may be worthwhile extending towards various possible subgroupings such as the multitude of occurring distance configurations in our study. Furthermore, we should take into consideration that the effects of faultlines may not be as straightforward as currently assumed, but may be non-linear in nature (Earley et al., 2000).

### 3.6.1 Implications for Research

The findings of prior virtual team research are largely restricted with regard to the unilateral reliance on objective distance measures. Such a research handles distance as a black box and reveals that objective distance— in most cases – has a negative main effect on team processes and effectiveness (Webster et al., 2006). But what can scholars and practitioners learn from this research, relying on objective distance measures alone?

Objective distance as such is a meaningless variable of social science research. It does not tell anything about the dynamics in the team. Objective distance measures only provide descriptive information about the configuration of team members across different locations, countries, continents or time zones. This research, however, suggests that it is rather the perception of distance that represents the more critical, though missing link to understand distance and dispersed team dynamics. As theoretically suggested by Wilson et al. (2008) and empirically shown in our research, the state of *being physically distant* can obviously co-exist with *feeling close*. In this regard, perceived distance brings a new quality into researchers' conceptualization of distance.

But the perception of distance may not only be included into group research to better predict virtual team functioning and to demonstrate that distance matters but also to explain *why* distance matters. Theory building as well as empirical modeling of geographically distributed teams' processes and outcomes will be enhanced by providing scholars with the subjective dimension of dispersion. The already discussed faultline model (Lau et al., 1998), for instance, is build on the assumption that team member processes are influenced by 'faultlines' that emerge along objective characteristics that split teams into different sub-groups such as locations and demographic categories (Polzer et al., 2006). Our research contributes to this discussion by indicating that it may be the perception of those differences in locations and demography rather than their objective presence per se that affects subsequent team outcomes. According to this research, idiosyncratic perceptions of the same objective stimuli can lead to very different per-

ceptions, a fact that may account for many inconsistencies found with respect to faultline effects so far (e.g., Lau et al., 2005; Li et al., 2005; Polzer et al., 2006). In addition, since subjective distance seems to be not only a cognition of physical distance but also a social appraisal of an interaction partner's availability with severe consequences for subsequent team processes, theorizing in other areas of team research such as knowledge exchange and inter-group processes (e.g., Tallman & Phene, 2007) may gain new insights by including measures for perceived distance.

The examination of perceived distance may therefore pave the way towards the development of more advanced theory with respect to the mechanisms that underlie the effects of distance on the functioning of dispersed teams. In this regard, we find support for Wilson et al. (2008) assumption "that conflicting claims about the impact and importance of distance, as well as contradictory empirical findings may stem from prior authors' focus on physical proximity." As our understanding of distance and its subjective representation advances, we may better understand to isolate the effect of geographic distribution from other factors often associated with distance, such as language, cultures, time zones, configuration, or shared team contexts (Espinosa et al., 2002).

### **3.6.2 Implications for Practice**

The results in this article challenge managers' widespread belief that spatial distance instantaneously impedes any form of effective team collaboration, a mindset expressed in managers preferring to co-locate team members rather than working with virtual teams (Espinosa et al., 2006b). As the seemingly more proximal predictor of team collaboration, subjective distance provides managers with a new approach regarding the opportunities presented by dispersed collaboration, thus avoiding the effort required for relocation or travel. Organizing effective virtual teamwork should focus on fostering perceptions of proximity instead of achieving sufficient physical proximity through permanent co-location and/or face-to-face contact.

In order to maintain perceptions of proximity, a team's level of national diversity has been identified as a pivotal factor in stimulating distance perceptions among team members. Ensuring a more or less homogeneous team with regard to nationality could, however, be a double-edged solution. While obviously reducing distance perception, national diversity has shown to be a valuable knowledge asset which increases problem solution and decision quality (Hambrick et al., 1998). Given our presumption that social categorization is the most important

mechanism underlying the national diversity effect, we recommend weakening the intensity of categorization processes instead of advocating the use of nationally homogenous teams.

Managers can take action to effectively handle processes such as polarization or coalition formation which we believe to foster perceptions of distance. One of these actions against location-based categorization is to temporarily relocate some individuals from one subgroup to another. While this procedure partially offsets the expected benefits of facilitating perceptions of distance without relying on co-location, an interesting leverage effect may take place. Research has shown that intensive contact with outgroup members, for instance through temporary relocation, reduces individual categorization activities which generally transfers to the entire outgroup. This result implies that when members of a dispersed team learn to appreciate one another's differences, they are likely to generalize the positive views to future teammates from the same cultures and locations (Cramton et al., 2005a). Hence, managers do well to temporarily relocate some of their team members to other sub-groups in order to reduce subgroup polarization and facilitate team members' tendency to perceive themselves as being close while being physically separated.

Another possibility to weaken intra-team categorization into different subgroups is the establishment of a shared team identity (Hinds et al., 2005). By emphasizing the common team vision and reinforcing the team members' identification with the group as a whole, rather than just local subgroups, a psychological tie can be built between team members of distant locations (Hinds et al., 2005). In fact, Jehn and Bezrukova (2008a) demonstrated in a recent study that a strong team identity reduces faultline strength and intra-group polarization. More specifically, their results show that a superordinate workgroup identity moderates the effects of activated faultlines on group processes such that a strong workgroup identity decreased the likelihood of activated faultlines leading to coalition formation and conflict (Jehn et al., 2008a).

Behavioral training in virtual teams provides additional opportunities to increase perceptions of proximity. It has been shown, for example, that virtual team communication training improved perceptions of the interaction process over time, specifically with regard to trust, commitment, and frank expression between team members (Warkentin et al., 1999). Since these perceptions are directly intertwined with perceptions of proximity – as has been shown in this research – the use of behavioral trainings should also be effective in fostering feelings of closeness. Furthermore, training is a potent way of reducing negative categorization effects when

team members become familiarized with the opportunities and pitfalls of a nationally diverse team (Hambrick et al., 1998). Trainings that foster pro-diversity beliefs, for instance, have been shown to enhance the performance of diverse teams (Van Knippenberg et al., 2007a) and are also likely to facilitate the perception of proximity. However, managers are well-advised to use these training interventions very early, before the mindless categorizations and feelings of distance set in and people become resistant to appeals (Webster & Wong, 2008).

A more holistic way for managers to foster perceptions of proximity is to create an organizational environment that supports intra-team interaction over distance thus making team members more familiar with each other and reducing uncertainty. Increasing inter-site connectedness defined as the level of formal and informal links between employees of different departments / locations (Jaworski et al., 1993) may be one organizational context variable to alleviate distance perceptions. To the extent that the organizational context facilitates 'inter-location' contact between members of a dispersed team, it also fosters social processes that let team members feel more proximate (Wilson et al., 2008). While face-to-face interaction can - in the short term - amplify the salience of demographic categories such as nationality, it can also reduce prejudice and categorization in the long run. Nesdale and Todd (1998), for example, found that Asian and Australian students who had extensive contact with one another were more accepting and appreciative of cultural differences between the two groups than were students with little cross-cultural contact. Thus, the organization design may also provide managers with ample opportunities to facilitate perceptions of closeness. Increasing inter-site connectedness may be only one of these opportunities.

Given these potential opportunities for managers to facilitate perceptions of proximity, it remains important to note that a managerial interpretation of our results as if spatio-temporal dispersion does not matter would be severely flawed. In fact, geographic dispersion forms the main frame of our discussion, since all other described effects such as national diversity, configurational distance, and subjective distance are to a greater or lesser extent traceable to the conscious management decision to form a team with physically dispersed team members. Managers must be aware of the consequences that a dispersed team setting will have and how they can optimally react to all the expected consequences in respect of team processes. Physical proximity no longer seems to be a prerequisite for successful interaction.

### 3.6.3 Limitations and Future Research

The present study does have some limitations as well. First, the data used for this research are cross-sectional rather than longitudinal. A longitudinal research design would further our knowledge with regard to both the causality of relationships as well as the development of distance perceptions over time. Second, we consciously focused on software development teams because the IT-industry has taken a pioneering role in virtual team collaboration. The digital output of this industry makes it more feasible to collaborate across geographical boundaries. Our choice of this industry was not motivated by convenience, but rather enabled us to collect data from a highly dispersed sample and to reduce within-sample variance in attributes for which the study does not account. Although we do not assume that our results are specific to the task contexts inside software development, we motivate future research to assess whether the present study's findings could be replicated in task contexts outside the software industry. Third, our calculations of national diversity and cultural distance were based on team members' nationality as a surrogate for culture and we did not explicitly assess each team member's idiosyncratic arrangement of values, schemata, and beliefs. Our measurement approach does not capture individual reality to the extent that people possess psychological characteristics that deviate from their nationalities' central tendency. Future research is necessary to investigate what aspects of national culture specifically affect distance perceptions. Finally, our measure of subjective distance is a first step towards the establishment of a new and promising construct in the research field of virtual team dynamics.

Other conceptualizations like the proposed dyadic measurement approach by Wilson et al. (2008) are further interesting perspectives on the same variable. All such conceptualizations need more theorizing, empirical justification, and cross-validation to related constructs. Once researchers have a set of subjective dispersion measures for different levels of analysis (e.g., dyadic, team-level) at hand, subjective and objective distance should both be captured and should characterize the 'latitude and longitude' along which any dispersion construct will be routinely mapped.

The classification of other constructs of team dispersion within such a coordinate system leads to another important issue, namely whether subjective and objective distance subsume all there is to say about dispersion. The answer is almost certainly 'no'. Whereas it seems possible to map almost any dispersion construct along these two more or less distinct dimensions, one cannot fully characterize every dispersion construct only with these two dimensions. Thus, fu-

ture research endeavors are necessary to identify all relevant cognitive and affective dimensions of dispersion to answer the most crucial question: ‘What does being dispersed mean for a team?.’

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## **4 A Multi-Level Approach to Explain Distance Perceptions in Virtual Teams**

### **ABSTRACT**

Although the analysis of dispersed teams has received considerable research attention within the last two decades, there has been little theorizing of how team members experience distance and to what extent the perception of distance is shaped by organizational context variables. Many studies unquestionably assume that distance is experienced equivocally by all team members and dismiss the possibility that the mental representation of dispersion is rather idiosyncratic and dependent on the organizational situation at present. This paper draws on social information processing theory and examines empirically to which degree the organizational context affects team members' perceptions of distance. Using data from 678 members and team leaders from 161 software development teams, our analyses reveal that team members' shared experience of distance is largely molded by organizations' level of formalization and innovation culture. Our results should motivate researchers to include subjective elements of distance in their study of distributed team dynamics and present new avenues for practitioners how to establish an organizational context which fosters feelings of proximity among team members.

Key words: Virtual teams, perceived distance, multi-level analysis, organizational context.

## 4.1 INTRODUCTION

Since organizations cluster their activities around the globe to make use of favorable cost structures or unique knowledge resources, dispersion has become an important team design parameter with a considerable amount of research endeavors addressing this topic. Scholars recently agreed that dispersion or the virtualness of a team can vary greatly and that it cannot be sufficient to only differentiate between co-located and distributed teams. Accordingly, a multitude of possible dimensions of virtuality have been proposed in the meantime. Most commonly, scholars referred to dimensions of dispersion, such as team members' time zone separation (Espinosa et al., 2006b), travel time between sites (Harrison-Hill, 2001), proximity to team leaders (Antonakis et al., 2002), or walking distance along a floor plan (Rice et al., 1991). All these measures are more or less direct resultants of physical distance. While stressing the multi-dimensionality of dispersion and enriching its conceptualization, a decisive issue in virtual team collaboration seems not to be the existence of geographical distance per se, but the way distance is perceived, interpreted, and managed by team members of different locations, cultural backgrounds, and organizational contexts (Kiesler et al., 2002). The preponderance of objective distance measures is somewhat surprisingly given that there are theoretical suggestions and empirical indications which let us assume that the consideration of psychological aspects of dispersion will bring new insights into the discussion of virtual teamwork:

First, physical distance and perceived distance both are related but seem to represent distinct qualities of the same overall construct 'dispersion' (Chidambaram & Tung, 2005). There is empirical evidence for the paradox that members of a team with low levels of physical proximity do not feel distant from each other and, conversely, physical proximity does not always lead to feelings of closeness in team settings (Antonakis et al., 2002; Wilson et al., 2008). Perceived distance, in fact, seems to be more than a cognitive representation of distance.

Second, by exploring the consequences of dispersion for virtual team behavior, first research findings indicate that the perception of distance is a more proximal predictor and a more pivotal element of team dispersion than physical distance. We know, for instance, from Mooney, Sherman and LoPresto (1991) that people's perceptions of distance from home are much better predictors for their social and personal-emotional adaptation to new situations than actual distance from home. Third, the examination of perceived distance does not only broaden our understanding of distance in virtual teams but also helps to reconcile the inconsistent and conflict-

ing findings regarding the effects of distance on team processes and performance (Wilson et al., 2008).

This theoretical and empirical relevance of perceived distance is contrasted with researchers' negligence of psychological dimensions of dispersion. They neglected the possibility that distance may be experienced differently and instead silently assumed dispersion to be directly associated with its mental representation. In our study, we address this research vacuum and ask for the cross-level antecedents of subjective distance. Drawing on the social information processing approach (Salancik et al., 1978), we investigate whether experienced or *perceived distance* is an appraisal not only derived from physical dispersion or other more structural team-level characteristics but instead further molded by the larger organizational context in which the respective team is nested. Following social information processing theory, we assume that characteristics of the organizational context such as the inter-site connectedness or the level of formalization shape individuals' construction of reality and, more specifically, will determine team members' perception of distance. Using data from 678 team members and team leaders from 161 software development teams pertaining to 19 different software labs, we test hypotheses corresponding to our central research question whether team members' perception of distance is affected by the organizational context beyond any team-level characteristics. We address this research question using a multi-level approach and contribute to the extant research on virtual team dynamics in at least three ways (see Figure 4-1 showing the conceptual framework of this study).

First, we enrich scholars' view of distance in virtual teams by broadening our understanding of how teams experience dispersion. Extending the construct 'dispersion' with its subjective dimension will not only further scholars' theoretical understanding of distance but may also help to reconcile the inconsistent and conflicting findings regarding the effect of distance on processes and performance (Wilson et al., 2008). Second, several authors claimed that the larger organizational context should strongly determine distributed team perceptions (Armstrong et al., 1995; Fiore, Salas, Cuevas, & Bowers, 2003). We will answer this still open research question by identifying the organizational context's relative importance and specifying those organizational elements which affect team members' perception of distance. Finally, by considering the larger organizational context as a widely neglected input variable of virtual team dynamics, we suggest new avenues for practitioners how to overcome the pitfalls of distance beyond using more impracticable modes to facilitate collaboration. More precisely, our research



identifies organizational design opportunities how practitioners can establish perceptions of proximity without having team members together in one place.

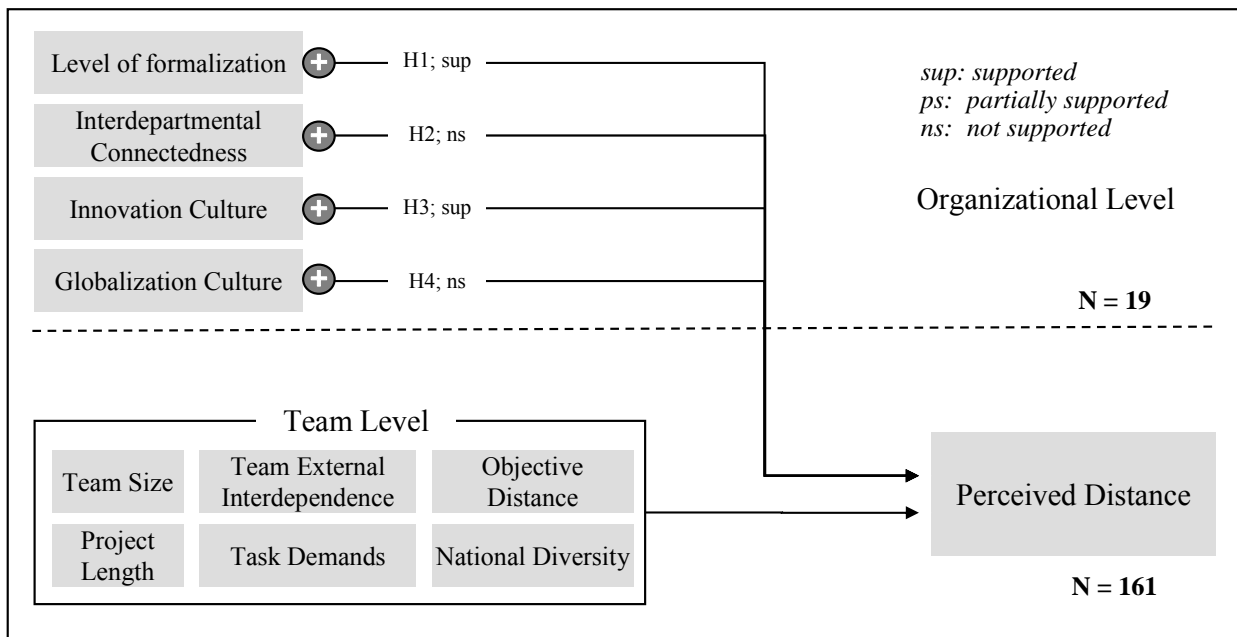


Figure 4-1: Conceptual Framework of this Research

## 4.2 ORGANIZATIONAL CONTEXT AND PERCEIVED DISTANCE

Prior research on virtual teams indicates that distance in work teams is not unitarily perceived by team members and, thus, seem to be more than just a matter of objective data (Torre et al., 2005). In this study, we assume that the organizational context has a powerful influence on individuals' perception of distance. While we assume that the perception of distance is first and foremost an individual judgment of distance between two people, in the present study, we assess the perception of distance on the team-level of analysis since dispersed work predominantly takes place in teams rather than dyads. In alignment to this notion Gully (2000: 27) submitted that 'to conduct research on work teams in the organizational context, the team has to be treated as the primary level of analysis. Hence, for a team-level conception of subjective distance we draw upon Wilson et al.'s (2008) dyadic approach and define perceived distance as a team's shared cognitive and affective representation of spatial distance between team members.

The observation that team member judgments have a subjective component is in line with predictions from social information processing theory which holds that job perceptions do not depend exclusively on objective characteristics of the actual job context, but instead on social constructions of the information available to workers at the time they make their judgments

(Salancik et al., 1978). There is a long history of research which suggests that the larger organizational environment has a significant impact on individuals' cognitive and emotional appraisals. Prior research revealed, for instance, that individual cognitions and emotions are significantly affected by structural factors such as compensation systems, reinforcement patterns, job design parameters as well as physical working conditions (Gist & Mitchell, 1992). Similarly, Jackson and Joshi (2004: 684) contended that "the social contexts within which teams are embedded may shape the daily experiences of team members."

In our study, we refer to the level of formalization, inter-site connectedness, and organizational culture as possible cross-level factors, influencing the perception of distance in teams. We have chosen these organizational characteristics because they are referred to as organizational substitutes for proximity (Hertel, Konradt, & Orlikowski, 2004; Sethi, 2000; Wilson et al., 2008), such that team members suffer less from dispersion and may perceive more proximity in organizational environments characterized by these variables. Hence, we assume a direct cross-level effect for all of these organizational attributes on perceived distance. In the following, we will introduce each of the organizational context dimensions and describe its potential impact on subjective distance.

Given the predictions of social information processing theory, we assume that the organizational context is very likely to be of particular importance for the perception of distance. We hypothesize that organizational factors at a higher level of analysis than the team level strongly impact the processes through which perceptions of distance or proximity are formed and maintained. As specified in the social information processing approach, the organizational context exerts a direct and an indirect effect on the perception of distance. The organizational context can influence distance perceptions directly by providing guidelines and norms what is used to be near or far in the respective organization. For instance, an organizational culture can differ in the extent to which diversity and dispersed collaboration is valued with profound effects on individuals' perception how to judge and deal with such distance and differences (Ely & Thomas, 2001; Van Knippenberg, Haslam, & Platow, 2007b). Second, the organizational context also indirectly affects the perception of proximity or distance through design parameters which let team members appear more or less salient (Salancik et al., 1978). We know, for instance, from information systems research that the cognitive salience or presence of interacting individuals affects their perception of interpersonal closeness versus distance (Kiesler et al., 2002).

Similarly, the organizational context possesses attributes such as the inter-site connectedness which may let team members appear more salient, hence more proximate.

Initial support for a cross-level effect of organizational characteristics on distance perceptions comes from a study by Clinebell and Shadwick (2005) who investigated whether physical distance between main office employees and branch office employees has an impact on their job-related perceptions. They found that the perception of being part of the overall organization was primarily determined by the level of inter-organizational connectedness (e.g. weekly phone conferences) between branches and main offices rather than the physical distance between locations (Clinebell et al., 2005). While not explicitly assessing perceived distance, Clinebell and Shadwick's (2005) findings provide support for our assumption that organizational context variables are likely to exert substantial influence on the perception of distance.

#### **4.2.1 Level of Formalization**

The level of formalization or structural assurance is one hypothesized cross-level predictor for the perception of distance versus proximity in dispersed teams. Companies with a high level of formalization create explicit rules, policies, procedures, plans, goals, and responsibilities which provide all employees with a clear roadmap for collaboration. The consequences of formalization for teams in general can be assumed to be ambivalent. While a formalized organization can detract from creativity and personal enhancement it provides team members with a reliable and predictable environment (Nylen, 2007). Particularly for dispersed team members who interact in a more ambiguous environment with a great scope for misinterpretation and conflict a shared context with formalized and predictable ground rules should facilitate collaboration and the commitment to the team (Kiesler et al., 2002). Fiore et al. (2003) use the term 'team opacity' to describe virtual team members' experience of increased ambiguity, artificiality, and uncertainty caused by technology-mediated interaction. The decreased awareness of team members' actions creates an environment lacking the richness of face-to-face contact, normally experienced in co-located interaction. This, in part, artificial and uncertain virtual team environment potentially negatively affects social team processes and facilitates feelings of distance (Cuevas, Fiore, Salas, & Bowers, 2004).

We argue that a high level of formalization enhances perceived proximity by reducing this uncertainty through structural assurance. A high level of organizational formalization is able to decrease the experience of opacity (Cuevas et al., 2004; Podsakoff, Niehoff, MacKenzie, &

Williams, 1993) by reducing the scope for misinterpretations and conflicts (Cramton, 2001). Structural assurance develops confidence that problems will be dealt fairly and promptly before they get out of hand. With a high level of formalization team members will be more likely to communicate openly, disclose personal information, and discover or create a common identity with other members of the team. The more open communication and stronger commitment to the team due to structural assurance is likely to establish a psychological tie between distance team members that helps them bridge the geographical distance between them and leads to perceived proximity (Wilson et al., 2008).

Furthermore, formalized structures and processes within an organization create the perception of a commonly shared setting. We know from research in the tradition of social ecology (Barker, 1968) that people use cues from their own and others' locations, such as physical boundaries and functional specialization, to develop proprietary feelings about physical spaces labeled as 'territories' (Kiesler et al., 2002). These cognitively constructed territories help team members to organize their perceived boundaries and, thus, determine their experience of distance. An organization possessing highly formalized structures fosters employees' tendency to perceive a cognitively shared social territory within these formalized structures (Kiesler et al., 2002). People who reside within these commonly shared structures should therefore be seen as belonging to the same cognitive territory, hence as more proximate.

In summary, we claim that an organization's level of formalization is a potent cross-level predictor for team members' perceptions of distance versus proximity due to uncertainty reduction and territory alignment. Hence, we posit:

*Hypothesis 1: Organization's level of formalization positively relates to perceived team member proximity.*

#### **4.2.2 Inter-Site Connectedness**

Dispersed teams are per definition distributed across different locations and often represent multiple organizations. We already highlighted that differences in organizational affiliations can foster perceptions of distance by inhibiting a group's ability to develop a shared sense of identity and reducing team communication (see also Zack & McKenney, 1995). The development of a shared identity is at risk in distributed teams, because team members use the location as a salient basis for social categorization processes. Polzer et al. (2006) recently showed that

the assignment to different locations can (especially when split across only two subgroups and when subgroups are homogeneous with regard to nationality) led team members to an “us-versus-them” mentality and, thus, could elicit perceptions of distance. Cramton and Hinds (2005a: 236) likewise exemplified that “a product development team that is split between Germany and India is likely to perceive two subgroups – one in Germany and one in India.”

We assume that the inter-site connectedness of organizations is a possible counterforce against this location-based subgrouping and the tendency to see team members from other locations as being more distant. We refer to inter-site connectedness as the level of formal and informal direct contact among employees across departments and/or locations (Jaworski et al., 1993). Following the predictions of intergroup contact theory (Allport, 1954), we assume that contact between team members of different locations can effectively reduce intergroup prejudices (Cramton et al., 2005a). It is a ground rule of social psychology that repeatedly and greater exposure to targets can significantly enhance liking for those targets (Pettigrew, 1998; Zajonc, 1968). Rhodes, Halberstadt, and Brajkovich (2001) showed in their study that the enhanced liking that results from mere exposure can generalize to greater liking for other related, yet previously unknown, individuals as it is often the case in internationally distributed teams. Hence, to the extent that the organizational context facilitates ‘inter-site’ contact between members of a dispersed team, social processes are facilitated which let team members feel more proximate (Hinds et al., 2003a). For instance, Festinger et al. (1950) in their seminal study showed that graduate students and their families who were randomly assigned to housing near one another had more opportunities to connect with each other, were more likely to become friends and, thus, more likely to perceive closeness. Recently, Clinebell and Shadwick (2005: 91) noted that “more distant locations might have fewer informal links [...] simply due to distance” and that such a weakened connectedness let the employees feel “left out of the loop.” Likewise, Leonardi et al. (2004) found in their interview-based study on seventeen virtual teams from diverse industries that frequent conversation was critical to establishing and maintaining feelings of connection. Consequently, we posit:

*Hypothesis 2: Organization’s level of inter-site connectedness positively relates to perceived team member proximity.*

### 4.2.3 Organizational Culture

An organizational culture is widely assumed to have a profound impact on individuals' cognitive and affective perceptions, once it is commonly shared (Karahanna, Evaristo, & Srite, 2005). Theoretically, scholars mainly rely on two different bodies of psychological theory to explain the transfer from organizational values to individual perceptions and beliefs (Jarvenpaa & Staples, 2001). One is social exchange theory, which argues that people adapt to organizational values in order to gain desired resources through social reciprocity (Wayne, Shore, & Liden, 1997). To maximize such resources, individuals align their attitudes and perceptions as being the same or similar to those of their organizational context. The second theoretical argument for the alignment between organizational culture and team members' perceptions stems from social identity theory (Ashforth & Mael, 1989). By demonstrating consistency with the organization's values and mind-sets, individuals revalidate their status in the organization for the sake of their own self-esteem. Hence, team members adhering to the same organizational culture are likely to also align their perceptions of distance either due to social exchange or social identity reasons.

We therefore consider organizational culture as another cross-level predictor of perceived distance in this study. Recently, researchers criticized the concept of a unitary, monolithic organizational culture when interested in studying intra-organizational dynamics of organizational sub-units such as virtual teams (Karahanna et al., 2005; Lok, Westwood, & Crawford, 2005). This is because organizations have been shown to contain subcultures (Hofstede, 1998) which form around organizational groups on the basis of a range of factors such as location, functional focus, and professional backgrounds (Bloor & Dawson, 1994). Given that this study considers software laboratories rather than whole corporations as organizational entities, we employ the conceptualization of sub-cultures. Further on, we argue that subcultures are likely to have stronger relationships with perceived distance than main cultures because they provide a more salient, intimate, and informal reference group (Armstrong et al., 1995).

In this work we draw on the conceptualization of DeBrentani et al. (2004) and distinguish between 'globalization culture' and 'innovation culture' as two sub-types of culture. These two types of sub-cultures are particularly relevant for this study because our sample is comprised of globally distributed teams working on innovative software-development tasks. In addition, both cultural sub-types are conceptually closely linked to our research subject 'perceived distance' as we will describe in the following.

### *Innovation Culture*

We refer to ‘innovation culture’ as an organizational environment in which company personnel emphasize the importance of new products, where the firm is receptive to new ideas and innovation, and where involvement in new product development, entrepreneurship, and risk taking are encouraged and rewarded (De Brentani et al., 2004). In organizations with an innovation culture managers and employees believe in the importance of new products for the company’s continued success, domestically and internationally (Smith, 1998). It is a mindset that motivates employees to endorse holistically a belief in creating newness. Organizations with such an innovation-driven culture typically possess a climate of openness, informal communication, and involvement (Andriopoulos, 2001; Capon, Farley, Lehmann, & Hulbert, 1992). Thus, teams adhering to the values of this organizational sub-culture are prone to develop norms of open communication and a commonly shared team spirit which enable them to better cope with challenging situations (Weick, 1993). Collaboration across distance is one such challenge, and teams adhering to an innovation culture are likely to perceive their teammates as being close in spite of their lack of physical proximity (O’Leary, Orlikowski, & Yates, 2001).

Scholars consistently refer to open source software developers to exemplify a constellation in which a high level innovation culture is lived and leads team members to perceive interpersonal closeness despite of considerable geographical distance between them (Bergquist & Ljungberg, 2001). Open source software development teams are internet-based communities of software-developers regularly including geographically dispersed members who voluntarily collaborate to develop software and typically share a highly innovation-driven culture (von Hippel & von Krogh, 2003). In fact, open source projects have been able to bring together the contributions of thousands of developers scattered throughout the world to create highly innovative products such as the Linux operating system or the Apache web server (Bergquist et al., 2001). Due to this shared culture of joint innovation, open source developers typically perceive high levels of proximity in spite of the absence of face-to-face interactions (Wilson et al., 2008).

We conclude that a shared innovation culture might be able to foster feelings of proximity among team members by supporting a common identity, enhancing communication, and facilitating the development of an open team climate. Further on, a highly pronounced innovation culture can provide a substitute for proximity in the form of structural assurance which has al-

ready be assumed to facilitate perceptions of proximity (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002). Hence, we posit:

*Hypothesis 3: Organization's innovation culture positively relates to perceived team member proximity.*

### *Globalization Culture*

We refer to a 'globalization culture' as an organization's mindset where people see themselves as a part of an international network (De Brentani et al., 2004). Organizations possessing a globalized culture are open to world market opportunities, diverse customer needs and preferences, and different national cultures and competitive scenarios (De Brentani et al., 2004). Thus, whereas an innovation culture supports openness and entrepreneurship that helps to pull together ideas and individuals to work in a more holistic and risk-oriented manner, a globalized culture becomes even more important when organizations' efforts and competencies are spread across different geographical regions and national cultures (Kleinschmidt, de Brentani, & Salomo, 2007). More specifically, teams that are comprised of individuals from different geographic locations are more likely to manifest higher levels of demographic, functional, and structural diversity (Cummings, 2004). From diversity research we have learned that demographic dissimilarity within a team can lead to 'social distance' which, in turn, can lead to psychological distance (Williams et al., 1998). As outcome of self-categorization, team members identify with their own sub-group and feel – in part independent from real distance – closer to the members of their own sub-group than to members of other sub-groups (Polzer et al., 2006).

Accordingly, we assume that a globalization culture that promotes a global leverage of specialized skills, resources, and ideas can diminish categorization processes and support the evolvment of feelings of proximity in dispersed teams. More specifically, we hypothesize that the results of diversity in dispersed teams tend to be more positive in contexts where individuals and groups have more favorable beliefs about and attitudes toward diversity, are more focused on harvesting the benefits of diversity, and have a better understanding of how to realize these benefits (Van Knippenberg et al., 2007a). In other words, we believe that a globalization culture will favor diversity mindsets which we expect to prevent intergroup bias as well as to stimulate the integration of diverse information, viewpoints, and perspectives. The reduced stereotyping through more open communication should, in turn, enable dispersed team members to perceive proximity in spite of physical distance.



Empirical studies that examine the effects of diverse teams in organizations with differing cultures, climates or mindsets seem to support our line of reasoning (Chatman, Polzer, Barsade, & Neale, 1998). Gibson and Gibbs (2006), for instance, showed in their study that a psychologically safe communication climate helped virtual teams to overcome the challenges of national diversity and hypothesized that this effect originated at least in part from a reduction of categorization processes. Likewise Kotlarsky and van Fenema (2005) reported evidence from a distributed, multi-cultural software project in which remote developers in Geneva still felt close to the other members of the team in New York because they perceived a shared organizational culture. Thus, we expect a globalization culture to be a possible mean to build social bonds between dispersed team members and to facilitate perceptions of proximity. Hence, we posit:

*Hypothesis 4: Organization's globalization culture positively relates to perceived team member proximity.*

## **4.3 METHOD**

### **4.3.1 Participants and Procedure**

For the purpose of this study, we collected data from 19 different software laboratories pertaining to five software developing companies with four headquartered in Germany and one headquartered in the USA. All software laboratories are dedicated to the development, testing, and adaptation of basic software programs. While most software labs are proficient in the whole value chain of software development, some labs are specialized on certain functionalities or development processes. Because organizations are known to be far from monolithic, we focus our analysis on the organizational level of laboratories and not on the overall company. We favor the laboratory level in order to find a team-context, specific enough to be homogeneous and broad enough to appropriately capture the organizational context for all associated teams (Pfeffer, 1982). For our analyses we draw on data from 161 software development teams pertaining to the 19 different labs. Each laboratory employed between 20 and 5,500 software developers (median = 600). Included in the study are software development projects that were completed within 12 months prior to data collection and that were worked on by 'teams.' For multi-team projects each team could participate separately in the study as long as independent performance evaluations were possible. The responses were gathered via a web-based survey. Descriptive details about the team and all team members were provided by the team leaders within a pre-defined spreadsheet. Team members were randomly contacted and asked to com-

plete the online questionnaire. Respondents' participation in this study was strictly voluntary. The response rate for team leaders and site managers was 100%, and for team members was 68%. Finally, data on the organizational level of analysis were gathered through the first author in individual phone interviews with laboratories' site managers by using a fully standardized questionnaire. For each team included in the final data set of this study, we have responses of the team leader and at least two team members. The use of different informants for different levels of analysis enables us to ensure content validity and to avoid a possible common source bias. In particular, all lab-level data is provided by site managers, team-level control variables are derived from team leader information, and subjective distance is judged by team members. Overall, our analyses are based on a total of 678 responses from 161 team leaders, 515 team members, and 19 site managers.

### 4.3.2 Measures

#### *Organizational Level Variables*

Most of the teams in our sample are dispersed, thus complicating a clear-cut allocation of teams to its laboratory context. We decided to assign a team to that laboratory context to which most members belong. In case of equal membership in different labs, we related teams to the context to which the team leader belongs. We reasoned that this assignment procedure is appropriate since research from other domains discovered that individuals and groups are mostly influenced by their dominant context (e.g., Hearn & Piekkari, 2005; Passmore & French, 2003) and that both criteria (largest sub-group and team leader location) can be justifiably used to identify this 'dominant' context. As variables of the organizational team context we consider in this study: 1) level of formalization, 2) inter-site connectedness, 3) innovation culture, and 4) globalization culture. In order to assess labs' level of formalization and inter-site connectedness we employed the measures provided by Jaworski & Kohli (1993) (Cronbach's alpha = .81 and .70). The scale to measure innovation and globalization culture are adapted from DeBretani and Kleinschmidt (2004) (Cronbach's alpha = .87 and .88). All items are coded as '1' "strongly disagree," to '5', "strongly agree." The adapted scales for all cross-level variables are included in Table 4-1. Inter-correlations and reliability of constructs are illustrated in Table 4-2.

Variables	Items
Independent Context Variables (Organizational Level)	<p><i>Level of Formalization.</i> (1) The organization has a large number of rules and written procedures; (2) In the organization there are manuals that specify procedures; (3) There are written job descriptions for most positions in the organization; (4) There are written performance indicators for the people who work in this location; (5) There is a formal orientation program for individuals who are new to the organization</p> <p><i>Level of Inter-Site Connectedness.</i> (1) In this organization, it is easy to talk with virtually anyone you need to, regardless of rank or position; (2) There is ample opportunity for informal "hall talk" among individuals from different departments in this organization; (3) In this organization, employees from different departments feel comfortable calling each other when the need arises; (4) Managers here discourage employees from discussing workrelated matters with those who are not their immediate superiors or subordinates; (5) People around here are quite accessible to those in other departments; (6) Communications from one department to another are expected to be routed through "proper channels;" (7) Junior managers in my department can easily schedule meetings with junior managers in other departments</p> <p><i>Innovation Culture.</i> Management has created an open and innovative corporate culture for our international software engineering by: (1) recognizing and strongly rewarding entrepreneurship; (2) actively encouraging employees, worldwide, to submit new product ideas; (3) ensuring that project leaders are not punished if new product projects fail or are cancelled</p> <p><i>Globalization Culture.</i> To create a "truly global" innovation culture, our organization: (1) strongly encourages contributions from team members located in different countries/cultures; (2) strongly emphasizes knowledge sharing across different geographical subunits; (3) emphasizes responsiveness to differences in local markets; (4) strongly endorses informal communication and coordination development activities across country units; (5) achieves a high degree of interdependence among other labs worldwide.</p>
Dependent Variable (Team-level)	<p><i>Perceived Distance.</i> I could easily visit most team members with whom I collaborated. <sup>(r)</sup> It was easy to get the team members together in one place for spontaneous meetings (e.g. for discussions and decisions). <sup>(r)</sup> In this team we had frequent face-to-face meetings with all team members. <sup>(r)</sup> To which % has team communication been channeled through virtual tools (Phone, Email, Tele-Conferencing etc.)?</p>
Controls (Team-level)	<p><i>Team-external Interdependence.</i> '1' an isolated teamwork with only little interaction with other teams / projects (e.g. for some requests), '2' an isolated teamwork with significant interaction with other teams / projects in at least one project phase, '3' a teamwork with a continuous need for interaction with several other teams / projects, '4' a multi-team project, in which your team's work output integrated into a larger software-solution causing significant and continuous need for coordination.</p>
<p>Notes. Please note that while all items are measured on a five-point Likert scale, we measured the virtuality of communication (part of 'perceived distance') in percent and retransformed the scale into the same range as the other scales. Items with an <sup>(r)</sup> are reverse coded.</p>	

*Table 4-1: Selected Survey Items Used in this Research*

Variables <sup>1)</sup>	Infor- mant <sup>2)</sup>	N	Mean	SD	2	3	4	5	6	7	8	9	10
1 Team Size (log) <sup>T</sup>	TL	161	2.22	.58	.16*	.33**	.26**	.13	.08	.14	.11	.22	.25*
2 Project Length <sup>T</sup> (log)	TL	161	1.17	.27	–	.15 <sup>+</sup>	-.07	.04	-.14 <sup>+</sup>	.03	.01	-.12	-.20*
3 Team-External Interdependence <sup>T</sup>	TL	161	2.89	1.06	–	.13 <sup>+</sup>	.11	.16*	-.04	-.11	.05	.25*	
4 Objective Distance <sup>T</sup>	TL	161	.00	.73	–		.53**	.54**	.08	-.19	-.07	.24 <sup>+</sup>	
5 National Diversity <sup>T</sup>	TL	161	.24	.25	–			.43**	.07	-.19	-.12	.27*	
6 Perceived Distance <sup>T</sup>	TM	161	2.91	.87	–				-.32 <sup>+</sup>	-.44**	-.39**	.11	
7 Level of Formalization <sup>L</sup>	SM	19	4.12	.69	–					.32**	-.06	-.01	
8 Inter-Site Connectedness <sup>L</sup>	SM	19	4.33	.53	–						.10	-.23**	
9 Innovation Culture <sup>L</sup>	SM	19	3.14	1.04	–							.17*	
10 Globalization Culture <sup>L</sup>	SM	19	3.90	.99	–								–

Note. <sup>+</sup>p < 0.10, \*p < 0.05, \*\*p < 0.01.

<sup>T</sup> Team-level variables; <sup>L</sup> Lab-level variables

1) Team-level correlations (N = 161) and Lab-Level correlations (N = 19) are zero order correlations. Cross-level values computed by calculating standardized effects from simple (one independent variable) regressions in HLM using centered predictors.

2) This study used different informants for different levels of analysis: TL = Team Leader; TM = Team Member; SM = Site Manager

Table 4-2: Descriptive Statistics and Correlations (N= 161 teams)

### Team-level variables

We assessed subjective distance with four items (see Table 4-1), asking the perceived ease with which dispersed team members could be visited, the felt effort required to get them in one place for a meeting, the perceived virtuality of communication, and the perceived frequency of face-to-face meetings during the project (Cronbach's alpha = 0.76). The rationale for our operationalization of subjective distance was that the felt easiness to visit / meet with distant team members is not just a question of linear travel time but merely reflects individual's perception of how distant other team members are (Harrison-Hill, 2001). We furthermore considered other team members' level of 'visibility', or 'salience' as a central element of the experience of physical work environments and, hence, of the perception of distance (Crowston et al., 2007; Haner, 2005; Kiesler et al., 2002). By using a team-level approach to assess perceived distance,

though a foremost dyadic concept (Wilson et al., 2008), we need further justification that team members really have shared perceptions of their distance. We therefore calculated interrater agreement by using the multiple-item estimator for within-group interrater reliability (IRR) as proposed by James, Demaree, and Wolf (1984a). We found a strong agreement between raters (team members) across all teams ( $r_{wg} = .90$ ) and employed the aggregated team-level responses as a reliable data basis for further analysis.

### *Control Variables*

In the theoretical part of this work, we hypothesized that structural variables of the organizational level are likely to trigger perceptions of distance or proximity. In our analyses, we control for structural team-level variables which are also likely to affect distance perceptions. First, we controlled for team size since large team sizes make it more difficult for team members to interact with all other team members which may foster perceptions of interpersonal distance. Moreover, team size can elicit feelings of disconnectedness since with higher group sizes the possibility that team members are located apart from each other also increases (Hoegl et al., 2004a). We furthermore included project length as a control variable, since we know from prior studies that the longevity of a group is positively associated with the degree to which group members have a shared outlook and perception (Burke et al., 1999). In addition, we controlled for the intensity of team-external linkages as in-depth interviews with R&D managers from different labs mentioned it as a central characteristic for dispersed team perceptions (see Table 4-1). A measure for physical distance was included as a control variable into our analysis to ensure that our results for subjective distance are not inflated through a hidden effect of its objective correlate. We employed the state-of-the-art approach to measure dispersion as proposed by O'Leary & Cummings (2007) who distinguish between five elements which we combined to one 'objective distance' index after standardizing its component dimensions (Cronbach's alpha = 0.78). Finally, we also included national diversity based on Blau's index (1977) because it is a salient cue for seeing other team members as more apart from each other, especially when national diversity aligns with team members locations (Cramton et al., 2005a; Polzer et al., 2006).

### **4.3.3 Data Analysis**

Given our basic proposition that team's perception of distance is significantly affected by the larger organizational context, we employed two-level hierarchical linear modeling for our

analyses (Hofmann, 1997). At level 1, the unit of analysis was the team and each team's perceived distance was a function of a set of team characteristics (e.g., national diversity, objective distance). At level 2, the unit of analysis was the lab context, where subjective distance was hypothesized to depend on specific lab characteristics adjusted for the regression coefficients in the level-1 model. Since our hypotheses include main effects of level-2 variables on the lab mean level-1 outcome (perceived distance) adjusted for team-level controls, we used intercept-as-outcomes models with grand-mean centered level-1 and level-2 predictors (Hofmann & Gavin, 1998). Finally, because we are interested in the prediction of team-level intercepts in perceived distance with level-2 variables, we used a random effects model (as opposed to a fixed effect model) to deal with variance across teams' intercepts.

#### 4.4 RESULTS

Table 4-2 presents the team-level descriptive statistics and zero-order correlations in a hybrid correlation matrix including all study variables. Whereas zero-order correlations between variables at the team-level or the lab-level of analysis were calculated on their level, HLM was used to calculate the correlations between team-level and lab-level variables (as univariate cross-level effects; i.e.,  $\gamma$ ; Judge, Scott, & Ilies, 2006; Mathieu, Maynard, Taylor, Gilson, & Ruddy, 2007). To investigate our four hypotheses, we performed a sequence of models by using the HLM 6.06 statistical package (Raudenbush, Bryk, & Congdon, 2004). Each HLM analysis was conducted in a hierarchical fashion and comprised three steps (Hofmann, 1997; Raudenbush et al., 2004). In a first step, we estimated a null model in which no predictors were specified for either level 1 or level 2 functions. This procedure allowed us to estimate the level 2 residual variance of intercepts and, thus, partitioned the variance of perceived distance into its within and between lab variance components using the intra-class correlation (ICC) (Gavin & Hofmann, 2002). The ICC value for perceived distance in our sample is significant and equals 0.26, reflecting that 26% of variance in perceived distance resides between labs.

Having confirmed that dispersed collaboration varies both within and between groups, a second step tested whether there is still significant cross-lab variance after all team level controls have been included in a level-1 random coefficient model (Gavin et al., 2002). The Chi-Square test associated with the residual variance (between lab variance) reveals significant inter-lab variability [ $\chi^2(18) = 53.80, p < .001$ ] and provides the basis for testing our cross-level hypotheses. Our third step therefore comprises the question whether level-2 predictors explain variabil-

ity in our level-1 outcome or, more specifically, whether our context variables are associated with varying intercepts in dispersed collaboration across labs ( $\beta_{0j}$ ), while we controlled for our level-1 variables. Such an intercept-as-outcome model is specified below:

$$\text{Level 1: } y_{ij} = \beta_0 + \beta_1 (\text{Team size}) + \beta_2 (\text{Project Length}) + \beta_3 (\text{Team External Linkage}) + \beta_4 (\text{Objective Distance}) + \beta_5 (\text{National Diversity}) + r_{ij} \quad (1)$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01} (\text{Formalization}) + \gamma_{01} (\text{Inter-Site Connectedness}) + \gamma_{01} (\text{Innovation Culture}) + \gamma_{01} (\text{Globalization Culture}) + U_{0j} \quad (2)$$

$$\beta_1 = \gamma_{10} \dots \beta_5 = \gamma_{50} \quad (3)$$

Where  $y_{ij}$  is the team-level dispersed collaboration measure for team  $i$  in lab  $j$ ,  $\beta_{0j}$  represents the lab intercepts, while  $r_{ij}$ , and  $U_{0j}$  are team and lab-level error terms assumed to be independent and normally distributed with a mean of zero and a variance of  $\sigma^2$ .

Variable	Parameter estimate	SE	df	t-Test	p-value
<i>Team-level Controls</i>					
Team Size	.06	.10	150	0.61	.55
Project Length (LOG)	-.50	.21	150	-2.39	.02
Team-External Interdependence	.10	.05	150	1.86	.06
Objective Distance	.40	.09	150	4.53	.00
National Diversity	.76	.26	150	2.95	.00
<i>Cross-Level Predictors</i>					
Level of Formalization	-.33	.13	14	-2.48	.03
Inter-Site Connectedness	-.20	.16	14	-1.30	.22
Innovation Culture	-.24	.08	14	-3.23	.01
Globalization Culture	-.02	.07	14	-0.29	.78

Table 4-3: Intercept-as-Outcome Model Results Predicting Subjective Distance

The results for this model are presented in Table 4-3 and indicate that  $\gamma_{01}$  and  $\gamma_{03}$  are significant and negative, providing support for our hypotheses 1 and 3 that organizations with more formalized structures, incorporating an innovation-oriented culture, foster feelings of proximity among team members. The results of our final HLM model further indicate that our four predictors explain nearly all of the level-2 variance in perceived distance without any significant portion of variance remaining in the intercept terms [ $\chi^2(18) = 17.45$ ,  $p > .23$ ]. Given the limited

power afforded by our sample – with a level-2 sample of 19 and 4 level-2 predictors, we are at the lower bound of what researchers generally recommend – we investigated the robustness of our cross-level relationships and reran all intercept-as-outcome models with only one single level-2 predictor. This procedure, as recently recommended by Parboteeah, Hoegl, and Cullen (2008), yielded the same result pattern which suggests high robustness of our results. In addition, the cross-level effect exerted by lab's inter-site connectedness becomes significant when integrated as sole level-2 predictor ( $\gamma_{01} = -.52$ ;  $p < .05$ ). We conclude that this variable seems also relevant for the perception of distance and encourage further research on this variable using larger-scaled samples.

Beyond our hypothesized cross-level effects, we observe that our control variables project length, team-external linkage, objective distance, and national diversity all have a significant association with team members' perception of distance. Interestingly, national diversity and objective distance, while being strongly inter-related (see Table 4-2), exert both an independent and significant influence on the experience of distance (see Table 4-3).

#### **4.5 DISCUSSION**

A considerable amount of research has been devoted to the exploration of dispersion in work teams and its consequences for team dynamics (Martins et al., 2004). But also Poole and Zhang (2005: 380) recently noted that we “know less about the phenomenological experience of virtuality than would be desirable.” Our study addresses this research gap and investigates whether the organizational context influences how work teams perceive dispersion. In alignment with predictions from social information processing theory we could show that team members' feelings of proximity are not only a function of objective distance but considerably depend on characteristics of the context in which team collaboration takes place. More precisely, we identified that laboratories' level of formalization and innovation culture foster feelings of proximity among team members. We further showed that these cross-level effects persist while controlling for objective distance at the team-level. Additionally, we found structural team-level characteristics such as project length, team-external linkages, national diversity, and most straightforwardly objective distance to be significantly associated with team members' perceptions of distance. Overall, team members' sense of distance seems to be based on a multitude of factors of which a considerable amount of variance is explained by the larger organizational context. Most interestingly, as already suspected by some authors (Mooney et al., 1991; Wilson et al.,



2008), actual distance seems to exert only a small influence on team members' perception of distance. Since perception is an active process (Stroh et al., 2002), it seems to be susceptible to a variety of internal and external influences, including structural characteristics of the team, as well as the context in which the perception occurs. Our results provide support for Wilson et al.'s (2008) propositions that especially team member salience and shared values towards an open communication climate are critical for the perception of proximity versus distance. Thus, team member's propensity to perceive proximity is apparently more sensitive to the fulfillment of their needs for predictable work conditions and an open communication culture than to physical co-location. And organizations can take important steps to support teams working at a distance and to increase their sense of proximity by changing the collaborative environment accordingly.

#### **4.5.1 Implications for Research**

For researchers, our results suggest that it would be important to reconsider several existing notions about distance and its effects on virtual team dynamics. First, while the majority of researchers assess dispersion as a one-dimensional variable with more or less direct associations to spatial distance, our results indicate that dispersion has a subjective component which is far from being fully explained by objective distance. Rather, the judgment of distance seems to proceed from a complex evaluation of multiple team-level as well as multiple organizational level variables. Due to the fact that scholars in the domain of organizational behavior so far have not appropriately accounted for this subjective dimension of dispersion, several empirical results may need to be reconciled (Wilson et al., 2008).

Second, conventional wisdom in behavioral research holds that "we feel closest to others who are in close physical proximity to us" (Wilson et al., 2008: 979). Allport's (1954) intergroup contact theory, for instance, is based on the assumption that contact between groups or sub-groups could effectively reduce intergroup prejudice while fostering interpersonal closeness and friendship with strong empirical justification in subsequent research (Pettigrew & Tropp, 2006). Our study results, however, revealed that this social psychological ground rule of personal interaction as detected in co-located settings does not equally apply in more virtual team constellations. While interpersonal contact can be assumed to foster perceptions of closeness even in dispersed teams (see results of the sub-model including inter-site connectedness as the sole level-2 predictor), propinquity seems neither necessary nor sufficient for the perception of closeness, and therefore for the development and maintenance of positive interpersonal rela-

tionships and successful interaction. As we have shown in this paper, feelings of closeness within a team can be maintained in organizations without relying on physical proximity. In fact, companies' level of formalization and innovation culture can act as substitutes for proximity and provide teams with a necessary common ground for close interaction and the perception of propinquity.

Third, our research results underline the importance to study more methodologically how contextual or situational factors in work teams influence virtual team dynamics. While several scholars already pointed to the necessity to account for contextual parameters in the study of virtual teams (Jarvenpaa, Shaw, & Staples, 2004; Zack et al., 1995), cross-level effects in this research area remain largely unexplored (Martins et al., 2004). Especially for more subjective phenomena such as perceived distance, equal values on an objective dispersion measure may have different effects in different settings. Jarvenpaa et al. (2004), for instance, could show that trust affects virtual teams differently in different situations. Similarly, the perception of faultlines may well depend on the organizational context at present (Jehn & Bezrukova, 2008b). We contribute to this line of research by showing that idiosyncratic perceptions of the same objective stimuli can lead to very different perceptions in different contexts. Many inconsistencies found in faultline research (e.g., Lau et al., 2005; Li et al., 2005; Polzer et al., 2006), for instance, may be due to the negligence of the organizational context at present. Researchers who explore how context affects the dynamics of virtual teams may be finally rewarded with the resolution of these inconsistencies.

Overall, future research should rely on more nuanced conceptualizations of virtuality and consider the organizational context as an important cross-level determinant of virtual team dynamics. While there are promising approaches of more comprehensive operationalizations of virtuality (Gibson et al., 2006; Kirkman et al., 2005; O'Leary et al., 2007), scholars still have largely failed to account for the subjectivity of dispersion. Future modeling of virtual team dynamics will certainly gain from more holistic approaches towards dispersion measurement and will let us better understand the mechanisms inherent in dispersed teams (O'Leary et al., 2007; Wilson et al., 2008). In addition, future research on the cross-level effects of the organizational context will help us to better understand the sensitivity of specific team processes to the context in which these processes occur.

#### 4.5.2 Implications for Practice

Flexible work arrangements proliferate in today's business world with employees working at home, meeting at client sites and interacting through technology. Most managers concerned with virtual work arrangements assume that good collaboration is only possible if costly and time consuming activities support team interactions such as frequent travels to meet face-to-face (Espinosa et al., 2006b). However, our research discovered organizational level variables under the control of management that can be leveraged to foster feelings of proximity among team members without relying on co-location. Instead, managers can provide organizational substitutes for proximity in the form of formal rules and procedures, inter-connected work structures, and an innovation culture to achieve higher levels of perceived proximity. Inter-connected work structures between sites, for instance, can be effectively managed through interpersonal forums, periodic department meetings, social events, or virtual meetings (Raghuram, Gamd, Wiesenfeld, & Gupta, 2001). The implementation of formal rules for organizational processes such as formalized mentoring programs, personnel selection standards or standard procedures for administration and communication may be useful to reduce uncertainty for dispersed interaction (Kiesler et al., 2002; Wilson et al., 2008). And an innovation culture – while much more difficult to frame – might be facilitated through the encouragement of entrepreneurship and the refrain from punishment in case of risk taking or failure (De Brentani et al., 2004).

But while our results suggest that these activities are likely to be effective in increasing the level of perceived proximity, they are far from being a panacea. The level of formalization, for instance, may not only remove uncertainty from distributed work but has also been shown to impede informal communication, depersonalize interaction, and can exert corruptive effects on the innovation climate (Kiesler et al., 2002). Likewise, enhancing the inter-site connectedness between two or more sites may also be a double-edged solution in the light of research findings that increased salience also enhances sub-group stereotyping. More specifically, while salience of team members at other sites is likely to be supportive for the perception of interpersonal closeness (Wilson et al., 2008), it also makes surface-level attributes more visible and facilitates categorization processes (Polzer et al., 2006). Special attention in this context should be placed on national diversity which is a positive team level predictor for perceived distance (see Table 4-3) and might amplify its influence through location-based faultline dynamics when sites are closely connected (Polzer et al., 2006). Thus, practitioners are well advised to consciously de-

sign organizational parameters in order to decrease perceived distance among team members but with being aware of potential corruptive effects.

Additionally, organizational design choices are likely to be diffuse in their effects and may favor perceptions of proximity in some team members but achieve no impact or opposed influence in other individuals. More research is definitively needed to explore such contingencies upon which organizational actions unfold its effects on the perception of distance. One of these contingencies could be company size. It might be much more difficult for a large company to implement effective programs that directly facilitate perceptions of proximity among team members such as a company-wide innovation culture. Specifically, for larger companies a more indirect strategy to establish feelings of proximity through formalized processes and inter-site linkages seems most feasible since a corporate-wide innovation culture hardly develops. Smaller companies with less structured processes such as a high-tech startup company, however, may make use of their entrepreneurial climate to achieve high levels of perceived proximity (De Brentani et al., 2004).

Overall we conclude that our organizational context parameters provide practitioners with opportunities to elicit feelings of proximity even in dispersed teams. Along this way and with careful attention to possible side effects of organizational redesigning, managers can achieve the benefits of proximity without necessarily resorting to physical co-location. However, our research further suggests not to solely relying on organizational level parameters to increase feelings of proximity among team members. According to our multi-level results, perceptions of proximity can be optimally complemented with additional attention to team design elements such as project length, external team-linkages, and team members' national diversity. All of these team-level variables seem to provide further possibilities to maintain the psychological connectedness within a team. Thus, our research suggests practitioners to address the challenges of distance perceptions with a multi-level approach rather than a one-sided focus on organizational level parameters.

#### **4.5.3 Limitations and Future Research**

Despite the contributions of our study, below we note a few limitations along with suggestions for further research. First, we did not consider possible interactions among organizational level and team level characteristics on the perception of distance due to limitations in sample size. However, we hope that based on our discussion of direct effects, future research will

tackle more complex, interactive models of distance perceptions in specific organizational contexts. For example, team members' national diversity might have a less negative effect on the perception of distance in organizations with a global mindset than in locally operating companies. Second, the context of distributed teams includes not just organizations, but larger entities such as industries, markets, and countries. The industrial trend toward more globalized R&D activities and all associated turbulences may affect team functioning by exerting a constant pressure to adapt and engendering a significant impact on distance perceptions. Third, besides any context factors, the perception of distance is also likely to be affected by individual level variables such as age, gender, personality, social background, and the experience with dispersed teamwork (Torre et al., 2005; Wilson et al., 2008). There is a considerable research vacuum regarding the study of individual differences in the field of virtual teams (Martins et al., 2004) but we believe that certain individual attributes help team members to better cope with distance and virtual teamwork. Finally, this study is cross-sectional in nature and we cannot establish causality. We hope that future studies can examine the development of distance perceptions over time. As our results indicate that with ongoing project length the perception of distance decreases (see Table 4-3), further research incorporating the timing of distance perceptions is likely to bear interesting insights in related team dynamics (Burke et al., 1999).

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## **5 The Bright Side of Virtual Collaboration: How Teams Can Profit From Dispersion**

### **ABSTRACT**

Prior research has shown both positive and negative effects of team dispersion on team performance. Given these inconsistent prior evidence, we argue that whether team dispersion is detrimental or beneficial for team performance is contingent upon the teams' task-related and socio-emotional processes. We test our hypotheses using data from multiple informants pertaining to 80 software development teams with highly varying degrees of dispersion. Results suggest that teams with lower levels of task-related team processes considerably suffer from dispersion. By contrast, dispersed teams with excellent task-related team processes can even reach higher levels of team performance than co-located teams. The proposed contingency effect of socio-emotional processes was not supported. Theoretical and practical implications are discussed.

Key words: Dispersed teams, teamwork, team effectiveness.

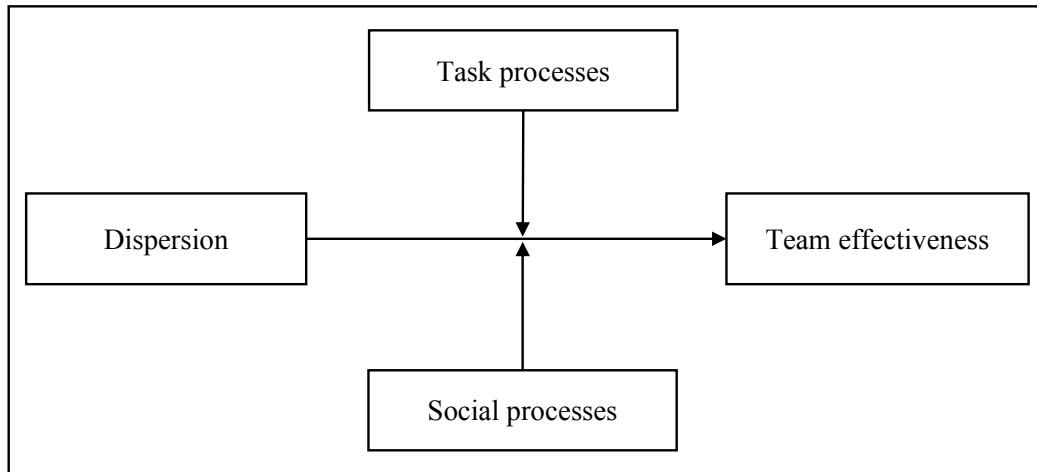
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## 5.1 INTRODUCTION

Current practice in new product development is to split teams over different locations according to different expertise, technology, and cost structures with the expectation that such dispersed teams offer performance advantages over more co-located teams. While such positive effects of dispersed teams are supported by some studies (e.g. Cummings, 2007; Singh, 2008), other research supports the notion that dispersion is detrimental for teamwork (e.g. Cramton et al., 2005b; Hoegl et al., 2004a), with subsequent implications for performance. Moreover, studies carried out on student teams indicate a negative association between team member dispersion and team processes as well as team performance (Powell et al., 2004). As such, companies' hopes for performance advantages of dispersed teams are often contrasted with difficulties in running these teams and subsequently less than expected outcomes.

Given the mixed findings regarding the effects of geographic dispersion, with no unequivocal conclusions to draw, the need for a contingency approach (Lawrence & Lorsch, 1967) emerges. Such an approach can close the gaps in prior research by showing which contingent variables may influence whether dispersion has a positive, a negative, or no impact on team performance. The limited knowledge about contingency factors of the dispersion–performance link presents a research vacuum which may also account for the conflicting research results found for the effects of dispersion on team performance (Martins et al., 2004; Powell et al., 2004). A more stringent focus on moderators is important not only to identify when dispersion may be expected to have positive or negative effects, but also because it is informative about the processes underlying the influence of work group dispersion.

We address this research gap in two steps: First, we generally challenge the assumption that dispersion has a positive or negative main effect on team performance in real-live product development teams. Several studies emphasize the costs as well as the benefits of team dispersion. While dispersion enables the access to diverse knowledge and skills in a flexible and cost efficient manner (Chudoba et al., 2005), the collaboration across boundaries such as time, space, and culture is harmful to a wide set of different teamwork dimensions (Chudoba et al., 2005; Hoegl et al., 2004a). We assume that potential gains from access to diverse ideas and expertise from different locations are, on average, offset by the difficulty of achieving high levels of teamwork behavior across multiple locations.



*Figure 5-1: Conceptual Framework of this Research*

Second, we propose a conceptual framework based on contingency theory which conceives the effect of dispersion to be dependent on the level of team processes and not to be detrimental in itself (see Figure 5-1). More precisely, we argue that dispersion can be a valuable team resource and outline team processes with which teams are able to capitalize on their structural capacity and even outperform their more co-located counterparts. As such, dispersion is a managerial team design choice which is affected by managers' motivation to save costs, acquire unique knowledge, or to fulfill local content requirements (Leonardi et al., 2004). The decision about the level of dispersion precedes all team building and collaboration processes and should therefore be conceptualized as an independent variable having direct implications for team performance (Mitchell & James, 2001). The consideration of dispersion as an independent variable, therefore, constitutes a research line which addresses the question whether the dispersion–performance link is conditional upon team processes. There are a few studies dedicated to this research question (e.g. Hinds et al., 2005). These studies, while shedding light on the conditional nature of the dispersion–performance relation, do not mirror the total picture because they focus on some specific process variables such as communication and identification (Hinds et al., 2005). In our study, we build on these results aiming to further identify the specific team processes which may decide between success and failure in virtual teams. More specifically, we focus our analysis on various task-related and socio-emotional team processes and their contingent impact on the relationship between dispersion and team performance. The distinction between task and social team processes (Wittenbaum et al., 2004) allows us to consider whether each of the two process bundles as well as individual process variables within them have their idiosyncratic influence on the dispersion-performance link.

By examining this research question, we contribute to the extant research on virtual teams in several ways. First, we employ multi-dimensional measures for team dispersion in our analysis, which measure not only geographic, temporal, and configurational aspects of spatial distance (O'Leary et al., 2007), but also include perceived distance as a widely neglected aspect of dispersion (Wilson et al., 2008). This more detailed assessment of various aspects of dispersion builds on recent more comprehensive conceptualizations of dispersion (Chudoba et al., 2005; O'Leary et al., 2007) and goes beyond prior work that more selectively relied on regularly just one measure of dispersion (e.g. Cramton et al., 2005b; Hoegl et al., 2007a).

Second, we consider a broad set of process variables to provide fuller insight into the mechanisms of how dispersion might be harnessed through task-related and socio-emotional processes. This more comprehensive approach thus contributes in providing necessary detail beyond prior, more general, investigations of teamwork in dispersed teams (e.g. Hoegl et al., 2007a). Such a more detailed analysis thus contributes to our understanding of how various elements of a team's process operate to overcome challenges and capitalize on the potential of dispersed teams.

Third, we rely on different informants for different constructs to ensure content validity and to avoid inflated results due to common source bias. Moreover, we test our hypotheses on a highly dispersed sample of 80 software development teams with members from 28 software laboratories and 29 nationalities. The software development field is particularly suitable for our research given that the nature of the product is intangible and therefore lends itself to dispersed collaboration.

## **5.2 CONCEPTUAL BACKGROUND AND HYPOTHESES**

### **5.2.1 Dispersion and Team Performance**

While researchers have regularly found a negative relationship between physical distance and team processes, the main effect on team performance remains inconclusive (Webster et al., 2006). A few studies reported higher performance in virtual teams (e.g. Sharda, Barr, & McDonnell, 1988), and several other studies found that virtual teams underperform relative to traditional teams (e.g. Cramton et al., 2005b). Others detected no difference between the two types of teams (e.g. Lu, Watson-Manheim, Chudoba, & Wynn, 2006). Such conflicting results stem, at least in part, from the ambivalent and more indirect effects of dispersion on perform-

ance. On the one hand, collaboration across boundaries such as time, space, and culture has been shown harmful to a wide set of different team processes. Researchers, for instance, found negative outcomes, including a decline in trust (Jarvenpaa et al., 1999), mutual knowledge problems (Cramton, 2001), communication and coordination difficulties (Cramton et al., 2005b), and an increased inability to establish a common ground (Cramton, 2002). On the other hand, virtual collaboration increases access to diverse knowledge and skills and therefore may be a source of superior performance (Singh, 2008). There are at least two reasons for the superior knowledge potential of virtual teams. First, in order to accomplish the increasingly complex R&D activities, firms (particularly larger ones such as IBM or SAP) tend to cluster their competencies in different centers of excellence, which are often a part of the company's extra-national R&D network (Brockhoff et al., 2007). Within each competence center, the depth of expertise tends to be very high, while the diversity of functional backgrounds is relatively weak due to the center's specialization (Boh et al., 2007a). Virtual teams can take advantage of this structure by staffing team members from different locations of such networks and, thus, creating a team which can optimally integrate the different pools of expertise to fulfill the team's task (Van der Vegt et al., 2005; Zhu et al., 2008).

A second source of superior knowledge in virtual teams stems from their structural heterogeneity and is inherent to the nature of dispersed teams. Dispersed teams, by definition are composed of members from multiple locations, frequently residing in several countries, pertaining to different organizational units, representing different competence centers and reporting to different managers (Cummings, 2004). Consequently, virtual teams incorporate higher levels of 'structural diversity' than co-located teams. Structural diversity has recently been shown to be highly valuable for teams, because of its potential to expose team members to heterogeneous sources of task experience, feedback, and networking opportunities (Cummings, 2004). In his recent study, Cummings (2004) demonstrated that the beneficial contribution of structural diversity exists in the teams' outbound activities, i.e., their external knowledge sharing.

In sum, our arguments above highlight the 'double-edged' nature of dispersion to expose teams to heterogeneous, potentially superior knowledge while challenging the development and maintenance of team processes necessary to benefit from such resources. We argue that these opposite effects in dispersed teams mutually balance each other and result in a zero effect of dispersion on team performance. Thus, we hypothesize:



*Hypothesis 1: There is no direct relationship between team dispersion and team effectiveness.*

## **5.2.2 Team Processes as Contingency Variables for the Dispersion-Performance Link**

### *Task- and Socio-emotional Team Processes*

Given the ‘double-edged’ nature of dispersion and the mixed findings regarding the effects of dispersion in research so far, with no unequivocal conclusions to draw, the need for a contingency approach emerges. Such an approach specifies the contingencies upon which the potential of dispersed workgroups can be achieved (Jehn & Bendersky, 2003). In this study, we view the effect of dispersion as contingent upon the level of task and socio-emotional team processes and not as detrimental in itself. More precisely, we argue that teams with excellent team processes harness dispersion as an important source of diversity and expertise. Both structural and functional diversity have been shown to be more prevalent in virtual teams (Furst, Blackburn, & Rosen, 1999) and have turned out to be best accessible through proper team processes (Cummings, 2004; Van der Vegt et al., 2005). This highlights the need to look at the effect of contingency variables on the process-level. Drawing from these arguments, we suspect that dispersed teams own the structural capacity to outperform their co-located counterparts depending on the quality of their team processes. Ultimately, individual expertise is only as valuable to the team as the process that allows it to be accessible to the team (Griffith et al., 2001).

Team processes generally describe how team inputs are transformed into outputs and they tend to bring together the behavioral, cognitive, and affective phenomena existing in teams (Ilgen et al., 2005; Marks, Mathieu, & Zaccaro, 2001). Theoretically, we align our argument with the functional perspective (Wittenbaum et al., 2004), stating that team processes have to fulfill two basic functions of team activity: team performance and team maintenance. While processes addressing the first function are usually classified as ‘task processes’ that relate directly to a group’s work on its tasks, processes addressing the latter function generally are referred to as ‘social processes’ or ‘interpersonal processes’, which relate to the relationship among team members and therefore to more social and emotional interactions between individual team members (Hackman, 1987).

Both task processes and social processes are potential contingency variables for the dispersion–performance relationship since they determine the quality of team interactions from a task

fulfillment and a social interaction perspective. Due to their distinct nature, we develop our hypotheses separately for salient task-related and socio-emotional processes.

### *Task Processes as Contingency Variables*

Task processes are the building blocks of the task accomplishment process and mainly fulfill the sequential functions of preparation, execution, evaluation, and adjustment (Frese & Zapf, 1994). In this paper, we focus on processes which address task execution and exclude team processes which are mainly dedicated to other functions of the task accomplishment process like planning, monitoring, or coaching (Rousseau et al., 2006). In alignment with Rousseau et al. (2006), we regard task processes as a category comprising distinct process variables. Building on Hoegl and Gemuenden (2001), we refer to mutual support, effort, balance of contribution, coordination, and task-related communication as relevant task processes.

*Mutual Support.* We refer to mutual support as one important task process that fosters the integration of team members' expertise through their willingness to openly share valuable information (Hoegl et al., 2001). The importance of mutual support among team members will be intensified in dispersed team settings as geographic boundaries foster the tendency to see dispersed members as an out-group and to retain information and other resources from them (Alavi & Tiwana, 2002). Thus, mutual support facilitates the integration of team members' expertise and is, therefore, a critical prerequisite to leverage the structural potential of virtual teams and a meaningful contingency variable for the assumed conditional relationship between dispersion and team performance.

*Effort.* Social loafing describes the team's choice to withhold co-operative effort from group endeavors with the potential to jeopardize group performance and well-being (Furst et al., 1999; Wagner, 1995). Virtual teams are more prone to these forms of dysfunctional behavior because the absence of face-to-face contact and informal conversations tends to interfere with feelings of meaningfulness and belonging to a group, whereby the orientation towards common work norms will be absent (Finholt et al., 1990). Teams with high levels of effort, however, display a strong endeavor towards the common team norms usually associated with high levels of intrinsic motivation (Furst et al., 1999). Conversely, if team members are reluctant to push the project's progress, then this compounds the challenges of geographic dispersion because team members feel more distant to the team and its norms and it is more difficult to motivate through hands-on leadership (Montoya-Weiss et al., 2001).

*Balance of Member Contributions.* In order to orchestrate the task processes to employ the team's full potential, it is important that every team member is able to contribute all task-relevant knowledge and experience to the team (Seers, Petty, & Cashman, 1995). This is especially critical for virtual teams whose members often belong to different organizational units and functional areas (e.g., marketing, R&D, finance, operations). It would undermine the effectiveness of such cross-functional teams, if some team members cannot bring in their views and ideas because others are dominating discussions and decision-making processes (Hoegl et al., 2001). We therefore posit that the effect of dispersion on team performance will be contingent on the degree that team members' contributions are balanced with respect to each member's specific knowledge and experience.

*Task Coordination.* Since virtual teams by definition consist of members from different sites, their virtual setting puts heavy demands on the coordination of tasks. Task progress must be monitored, processes have to be aligned, and contributions to task fulfillment from individuals at different locations must be harmonized to fit into the overall project (Lu et al., 2006). Since team members from different areas of expertise and various locations normally work on different subtasks simultaneously, the coordination of such actions plays a pivotal role in the project's success. Well coordinated teams should take advantage of dispersion, because they can optimally leverage the diverse sets of knowledge. For poorly coordinated teams dispersion further impairs performance because distance interrupts ongoing awareness of team activities and tasks important for the successful tracking of team member's progress (Kraut, 2002; Tyran, Tyran, & Shepherd, 2003).

*Task-related Communication.* We refer to task-related communication as the discussion of task-relevant knowledge in team members' respective functional area with other members of the team (Zhu et al., 2008). Task-related communication steers the exchange of information held by different group members, facilitates coordination within the team, conveys a common understanding of 'who knows what', and what the team task is about. Task-related communication may be transmitted through different channels, for example through scheduled meetings, phone-calls, written status reports or e-mails. We argue that the effect of dispersion on team performance is conditional on the level of task-related internal communication, as dispersed teams capitalize more on their heterogeneous knowledge resources.

In sum, we conclude that dispersed teams can only harness their functional and structural diversity if they develop necessary task processes. Dispersed teams with such task processes should be able to outperform co-located teams because they can leverage the knowledge held by team members from different locations. Conversely, dispersed teams with poor task-related processes should underperform relative to co-located teams with the same process quality. Hence, we posit:

*Hypothesis 2: The effect of dispersion on team performance is contingent upon task-related processes. More specifically, the dispersion–performance link is positive for teams with high levels of mutual support (H2a), effort (H2b), balance of member contributions (H2c), task coordination (H2d), and task-related communication (H2e) and likewise negative for low levels of these contingency variables.*

### *Social Processes as Contingency Variables*

For teams to be successful in their task fulfillment process it is essential that all team members commit to the overall team goals, collaborate, and actively support the team's efforts. Especially in teams with geographically distant team members, interpersonal differences can endanger the social stability of the team, because of restricted coping possibilities across geographic boundaries (Kozlowski, Gully, Nason, & Smith, 1999; Tesluk & Mathieu, 1999). Such difficulties, in turn, prevent team members from fully contributing to task accomplishment and consequently jeopardize team performance. In order to capture the multi-dimensionality of social team processes, we follow the conceptualization of Martins et al. (2004) who classify cohesion, identification, and social interactions such as informal communication under the umbrella of socio-emotional processes. All of these social processes have in common that they regulate the maintenance of motivation and emotion within a team and therefore enable a team to better cope with personal difficulties and conflict (Espinosa et al., 2006b).

*Cohesion.* Cohesion describes the members' attraction to the team and to its task (Kozlowski et al., 2003). Team cohesion is considered to be highly important to the success of virtual teams because it facilitates team functioning, encourages assistance beyond formal team roles, and decreases the fluctuation of employees (Wiesenfeld, Raghuram, & Garud, 1999). Additionally, group cohesion is associated with a number of positive outcomes in virtual teams, such as enhanced motivation, improved decision-makings, less restricted communication, and increased satisfaction (Bouas & Arrow, 1996; Warkentin et al., 1999). We argue that the dispersion-

performance relation is contingent on the level of cohesion in the team. We propose that virtual teams will profit more from their functional and structural heterogeneity if the team is very cohesive, because highly cohesive teams have been shown to exchange information more effectively regardless of communication media (Chidambaram, 1996). The performance of more dispersed teams is further diminished by weak cohesion, due to the weaker interpersonal bonds between remote employees, which have been shown to increase destructive forms of conflict (Hinds et al., 2005).

*Team Identification.* Team identification, defined as the perception of oneness or belonging to a team, is contingent on the dispersion–performance link along two different paths. First, a strongly shared team identity reduces conflict (Jehn, Northcraft, & Neale, 1999), enhances the team’s ability of self-regulation (Hertel et al., 2005), and therefore contributes to the team’s social stability. Second, as derived from social identity theory, team members with high levels of collective team identification are committed to the overall team and its goals rather than (or in addition to) their individual goals or the goals of their particular functional areas. This redirection or extension of team members’ relevant units of affiliation, has, in prior studies, turned out to be a critical prerequisite of the effective integration of divergent ideas and perspectives (Van der Vegt et al., 2005). The contribution of a team’s level of identification on the team’s social stability as well as on the team’s knowledge sharing enables teams with a shared team identity to profit from dispersion and therefore to account for the proposed conditional nature of the dispersion-performance link.

*Informal Communication.* Informal communication refers to spontaneous, unplanned interactions that occur among team members outside of guidelines or rules on how communication should be channeled within an organization (Kiesler et al., 2002; Kraut, 2002; Monge & Kirste, 1980). Numerous scholars have argued for the importance of informal, spontaneous communication among distributed workers, suggesting that these interactions build social ties between distant colleagues (Nardi, Whittaker, & Schwarz, 2002) and enable information to flow more fluidly between remote co-workers at different sites (e.g. Hansen et al., 2004; Kiesler et al., 2002; Kraut, 2002). We posit that informal communication affects the connection between team dispersion and performance because it allows remote team members to build social bonds and thus facility the remote exchange of task-relevant knowledge.

In sum, cohesion, identification, and informal communication improve the interpersonal connections between team members. Only dispersed teams with high quality social processes are able to fully utilize their structural potential and to employ task processes more effectively than their co-located counterparts, while in cases of dispersed teams with poor social processes team members are not able or not willing to share their unique knowledge and thus underperform. Therefore, we posit:

*Hypothesis 3: The effect of dispersion on team performance is contingent upon socio-emotional processes. More specifically, the dispersion–performance link is positive for teams with high levels of cohesion (H3a), team identification (H3b), and informal communication (H3c) and likewise negative for low levels of these contingency variables.*

## 5.3 METHODS

### 5.3.1 Data Collection

To test our hypotheses we conducted a web-based survey of software development teams. Each company participating in this study produced a list of projects, including names and contact information of team leaders. In the second step, team leaders were provided with additional information about the present study and asked to complete a pre-defined spreadsheet with descriptive details about the team and all team members. In the third step, all team leaders and team-external managers as well as randomly chosen team members were contacted and asked to complete the online questionnaire. Respondents' participation in this study was strictly voluntary. For each team to be included in the final data set, the team leader, the team-external manager, and at least two team members must have completed the questionnaire. The response rate for team leaders and managers was 100%, and for team members was 68%.

### 5.3.2 Sample

For our analyses we draw on data from 80 software development teams from 28 different labs worldwide pertaining to five software development companies. Each laboratory employed between 20 and 5,500 software developers (median = 600). Included in the study were software development projects that were completed within 12 months prior to data collection and that were worked on by teams of nine or fewer members. For multi-team projects each team could participate separately in the study as long as independent performance evaluations were possible. Overall, our analyses are based on a total of 392 responses from 80 team leaders, 80 man-

agers, and 232 team members. This sample contains 28% female team leaders and 24% female team members. Teams in our sample have an average of 5.9 members (median = 6, standard deviation = 1.8, min = 3, max = 9) and an average age of all team members of 37.0 years (median = 37.0, standard deviation = 8.6).

### 5.3.3 Measures

All constructs considered in this investigation refer to the team as the unit of analysis. Accordingly, all measures were specified on the team level. Thus, respondents were asked to evaluate properties and behaviors of the team as a whole. The questionnaire was administered in German and in English. All constructs investigated in this study were assessed using multiple questionnaire items. A pretest was conducted including seven members of a software development team at a Swiss consulting and engineering company. Following this pretest, the wording of some items and the layout of the online questionnaire were refined for later use in the present study. To ensure content validity and to avoid a possible common source bias, data from different respondents were used to measure the different variables. We assessed all questionnaire items using a scale ranging from 1, “strongly disagree,” to 5, “strongly agree.” Exempt from this scaling are two control variables, i.e., ‘task innovativeness’ and ‘team-external interdependence’, which both were measured on an ordinal scale. In addition, the virtuality of communication (one item measuring subjective dispersion) was measured on a scale ranging from 0% to 100%. Nearly all items were drawn from published scales. Items were additionally discussed with company representatives before the questionnaire went online. This process resulted in making several changes to the wording of items in order to increase clarity and interpretability. Table 5-1 provides descriptive statistics and correlations for all variables used in this study.

Variables	Informant <sup>2)</sup>	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
(1) Team Size	TL	5.94	1.77														
2) Team-External Interdependence	TL	2.58	1.06	0.14													
(3) Project Length (LOG)	TL	1.14	0.29	0.04	0.24												
(4) Task Innovativeness <sup>1)</sup>	TL	3.13	1.13	0.07	0.42	0.13											
(5) Objective Distance	TL	1.29	1.50	0.14	0.02	-0.16	-0.01										
(6) Subjective Distance	TL	2.87	1.03	-0.17	0.01	-0.08	-0.12	0.60									
(7) Mutual Support	TM	4.18	0.46	-0.03	-0.28	-0.10	-0.19	-0.15	-0.19								
(8) Effort	TM	3.84	0.57	-0.06	-0.09	-0.20	-0.01	0.11	0.11	0.48							
(9) Balance of Contribution	TM	3.86	0.56	-0.10	-0.10	-0.16	0.00	0.12	0.10	0.46	0.85						
(10) Task Coordination	TM	3.76	0.51	0.14	-0.18	-0.06	-0.19	-0.01	-0.11	0.50	0.51	0.53					
(11) Task-related Communication	TM	3.75	0.50	0.13	0.10	0.03	0.04	-0.05	-0.25	0.38	0.23	0.31	0.53				
(12) Cohesion	TM	3.51	0.65	0.05	0.06	0.13	0.08	-0.05	-0.26	0.39	0.09	0.13	0.13	0.37			
(13) Identification	TM	3.84	0.58	0.05	0.01	-0.02	-0.06	-0.03	-0.07	0.12	0.23	0.26	0.27	0.21	0.14		
(14) Informal Communication	TM	3.21	0.71	0.06	0.06	0.19	0.08	-0.23	-0.25	0.21	0.14	0.12	0.30	0.44	0.26	0.08	
(15) Effectiveness	M	4.05	0.75	-0.26	-0.46	-0.15	-0.28	-0.31	-0.18	0.33	0.17	0.19	0.33	0.07	-0.01	-0.04	0.20

Note.  $r > 0.19$ ,  $p < 0.10$ ;  $r > 0.22$ ,  $p < 0.05$ ;  $r > 0.29$ ,  $p < 0.01$ .

<sup>1)</sup> For task innovativeness (1 = 'software maintenance'; 4 = 'new product development') the spearman rank correlation is calculated.

<sup>2)</sup> This study used different informants for different levels of analysis: TL = Team Leader; TM = Team Member; M = Manager

Table 5-1: Descriptive Statistics and Correlations (N= 80 teams)



### *Dispersion*

To measure geographic distribution, we used the team descriptions provided by team leaders to identify each team member's office location. Building on O'Leary and Cummings (2007), we used this information to calculate five indices of objective dispersion: (1) spatial distance (the log of physical distance), (2) time zone (time difference among team members' locations), (3) site (number of locations), (4) percentage of isolates, and (5) imbalance (unevenness of membership across sites). To broaden the conceptualization of dispersion we also assessed perceived (or subjective) dispersion with four items asking for the perceived difficulty to visit dispersed team members, the subjectively defined effort to gather members in one place for a spontaneous meeting, the virtuality of communication, and the frequency of face-to-face meetings during the project ( see Table 5-2). In an effort to consolidate the multiple indicators of dispersion, we used an exploratory factor analysis to empirically identify groups of indices that could justifiably be reduced to a smaller set of factors. A varimax rotation grouped the indices into two distinct factors, which further good grounds for a theoretical justification by differentiating between the five objective indicators of geographic dispersion and the four items representing subjective dispersion. We calculated z-scores and averaged them within each of the two factors, yielding two reliable (Cronbach's alpha = 0.85 and 0.81, respectively) measures: objective and subjective dispersion.

### *Team Processes*

The scales used to measure mutual support, effort, balance of contribution and cohesion consist of two to four items each and are all derived from Hoegl et al. (2004b) and already successfully employed in the context of a longitudinal study in the automotive industry (Cronbach's alpha between 0.71 and 0.86). The three items measuring task coordination are derived from scales of Hoegl et al. (2004b) and Espinosa, Cummings and Pickering (2006a) (Cronbach's alpha = 0.66). To measure task-related communication, participants were asked to rate how often they had discussions about their team tasks or discussions with respect to their own functional area with other members of the team (Cronbach's alpha = 0.76). Similarly, to measure informal communication, participants were asked to indicate whether they have frequently been involved in informal 'hall talks' with others inside and outside of the team (Cronbach's alpha = 0.75). To measure team identification, we used Mael and Ashforth's (1992) five-item scale (Cronbach's alpha = 0.79). This measure has shown validity in several studies in the team con-

text and incorporates both cognitive and affective facets of team identification (Edwards, 2005; Riketta, 2005).

Variables	Items
Controls	<p><i>Task Innovation.</i> ‘1’ software maintenance, ‘2’ client specific adaptation, ‘3’ software upgrade, ‘4’ new development’ (<i>ordinal scale</i>)</p> <p><i>Team-External Interdependence.</i> ‘1’ an isolated teamwork with only little interaction with other teams / projects (e.g. for some requests), ‘2’ an isolated teamwork with significant interaction with other teams / projects in at least one project phase, ‘3’ a teamwork with a continuous need for interaction with several other teams / projects, ‘4’ a multi-team project, in which your team’s work output integrated into a larger software- solution causing significant and continuous need for coordination</p>
Subjective Distance	<p>I could easily visit most team members with whom I collaborated. It was easy to get the team members together in one place for spontaneous meetings (e.g. for discussions and decisions). In this team we had frequent face-to-face meetings with all team members. To which percentage has team communication been channeled through virtual tools (Phone, Email, Tele-Conferencing etc.)?</p>

Notes. Please note that while all items are measured on a five-point Likert scale we measured the virtuality of communication in percent and retransformed the scale into the same range as the other scales.

*Table 5-2: Selected Survey Items Used in this Research*

The variables for team processes were measured using aggregated responses from multiple team members, excluding team leaders. Prior to aggregating team members’ evaluations of team processes, inter-rater agreement was assessed using the multiple-item estimator for within-group interrater reliability as proposed by James et al. (1984b). This test yielded results indicating generally very strong agreement of ratings referring to the same team. The average scores of this test across all teams are between 0.77 (for task-related communication) and 0.90 (for identification) across all team process variables, therefore sufficient to justify aggregation (LeBreton, Burgess, Kaiser, Atchley, & James, 2003). Additionally, we calculated the agreement index recently proposed by Brown and Hauenstein (2005) to overcome the limitations of scale dependency, sample size dependency, and the possible bias of the falsely assumed uniform null distribution which are inherent in the  $r_{wg(1)}$  family of interrater agreement indices. In comparison to the  $r_{wg}$  family of interrater agreement, the  $a_{wg}$  statistic does not compare the observed variability of judgments to a uniform distribution (all scale values are rated with equal frequency), but compares the observed variance to the maximum possible variance. The  $a_{wg}$  coefficient ranges from ‘-1’ to ‘1’ with ‘1’ indicating perfect agreement. This improved index of interrater agreement also confirms interrater agreement with scores ranging from 0.73 for cohesion and 0.79 for task-related communication. Given this homogeneity of within-team ratings, data were aggregated on the team-level by calculating the arithmetic mean.

### *Team Performance*

The measurement scale for team performance was based on the scale used by Hoegl and Gemuenden (2001), which has been specifically designed for the assessment of team effectiveness in software development teams. To capture team performance, the items assess overall team performance such as customer satisfaction with work output, as well as detailed measures evaluating important performance dimensions including product quality, reliability, and usability of the software solution. All 10 indicators for team performance are judged by team-external managers and revealed strong consistency (Cronbach's alpha = 0.92).

### *Control Variables*

Previous research on work groups suggests that task type, team size, project length, team's external linkages, and the organizational context may influence team performance and are therefore considered as control variables in this study. All variables but the organizational context are provided by team leaders. 'Team task' was included as a dummy variable in the study's analysis and is categorized as (1) software maintenance (16%); (2) client specific adaptation (9%); (3) software upgrade (21%); or (4) new software development (53%). Moreover, we controlled for the size of the group and included team size as a control variable in the analysis, since research suggests that even within a limited corridor of variability team size still matters (Voelpel et al., 2008).

Since some researchers claim that there is a fundamental difference between temporary and ongoing virtual teams (Saunders et al., 2006), we also assessed project length in terms of months from the beginning of the team's work to its conclusion (Mean = 17.5; Median = 12.0; SD = 16.3) and included it after a log-transformation as a control variable. A fourth control variable accounts for the different levels of team's external interdependence with other teams, which has shown to be highly influential on virtual team's success (Gassmann et al., 2003). We therefore assessed whether teams performed (1) more or less in isolation (14%), (2) had significant interaction with other teams (21%), (3) interacted continuously with other teams (28%), or (4) the team was part of a multi-team project with strong and continuous interaction and high coordination effort (37%) (see Table 5-2). Finally, given that this study includes data from several different software development companies, the study controlled for possible organizational effects in the analysis by including dummy variables for the respective country organization in the regression analyses. A country organization incorporates one or more labs which generally

share the same infrastructure, processes, and technologies. The consideration of this organizational context enables us to effectively control for all constant and unmeasured differences across country organizations that may explain differences in the variables and relationships investigated.

Hypotheses		Models										
		Task-related processes							Social processes			
Variables	-	-	1	2a	2b	2c	2d	2e	3a	3b	3c	
Organization	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	
Task Innovativeness		<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	
Team Size		-.18 <sup>+</sup>	-.16	-.24*	-.22 <sup>+</sup>	-.19 <sup>+</sup>	-.22*	-.19 <sup>+</sup>	-.18	-.16	-.18	
Team-External Interdependence		-.18	-.20	-.09	-.14	-.04	-.08	-.12	-.15	-.20	-.21	
Project Length		-.03	-.05	-.02	-.02	-.02	-.03	-.05	-.04	-.05	-.10	
Objective Dispersion			-.12	-.07	-.15	-.19 <sup>+</sup>	-.10	-.13	-.09	-.12	-.10	
<i>Objective Dispersion x</i>												
Mutual Support				.19 <sup>+</sup> (.24*)								
Effort					.28* (.23*)							
Balance of Contribution						.34** (.32**)						
Task Coordination							.21* (.24*)					
Task-related Communication								.17 <sup>+</sup> (.21 <sup>+</sup> )				
Cohesion									.18 (.13)			
Identification										.00 .00		
Informal Communication											.10 (.16)	
F		.43**	3.14**	3.02**	3.39**	3.44**	4.12**	3.68**	3.26**	2.88**	2.62**	2.94**
R <sup>2</sup>		.38	.44	.45	.52	.52	.57	.54	.51	.48	.45	.48
Δ R <sup>2</sup>		-	.06	.01	.02 <sup>+</sup>	.05 <sup>+</sup>	.08**	.04 <sup>+</sup>	.02 <sup>+</sup>	.01	.00	.01

Notes. <sup>+</sup>p < 0.10, \*p < 0.05, \*\*p < 0.01.

Direct effects are in parentheses below standardized coefficients of interaction terms. Significance of Delta R<sup>2</sup> for interaction terms pertaining to H2a – H3c were calculated separately after all control variables and main effects had been entered in the baseline model. Independent variables were centered before entering models. Degrees of freedom are not reported here. Dummy variables for company and task innovativeness are included as a single row in this table.

Table 5-3: Multiple Regression Analysis predicting Team Effectiveness (Manager Judgements) from Objective Dispersion and Team Collaboration

## 5.4 RESULTS

Hierarchical multiple regression was used to test the hypotheses of the present study (Cohen, Cohen, West, & Aiken, 2003a). The significance of the proposed interaction effects was assessed after all control variables and main effects had been entered, using the significance level (p-value) of the interaction term as the key indicator for moderation (Baron & Kenny, 1986). Table 5-3 reports the results of the regression analysis based on the objective dispersion measure with numbered columns referring to our hypotheses (1 to 3c). Looking first at the linear relationship between dispersion and team performance, we found that subjective team dispersion has a significant negative relationship with team performance ( $\beta = -0.28$ ,  $p < 0.05$ ; see Table 3). Based on the objective dispersion measure, however, dispersion shows the expected zero relationship with team performance. Taken together, these results provide partial support for our first hypothesis. Hypotheses 2 and 3 state that the effect of dispersion is conditional on the team's quality of task- and socio-emotional team processes. In support of hypothesis 2, Table 5-3 shows that the interaction terms for all five indicators of task processes are significant (with the interaction term for mutual support and task-related communication being only marginally significant).

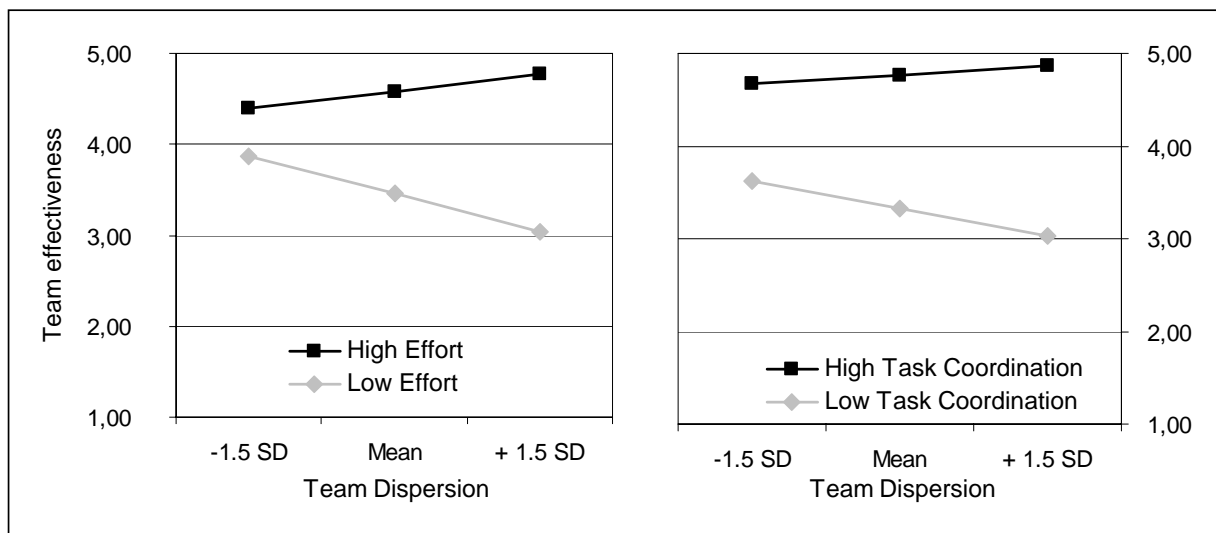


Figure 5-2: *Effort and Task Coordination Contingent to the Dispersion-Performance Relation*

The interaction plots for effort and task coordination (see Figure 5-2) as two representatives of task-related team processes show that only teams with low levels of task processes suffer considerably from dispersion. By contrast, dispersed teams which manage to achieve high levels of effort and task coordination despite their physical separation outperform co-located teams with the same level of these processes. The pattern of slopes is the same for all five task-related team processes and only exemplified by team effort and task coordination for parsimony. For hypothesis 3, which says that the dispersion-performance link is conditional on the team's level of socio-emotional team processes, we found no support. Neither team identification nor the team's level of cohesion or informal communication showed contingency effects on the relationship between team member dispersion and team performance.

## 5.5 DISCUSSION

As our point of departure in this study, we argued that across a large sample of teams, the positive potential of dispersion (e.g., access to superior knowledge resources) is offset by the challenges of working over distance, resulting in a zero effect. Empirically testing this 'net outcome' of dispersion, we found a zero relationship based on objective dispersion and a significant negative relationship based on subjective distance (i.e., team members' perceived distance). While this only partially supports what we expected, we believe these findings do not contradict the assumed 'double-edged' nature of dispersion, but rather show that dispersed teams - on average - are unable to effectively manage the consequences of their physical distribution and thus are unable to leverage their heterogeneous and potentially superior knowledge. This finding is one piece of a larger puzzle of mixed results regarding the main effect of dispersion on team performance, and underscores the necessity to identify team-internal and -external factors upon which the performance of virtual team is contingent (Martins et al., 2004; Powell et al., 2004; Webster et al., 2006).

In our study, we addressed this research question on the team-level of analysis and identified team processes as possible contingency variables which may account for the different research findings on the main effect of dispersion. In doing so, we drew from the functional perspective and distinguished between team processes which directly focus on task accomplishment and those which focus on teams' interpersonal relations. As the results of this study demonstrate, only the task-related processes have a contingent effect on the relationship between dispersion and performance. None of the team processes within the socio-emotional group are signifi-

cantly associated with the dispersion–performance link. At first glance, these results contradict the findings of other researchers who found evidence for informal communication or identification as socio-emotional contingency variables for the dispersion–outcome link (Hansen et al., 2004; Hinds et al., 2005). However, in contrast to our study, these authors used team outcomes such as knowledge transfer and team conflict, both of which are variables which seem to be more closely linked to socio-emotional processes than team performance in terms of product quality and customer feedback. Hence, based on these results it seems possible that the socio-emotional processes are not as directly related to task accomplishment, but may well facilitate more task-related processes through such factors as better team conflict resolution. Our expected direct contingency effect on the dispersion-performance relationship, however, did uniformly not come through for any of the socio-emotional processes investigated in this research, thus pointing to the necessity for further inquiry.

In the conceptual part of this article, we argued that superior knowledge due to functional and structural diversity may account for the potential of virtual teams to outperform their co-located counterparts. The first support for this notion is provided by the result pattern in Table 5-3 as formal, task-related communication has no direct link to team effectiveness ( $\beta = .11$ ;  $p > .10$ ) but shows a (marginally) significant interaction term with dispersion ( $\beta = .17$ ;  $p < .10$ ). Thus, the frequency of task-related communication itself does not seem to be a success factor for team performance, but if teams consist of members from different locations, their knowledge becomes more heterogeneous and consequently their task-related communication more effective. To further evaluate the plausibility of our assumption that the conditional effect of dispersion on team performance is due to exchange of superior knowledge, we conducted an additional analysis:

We replicated the entire analysis presented in Table 5-3 with team efficiency as a dependent variable, measured as the degree to which the team's budget and schedule are undercut or exceeded. We only found significant interaction terms for balance of contribution ( $\beta = .25$ ,  $p < .05$ ) and task-related communication ( $\beta = .19$ ,  $p < .10$ ). Thus, our results demonstrate that the combined effect of dispersion and task processes results more in improved product quality and customer feedback than simply in budget savings, providing support for the notion that superior knowledge was transmitted.

<i>N</i> = 80 teams		Models										
		Task-related processes							Social processes			
Hypotheses	-	-	1	2a	2b	2c	2d	2e	3a	3b	3c	
Organization	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	
Task Innovativeness		<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	<i>Incl.</i>	
Team Size		-.19 <sup>+</sup>	-.20 <sup>+</sup>	-.25*	-.24*	-.23*	-.24*	-.23*	-.21 <sup>+</sup>	-.20 <sup>+</sup>	-.21 <sup>+</sup>	
Team-External Interdependence		-.18	-.17	-.12	-.13	-.03	-.09	-.12	-.11	-.17	-.19	
Project Length		-.03	-.04	-.02	.02	.03	-.04	-.08	-.04	-.04	-.09	
Objective Dispersion			-.28*	-.24*	-.27*	-.26*	-.24*	-.25*	-.28*	-.29*	-.24 <sup>+</sup>	
<i>Objective Dispersion x</i>												
Mutual Support				.21* (.17)								
Effort					.27** (.22*)							
Balance of Contribution						.31** (.26**)						
Task Coordination							.14 (.19 <sup>+</sup> )					
Task-related Communication								.20 <sup>+</sup> (.11)				
Cohesion									.18 (.17)			
Identification										.01 (-.01)		
Informal Communication											.12 (.12)	
F		4.30**	3.14**	3.52**	3.93**	4.02**	4.59**	3.76**	3.62**	3.44**	3.05**	3.33**
R <sup>2</sup>		.38	.44	.49	.55	.56	.59	.54	.53	.52	.49	.51
Δ R <sup>2</sup>		-	.06	.05*	.03*	.05**	.07**	.01	.02 <sup>+</sup>	.02	.00	.01

Notes. <sup>+</sup>p < 0.10, \*p < 0.05, \*\*p < 0.01.

Direct effects are in parentheses below standardized coefficients of interaction terms. Significance of Delta R<sup>2</sup> for interaction terms pertaining to H2a – H3c were calculated separately after all control variables and main effects had been entered in the baseline model. Independent variables were centered before entering models. Degrees of freedom are not reported here. Dummy variables for company and task innovativeness are included as a single row in this table.

*Table 5-4: Multiple Regression Analysis predicting Team Effectiveness (Manager Judgments) from Subjective Dispersion and Team Collaboration*

Second, we tested whether the conditional effect of objective dispersion also holds for subjective dispersion. We argue that functional and structural diversity result from geographic distance between different locations and that subjective dispersion coincides with heterogeneous knowledge only to that extent to which subjective dispersion correlates with real distance. As current research shows that perceived distance does not increase linearly with actual distance (Hansen et al., 2004), we assumed at least lower coefficients for the multiplicative effect of dispersion and team processes on performance. Our results partly support this notion. In the



model predicting team effectiveness as judged by team-external managers, the interaction term of task coordination ( $\beta = .14, p > .10$ ) became insignificant but all other terms remained significant or marginal significant (see Table 5-4).

In sum, the effect of dispersion is not necessarily detrimental to team performance but rather depends on the level of task-related team processes. As the interaction plots in Figure 5-2 reveal, highly dispersed teams can reach higher levels of effectiveness than co-located teams if they manage to achieve high levels of task-related teamwork quality over distance. While we have emphasized the possibility of dispersed teams to outperform their co-located counterparts so far, there are significant costs of dispersion as well. The interaction plot also shows the straight downward slope for teams with poorer team processes (1.5 standard deviations below the mean) and illustrates that those teams suffer heavily from dispersion. Finally, the quality of task-related processes seems to be a significant factor to decide whether dispersion becomes a liability or an opportunity for the effectiveness of virtual teams. Perhaps future research will refer to team members' distance as the 'value in dispersion' hypothesis as it already exists for the idealistic view of team's diversity (Cox, Lobel, & McLeod, 1991).

### 5.5.1 Implications for Research

Our findings have implications for the extant literature on the dynamics of distributed teams in several ways. First, we complement recent discussions of scholars concerning the appropriate conceptualization and measurement of dispersion (e.g. Chudoba et al., 2005; Kirkman et al., 2005; O'Leary et al., 2007). Most of the researchers up to now have failed to acknowledge the multi-dimensionality of the dispersion construct and have instead employed discrete dichotomous variables (Cramton et al., 2005b; Warkentin, Sayeed, & Hightower, 1997). In the present study we go beyond past research in that we use two multi-dimensional measures assessing objective as well as subjective dispersion. With such a broadening of focus we claim to capture more behaviorally relevant dimensions of dispersion since the cognitive salience of team members seems to be a widely neglected facet of the overall construct dispersion (Wilson et al., 2008). Researchers relied falsely on objective measures of dispersion, assuming it to be a proxy for experienced distance. Table 5-1, however, demonstrates that subjective distance and objective distance share only 36% of variance in our sample ( $r = .60, p < .01$ ). Scholars are therefore encouraged to include subjective representations in their assessment of dispersion since research in different domains of behavioral science also reveals that the psychological representa-

tion of specific phenomena is more influential on individual behavior than their objective value (Wilson et al., 2008).

Second, this study indicates that a team's challenges and opportunities increase as dispersion increases. Figure 5-2 again reveals that both more and less dispersed teams benefit from high levels of effort and task coordination, but dispersed teams benefit more. These teams can thus outperform less dispersed teams. Nevertheless, it remains important for theory as well as for practice to identify contingency variables which demonstrate that the effect of dispersion on team performance is highly sensitive to the influence of third variables (task-related processes in the present study). For instance, Hinds and Mortensen (2005) showed in their field study on distributed teams that the relationship between dispersion and conflict is contingent upon the level of shared identity and shared team context. They concluded that much more research is necessary on contingency factors which moderate the dispersion outcome link to gain a more detailed understanding of virtual team dynamics. Along this route, research on distributed teams may have the opportunity to discover currently undetected phenomena because of their weaker effects in co-located teams (Hinds et al., 2005).

Third, our research has implications for research on team diversity, as we agree with Cummings (2004) that dispersion itself seems to constitute one source of structural diversity. Williams and O'Reilly (1998: 81) defined that "any attribute people use to tell themselves that another person is different" may qualify as a dimension of diversity. Attributes such as location or organizational unit affiliation may be cues which immediately come into team members' minds and are likely to be a source of self-categorization (Polzer et al., 2006). Thus, viewing team members' locations as a dimension of diversity, our results complement this discussion and posit that virtual teams need adequate task processes to build on this structural potential.

### **5.5.2 Implications for Practice**

The results of this study indicate that teams' task-related processes should be a focal variable to obtain the desired positive effects when managers rely on dispersed project members with specialized knowledge and expertise. Calling into question the common practice of staffing teams solely on the basis of team members' expertise and availability, we suggest to further considering the team's ability to establish sound team processes when staffing a dispersed project team. Social skills, as a major prerequisite for good teamwork, should become a more pivotal part of the managerial catalogue of requirements in staffing a virtual team. Our study

clearly shows that bringing individuals from different locations together under the expectation that they will automatically know how to collaborate in a virtual environment is insufficient. We have demonstrated the high risks of failure in setting up a team across different geographic locations as well as the potential for superior performance.

That we did not find evidence for the importance of socio-emotional team processes as contingency variables for the dispersion–performance relation should not be misinterpreted that these processes are not important. Socio-emotional processes may instead serve as a necessary condition for teams. In other words, workgroups fall apart if they lack some degree of cohesion (Bachmann, 2006). For a dispersed workgroup to realize the potential inherent in its functional and structural diversity, members must first and foremost establish a basis for the exchange of their differing perceptions.

### **5.5.3 Limitations and Outlook**

A few limitations of this study should be noted. First, the data for this research are cross-sectional rather than longitudinal. While our study demonstrates associations between variables, it cannot establish causality. A longitudinal research design using multiple informants would further our knowledge of both the causality of relationships as well as the development of the contributory value of team processes on the dispersion–performance link over time. Second, we consciously focused on software development teams because the digital output of this industry makes it more feasible to collaborate across geographical boundaries. While we do not assume that our results are specific to the task contexts of software development, we encourage further research to test the transferability of our results to other industries. Finally, the weak and often unclear connection between dispersion and team performance in research on real business teams so far should motivate scholars to further examine the conditions under which dispersion may be beneficial for team performance and when it is not. The current work provides insight into the ongoing dispersion-performance debate in that it specifies team processes that are important contingency variables for the dispersion–performance link. Additional insights with regard to further contingency variables on other levels of analysis, e.g., on the level of individual traits or organizational parameters, could provide a more comprehensive picture of this research issue. The conceptual arguments and empirical evidence from this study may serve as input for such necessary future work.

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## **6 Multi-level Predictors of Dispersed Collaboration**

### **ABSTRACT**

Research addressing the link between team virtuality and collaboration can be described as ‘mature’. However, scholars have, to date, considered team collaboration and team dispersion as two distinct entities, neglecting that collaboration in virtual teams is directly intertwined with continuous levels of distance at which it takes place. In addition, scholars have largely neglected the situatedness of collaboration and the impact of context variables on teamwork. We address this research gap and investigate how organizational characteristics affect dispersed collaboration effectiveness, measured as an index of geographic distance and teamwork variables. Our analysis draws on 114 dispersed software development teams pertaining to 19 software-engineering laboratories and reveals that ‘dispersed collaboration’ is positively affected by the globalization culture, the level of formalization, and by dedicated team support practices. Our results should motivate researchers to include context variables in their study of distributed team processes and present new avenues for practitioners to establish an organizational context that fosters dispersed collaboration effectiveness.

Key words: Virtual teams, dispersed teamwork, organizational context.

## 6.1 INTRODUCTION

The interdependencies inherent in teamwork have historically required teammates to be co-located, but technological advances now enable members of the same team to reside in distant locations (Salas, Stagl, & Burke, 2004). In today's business world, virtual team collaboration with its manifold organizational definition has become common practice. Organizations try to staff their teams from different locations to gain advantages in expertise, technology, and cost structures, with the expectation that such dispersed teams offer performance advantages over more co-located teams.

While good collaboration seems difficult to achieve in dispersed settings, recent studies show that virtual teams are able to outperform their co-located counterparts if they reach high levels of teamwork. Siebdrat, Hoegl, and Ernst (2008), for instance, showed that dispersed teams with sound task-related team processes are able to outperform co-located teams with the same levels of task-related behavior. Similarly, in his study on cross-regional innovation teams, Singh (2008) demonstrated that distributed teams can only reach superior innovative performance if they manage to achieve high levels of knowledge integration. Thus, team processes seem to play a pivotal role in the study of virtual teams, as they are the critical means through which dispersed teams can optimally leverage their heterogeneous knowledge resources (see also results in chapter 5). Consequently, team processes have received considerable research interest in the study of virtual teams. Dozens of studies have discovered that dispersion is harmful to a broad set of team processes leading, for instance, to misunderstandings and conflict escalation (Armstrong et al., 1995), to a decline in informal or spontaneous communication and reduced social cohesion (Kiesler et al., 2002), to disagreement about the task context (Malhotra, Majchrzak, Carman, & Lott, 2001), and to difficulties in coordinating activities (Espinosa, Slaughter, Kraut, & Herbsleb, 2007a).

However, while these studies examine the direct effect of geographic distance on team collaboration with interesting insights into virtual team dynamics, such research is restricted to the conclusion that the more (fewer) co-location there is, the better (worse) the teamwork will be. This research still leaves open under which circumstances high-level dispersed teamwork is most likely. While managers who rely on virtual teams are widely aware of complications due to distance and the virtuality of communication (Armstrong et al., 2002a), they still have little guidance in how to create an organizational context that is supportive for dispersed collabora-

tion. There is a considerable lack of knowledge which organizational factors hinder or foster 'dispersed collaboration.' To date, only sporadic efforts have been made to investigate the occurrence of teamwork in distributed environments (e.g., Kahai, Sosik, & Avolio, 1997). Consequently, the decisive impact of the organizational context on virtual team collaboration is still a black box in the study of virtual team dynamics. Salas et al. (2004: 69) recently acknowledged this research gap and stated that "distributive teamwork is still evolving and remains largely unexplored."

In this study, we contribute to this research gap and investigate the cross-level influence of organizational characteristics on dispersed collaboration quality. By using this research framework, our contributions to the extant literature on team dynamics are twofold:

First, we go beyond past research, which mainly investigated the interrelation of dispersion and team processes, handling both as two distinct variables. We investigate dispersed teamwork instead of examining teamwork in dispersed teams. We therefore create an index that consists of a dispersion measure and a measure of teamwork. Only the consideration of both, dispersion and teamwork, in one 'dispersed teamwork' index allows us to identify the enabling conditions of successful teamwork in dispersed settings. As such, our research is not restricted to discovering team virtuality as a limiting factor for successful team processes, but rather identifies the enabling conditions of successful dispersed teamwork. Since virtual teams have the potential to outperform their co-located counterparts through high level team processes (Cummings, 2004; Siebdrat et al., 2008; Singh, 2008), our research approach ultimately identifies organizational conditions under which superior virtual team performance is most likely.

Second, we contribute to the fundamental, yet largely unexplored research area of multi-level determinants of virtual team dynamics. Drawing on the situationalist perspective (Davis-Blake & Pfeffer, 1989; Mischel, 1968, 2004) that considers interpersonal behavior as primarily determined by the surrounding context, we apply a multi-level analysis to assess the influence of organizational design parameters on dispersed teamwork. More specifically, we analyze whether characteristics of the surrounding organizational context such as the level of formalization affect team members' ability to successfully collaborate in a dispersed team situation. Such an analysis seems critical to better understand whether and how the organizational context affects teamwork effectiveness. By extending the perspective from the team to the organizational level, we go well beyond prior research that mostly has not appropriately accounted for the con-

text in which these processes occur (Martins et al., 2004; Zellmer-Bruhn et al., 2006). Our study results put into question the common practice to investigate virtual team dynamics irrespective of the context in which these dynamics take place. We base our analyses on a sample consisting of 492 members and team leaders from 114 dispersed software development teams pertaining to 19 different software labs.

## **6.2 ORGANIZATIONAL CONTEXT FOR SUCCESSFUL DISPERSED TEAMWORK**

In keeping with Salas, Sims, and Klein (2004: 190), teamwork is defined as “a set of flexible behaviors, cognitions, and attitudes that interact to achieve desired mutual goals and adaptation to the changing internal and external environments.” A multitude of studies has shown that high-level teamwork is more difficult to achieve in virtual settings (Powell et al., 2004). The difficulties of virtual teams to maintain high levels of teamwork are regularly considered to account for the problems of leveraging their knowledge and expertise from different locations (Argote, 1999). Researchers have therefore investigated whether teams that achieve high levels of teamwork are able to outperform more co-located teams with the same levels of teamwork processes. Some researchers have found that dispersed teams are able to outperform their co-located counterparts if they manage to achieve high levels of communication (Cummings, 2004, 2007), knowledge integration (Singh, 2008) or task-related behaviors (Siebdrat et al., 2008). While these authors show that superior performance is possible through high-level teamwork and dispersion, they do not show under which conditions such a combination is likely to occur.

Scholars concerned with this research gap can generally focus on two fundamental antecedents of teamwork quality in dispersed teams: dispositional and situational characteristics, or an interaction of both (Davis-Blake et al., 1989; Denison, Hart, & Kahn, 1996). There is a long debate whether individual behavior is rather a function of the person than of the situation (Funder, 2006; Mischel, 2004). In this study, we focus our research on situational attributes, i.e. organizational design parameters, which constitute the context for team members' dispersed collaboration. We emphasize situational parameters rather than individual, more dispositional characteristics because organizational settings are known to represent strong situations (Davis-Blake et al., 1989). Strong situations are those in which the demands are likely to cause everyone to behave in the same way, consequently, weakening the influence of individual characteristics on team processes (Mowday & Sutton, 1993). Recognizing the situational strength of or-

ganizational settings, Sutton and Rousseau (1979: 675) stated that “behavior in organizations is largely a function of the settings in which it occurs.”

Our focus on situational characteristics is further suggested by empirical evidence that the impact of the situational context depends on the degree of dispersion among team members. The insights revealed from contextual research on co-located teams may, therefore, not equally apply to their distributed counterparts. In their study of communication break-downs in virtual teams, Bjørn and Ngwenyama (2008), for example, showed that the absence of a shared work practice within formalized organizational structures jeopardizes intra-team dynamics only in dispersed teams but not in co-located ones. Similarly, organizational support through diversity training and IT infrastructure is more likely to increase team performance when dispersion increases (Furst et al., 1999). However, to date, teams’ larger organizational context has hardly been recognized in empirical research – specifically with regard to dispersed teams (Porter & McLaughlin, 2006).

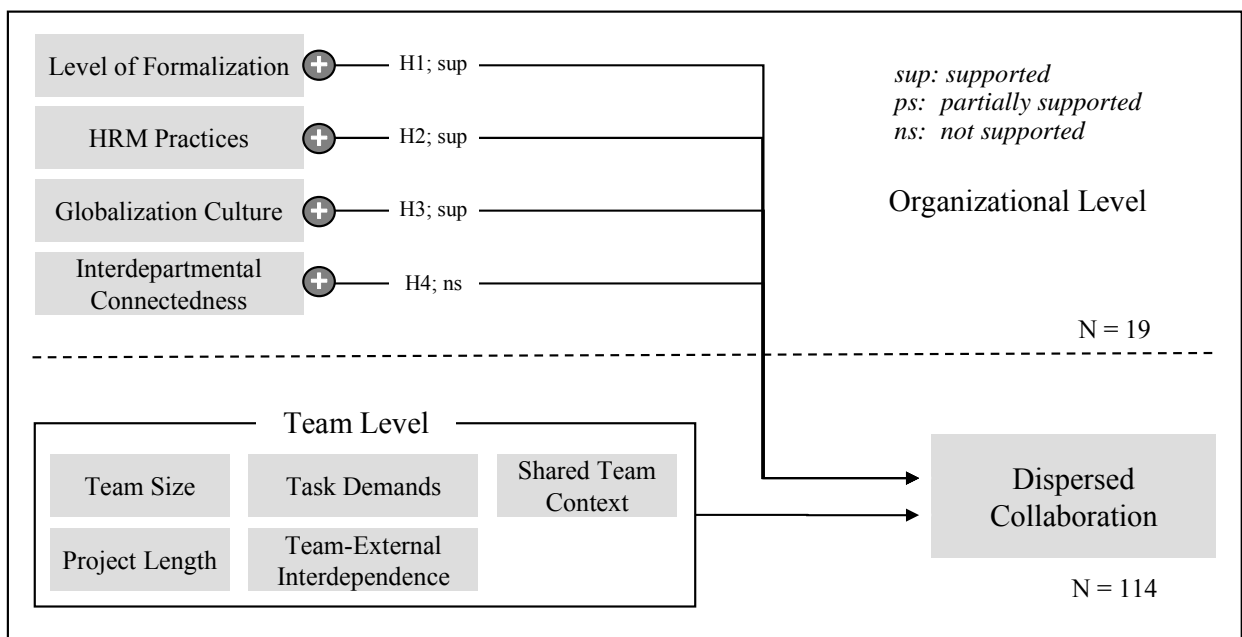


Figure 6-1: Conceptual Framework of all Hypothesized Cross-Level Effects

Given situational context variables’ potentially strong influence, we focus our research on organizational design parameters which are likely to facilitate dispersed teamwork and, in turn, are able to leverage the capability inherent in virtual teams. In the following section, we will refer to the level of formalization, interdepartmental connectedness, globalization culture, and organizational team support (OTS) practices as organizational factors contributing to successful

teamwork in dispersed teams. We have chosen these variables based on previous cross-level research and literature reviews that suggest that the chosen attributes should have significant effects on dispersed team collaboration (Hertel et al., 2005; Sethi & Nicholson, 2001; Staples, Wong, & Cameron, 2008b; Zellmer-Bruhn et al., 2006). In addition, these variables have been referred to as organizational substitutes for proximity (Hertel et al., 2004; Sethi, 2000; Wilson et al., 2008) such that team members suffer less from dispersion and may perform better teamwork in organizational environments characterized by these variables. Hence, we assume a direct cross-level effect for all of these organizational attributes on dispersed collaboration effectiveness. Figure 6-1 summarizes our conceptual framework for this study and provides an overview of the related hypotheses.

### **6.2.1 Level of Formalization**

The level of formalization is our first hypothesized cross-level predictor of dispersed collaboration in virtual teams. Companies with a high level of formalization create explicit rules, policies, procedures, plans, goals, and responsibilities, which provide all employees with a clear roadmap for collaboration (Menon, Bharadwaj, & Howell, 1996). In general, the consequences of formalization for teams seem to be ambivalent. While a formalized organization can detract from creativity and diminish the sense of autonomy, it provides team members with a reliable and predictable environment (Menon et al., 1996; Nylene, 2007). Specifically in respect of virtual teams, who interact in a more ambiguous environment that offers a greater scope for misinterpretation and conflict, the advantages of a shared context with formalized and predictable ground rules should exceed the disadvantages. A commonly shared context, for instance, provides dispersed team members with standard procedures and policies for interaction that harmonize norms and expectations and facilitate dispersed collaboration (Hinds et al., 2005; Kiesler et al., 2002; Staples et al., 2008b). Team members from distant locations who lack a sense of shared context are, however, likely to have divergent perceptions regarding appropriate behaviors, which could lead to conflict (Hinds et al., 2003a; Hinds et al., 2005; Kiesler et al., 2002).

For instance, Armstrong and Cole (1995) observed that site-specific cultures and expectations acted as significant sources of misunderstandings and conflict between distant sites. Similarly, Grinter et al. (1999) found that members of distributed software development teams, irrespective of the way they structured their work, were ‘constantly surprised’ and confused regarding the activities of their distant colleagues. In their field study, Hinds and Mortensen

(2005) showed that virtual teams with a shared, more formalized team context were less affected by distance and, consequently, performed better teamwork (i.e., less conflict). Thus, a formalized organizational environment seems to reduce the uncertainty of remote interaction and, as a result, fosters the likelihood that team members' dispersed collaboration will be of a high level. Consequently, we posit:

*Hypothesis 1: Organizations' level of formalization is associated with higher levels of dispersed team collaboration.*

### **6.2.2 Organizational Team Support**

Organizational team support (OTS) is defined here as a coherent system of human resource policies and practices that are dedicated to support virtual teamwork. It describes a collection of loosely coupled practices rather than a dimensional attribute ranging from low to high (Wood, 1999). A substantial body of research has investigated the relationship between OTS and different indicators of organizational performance (Verburg, den Hartog, & Koopman, 2007). However, the impact of OTS on dispersed team behavior or team processes in general remains largely unexplored (Geringer, Frayne, & Milliman, 2002; Schuler, Budhwar, & Florkowski, 2002). Numerous scholars have suggested that OTS practices and policies specifically designed to meet the challenges inherent in dispersed team constellations should enhance virtual process quality (e.g., Duarte & Snyder, 2001; Staples et al., 2008b). We therefore assume that dispersion-oriented OTS encompasses practices such as dedicated training opportunities for virtual teams and/or organizational policies valuing diversity that directly fosters dispersed collaboration (Hertel et al., 2005; Staples et al., 2008b).

There is empirical evidence that such OTS practices can establish an organizational environment which facilitates dispersed collaboration effectiveness. For instance, with regard to organizational policies, Jehn and Bezrukova (2004: 709) stated that "HR practices with emphasis on valuing diversity represent a crucial contextual factor that may bring net-added value to group processes and translate diversity into positive outcomes." Similarly, Snell et al. (1998) reported that transnational team processes benefited from organizational practices that emphasize cross-site integration, multi-cultural team buildings, and team-based rewards. In order to increase virtual teamwork, Staples et al. (2008b) propose that special career development opportunities, job rotations and team recognition, should be established for virtual team members



so that an ‘out of sight, out of mind’ phenomenon does not occur. Adding up all these results, we posit:

*Hypothesis 2: Organizational team support is associated with higher levels of dispersed team collaboration.*

### **6.2.3 Globalization Culture**

Past research suggests that a shared organizational culture can promote teams’ collaborative process effectiveness over distance through the establishment of an open and supportive communication climate and a commonly shared organizational identity (Axtell, Fleck, & Turner, 2004). For dispersed teams, an organizational culture promoting openness to diverse nationalities and ideas, and fostering the exchange of knowledge across locations, should be particularly conducive to teamwork. Therefore, we draw on the conceptualization of De Brentani and Kleinschmidt (2004), who referred to such a ‘globalization culture’ as an organization’s mindset to effectively deal with the complexities and opportunities that result from the geographic dispersion of markets and sites (De Brentani et al., 2004). Organizations with a globalized culture are open to world market opportunities, diverse customer needs and preferences, and different national cultures (De Brentani et al., 2004). A globalized culture becomes even more important for teamwork when organizations’ efforts and competencies are spread across different geographical regions and national cultures (Kleinschmidt et al., 2007). More specifically, teams that are comprised of individuals from different geographic locations are more likely to manifest higher levels of demographic, functional, and structural diversity (Cummings, 2004). From diversity research we further know that variation or dissimilarity across such diversity constructs can activate social categorization processes which, in turn, impede high-level dispersed teamwork (Jackson et al., 2003). We assume that a globalization culture promoting a global leverage of specialized skills, resources, and ideas can diminish categorization processes and support effective teamwork across sites. In other words, we believe that a globalization culture will favor diversity mindsets, which we expect will prevent intergroup bias and stimulate integrative instead of separating behaviors and attitudes (Van Knippenberg et al., 2007a). The reduced stereotyping should, in turn, enable dispersed team members to achieve higher effectiveness in dispersed team collaboration.

Empirical studies that examine the effects of diverse teams in organizations with differing cultures, climates or mindsets seem to support our line of reasoning. Chatman et al. (1998), for

instance, showed that interaction among dissimilar participants in a business simulation was more effective in cultures emphasizing cooperation, empathy, and good interpersonal relationships (collectivistic culture) than in more individualistic cultures. Similarly, Gibson and Gibbs's study (2006) demonstrated that a psychologically safe communication climate helped virtual teams to overcome the challenges of national diversity and hypothesized that this effect originated at least partly from a reduction in categorization processes. Similarly, Mathieu et al. (2007) recently found that an openness climate exhibited a significant cross-level relationship with team processes and performance. Therefore, we expect a globalization culture to be an organizational characteristic that provides team members with pro-diversity beliefs, fosters the establishment of social bonds between dispersed team members, and, as a result, facilitates high level dispersed collaboration. Consequently, we posit:

*Hypothesis 3: A globalization culture which promotes openness to different nationalities and new ideas is associated with higher levels of dispersed team collaboration.*

#### **6.2.4 Inter-Site Connectedness**

Per definition, dispersed teams are distributed across locations and often represent multiple organizations. Current research has shown that team members use their location as a salient basis for social categorization processes, leading to an 'us-versus-them' mentality, a mindset that prevents them from achieving high level teamwork processes over distance (Polzer et al., 2006). We believe that organizations' inter-site connectedness is a possible counterforce to location-based subgrouping and its detrimental effect on team interaction processes. We refer to inter-site connectedness as the extent to which the organizational context facilitates or fosters formal and informal direct contact between employees across different locations / sites (Jaworski et al., 1993; Nysten, 2007). Inter-site connectedness is related to the concept of 'organizational proximity' (Boschma, 2005) and increases the amount of interaction that can occur among team members. When people are connected via formal and / or informal ties such as regularly scheduled team meetings or organized events, the number of casual encounters, unplanned conversations, and multipurpose interactions increases (Kraut et al., 2002). Subsequent to the predictions of intergroup contact theory (Allport, 1954), we assume that contact between team members of different locations can effectively reduce intergroup prejudices and, therefore, reduce conflict and enhance interpersonal team processes (Cramton et al., 2005a; Pettigrew, 1998; Zajonc, 1968).

Following this logic, several authors have argued that virtual teams can benefit from working in contexts that have effective cross-team linkages (Kirkman & Rosen, 1999; Mathieu, Marks, & Zaccaro, 2001). Scholars have found, for instance, that greater dependence between partners can lower the degree of conflict since it is in their mutual self-interest to collaborate (Anderson & Narus, 1990; Barclay, 1991). Similarly, integration processes are necessary for teams in multiteam networks to orchestrate each team's efforts and for them to succeed collectively (Marks, Dechurch, Mathieu, Panzer, & Alonso, 2005). Sethi and Nicholson (2001) demonstrated a significant link between the interdepartmental connectedness of a consumer product manufacturer and the ability of its partly dispersed development team to maintain high levels of charged behavior (the extent to which teams are enthusiastically and jointly driven to develop new products). Finally, Raghuram et al. (2001) found organizational connectedness to be an important factor in predicting adjustment to virtual work arrangements. We therefore assume inter-site connectedness to be an organizational design parameter that fosters dispersed teamwork through a reduction in location-based categorization and the establishment of interpersonal liking. Consequently, we posit:

*Hypothesis 4: Higher organizational inter-site connectedness is associated with higher levels of dispersed team collaboration.*

## **6.3 METHOD**

### **6.3.1 Participants and Procedure**

The participants in this study were software development teams from five software developing companies, of which four were headquartered in Germany and one in the USA. The companies participating in our study organize their R&D in various software laboratories dedicated to the development, testing, and adaptation of basic software programs. While most software labs are proficient in the entire software development value chain, some labs are specialized in certain functionalities or development processes. Since our study focuses on dispersed team collaboration, we only selected teams with at least marginal levels of dispersion (e.g., working in different rooms). For our analyses, we draw on data from 114 software development teams pertaining to 19 different software labs. Each laboratory employs between 20 and 5,500 software developers (median = 600). Software development projects that had been completed within 12 months prior to data collection and that had been worked on by 'teams' were included in the

study. Each team in multi-team projects could participate separately in the study, as long as independent performance evaluations were possible.

The data that we collected for this study were from three different sources: team leaders, team members, and site managers of the respective laboratories. Descriptive details about the team and all team members were provided by the team leaders within a pre-defined spreadsheet. In addition, team members' and team leaders' responses to our questionnaire were gathered via a web-based survey. Team members were randomly contacted and asked to complete the online questionnaire. The respondents' participation in this study was strictly voluntary. In the final data set of this study, we have responses from the team leader of each team included and from at least two team members. Finally, the first author gathered data on the organizational level of analysis during individual phone interviews with the respective site manager by means of a fully standardized questionnaire.

Overall, our analyses are based on a total of 511 responses from 114 team leaders, 378 team members, and 19 site managers. This sample is highly international with team members belonging to 32 different nationalities. Teams in our sample have an average of 11.8 members and an average age across all team members of 36.3 years (standard deviation = 8.8).

### **6.3.2 Organizational Level Variables**

By definition, members of a virtual team are dispersed across multiple locations (Alavi et al., 2002). Owing to dispersed teams often comprising members who pertain to multiple organizational contexts, we had to decide from which lab we would assign the respective organization-level predictors. We decided to assign each team to the laboratory context to which most of its members belong. If the team members were members of different labs, we assigned the context to which the team leader belongs. In most cases, the assignment of the respective lab context was straightforward with most team members belonging under the same organizational roof. We reasoned that this assignment procedure is appropriate since research from other domains discovered that individuals and groups are mostly influenced by their dominant context (e.g., Hearn et al., 2005; Passmore et al., 2003) and that both criteria (largest sub-group and team leader location) can be justifiably used to identify this 'dominant' context.

In this study, we consider the following as variables of the organizational team context: 1) level of formalization, 2) OTS practices, 3) globalization culture, and 4) inter-site connected-

ness. In order to assess labs' level of formalization and inter-site connectedness, we adapted the measures provided by Jaworski & Kohli (1993). The scale used to measure OTS comprises items adapted from Verburg et al. (2007). It was further extended to account for different practices with regard to mission statements (Snell et al., 1998) and teams' goal setting practices (Hertel et al., 2004) (see Table 6-1). Finally, globalization culture was measured by using the scale provided by DeBretani et al. (2004). All items are coded from 1, "strongly disagree," to 5, "strongly agree." Inter-correlations and the reliability of constructs are illustrated in Table 6-2.

### 6.3.3 Team-level Variables

#### *Control variables*

Given this study's cross-level focus, we included team design variables in our analyses in order to control for these variables' variance and to determine their relative significance in predicting dispersed collaboration effectiveness. In particular, we refer to team size, project length, task demands, teams' external interdependence, and shared team context as descriptive variables for the team design. We included team size in the study's analysis since several studies underline its significance for effective team collaboration (Bradner, Mark, & Hertel, 2005). Since research on teams has revealed a fundamental difference between temporary and ongoing virtual teams (Harrison, Price, Gavin, & Florey, 2002; Saunders et al., 2006), we also assessed project length in terms of months from the beginning of the team's work to its conclusion and, after a log transformation, included it as a control variable. Further, task properties such as innovativeness and complexity have been shown to be critical for a team's teamwork effectiveness (Rousseau et al., 2006). We therefore included the level of task demands as a five-item construct in our analysis (see Table 6-1).

A fourth control variable accounts for the different levels of a team's external interdependence with other teams, as, prior to our data collection, in-depths interviews with R&D managers from different labs revealed its significance for virtual team collaboration in the software development industry. We therefore assessed whether teams performed (1) more or less in isolation (14%), (2) had significant interaction with other teams (21%), (3) interacted continuously with other teams (28%), or (4) the team was part of a multi-team project with strong and continuous interaction and high coordination effort (37%) (see Table 6-1).

Finally, we assessed the degree to which team members have access to the same information, share the same tools, and have the same priorities and work cultures, referring to it as a

‘shared team context’ (Hinds et al., 2005). Research on virtual teams suggests that a shared team context facilitates dispersed teamwork by providing the grounding required to better understand and make sense of others’ behaviors, to potentially mitigate harsh attributions, and, consequently, to reduce interpersonal conflict (Cramton, Orvis, & Wilson, 2007; Hinds et al., 2005; Hinds & Weisband, 2003b).

### *Dispersed Team Collaboration*

We assess ‘dispersed collaboration,’ the dependent variable in this study, as a multiplicative index consisting of a measure of dispersion and a measure of teamwork. The first component of our index ‘dispersion’ was measured by using O’Leary and Cummings’s (2007) spatial index, which captures the geodesic distances between sites weighted by the number of members at such sites, and which is based on a matrix of all possible, non-redundant, member-to-member connections. We took the natural logarithm of the obtained scores to normalize their distribution. For the second component of our index, namely teamwork, we used the Teamwork Quality (TWQ) measure as suggested by Hoegl et al. (2004b). TWQ has been successfully employed to measure teamwork in several different contexts (Easley, Devaraj, & Crant, 2003; Hoegl et al., 2001; Hoegl et al., 2004b). TWQ is a second order construct comprised of six different facets of the collaborative team process – communication, coordination, balance of member contributions, mutual support, effort, and cohesion – which comprehensively describes the performance-relevant aspects of internal team collaboration (Hoegl et al., 2001). The concept of TWQ suits our research focus optimally, as it conceptualizes the quality of interactions within teams rather than team members’ (task) activities. We used team members’ responses to calculate a mean TWQ score for each team (the average value of all 18 TWQ items) – a procedure supported by strong inter-rater agreement ( $r_{wg} = 0.97$ ).

Variables	Items
Independent Context Variables (Organizational Level)	<p><i>Level of Formalization.</i> (1) The organization has a large number of rules and written procedures; (2) In the organization there are manuals that specify procedures; (3) There are written job descriptions for most positions in the organization; (4) There are written performance indicators for the people who work in this location; (5) There is a formal orientation program for individuals who are new to the organization</p> <p><i>Organizational Team Support.</i> (1) The location makes use of a mission statement; (2) The location takes team performance into account for rewarding employees; (3) The location makes use of a formal system for performance evaluation; (4) At the location it is usual to have non-financial compensation (dinner, award, publication of outstanding team performance) on team-level; (5) At the location management-by-objectives discussions are always on time</p> <p><i>Globalization Culture.</i> To create a “truly global” innovation culture, our organization: (1) strongly encourages contributions from team members located in different countries/cultures; (2) strongly emphasizes knowledge sharing across different geographical subunits; (3) emphasizes responsiveness to differences in local markets; (4) strongly endorses informal communication and coordination development activities across country units; (5) achieves a high degree of interdependence among other labs worldwide</p> <p><i>Level of Inter-Site Connectedness.</i> (1) In this organization, it is easy to talk with virtually anyone you need to, regardless of rank or position; (2) There is ample opportunity for informal "hall talk" among individuals from different departments in this organization; (3) In this organization, employees from different departments feel comfortable calling each other when the need arises; (4) Managers here discourage employees from discussing workrelated matters with those who are not their immediate superiors or subordinates; (5) People around here are quite accessible to those in other departments; (6) Communications from one department to another are expected to be routed through "proper channels;" (7) Junior managers in my department can easily schedule meetings with junior managers in other departments</p>
Controls (Team-level)	<p><i>Task Demands.</i> (1) Our team task was very complex; (2) This task dealt with something new (for us); (3) There was considerable time pressure (compared to other projects); (4) This task involved a high degree of technical uncertainty; (5) This task posed a high level of economic risk (to this business unit)</p> <p><i>Team-external Interdependence.</i> ‘1’ an isolated teamwork with only little interaction with other teams / projects (e.g. for some requests), ‘2’ an isolated teamwork with significant interaction with other teams / projects in at least one project phase, ‘3’ a teamwork with a continuous need for interaction with several other teams / projects, ‘4’ a multi-team project, in which your team’s work output integrated into a larger software-solution causing significant and continuous need for coordination</p> <p><i>Shared Team Context.</i> (1) Members of the team frequently misunderstood each other; (2) Members of the team had problems speaking the same technical language; (3) Members of the team had problems speaking the same national language; (4) Incompatibility existed between different team members' work organization (e.g. tools / processes); (5) Members of the team had different priorities</p>

*Table 6-1: Selected Survey Items Used in this Research*

Before calculating our dispersed collaboration index, we performed two preliminary data transformations. First, to ensure that teamwork and dispersion are equally represented in our

dispersed collaboration index, we transformed both measures into z-scores (standardized scores with a mean of zero and a standard deviation of one). Second, to increase the interpretability of our index, the minimum value of both of our two index variables was added to each raw score. This transformation allows the zero point to be the minimum of each sub-index and allows higher (lower) values in each of the both index components to be interpreted as leading to higher (lower) values in our overall index. Finally, the *Dispersed Collaboration Index* is comprised of the multiplication of both sub-indices.

The use of such a multiplicative index has been postulated from numerous theories in many different fields of organizational research (for an overview see Blanton & Jaccard, 2006). We have chosen a multiplicative approach for two reasons. First, we aim to assess the cross-level antecedents of dispersed collaboration, arguing that teamwork and geographic distance represent different aspects of virtual team dynamics (structural and procedural), both of which are necessary for high values in this index. Second, the multiplicity of our index is further suggested by the considerable number of research studies that have shown that the (multiplicative) interaction of distance and teamwork is highly predictive of team performance (Cummings, 2004; Siebdrat et al., 2008; Singh, 2008). Consequently, a multiplicative index best fits the focus of our study.

#### **6.3.4 Data Analysis**

Given our basic hypothesis that dispersed collaboration is not only affected by team-level attributes, but further molded by influences from the lab context, we employed two-level hierarchical linear modeling (HLM) for our analyses (Hofmann, 1997). The advantages of applying HLM for our study are twofold. First, HLM explicitly partitions the variance in the outcome variable and provides estimations of the magnitude of the variance components in the outcome variable for both levels of analysis. Second, hierarchical linear modeling allows us to simultaneously investigate team-level relationships with dispersed collaboration as well as relationships across hierarchical levels by using our level-2 predictors. Hence, we can study the impact of level-2 predictors (e.g., globalization culture) on dispersed team collaboration while controlling for any team-level attributes (Hofmann, 1997). In order to ensure content validity and to avoid a possible common source bias, data from different respondents were used to measure the different variables. Lab characteristics were judged by the respective site managers, TWQ by team members, and all other team-level constructs were assessed using the information provided by team leaders.



### 6.3.5 Results

A hybrid correlation matrix of all study variables is presented in Table 6-2. Whereas the relationships between variables at the same level of analysis were calculated as zero order correlations, HLM was used to calculate the correlations between team-level and lab-level variables (as univariate cross-level effects; i.e.,  $\gamma$ ; Judge et al., 2006; Mathieu et al., 2007). To investigate our four hypotheses, we generated a sequence of models, using the HLM 6.06 statistical package (Raudenbush et al., 2004). Each HLM analysis was conducted hierarchically and comprised three steps (Gavin et al., 2002; Raudenbush et al., 2004). In a first step, we estimated within and between-group variance in our dependent, dispersed collaboration index variable in a ‘null model.’ Consequently, we partitioned the variance in our index into its within and between lab variance components by means of intra-class correlation (ICC) (Gavin et al., 2002). The ICC value for dispersed collaboration in our sample is significant and equals 0.21, reflecting that 21% of variance in dispersed collaboration lies between labs.

Having confirmed that dispersed collaboration varies both within and between groups, a second step tested whether there is still significant cross-lab variance after all team level controls have been included in a level-1 random coefficient model (Gavin et al., 2002). The chi-square test associated with the residual variance (between lab variance) reveals significant inter-lab variability [ $\chi^2(18) = 44.35, p < .001$ ] and provides the basis for testing our cross-level hypotheses.

Variables	Infor- mant <sup>2)</sup>	Mean	SD	$\alpha^3)$	1	2	3	4	5	6	7	8	9
(1) Team Size <sup>T</sup>	TL	11.76	7.56	-	-								
(2) Project Length <sup>T</sup>	TL	17.62	12.67	-	.20*								
(3) Task Demands <sup>T</sup>	TL	3.61	.81	.77	.26*	.14							
(4) Team-External Interdependence <sup>T</sup>	TL	2.89	1.05	-	.36**	.17 <sup>+</sup>	.46**						
(5) Shared Team Context <sup>T</sup>	TL	3.77	.80	.74	.04	-.21*	-.21*	-.18*					
(6) Dispersed Collaboration <sup>T</sup>	TM	5.35	3.48	-	.05	-.21*	.04	.03	.07				
(7) Level of Formalization <sup>L</sup>	SM	4.12	0.69	.81	.15	-.01	-.07	.00	.22*	.26 <sup>+</sup>			
(8) Organizational Team Support <sup>L</sup>	SM	4.01	0.83	.70	.21	-.20	.15	.19	-.10	.35**	-.14		
(9) Globalization Culture <sup>L</sup>	SM	3.90	0.99	.88	.21	-.14	.06	.27**	-.05	.37**	.28	.16	
(10) Inter-Site Connectedness <sup>L</sup>	SM	4.33	0.53	.79	.22 <sup>+</sup>	-.05	-.04	-.12	.03	-.04	.42 <sup>+</sup>	-.02	.11

Note. <sup>+</sup> p < 0.10, \* p < 0.05, \*\* p < 0.01.

<sup>T</sup> Team-level variables; <sup>L</sup> Lab-level variables

<sup>1)</sup> Team-level Correlations (N = 114) and Lab-Level correlations (N = 19) are zero order correlations. Cross-level values computed by calculating standardized effects from simple (one independent variable) regressions in HLM using standardized predictors.

<sup>2)</sup> This study used different informants for different levels of analysis: TL = Team Leader; TM = Team Member; SM = Site Manager

<sup>3)</sup> Chronbach's alpha

Table 6-2: Descriptive Statistics and Correlations<sup>1</sup> (N= 114 teams)

Therefore, our third step comprises the question whether level-2 predictors explain variability in our level-1 outcome or, more specifically, whether our context variables are associated with varying intercepts in dispersed collaboration across labs ( $\beta_{0j}$ ), while we controlled for our level-1 variables. Such an intercept-as-outcome model is specified below:

$$\text{Level 1: } y_{ij} = \beta_0 + \beta_1 (\text{Team size}) + \beta_2 (\text{Project Length}) + \beta_3 (\text{Team External Linkage}) + \beta_4 (\text{Task Demands}) + \beta_5 (\text{Shared Team Context}) + r_{ij} \tag{1}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01} (\text{Formalization}) + \gamma_{01} (\text{OTS Practices}) + \gamma_{01} (\text{Globalization}) + \gamma_{01} (\text{Inter-Site Connectedness}) + U_{0j} \tag{2}$$

$$\beta_1 = \gamma_{10} \dots \beta_5 = \gamma_{50} \tag{3}$$

Where  $y_{ij}$  is the team-level dispersed collaboration measure for team  $i$  in lab  $j$ ,  $\beta_{0j}$  represents the lab intercepts, while  $r_{ij}$ , and  $U_{0j}$  are team and lab-level error terms assumed to be independent and normally distributed with a mean of zero and a variance of  $\sigma^2$ .

Variable	Parameter estimate	SE	df	t-Test	p-value
<i>Team-level Controls</i>					
Team Size	0.74	0.62	104	1.17	0.25
Project Length (LOG)	-1.87	1.26	104	-1.48	0.14
Team-External Interdependence	-0.42	0.34	104	-1.25	0.22
Task Demands	0.09	0.43	104	0.20	0.84
Shared Context	-0.17	0.38	104	-0.45	0.65
<i>Cross-Level Predictors</i>					
Level of Formalization	1.26	0.63	14	2.00	0.07
Organizational Team Support	1.17	0.48	14	2.46	0.03
Globalization Culture	0.97	0.35	14	2.79	0.02
Inter-Site Connectedness	-1.13	0.69	14	-1.62	0.13

Table 6-3: *Intercept-as-Outcome Model Predicting Dispersed Collaboration*

The results for this model in Table 6-3 indicate that  $\gamma_{01}$ ,  $\gamma_{02}$ , and  $\gamma_{03}$  are significant (with  $\gamma_{01}$  being marginally significant) and positive, providing support for our hypotheses 1, 2, and 3, while we have to reject hypothesis 4. Our results suggest that teams' ability to perform high level team collaboration across distance is positively affected by the laboratory's level of formalization, its globalization culture, and those OTS practices which foster teamwork. The results of our final HLM model further indicate that these three lab-level predictors explain nearly all of the level-2 variance in dispersed collaboration without any significant portion of variance remaining in the intercept terms [ $\chi^2(13.19) = , p > .50$ ]. To investigate the robustness of our multiplicative dispersed collaboration index, we conducted all analyses with an index that combines dispersion and TWQ additively. We found the same result pattern, which suggests that our results are highly robust. In addition, we analyzed the scatter plot with regard to extreme values in either of our two dimensions (dispersion and TWQ) but found no indication for critical outliers.

## 6.4 DISCUSSION

In our study, we revealed that the organizational context is an important cross-level factor for successful virtual collaboration and, consequently, a critical lever to increase virtual team performance. More specifically, we discovered that an organization's team support practices, globalization culture, and level of formalization positively affect dispersed team collaboration quality. Interestingly, our results further suggest that organizational context characteristics seem to be more important for dispersed collaboration effectiveness than a number of widely recognized team design characteristics (e.g., team size, project length, team task). Together, our organizational variables explain more than 20% of the team-level variance in dispersed collaboration effectiveness, while none of our team-level variables contributed significantly to explaining our dependent variable. In this respect, our results underpin earlier claims that the organizational context exerts a major influence in determining teams' processes and effectiveness (Ancona, 1990; Gladstein, 1984) and, therefore, requires far more research attention.

The identification of organizational cross-level predictors of effective dispersed collaboration leads us to the question which underlying mechanisms triggered our cross-level effects? In the theoretical part, we have argued that virtual team collaboration does not suffer from distance per se but more indirectly from the consequences of distance such as the lack of a predictable work context, less team member salience, and higher levels of diversity. Accordingly, we hypothesized that those organizational characteristics that provide a counterforce to these undesirable consequences of dispersion should be beneficial for dispersed collaboration effectiveness. But there are some inconsistencies in our data that need further research:

Organizations' level of formalization, for instance, is thought to provide virtual teams with a more predictable environment and to reduce the amount of uncertainty associated with distributed work (Kiesler et al., 2002). We found empirical evidence that higher levels of formalization are associated with higher levels of dispersed collaboration effectiveness. However, project length and a shared team context are elements of the immediate team context and are also known to provide team members with perceptions of stability and trust (Saunders et al., 2006) but without any proven association to dispersed collaboration in this study. Similarly, we found that a more globalized culture exerts a positive cross-level effect on dispersed collaboration effectiveness most likely due to a higher tolerance towards team member diversity. However, project length has also been shown to weaken the effect of surface-level diversity but without a significant effect on dispersed collaboration effectiveness in this study (Harrison et al., 2002).

There are multiple possible explanations for the ambivalence between team-level and lab-level findings in our research. One reason for this result pattern may be that the organizational and the team context interact and that both exert a more diffuse rather than straightforward influence on team behavior. The fuzzy and, in part, ambivalent influence of organizational context elements may also have been responsible for our non-finding with regard to the inter-site connectedness. Inter-site connectedness exemplifies this ambivalence, as it fosters social contact and therefore the feeling of proximity but – at the same time – fosters the perception of surface-level attributes and amplifies categorization processes, which may advance perceptions of distance (Martins et al., 2004). It is probably this complexity which has led to the demanding and insightful research into contextual effects and has allowed debates, such as those on the person and situation to be carried on for decades (Mischel, 2004). For our understanding of contextual effects on dispersed collaboration effectiveness, much more research is necessary, especially with regard to the underlying mechanisms which led to our cross-level findings.

#### **6.4.1 Theoretical Implications**

The contributions of this research for theory building are twofold. First, we contribute to the research on teamwork in virtual teams. While this line of research to date has generated a substantial body of research papers, the antecedents for successful teamwork in virtual team settings are still largely unexplored (Priest, Stagl, Klein, & Salas, 2006). Research papers by Cummings (2004) and Hoegl et al. (2007a) show that high-level teamwork is critical to virtual team effectiveness, however, they do not tell us how to design an organizational environments that optimally fosters these high-level processes. Our research is an effort to provide scholars with a new approach to study the enabling and limiting conditions for successful virtual teamwork. Our suggested approach – using a combined index consisting of a measure of dispersion and teamwork – will not only help to close the research gap regarding antecedents of successful virtual team collaboration, but it will also help us to gain more theoretical insights into the functioning of virtual teams. Future research on virtual team processes should make more deliberate choices regarding the appropriate assessment of teamwork in virtual teams. According to our theorizing, teamwork is directly intertwined with the context in which it occurs and our conceptualization of dispersed collaboration is a promising approach to account for this. While current research classifies team processes into categories such as transition processes, action processes, and interpersonal processes (e.g., LePine, Piccolo, Jackson, Mathieu, & Saul, 2008),

scholars investigating virtual teams may be well-advised by adding ‘dispersion’ as a new dimension to describe team processes in this taxonomy.

Second, we suggest that researchers include contextual variables in their research because the context “is there” (Johns, 2001: 34) and our research indicates that it seems to matter. There is a considerable ambivalence between researchers’ theoretical claims and contexts’ hypothetical impact on team functioning and its merely marginal consideration in the respective research. While the importance of contextual influences on team processes has been theorized since Hackman and Morris (1975), we still know surprisingly little about the contextual effects on team functioning, especially in dispersed teams (Kozlowski et al., 2003; Mathieu et al., 2007). Prior research has widely neglected the organizational context as an important predictor for team processes (Ilgen et al., 2005; Kozlowski et al., 2003), although it is the missing factor ‘context’ which “provides the purpose, resources, social cues, norms, and meanings that shape behavior” (Jackson et al., 2003: 813). Our study supports assertions that dispersed collaboration processes are strongly affected by organizational context variables, and pushes the idea of context beyond a team’s immediate micro context, demonstrating that macro context seems to matter even more.

Starting from the fundamental research question whether behavior is influenced more by dispositional or situational factors (Davis-Blake et al., 1989), we are unable to decide but conclude that the situational environment exerts a strong influence on dispersed collaboration effectiveness. Therefore, situational characteristics should receive much more attention when researchers study virtual team dynamics. Furthermore, the results of our study underline the need to extend researchers’ focus from team design characteristics, such as task characteristics or technological resources to organizational attributes such as inter-site connectedness, which are usually considered most important in virtual team settings (Scott, 1999). Theories used to describe virtual team processes such as adaptive structuration theory (Giddens, 1989) may be enriched by extending their focus from technological to organizational determinants of dispersed collaboration effectiveness.

Finally, we encourage researchers to place more emphasis on cross-level theory building. Beyond the lack of empirical cross-level research in the study of virtual team dynamics, there is a considerable neglect of the respective theory building. There is a lack of theories to describe the organizational context’s role and how the effect of context translates into team processes

(Jackson et al., 2004). For future research, there is a lot to learn about context variables and whether they exert their influence more indirectly through changes in situational strength or through the salience of situational features, through direct cross-level effects or perhaps through multiple inter-related ways. However, irrespective of this gap in theory development, our research shows that cross-level investigations provide a different perspective on team dynamics and promising avenues to further our understanding of virtual team dynamics.

#### **6.4.2 Managerial Implications**

Advances in information technology enable organizations to set the stage for employees to work from any place and at any time. However, recent studies showed that technology alone is not sufficient to enable high-level dispersed collaboration (Bjørn et al., 2008; Kiesler et al., 2002). In our study, we present other organizational variables under management's control that can be addressed to leverage the potential inherent in virtual teams. Consistent with our assumptions, we have shown that an organization's level of formalization, globalization culture, and organizational team support practices are effective means by which managers can facilitate high level teamwork over distance.

Nevertheless, despite the direct and positive effects on virtual teamwork, such organizational characteristics are far from being a panacea. An organization's level of formalization, for instance, is not only a means to establish a reliable roadmap for collaboration, but is also assumed to impede knowledge seeking behavior as well as organizational flexibility (Boschma, 2005; Cummings & Haas, 2008). Perhaps the overall performance of virtual teams is maximized at medium levels of some of our organizational characteristics. Furthermore, the contextual effect on virtual team dynamics does perhaps change from team to team. For instance, the person-environment fit framework suggests that careful attention must be paid to how individual team members react to specific organizational characteristics (Shin, 2004). In addition, team members referring to the same context may perceive organizational context variables quite differently (Johri, 2008).

We reason that although our results leave several questions unanswered, it should be noted that the organizational context represents a significant, yet neglected, way of fostering virtual team effectiveness. Currently, we do not have sufficient evidence to offer explicit prescriptions concerning the nature of these cross-level effects, but our results suggest the value of additional research to develop them. Additional knowledge of the mechanisms and contingencies of our

context variables can then be used to provide practitioners with more profound and fine-grained recommendations with which to organize their distributed work.

### **6.4.3 Limitation and Future Research**

A few limitations of this study along with questions for future research should be noted. First, the scope of the empirical data gathered for this research primarily allows generalization of the results to the domain of software development teams. Further research should assess whether this studies' findings can be replicated in task contexts outside the field of software development. Perhaps the digital product 'software' makes it easier to collaborate virtually than more physical products in other industries. Second, our organizational context variables were assessed by one site manager per location. An assessment with multiple judges would have further ascertained reliability, especially in respect of context variables that rely largely on individual perceptions, such as organizational culture.

With regard to further research on dispersed collaboration in virtual teams, we deem two aspects particularly interesting. First, our results highlight the importance of studying teams' surrounding context to gain a more comprehensive understanding of team dynamics and its antecedents. Although there are notable exceptions, team researchers have tended to view teams as closed systems that are unaffected by context. Second, future research on the antecedents of dispersed collaboration effectiveness has to acknowledge the matter of time. Since context is emergent, a longitudinal perspective is indicated in teams with dispersed membership. These teams are continually being reshaped due to ongoing social interactions and negotiations amongst team members (Bjørn et al., 2008). These more complex and interactive paths are not included in our study but are worth considering for future research. Investigating the contextual and team-level factors contributing to high-level teamwork in dispersed team settings should constitute an essential research subject, since it provides scholars with insights into the enabling conditions of virtual collaboration and reveals new avenues through which practitioners can optimally leverage their heterogeneous knowledge resources. Future team research would be well served by paying greater attention to the role that context plays in shaping dispersed team processes and effectiveness.



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## 7 General Discussion

### 7.1 VIRTUAL TEAMS: HOW TO LEVERAGE THEIR POTENTIAL

In recent history, information and communication technologies have had a significant impact on human interactions. The rapid uptake of technological advancements has made it easier than ever before to contact with others across borders and around the world (Kolb, 2007). This unprecedented surge in technical connectivity has led many observers to be wildly enthusiastic regarding the potential for information and communication technologies to transform organizational life (Davis, 1986; Davis & Meyer, 1998; Negroponte, 1995). At the zenith of this enthusiasm about the mastery of distance were two editions of a book entitled, *'The Death of Distance'* (Cairncross, 1997, 2001), with its glowing summaries of the possibilities of a highly connected world. In a similar vein, Friedman (2005: 1) shares this enthusiasm with regard to the end of distance and reasoned that advances in technology put people all over the globe in touch as never before and finally leads to a *"flattening of the world."*

However, the empirical results of this dissertation have clearly shown that it is premature to proclaim the end of distance and new technologies to eliminate the challenges faced by members of geographically dispersed teams. It seems not sufficient to provide access to email, videoconferencing, and groupware in the hope that these technologies will help to overcome the burdens of distance. Creating access to communication among team members alone does not guarantee that it will happen, and it is uncertain whether technology truly supports the types of interactions members often need to complete their work at a distance (Olson et al., 2000). The research results of this dissertation rather have shown that distance matters. It seems to matter for team members' cognitive and affective reactions as well as for their interactive team processes, and finally their performance. In particular, the negative zero-order correlations (i.e., the relationship between two variables, while ignoring the influence of other variables in prediction) between geographic distance and selected team processes (see Table 5-1), and team performance ( $r = -.31$ ; Table 5-1) show that virtual teams – on average – suffer considerably from dispersion.

Despite these discouraging results, working virtual has been proclaimed to be the 'gold standard' for integrating diverse knowledge in companies and has been often established to take maximum advantage of innovation creating capabilities (Eppinger & Chitkara, 2006; Santos, Doz, & Williamson, 2004). These claims were only supported in some studies (Cummings,



2004, 2007; Singh, 2008). Most studies, however, paint a more pessimistic picture of the consequences of team dispersion (Hertel et al., 2005; O’Leary & Mortensen, 2009; Olson et al., 2000). The present research therefore set out to identify ways, how virtual teams can overcome the liabilities of distance in order to leverage their performance. In the introduction it has been pointed out that this research is built on three hypothesized leverage points for virtual team performance: emergent states (perceived distance), team processes, and team context (see Figure 1-1). Reviewing all the results of this research, the three primary points of leverage are clearly confirmed and a fourth variable has to be added: team design. Hence, four leverage points can be derived from the results of this dissertation to enhance virtual team effectiveness. These are discussed more comprehensively in the following (see Figure 7-1). The managerial implications drawn from this discussion will be described in chapter 9 in more detail.

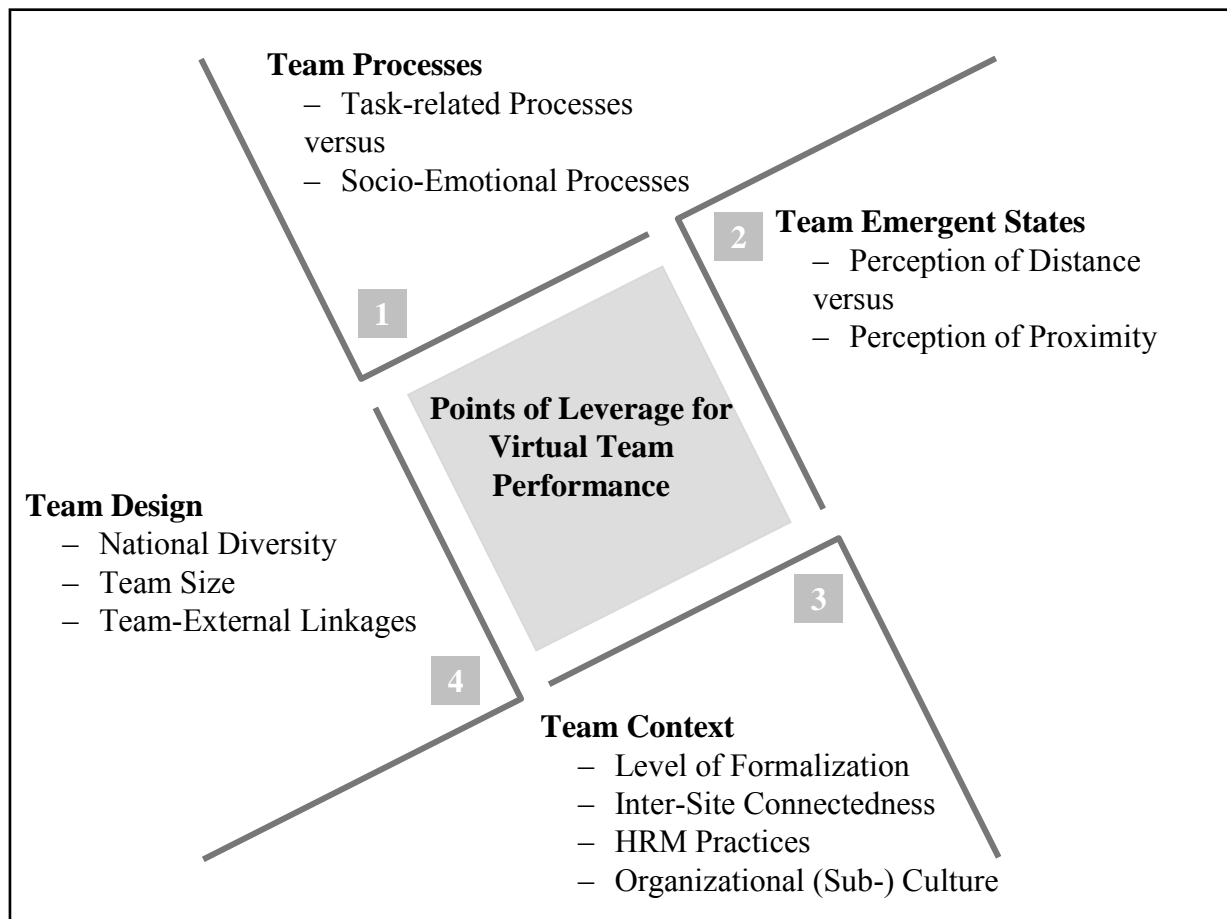


Figure 7-1: Strongly Interdependent: The Points of Leverage for Virtual Team Performance

The empirical results of this study revealed team processes to be the key drivers of team performance (see chapter 5). In fact, virtual teams with high-quality collaborative team processes are able to outperform their co-located counterparts, even those with the same quality of team

processes. A more detailed look at the study results indicates that those team processes with a direct task focus are most critical for the performance of dispersed teams. Virtual teams with high levels of mutual support, effort, task coordination, balanced contributions, and task-related communication outperform teams with lower levels of these processes. While emphasizing the possibility of dispersed teams to outperform their co-located counterparts, there are significant costs of dispersion as well. Teams with poor task processes, in contrast, suffer heavily from dispersion and underperform co-located teams with the same (low) levels of these processes. Thus, the effect of dispersion is not necessarily detrimental to team performance but rather depends on the quality of task-related team processes. Ultimately, the quality of task-related processes seems to be a significant factor in deciding whether dispersion becomes a liability or an opportunity for the effectiveness of virtual teams.

However, for teams to collaborate successfully across distance it is generally not sufficient that team leaders steer their task accomplishment process. It is at least as essential that all team members commit to the overall team goals, identify with the team, and actively support a team spirit; that is, having sound social processes. Especially in teams with geographically distant team members, interpersonal differences can endanger the social stability of the team, because of restricted coping possibilities across geographic boundaries. Such difficulties, in turn, prevent team members from fully contributing to task accomplishment and consequently jeopardize team performance. Cohesion, identification, and informal communication are often referred to as the most important social processes in teams. All of these social processes have in common that they regulate the maintenance of motivation and emotion and therefore enable a team to better cope with personal difficulties and conflict. But while the results of this research demonstrate that social processes are able to boost the performance of virtual as well as co-located teams (see the interaction plots in Figure 5-2), there is no indication that virtual teams with favorable social processes outperform co-located teams with the same level of socio-emotional processes. Thus, socio-emotional team processes are rather necessary for teams to stick together but not sufficient for virtual teams to achieve superior performance. Instead, socio-emotional processes more indirectly affect team performance by facilitating task-related processes through such factors as better team conflict resolution.

Thus, it can be concluded that task-related team processes should be a focal variable for team leaders to capitalize on team members' specialized knowledge and expertise and finally to increase team performance. But team processes are at risk to be effective across distance and

managers are influenced by the conventional wisdom about distance, especially the assumption that it is difficult to develop effective teamwork without considerable “face-time” (Winger, 2005). However, the presented research results again paint a slightly different picture: for effective team processes, it seems to be more important that team members *perceive* themselves as proximate, than that they really *are* proximate. While the perception of distance is clearly associated with physical distance, it also serves as an independent, yet better predictor of team processes and therefore represents a unique leverage factor of virtual team performance.

The perception of distance has turned out to be a mental state that is not fully congruent with physical distance but rather emanates from a more complex and socially based construction of reality and is significantly affected by team members’ national heterogeneity. Consequently, executives can make use of the benefits of dispersed collaboration when addressing the antecedents of distance perceptions and do not necessarily have to resort to bringing team members together face-to-face (Wilson et al., 2008). Just as people’s perceptions of time are a variable subject to managers’ strategic influence (Mosakowski & Earley, 2000), managers can also do important steps in fostering feelings of proximity; thus, making perceived proximity to a second point of leverage.

A third point of leverage for enhancing team effectiveness is the organizational context. The organizational context has been shown to affect virtual team performance more indirectly by changing the conditions in which team members collaborate. As reported in chapter 4 and chapter 6, there are at least two different ways of how the organizational context impacts virtual team performance. First, organizational context variables such as the degree of formalization, inter-site connectedness, and innovation-oriented culture facilitate the perception of proximity and, hence, provide a sound basis for high-level team processes. Thus, the experience of proximity seems to be most advanced in organizational environments that represent values such as safety, reliability, open communication, innovativeness, and informal knowledge transfer. Second, the organizational context can facilitate virtual team performance by creating an environment for superior dispersed collaboration quality. Comparing teams from different laboratories, the findings of this dissertation suggest that a global mindset, where people see themselves as part of an international network, human resource practices that actively foster openness to diverse co-workers, and organizational structures with clear-cut roles and procedures, provide a context conducive to dispersed team collaboration. Adding up all these context-related findings, the larger organizational environment can help distributed teams to cope with the liabilities of

distance more effectively. In particular, there are distinct and manageable attributes of the organizational context that can be addressed to helping team members to develop perceptions of interpersonal closeness as well as to perform high-level dispersed teamwork. Finally, executives can do important steps by shaping these context elements in order to increase virtual team performance.

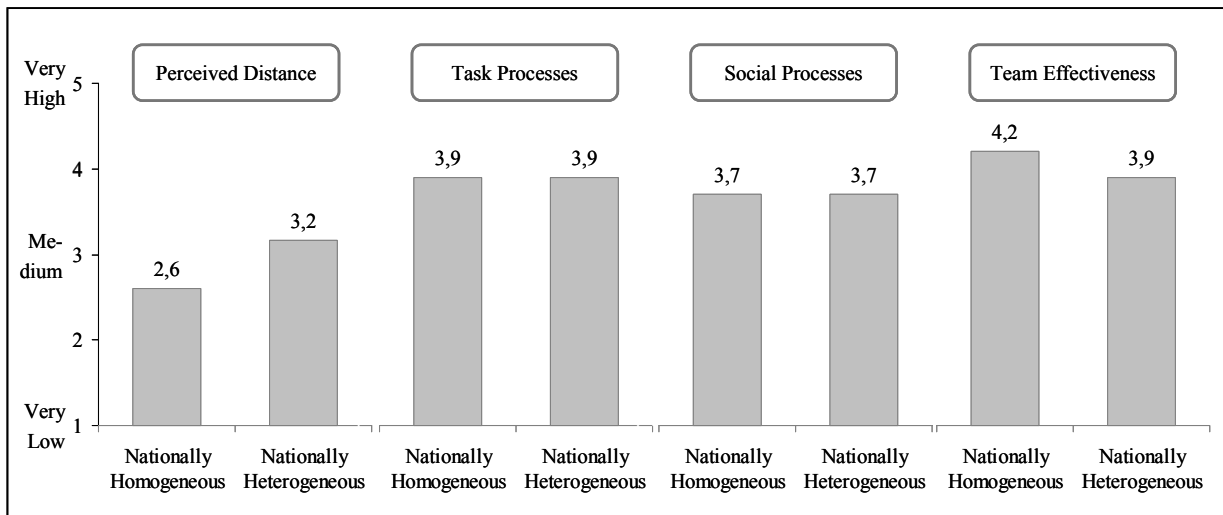


Figure 7-2: Comparing Nationally Homogeneous and Nationally Diverse Teams (N = 161 Teams)

A fourth impact factor of virtual team performance that emerged through the analyses of this research is the *team design*. Team design factors constitute the initial project configuration, setting the stage for team collaboration, and providing the immediate team context within which the team evolves (Caya, Mortensen, & Pinsonneault, 2008b). According to the famous Input-Process-Output models in team research, team design variables represent the group input that affects team processes more directly and also their performance potential (Ilgen et al., 2005). *National diversity* is one of the most conspicuous team design variables throughout this research as it has been shown to aggravate perceptions of interpersonal closeness (see chapter 3). Figure 7-2 summarizes the effects of national diversity on perceived distance, team processes, and team effectiveness. The pairwise comparison between national homogeneous (n = 71) and heterogeneous teams (n = 90) confirms the negative impact of national diversity on team members' perception of proximity and reveals that national diverse teams – on average – have lower levels of effectiveness.

However, national diversity does not lead to lower levels of team processes neither to task processes nor to social processes (see Table 3-2). There is no indication for a direct link be-

tween national diversity and team effectiveness that is mediated by team processes, as proposed by several authors (Gibson et al., 2006; Hambrick et al., 1998; Van Knippenberg et al., 2007a). Instead, the effects of national diversity may be mediated by teams' level of perceived distance, a presumption that should be addressed in future research. But even without the knowledge of how the effects of national diversity unfold, it apparently matters and should therefore be considered when aiming at leveraging virtual team performance. In contrast to other points of leverage, national diversity is closely related to geographic distance. When managers take the decision to build up a virtual team, they inevitably have to deal with higher levels of national diversity.

Nevertheless, in most cases managers are well-advised not to remove any national diversity from the team. Innovation studies revealed that it is the level of demographic diversity and especially variation in nationality that provides teams with access to more information (Watson, Kumar, and Michaelson, 1993) in terms different values and worldviews (Choi, Nisbett, and Norenzayan, 1999). Instead, team leaders and managers are asked to effectively manage higher levels of national diversity and to make use of this potential in the team. As Homan and colleagues (2007) recently emphasized, it is important for a diverse team to develop a global mindset and to be convinced of the value of diversity. It might be that the positive cross-level results found for innovation culture and globalization culture on dispersed team dynamics are due to an increase in such diversity-friendly mindsets. Additional in-depth research is needed at this point.

A second, very salient element of the team design is the number of team members corresponding to the team. As has been already emphasized in the description of the data collection procedure, group members were only recognized as a 'team' in this study when intense and direct collaboration took place among individuals during the course of the project. While *team size* is perhaps one of the most salient and obvious team variables, it is also one of the blind spots in team research. Team size has been considered as importance since very early team research (e.g., Steiner, 1966; Ziller, 1957) and also discussed extensively in theoretical papers on virtual teams (e.g., Furst et al., 1999); however, scant empirical attention has been paid to its effects on virtual team functioning (Martins et al., 2004).

Research on face-to-face teams suggests that with increasing team size it is more difficult for teams to perform good teamwork and to gain from the multiple resources associated with more

team members (Bradner et al., 2005; Hoegl, 2005). Consequently, most researchers found a negative association between team size and team performance (LePine et al., 2008; Steiner, 1972; Voelpel et al., 2008). The presented results in this work mirror the negative link from team size to team performance found in prior research (correlation with team effectiveness is  $r = -.26$ ; Table 5-1). But there is neither a direct association between team size and dispersed teamwork (see Table 6-1 and Table 6-2) nor between team size and perceived distance (see Table 3-2, Table 3-3, and Table 4-2). Thus, while an association between team size and team dynamics is not reflected in the presented data, it apparently matters and managers are well-advised to keep teams small to guarantee higher levels of effectiveness (Hoegl, 2005).

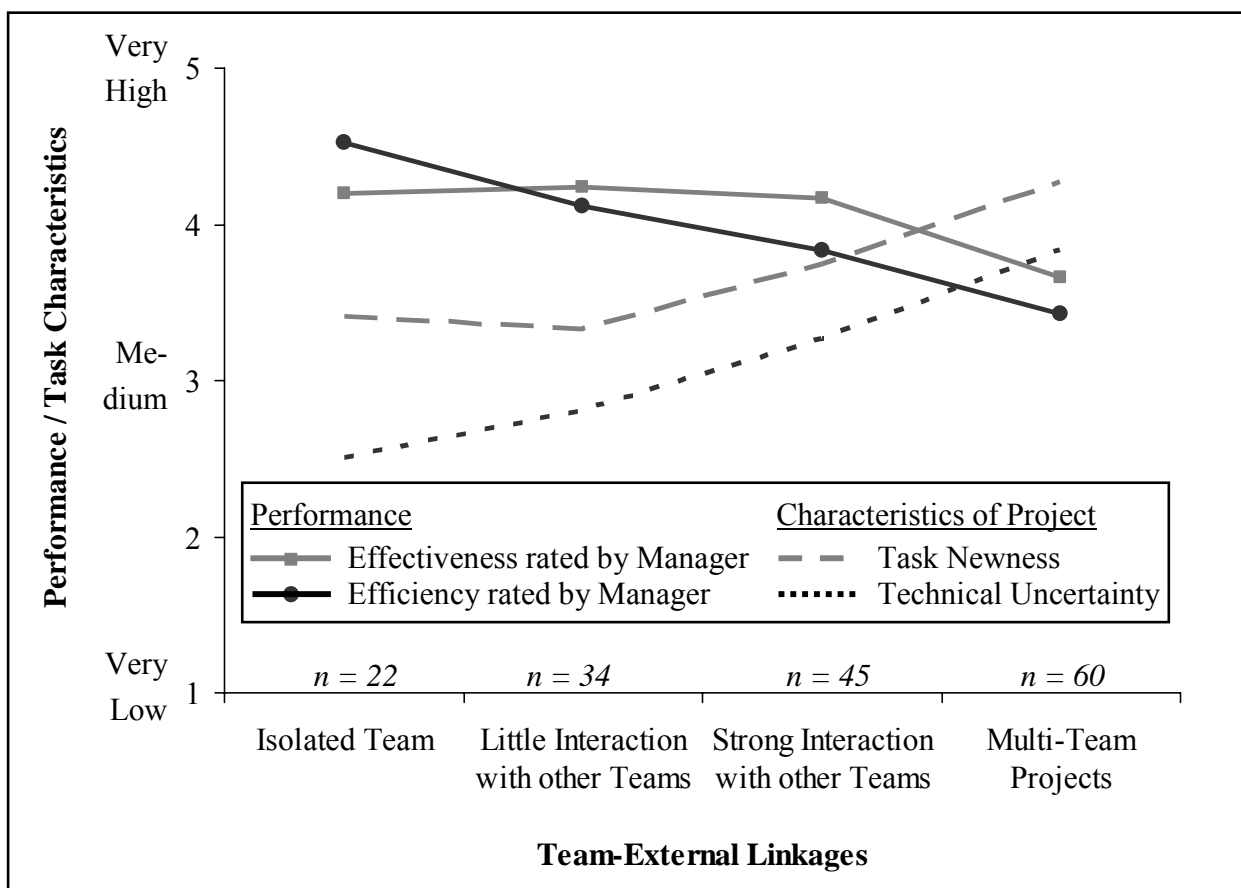


Figure 7-3: Performance and Task Characteristics in Dependence of Teams' External Linkages

One possibility to keep teams small is to split up the project into multiple sub-teams according to the team task (Hoegl, 2005). Managers in software development industry frequently use this multi-team project organization in which several teams contribute to the same overall project, leading to notable interaction between sub-teams. This level of team-external linkages between team members of the same overall project has been identified as an additional team de-

sign factor, relevant for team performance. As Figure 7-3 illustrates, multi-team projects seem to be the preferred working mode for teams dealing with new tasks and/or with tasks that possess high degrees of technical uncertainty. But as this figure also shows, the slopes for team effectiveness as well as efficiency notably drop from teams working more or less in isolation to teams that are part of a multi-team system. This decline in performance is probably due to the fact that multi-team systems make it more difficult for team members to coordinate their work, especially when modules of the task are distributed across various sub-teams (Burke et al., 2006). The results presented in Table 3-2 support this notion, as the quality of task-related processes like task coordination and mutual support appear to suffer from the higher demands associated with multi-team systems. Hence, it can be concluded that multi-team systems may be effective to reduce team sizes but seem also to increase coordination effort and complexity.

Overall, the results of this research have shown that dispersion clearly matters as it is more difficult for teams to establish high-level team processes and to achieve the desired performance across a distance. It is therefore not adequate to call out the death of distance due to the new technological advances (Olson et al., 2000). However, the presented research also demonstrates that dispersed teams hold very real opportunities for managers despite their higher challenges for effective teamwork compared to co-located teams. Dispersed teams are, in fact, able to outperform co-located teams when managing to achieve high levels of task-related processes. Team processes should therefore become a focal variable for managers and team leaders to obtain the desired positive effects when relying on dispersed project members with specialized knowledge and expertise. But the presented results also suggest that there are at least three additional points of leverage for virtual team performance: team design, emergent states, and context (see Figure 7-1). All of these elements have been shown to be critical for dispersed team effectiveness, either directly or mediated through their effect on team processes. Thus, there are many variables under organizational control that can be leveraged to increase virtual team performance.

Owing to the fact that these variables are apparently interdependent, managers probably realize the best results when using an integrated approach to leverage virtual team performance instead of focusing on only some of them. Such an integrated management approach should be arranged around the four starting points to virtual team performance and address three levels of intervention: individual, team, and the organizational level. Team members, for instance, can be selected for characteristics that increase their tolerance for working at a distance, hence a pre-

disposition to perceive interpersonal closeness while being distant (Wilson et al., 2008). The team design offers the potential to positively affect performance by using smaller teams while being aware of the increasing demands of multi-team systems. And finally, providing team members with an open and globalized culture together with supportive HRM practices and stable ground rules for collaboration fosters the perception of proximity and the occurrence of dispersed collaboration effectiveness. Stemming from the presented research findings in this dissertation, such an integrated management approach seems to be the most promising way to leverage virtual team performance. Or as Guzzo & Dickson (1996: 335) similarly contended after examining the antecedents of performance in traditional teams, “the greatest changes in team effectiveness are most likely to be realized when changes in teams’ organizational context are supported by the appropriate team design and process.”

## **7.2 PROJECT LENGTH: MORE THAN A CONTROL VARIABLE**

The above discussion provides an overview of the potential levers of team performance when managers set up a virtual team in order to gain from all potentially associated opportunities. But one important aspect should be focused to complement this discussion: the distinction between temporary and ongoing teams. As project length does not describe the structure of a team, it is often not referred to as a team design variable and therefore not included in the above discussion. However, the duration of a project can entail severe consequences for team dynamics and performance (Katz, 1982; Schippers, Den Hartog, Koopman, & Wienk, 2003). Project length or group longevity both refer to the time a team has existed and differ from team tenure, which refers to the length of time an individual has been with the team (Schippers et al., 2003). Project length is measured in this study in terms of months the team worked together and has been included as a control variable in most analyses.

The fundamental effects of time on dispersed team dynamics have been already demonstrated in early research. Newcomb's (1961) longitudinal field experiment on the acquaintance process in a heterogeneous group of students, for instance, has documented that the development of interpersonal closeness and friendship requires repeated interaction. Newcomb found that proximity matters only in the very first week and not thereafter. This supported Newcomb's hypothesis that homophily (i.e., the tendency to seek out others with similar traits, interests, and opinions) increasingly determines communication and attraction patterns over time, as individuals acquire further information about one another's orientations. Wells (1965) reported cor-



responding findings in a study of sociometric preferences in an insurance company. Employees of younger age (and most likely lesser tenure) had a high likelihood of naming people within one desk distance as preferred interaction partners, whereas groups of higher age (and tenure) selected a higher proportion of their workmate choices from large distances.

While this early research is based on individuals who work in very close proximity, later research suggests that the significance of time effects still holds true. Especially the influence of increased diversity on virtual team dynamics has been shown to undergo fundamental changes when time passes. Field research by Pelled, Eisenhardt, and Xin (1999), for instance, found that group longevity moderated the relationship between diversity and conflict, such that task and emotional conflict were lower in diverse teams with more longevity. They concluded that those teams either develop a shared understanding of tasks or learn to anticipate and deflect opposition to their ideas. Consistently, the findings of Citurs and Yoo's (1999) study of the interaction patterns of distributed teams show that distributed teams gain efficiency in interaction, performing processes, and manipulating knowledge because they develop norms and routines over time.

The results according to perceived proximity support these optimistic notions about the effect of longer project length. As reported in the empirical part of this work, team longevity and perceived distance are negatively related, that is, team members over time tend to perceive themselves as more proximate. Table 3-3 and Table 4-3 show two regression models (one linear multiple regression and one hierarchical regression) to explain subjective distance, each reveals a significant negative effect of project length on team members' perceptions of distance. These results mirror findings of Walther (1992), who found that computer-mediated communication over time permits the generation of a cumulative shared context, thus facilitating the development of proximity perceptions. This effect is likely due to the fact that tenure positively influences feelings of familiarity in the team (Hinds, Carley, Krackhardt, & Wholey, 2000), decreases the impact of surface-level diversity (Harrison et al., 2002), and improves social presence through ongoing computer-mediated communication (Burke et al., 1999).

However, while these theoretical arguments suggest that team processes should also benefit from increasing longevity, the analyses in this work revealed inconsistent results. On the one hand, the presented findings indicate that informal communication intensifies through ongoing team longevity which is in line with the above arguments of increased familiarity and perceived

proximity. On the other hand, team members' effort seemingly declines with the length of the project (see Table 3-2). Other dimensions of team processes seem to be unaffected by increased project length. These inconsistent findings may be due to the fact, that teams' longevity may have ambivalent implications with regard to team processes. Deeper trust, for instance, emerges from prior contact and is based on the premise that through ongoing interaction, parties learn about each other and develop trust around norms of equity (McAllister, 1995). Similarly, King and Anderson (1990) asserted that short-lived groups might be more creative, but expected group longevity to help cohesiveness. In contrast, research by Katz (1982) showed that after two to three years, teams tended to communicate less with important information providers, monitored the environment less, and communicated less with important groups outside the team than they did before.

One reason for such negative consequences of project length on team processes is found in basic principles of organization theory (Katz, 1982). Groups over time strive to structure their work environments to reduce the amount of stress they must face by directing their activities toward a more workable and predictable level of certainty and clarity (Pfeffer, 1981; Thompson, 1967). Based on this perspective, project members who interact over a long period develop standard work patterns that are familiar and comfortable, patterns in which routine and stability play a relatively large part. It is posited that one of the consequences of such behavioral routinization is that long-tenured project groups become increasingly isolated from outside sources of relevant information and important new ideas (Dubin, 1972; Pelz & Andrews, 1966 ). With increasing group longevity, project members gradually become less receptive toward communications that threaten to disrupt their comfortable and predictable work practices and patterns of behavior (Katz, 1980; Staw, 1977 ). In addition, as time passes in the project, the effect of surface-level diversity may be weakened, but that of deep-level diversity on team processes is likewise strengthened as team members learn more about each other and their personal differences (Harrison et al., 2002).

Together, the results of this study paint a mixed picture regarding the effect of time on dispersed team dynamics. Nevertheless, it has been shown that project length matters and that practitioners may have different priorities when managing ongoing or temporary teams. The presented research findings as well as the quoted literature suggest that in the long term, dispersed team members' willingness to contribute to the project may be at risk. Thus, leaders of ongoing teams should monitor team member efforts and their progress in meeting the task-

related goals. Likewise, efforts at building identity and deeper trust in ongoing teams may be warranted to a higher extent as they would be in temporary teams (Saunders et al., 2006).

In contrast, to maintain performance in temporary teams, much more attention should be placed on ensuring social processes such as informal communication or cohesion. While some research has shown that teams working in shorter projects can rely on swift trust and goal clarity (Meyerson, Weick, & Kramer, 1996), the presented results of this study together with more recent findings from an international innovation study (Muethel & Hoegl, 2007) suggests more skepticism about these beneficial short-term effects. Thus, more attention should be placed on teams' social stability in the beginning of the projects where informal communication and perceived proximity may be at risk and potentially endanger subsequent team building activities.

Further research is certainly required that includes project length not only as a control variable but rather investigates virtual team dynamics systematically along a time scale. While research so far has largely focused on temporary teams like ad-hoc student samples, scholars should acknowledge that virtual team activities do not occur all at once or at a particular time; they take place over time. One of the major gaps in current team research is the general neglect of such temporal perspectives (Saunders et al., 2006). Without an appreciation of what happens over time, answers to questions about the effective initialization and maintenance of virtual team functioning will be incomplete. More temporally based frameworks are needed to conceptualize the changes that are likely to occur in a group over time.

### **7.3 EXPERIENCE OF DISPERSION: A BLACK BOX WORTH CONSIDERING**

Team members perceive geographic distance differently, a finding that has been shown to be critical when investigating the antecedents of high level virtual team processes and identifying the leverage points of dispersed team performance (see chapter 7.1). However, the perception of distance may not only be included in group research to better predict virtual team effectiveness and to demonstrate that distance matters but also to explain *why* distance matters. The experience of distance should become a focal variable when scholars are interested in answering the question 'what it means to be dispersed?' (Scott, 1999: 463). Prior research largely failed to answer this question but lumped together high performing and low performing virtual teams to calculate the mean effect between objective measures of dispersion and performance (Powell et al., 2004). Such a research handles distance as a black box and reveals that objective distance—in most cases – has a negative main effect on team processes and effectiveness (Webster et al.,

2006). But what can scholars and practitioners learn from this research, relying on objective distance measures alone?

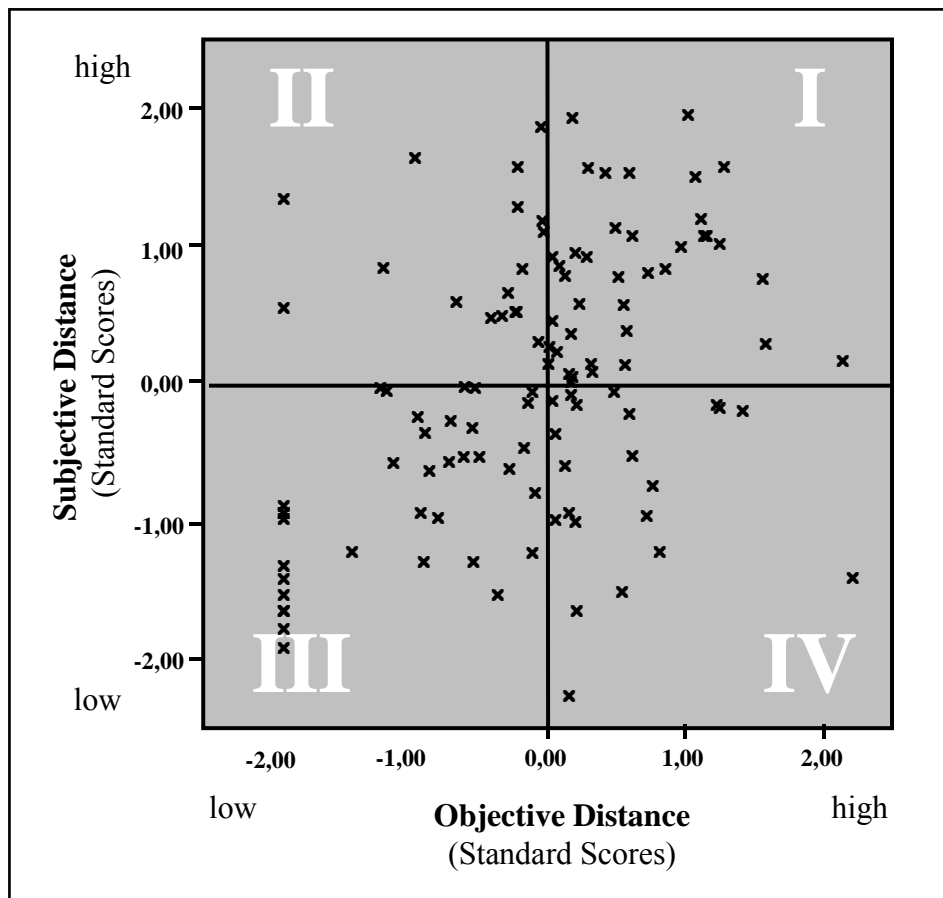


Figure 7-4: Association between Subjective and Objective Distance ( $N = 114$ )

Objective distance as such is a meaningless variable of social science research. It does not tell anything about the dynamics in the team. Objective distance measures only provide descriptive information about the configuration of team members across different locations, countries, continents or time zones. The results presented in chapter 3 give rise to the assumption that the consideration of perceived distance in team research provides a more critical, though missing link to understand distance and dispersed teams. Researchers should be concerned with the fact that the correlation between objective distance and subjective distance equals  $r = .52$  in this study (see Table 3-2), thus, being far from perfect. The state of *being physically distant* can obviously co-exist with *feeling close*. In this regard, subjective distance brings a new quality into researchers' conceptualization of distance. The co-existence of teams that perceive closeness while being distant or feel distant while being near is illustrated more descriptively in Figure 7-4. The figure shows the distribution of teams over four quadrants that are defined by

two axes: the horizontal axis represents objective distance in log miles and the vertical axis denotes the value of subjective distance as measured with the 4-item construct outlined in Table 3-1. Both variables were transformed into standard scores (mean = 0 and standard deviation = 1), before being integrated in the plot, to ensure a comparable distribution. In addition, the 47 'same floor'-teams in this sample are not included in Figure 7-4 to prevent a skewed distribution along the x-axis (these teams would all have identical standard scores).

This graphic exemplifies, more vividly than a correlation could ever do, that objective distance obviously does not directly translate into perceived distance. Quadrants II and IV rather illustrate situations when actual and perceived distances are not aligned. Teams in Quadrant II have members who perceive each other as distant despite close physical proximity. Conversely, members of teams in Quadrant IV perceive each other as proximate despite considerable geographic distances separating them. These counter-intuitive close-but-far and far-but-close teams cannot be accounted for with traditional views of the impact of physical proximity on team dynamics. In fact, the paradox they pose, presents an opportunity to examine assumptions, shift perspectives, and consider problems in fundamentally different ways (Poole and Van de Ven 1989). By embracing a 'both/and' view of distance and closeness, scholars will certainly develop a more comprehensive understanding of distance.

Ultimately, the considerable vertical spread of teams with similar values in objective distance along the subjective distance axis underlines the relevance of black-box thinking in current team research. Researchers to date assume objective distance to be a reliable proxy for its experience and that it is sufficient to rely solely on objective measures because of its clear-cut measurement and its appealing objectivity (Wilson et al., 2008). Figure 7-4 shows that this practice is not justified any longer. Teams clearly differ in the extent to which they perceive distance and this variation is only partially explained with objective distance. However, while Figure 7-4 demonstrates the necessity to learn more about the experience of dispersion, it does not explain why teams differ as much in their appraisals, keeping the black box still closed.

A first move forward has been made in this research. The presented research results suggest that far-flung team members who reside in contexts with predictable rules, permeable organizational boundaries, and an innovation-friendly culture tend to perceive each other as more proximate (see chapter 4). The reverse effect became apparent on the team level for national diversity. National heterogeneous teams tend to perceive higher levels of distance than would

have been expected on the basis of their physical separation. As the results in chapter 3 have shown, national diversity leads to increased perceptions of distance in teams, even when controlled for objective distance. These results suggest that the transition from objective distance to the subjective experience of distance is largely mediated by social categorization effects. However, whether social categorization is the only missing link to explain this transition or whether these effects originate from faultline dynamics (Lau et al., 1998), different thought worlds (Dougherty, 1992) or functions (Parker, 1994) is still unclear and remains to be explored.

Future research on the perception of distance is certainly necessary to learn more about its emergence and its consequences. Researcher should, for instance, respond to questions such as whether an ‘optimal’ level of perceived proximity exists, and whether this may depend on the type of tasks the team needs to accomplish. In teams whose tasks require close cooperation, perceived proximity may need to be high among a larger subset of members. Conversely, teams with more independent or routine tasks may not need high levels of perceived proximity (Wilson et al., 2008). Future research is also asked to investigate whether work teams need a certain minimum level of perceived proximity in order to function effectively. It may be that not everyone in the team needs to feel close. At a minimum, perhaps each group member needs to feel close to at least one other group member (Wilson et al., 2008). However, it might be also investigated whether the effect of perceived proximity is curvilinear, with perceived proximity having generally positive consequences up to a point – beyond which higher levels of perceived proximity can have negative effects on the quality of interactions between the two individuals (Kiesler et al., 2002). These research gaps together with the findings of the present study highlight the prospective insights when scholars investigate the cognitive and affective responses to dispersion and, thus, gain more insight into the black box of distance.

#### **7.4 RECONSIDERATION OF THE ‘TEAM LABEL’**

Traditionally, both terms “team” and “group” have been used to describe small collections of people at work. While the two terms are often used interchangeably in traditional as well as virtual team research (Cohen & Bailey, 1997; Langfred, 1998; Sundstrom, DeMeuse, & Futrell, 1990), this duality in terminology has been increasingly questioned (Fisher & Hunter, 1997; Powell et al., 2004). Several authors reason that the term ‘team’ should be reserved for those groups that display high levels of member interdependency and integration. These authors

therefore postulate using both labels distinctively in order to maintain a more elaborate conceptuality (e.g., Sundstrom, McIntyre, Halfhill, & Richards, 2000).

In their review on team definitions, Cohen and Bailey (1997: 241) suggested a meanwhile widely accepted definition of a team as a small “collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationship across organizational boundaries.” While some authors claim that this definition generally applies equally to traditional as well as virtual teams (Powell et al., 2004), other authors are more skeptical about the ‘teamness’ of virtual teams (Armstrong & Peter, 2002b). Authors such as Griffith and Neale (2001: 385), for instance, ascertain that “there is no theoretical requirement that groups exist only in face-to-face environments.” In fact, the team definition proposed by Cohen and Bailey (1997) makes no mention of the form that interaction must take. Other authors such as Armstrong and Peter (2002b: 187), however, point out that virtual teams often lack all team attributes and are a rather “anonymous loose network of people with a shared interest.” As the word ‘virtual’ already suggests, this form of team might probably be somewhat ‘unreal,’ thus having properties that fundamentally differ from traditional teams (Gillam & Oppenheim, 2006). *But why should one care about whether a distributed or virtual team is ‘real’ in this perhaps conservative and restrictive sense?*

The importance of this team-versus-group differentiation may be best exemplified when comparing virtual ‘team’ descriptions in the literature. Geber (1995), for example, described a virtual team that worked to develop the chlorofluorocarbon-free refrigerator for Whirlpool Corporation and worked together for two years with relatively few changes in team membership. The nine team members were recruited from sites in the United States, Brazil, and Italy. According to the team description by Geber (1995), the need for all members of the team to think, act, and feel like a group was so critical to the success of this project that team members met face-to-face nearly every four months to discuss the project and allow the team members to establish personal bonds.

In contrast, Armstrong and Neale (1995) reported on a case in which members of an international ‘team’ of a Fortune 100 computer company resembled a co-acting group rather than an integrated team. Individuals in this group belonged to four sites but performed their tasks independently, fighting among themselves as if they were enemies. Interviews with all the members

revealed that the group was not a single group, but rather four groups that reported to the same manager. Employees indicated that their alliances with other employees located in different departments at their sites were stronger than with their functional colleagues across the continent. “Their use of ‘we’ most often referred to people at their site, regardless of work group assignment” (Armstrong et al., 2002a: 173).

These two examples illustrate how much virtual groups can differ in their degree of team-ness. Evidently, distributed groups do not always attain the ideal of being a real team in the sense of the above team definition. Virtual teams’ boundaries are often permeable (Mortensen, 2008), their members often change (Mortensen, Woolley, & O Leary, 2007), and they have core and peripheral members (Cummings & Cross, 2003). Armstrong and Peter (2002b) argue that these differences are not negligible, since ‘real teams’ are more capable of showing strong commitment to shared goals, which overrides even individual members’ interests. Thus, virtual teams and virtual groups can have deviant characteristics with serious consequences for subsequent team dynamics, making this distinction very valuable.

In addition, this distinction seems to be desirable for summarizing research such as reviews or meta-analyses, which can reveal very different results if virtual groups and virtual teams are lumped together (Dubé et al., 2004). The literature is awash with examples of the misuse of the term ‘team’ and with articles that carelessly aggregate results across many different levels of analysis. Maznevski and Chudoba (2000), for example, confusingly included all empirical studies on virtual organizations, virtual groups, and virtual teams in their literature review of ‘distributed teams.’ While integrating observations across different levels of an underlying construct such as teamness may be desirable to increase the understanding of the phenomenon, this must be done with an acute awareness of the problems caused by aggregating and disaggregating data (Morgeson & Hofmann, 1999).

On the whole, these arguments call for more thought to be given to the question whether collections of co-acting individuals working on the same task can be regarded as teams or as groups. But on which team attributes should researchers focus when taking this decision? Departing from the definitional team characteristics outlined above, the following two elements are at particular risk in dispersed teams and should therefore be addressed in more detail: (1) team size and (2) perceived entitativity.



First, 'smallness' is an often used characteristic to differentiate between teams and groups and a therefore well-established element of team definitions (e.g., Katzenbach & Smith, 1993). Recent advances in information technologies provide employees with the freedom to simultaneously collect contributions from multiple team members from any place in the world (Wiesenfeld et al., 1999). This flexibility in work arrangements regularly leads to an increase in team sizes with 'teams' ranging from 3 to 100 members (e.g., Ahuja et al., 2003; Finholt et al., 1990; Kirkman et al., 2004; Riopelle et al., 2003).

While team size may affect virtual teams differently than face-to-face teams, it is doubtful whether groups with more than 50 co-acting team members regard themselves as a team, or even know one another by name. Furthermore, to be considered a team, team members are assumed to be interdependent on their tasks and to interact on a day-to-day basis (Cohen et al., 1997; Goodman, Ravlin, & Argote, 1986; McGrath, 1984). Groups that are larger in size hardly meet this criterion, as the internal team interaction between all the members must obviously become increasingly complex and unbalanced, especially in dispersed teams (Lichtenstein, Alexander, Jinnett, & Ullman, 1997). Consequently, virtual groups with a great number of members modularize their work and split up into multiple sub-teams – mostly per sites. Consequently, the overall group loses its teamness in favor of a loosely-coupled multi-team system with little teamness between sub-teams (Dubé, Bourhis, & Jacob, 2006; Mathieu et al., 2001). Herbsleb and Mockus (2003) showed empirically that such teams do not only lose team characteristics with regard to their organization, but also that these larger overall teams develop smaller social networks within their host locations. Thus, the larger team sizes often found in virtual teams give rise to doubts about their teamness.

To be considered a team, team definitions most often also require team members to regard themselves and to be regarded by others as a team (see also the virtual team definition used in this work in chapter 1.1). However, distributed team members frequently do not even agree about their own team membership (Mortensen, 2008; Mortensen & Hinds, 2002). Many cases are reported in the literature, in which virtual team members are not fully dedicated to one team but to multiple ones (Espinosa, Cummings, Wilson, & Pearce, 2003). Members may also start a new project before finishing their current one, or the project they are working on may be part of a larger project that has complex interdependencies. This multiple team membership makes it more difficult for group members to establish a common team identity (Mortensen, 2008). In addition, multiple team membership, together with a decline in team identification, leads to

‘boundary disagreement.’ *Boundary disagreement* is defined as the extent to which individuals, who are externally designated as members of a team, disagree regarding their actual team membership (Mortensen, 2008).

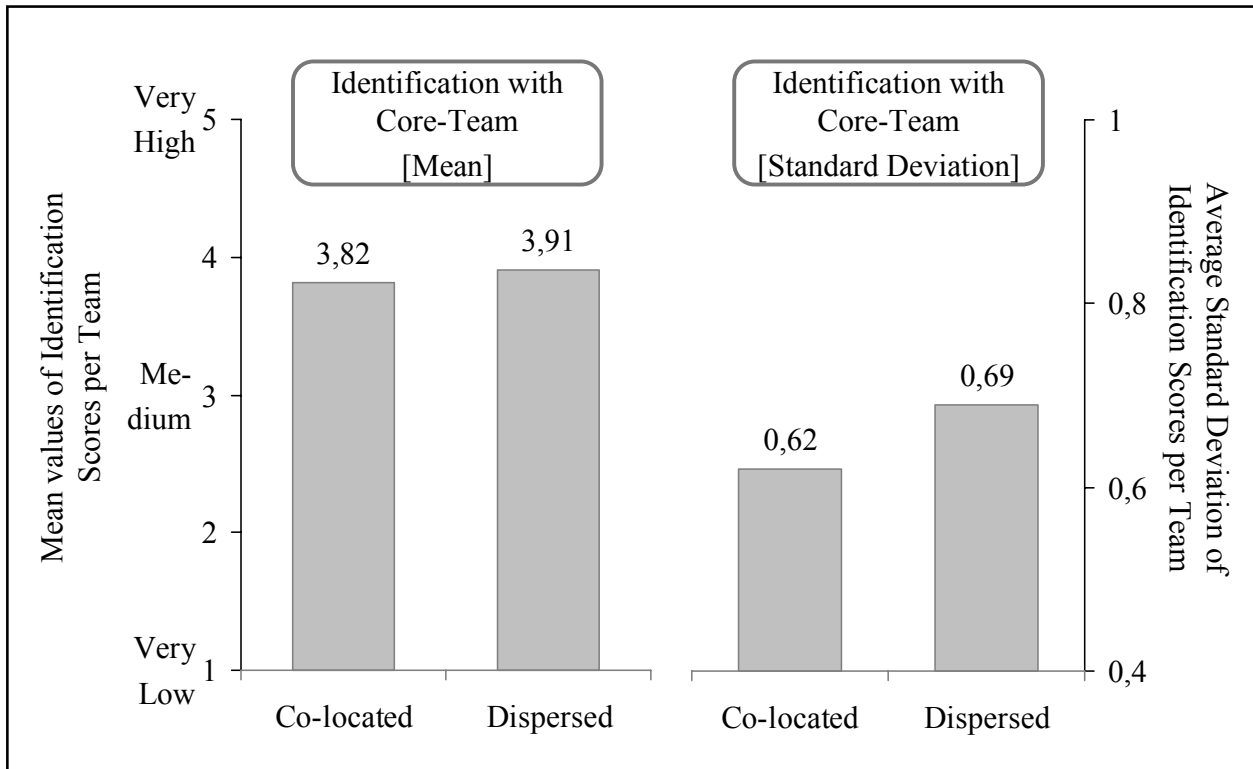


Figure 7-5: Mean and Standard Deviation of Identification Judgments by Team Members of Co-located and Dispersed Teams

There is compelling evidence that especially virtual groups frequently differ in respect of the degree to which they are regarded and regard themselves as a unified entity (Chudoba et al., 2005; Dixon & Panteli, 2007; Mortensen et al., 2002). In their study, Mortensen and Hinds (2002), for instance, found that none of their 24 co-located and dispersed teams was in complete agreement about their membership, with agreement scores ranging from 40% to 93% (average agreement = 75%). In addition, Mortensen and Hind's (2002) study revealed that the experience of boundary disagreement was associated with higher degrees of physical dispersion (Mortensen et al., 2002). In the present work, team members' agreement regarding their boundaries was not explicitly assessed. However, Figure 7-5 indicates that teams in this sample differ regarding the extent to which team members agree upon the strength of their identification with their team (measured as the average standard deviation of identification scores per team). Apparently, co-located members show more congruence in their identification with the team than virtual team members, who agree less on their perceived level of identification (while

having nearly the same medium levels). Whether this finding is due to virtual team members' lack of boundary agreement, their changing membership, or the inclusion of peripheral members, cannot be evaluated on the basis of these data. Nevertheless, boundary agreement and perceived entitativity are at risk in virtual teams, thus questioning their teamness.

Owing to the various centrifugal forces that tend to diminish the team-like characteristics of virtual teams, scholars are encouraged to be more skeptical about the level of their teamness. In line with the argument that many virtual groups operate as loose constellations of far-flung members, thus largely lacking any team-like properties, scholars investigating virtual team dynamics empirically are specifically encouraged to rethink their partly liberal use of the term *virtual team* (Mortensen, 2008; Mortensen et al., 2002). Larger team sizes and fuzzy boundaries are therefore emphasized as salient properties that should help researchers to make more considerate decisions on the level of teamness.

However, there is no theoretical requirement for teams to only exist in face-to-face environments. In fact, the presented team definitions make no mention of team members' geographical distributedness, nor do they postulate any mode (e.g., technologically mediated) that interaction must take (Griffith et al., 2001). Scholars should therefore exercise great care to assess the actual degree of teamness instead of a priori denying virtual teams any team-like characteristics. The discussion above clearly shows that teamness seems to be a continuous variable and that a discrete dichotomous differentiation between teams and non-teams would be too narrow.

However, while researchers are strongly encouraged to include continuous measures of teamness (e.g., level of perceived entitativity) in their research on virtual teams, this discussion has also shown that the question of teams' teamness can not be dealt with by simply including another control variable. The question of the level of teamness has far-reaching consequences for theory development, sample selection, and interpretation of study results, going to the heart of team research. The assumption of perceived entitativity in real teams, for instance, plays a pivotal role in virtual team theories that form the basis of the understanding of their dynamics. Current research on faultline effects (Greer & Jehn, 2007; Price, Shumate, Rowe, Lavelle, & Henley, 2007; Rico, Molleman, Sanchez-Manzanares, & Van der Vegt, 2007) and group composition (Chatman et al., 1998; Hopkins & Hopkins, 2002), for example, is based on the assumption that team members recognize one another as such. Similarly, work on boundary spanning (Golden & Veiga, 2005; Hinds et al., 1995; Tallman et al., 2007) relies on the idea that

there is an agreed-upon boundary that is crossed when team members interact with outsiders (Mortensen, 2008). Future research endeavors can use the construct 'teamness' both as a variable to explain team dynamics (Mortensen, 2008) and as selection criterion for sampling decisions (Arrow, McGrath, & Berdahl, 2000).

## 8 Implications for Future Modeling of Virtual Team Dynamics

### 8.1 CONCEPTUALIZING GEOGRAPHIC TEAM DISPERSION

Team dispersion is the central variable of this dissertation and the question of an appropriate measurement has been raised several times throughout the discussion of presented results. However, some findings cast doubt on geographic distance as a central variable for explaining virtual team functioning. It has been revealed, for instance, that concepts such as perceived distance and national diversity are more predictive of virtual team dynamics than physical distance (see chapter 3). *Based on these findings, does geographic dispersion really matter?*

The answer to this question should certainly be the affirmative. In fact, geographic dispersion forms the main frame of this discussion, since it is geographic distance that allows variables such as national diversity or perceived distance to become significant (Webster et al., 2006). In addition, given its straightforward and objective calculation, the assessment of geographical distance is and will be the most-applied measurement approach in virtual team research (O'Leary et al., 2007). The following discussion is therefore dedicated to the appropriate assessment of distance-based measures that are calculated by relying on team members' office locations. Consequently, this discussion explicitly includes spatial, temporal, and configurational elements of dispersion as recently suggested by O'Leary and Cummings (2007), but excludes other non-geographic dimensions of dispersion such as the level of technology mediation (Bouas et al., 1996) or time spent working apart (Griffith et al., 2001). In addition, other, more social-based, distance concepts such as *social distance* (sometimes *psychological distance*) (Antonakis et al., 2002), *psychic distance* (also referred to as *psychological distance*), and *relational or positional distance* (Rice et al., 1991) are also not taken into consideration in this section because they lack a link to geographic dispersion.

At first glance, the discussion on the appropriate conceptualization of objective dispersion appears to be a practical one. However, researchers have to acknowledge that the assessment of objective dispersion measures has serious consequences for building and testing theoretical models, thus going well beyond indicating the best-suited technique for the calculation team members' geographic distribution (Kolb, 2007; O'Leary et al., 2007). In addition, the measurement approach to geographic distance should be in line with the research questions and the study context. This discussion will therefore critically review different approaches to measuring

geographic distance in terms of emphasizing their strengths and weaknesses and by providing recommendations for their use in future team research.

Measurement Approach to Geographic Dispersion	Scaling	Example of Empirical Application	Sample Application Areas
Co-located versus dispersed	Categorical (dichotomous)	(Cramton et al., 2005b)	<ul style="list-style-type: none"> <li>▪ Descriptive data</li> <li>▪ Visualization</li> <li>▪ Comparing means (t-test)</li> <li>▪ Analysis of variance</li> <li>▪ Check for robustness</li> </ul>
Co-located, hybrid, and purely virtual	Categorical	(Griffith et al., 2003)	<ul style="list-style-type: none"> <li>▪ Descriptive data</li> <li>▪ Visualization</li> <li>▪ Comparing means (t-test)</li> <li>▪ Analysis of variance</li> <li>▪ Check for robustness</li> </ul>
Ordinal Distance Scale [Same Room to Different]	Ordinal	(Trevino, Webster, & Stein, 2000)	<ul style="list-style-type: none"> <li>▪ Exploratory analysis</li> <li>▪ Data visualization</li> </ul>
Heterogeneity index [Entropy-Based Index]	Ordinal	(Cummings, 2004)	<ul style="list-style-type: none"> <li>▪ Quantitative data analysis (in case of poor information on team member locations)</li> </ul>
Number of buildings / sites	Metric	(Cummings, 2007)	<ul style="list-style-type: none"> <li>▪ Coordination complexity</li> <li>▪ No data available on postal codes etc.</li> </ul>
Number of isolated team members	Metric	(Cooper et al., 2002)	<ul style="list-style-type: none"> <li>▪ Socio-emotional consequences of dispersion</li> <li>▪ Decreased awareness</li> </ul>
Imbalance of team members across locations	Metric	(Staples & Webster, 2008a)	<ul style="list-style-type: none"> <li>▪ Social categorization effects (e.g., faultline dynamics)</li> <li>▪ Majority-minority effects</li> </ul>
Time separation	Metric	(Espinosa, Carmel, & Nan, 2007b)	<ul style="list-style-type: none"> <li>▪ Real-time problem solving</li> <li>▪ 24-hour, follow the sun workflow</li> <li>▪ Coordination complexity</li> </ul>
Geographic distance	Metric	(Hinds et al., 2005)	<ul style="list-style-type: none"> <li>▪ Multiple effects of (log-) linear distance (e.g., communication frequency)</li> </ul>

*Table 8-1: Measurement Approaches for Geographic Distance*

To date, research on virtual teams offers a multitude of different approaches to calculate geographic dispersion (Kolb, 2007; O'Leary et al., 2007). Table 8-1 provides an overview of commonly used frameworks of dispersion with varying measurement and scaling approaches. Recent reviews of virtual team research clearly demonstrate that newer studies predominantly employ metric measures instead of distinct differentiations between co-located and dispersed teams (Caya et al., 2008b; Hertel et al., 2005; Webster et al., 2006). The use of metric dispersion scales obviously provides researchers with a more fine-grained approach to map varying levels of team member distribution than a simple dichotomous distinction (e.g., Caya et al.,

2008b; Hoegl et al., 2007a; Webster et al., 2008). The five-dimensional approach by O’Leary and Cummings (2007) has specifically received considerable research attention, because it allows virtual team configurations to be described in more detail than just with geography. But are these – in part multi-dimensional – measurement approaches the last resort for geographic distance assessment and always to be preferred above dichotomous or ordinal measures?

There are several indicators that cast doubt on the universal superiority of metric dispersion measures. The following discussion puts forth arguments for maintaining some diversity in measurement approaches to geographic dispersion. The argumentation relies on conceptual considerations as well as a critical review of current research results and is presented in respect of the following three issues:

*To date, there is only weak field study support for unique effects of other (physical) dispersion dimensions than geography:*

Early definitions of virtual teams sought to contrast virtual and face-to-face teams and therefore focused on physical dispersion and technology-based interaction. Such definitions were appropriate for the context in which they were used, namely, laboratory settings with student participants. However, with the focus of inquiry shifting toward organizational teams working on ‘real-world’ tasks, the assessment of distance has undergone a transformation and some refinement. O’Leary and Cummings’s (2007) formulation of five different indices to describe team members’ spatio-temporal and configurational distribution is the perhaps most elaborate and definitively the currently most widely used approach to assess the objective and structural aspects of geographic team distribution (see chapter 3 and chapter 5 for more details). O’Leary and Cummings (2007) justify the increasing effort required to calculate these different indices by pointing to their distinctiveness, both conceptually and in respect of their effects. As a part of their argumentation in favor of this differentiated distance measure, O’Leary and Cummings (2007: 448), for example, state that “scholars can more carefully assess the independent effects of space, time, and configuration, and separate those effects from socio-demographic ones, which are often correlated with dispersion, but which exert theoretically different effects.” Likewise, Gibson and Gibbs (2006: 483) justify their use of multiple dispersion indices with “the criticality of considering each team feature in its own right. Researchers who lump them together are missing important complexities in the realities of team work.”

However, while scholars do not tire of emphasizing the need to assess geographic dispersion's multi-dimensionality, the corresponding empirical results do not mirror this enthusiasm. Hinds and Mortensen (2005), for instance, used O'Leary and Cummings's (2007) framework to assess the impact of dispersion on team conflict. An exploratory factor analysis grouped the five indices into two distinct factors - separating the first three and last two indices - but the results were almost identical in respect of all five indices. Similarly, the present study did not find evidence that any of the five indices have distinctive effects beyond geography. Evidence of the significance of team member configurations has to date only been found in laboratory studies with predefined member assignments (Jehn et al., 2008b; O'Leary et al., 2009; Polzer et al., 2006). The influence of team configurations may have only become significant due to the extreme configurations used in these laboratory settings. In natural situations, however, configurational distance's influence on team dynamics may be too weak to become visible. Of course, time zone separation may, for instance, reveal new evidence when comparing teams distributed east-west and north-south. However, to date, only case studies and manager reports attest to the importance of this differentiation (Espinosa et al., 2004; Espinosa et al., 2003). Thus, further research is needed to evaluate the meaningfulness of O'Leary and Cummings's (2007) five sub-indices in order to justify researchers' considerable effort to calculate them.

*It is unlikely that dispersion effects follow the linearity of metric distance (e.g., meters or miles):*

Regardless of the used measurement approach to assess geographic distribution, researchers are asked to critically rethink whether their research subject really calls for the use of continuous distance measures. Metric distance is often not consistent with the real-world phenomenology of team dynamics, as the effects of distance hardly follow any linearity. Some authors have acknowledged this discrepancy between the metric measurement of dispersion and its non-linear effects. Most of these authors propose solving this problem by calculating distances' logarithm and, in so doing, linearizing its distribution (Hansen et al., 2004; O'Leary et al., 2007). It is, in fact, reasonable to assume that individuals most likely do not perceive that the burdens of travel increase linearly per air mile traveled. Hansen and Lovas (2004: 808), for instance, maintained that "a 5000-mile air flight to a target subsidiary is most likely not perceived as five times more burdensome than a 1000-mile air flight." Additional support for this notion may be found in Allen's (1977) evidence of an approximate logarithmic association between meter distance and communication frequency. Finally, in this study it also has been reasoned



that logarithmic distance is a better proxy for considered outcomes (see chapter 3, chapter 4, and chapter 5).

However, a log transformation is a nonlinear data transformation that always changes the form of the relationship between variables and, therefore, needs theoretical justification (Cohen et al., 2003a). There are prominent examples of the use of log transformations that are not only based on the need to simplify the relationships (mathematical condition for linearity) between variables, but also simply on the creation of conceptually meaningful units. For example, when economists use log (dollars) as their unit of analysis, it is partly because this function theoretically and empirically reflects the perceived utility of money; the use of the decibel scale to reflect loudness and the Richter scale to reflect earthquake intensity are other examples (Hoaglin, 1988). But there is still no compelling theoretical justification for using logarithmic transformations to attain more meaningfulness from the scaling of distance measures.

Instead, the non-linearity of distance may be better captured by using ordinal categories that divide distances into meaningful categories. Such a measure is used in the studies by Trevino, Webster, and Stein (2000) and Cummings and Gosh (2006). These authors measured dispersion in ordinal steps and assessed whether team members spent most of their time in the ‘same room,’ ‘same floor,’ ‘same building’ or far away on a ‘different continent.’ Such a division of distance into meaningful categories may be stronger related to experienced distance than its continuous measure in log (miles). Stalk and Hout (1990), for instance, found evidence that the effects of distance may change suddenly in terms of such meaningful categories. They showed that a team leader of a project distributed in a few adjacent buildings, logged up to eleven miles per week by walking. Even such marginal distances seem to increase coordination difficulties, mutual knowledge problems, and interpersonal conflicts to almost the same extent as a distance of hundreds of miles (Kiesler et al., 2002).

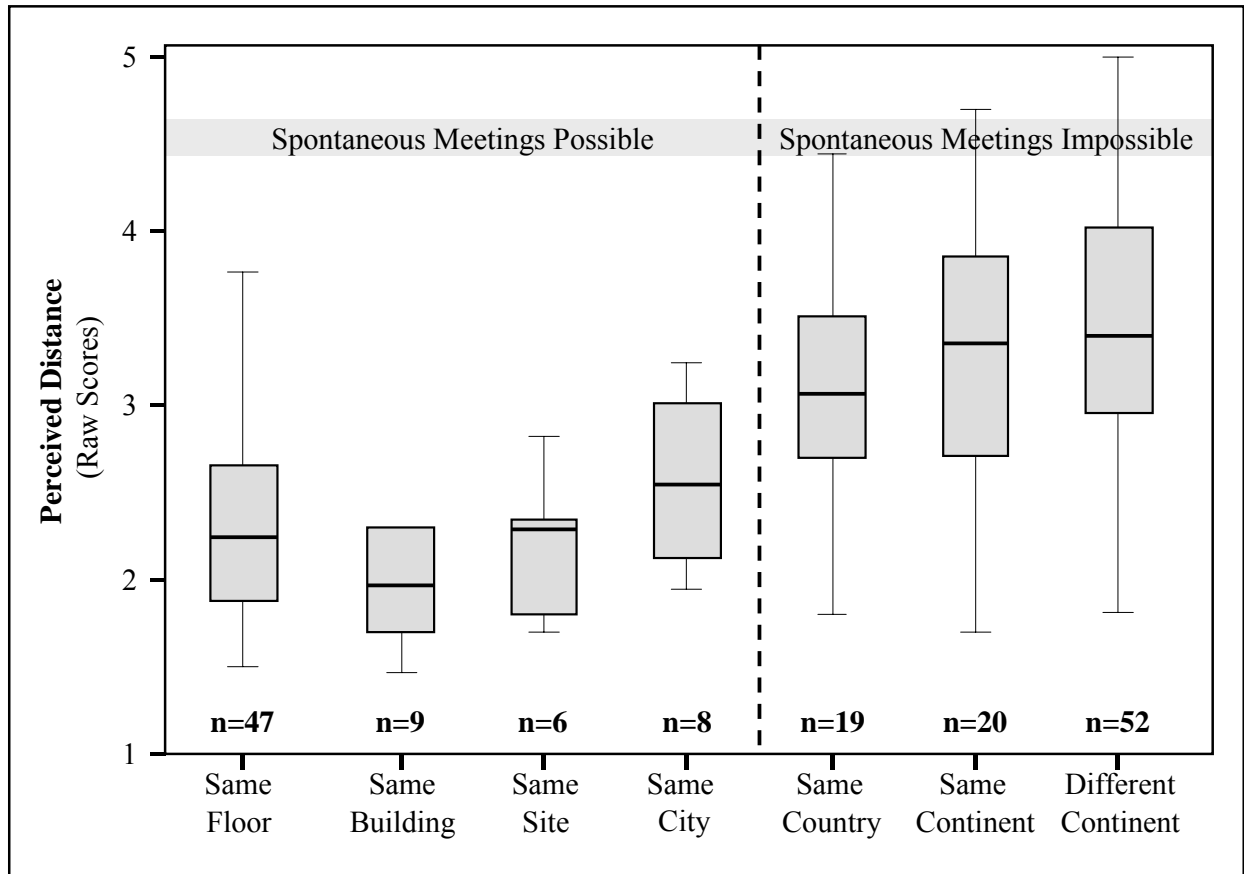


Figure 8-1: Boxplots of Perceived Distance along an Ordinal Measure of Distance

In the present study, there is also some evidence that the use of an ordinal measure provides meaningful results. Figure 8-1, for instance, illustrates the trend of perceived distance on a 7-point ordinal scale of distance with boxplots representing its distribution per category (the smallest observation, lower quartile, median, upper quartile, and largest observation). From this figure, it becomes apparent that the connection between geographic distance and subjective distance is most likely not a linear one: the medians of perceived distance are most sensitive to the transition from 'same city' to 'same country.' Again, the effects of proximity seem to die off quickly with relatively little distances, making short distances equal to long ones in their effects on group interaction (Armstrong et al., 2002a; Kiesler et al., 2002). Future research is therefore encouraged to make use of these, sometimes more meaningful measures of physical dispersion. However, the use of ordinal scales is often restricted to descriptive purposes only, as most statistical procedures require interval-scaled and normally distributed variables to reliably compute test statistics (see also 'application areas' in Table 8-1).

*Metric distance is not normally distributed*

Normal distribution is a statistical requirement that is also hardly achieved using metric distance measures. While perfect normal distributions are fiction in respect of behavioral science's data collection (Garrett, 1926), variables are generally assumed to be approximately normally distributed since most inferential statistical tests and procedures rely on this assumption (Malgady, 2007). It is very unlikely that the distribution of observations in respect of a variable such as distance is centered around a mean. Managers will most likely decide to either staff a team from the office locations in the vicinity to reduce coordination effort, or from global locations to take advantage of lower wages and heterogeneous expertise (see chapter 2.2). This practice is already suggested by the number of teams per category of the ordinal distance scale in Figure 8-1, with the most number of teams being either co-located or dispersed across continents. Thus, on the basis of the presented data, it seems very unlikely that distance distributions will even approximate a Bell curve and this mismatch won't disappear by taking the logarithm.

Scholars should be concerned that publishing descriptive information on the skewness of the data when using distance-related constructs is not common research practice. Owing to the violation of normality, great care should also be taken with the robustness of research findings. It may be advisable to test the robustness of models with included distance measures by either using scatterplots for visualization effects, or by rerunning the analyses with dichotomous measures. While a binary distinction between co-located and dispersed teams is not regarded as a favorable measurement approach, it is a feasible way of checking for model robustness (Hinds et al., 2005).

*What has been learned throughout this discussion?*

There seems to be no one best way of assessing objective distance, but there are various pros and cons that clearly demonstrate the complexity of this discussion. Instead of stretching convenient approaches to fit the study's purpose, researchers are encouraged to make more deliberate choices with regard to the measurement of dispersion. Ultimately, there are two fundamental criteria to be considered in the decision process: the technical fit of dispersion measures with the used research methods and the alignment with the theoretical and conceptual framework.

Technically speaking, there is still no superior measure of dispersion and it is doubtful if there will ever be one. The approach presented by O'Leary and Cummings (2007) is, of course,

still perhaps the most elaborate framework for this purpose. However, in addition to this approach being quite time-consuming, i.e., it requires in-depth information about team members' office locations, there are some occasions when dichotomous or ordinal-scaled variables may be preferred to metric frameworks. A binary distinction between co-located and dispersed teams – while usually disregarded as the only distance measure – can be useful for comparing means, visualizing differences, and for verifying the robustness of the research model in use (see also Table 8-1). O'Leary and Cummings (2007: 448) themselves contributed to this discussion by mentioning that “for scholars studying one specific process, or studying it in a very specifically defined context ... it may be sufficient to focus on one dimension or a dichotomous conception of dispersion.” Conversely, ordinal measures could be very helpful for the identification of non-linear effects or discontinuities in the effects of dispersion. In particular, ordinal measures could be optimally used when working on questions such as “how far away is far enough to be considered as working apart from team members: down the hall, across the street, or across the world?” (Arling, 2007: 1).

Despite these more technical criteria for selecting one dispersion measure over the other, another essential criterion for choosing an appropriate measurement approach is the study's underlying theoretical and conceptual framework. For researchers who are interested in studying the faultline effects in distributed teams, for instance, it may be most appropriate to include distance measures that describe team members' configuration across sites, since faultlines are known to form at location-based sub-groups (Lau et al., 2005; Polzer et al., 2006). Conversely, a measure of temporal separation may be indicated to study team coordination in far-flung software development teams, with such teams not only being distributed east-to-west but also north-to-south, as this difference is apparently an important issue for coordination work (Espinosa et al., 2006a). Direct effects of distance such as social presence or the extent of technological mediation may, however, be sufficiently explored if researchers rely solely on measures of geographic distance with ordinal measures testing for non-linear effects. Ultimately, researchers may agree upon O'Leary and Cummings's (2007: 448) suggestion that “it is not necessary to measure every dimension (of dispersion) in every study, but we believe that it is important to make conscious, well-informed, theoretically guided choices about which dimensions to measure and control.”

In conclusion, there are many questions still unanswered regarding the consequences of dispersion and future research will certainly benefit from taking more conscious decisions about

the selection of appropriate dispersion measures. More elaborate conceptions of dispersion will specifically increase scholars' ability to study virtual team functioning by (1) encouraging new theorizing on the causes, effects, mechanisms, mediators, and moderators of dispersion; (2) providing more unified frameworks for ex-ante hypotheses building as well as for post-hoc re-interpretation or meta-analysis; (3) improving the interpretability, robustness, and visualizability of results; and finally (4) separating the geographic dimensions of dispersion from their frequently correlated (and potentially confounding) demographic dimensions.

## 8.2 CONSIDERATION OF THE ORGANIZATIONAL CONTEXT

The main objective of this study is to gain more insight into virtual team functioning and to explain the varying effectiveness found in research so far. In early team research, scholars designed comprehensive models to theoretically explain team effectiveness, widely following an input-process-output framework (Ilgen et al., 2005). The famous and influential team models by McGrath (1964), Hackman (1987), Gladstein (1984), Tannenbaum et al. (1992), and Sundstrom et al. (1990), for example, all have the inclusion of organizational context as a prominent variable and emphasizing its significance for team effectiveness in common. In respect of virtual teams, there is a considerable amount of case study evidence pointing to the power of the organizational context as a driver of virtual team effectiveness (Guzzo et al., 1996; Joshi et al., 2008; Mathieu et al., 2007; Priest et al., 2006). Some authors even claim that the organizational context has a more powerful impact on virtual teams than on co-located teams. On the basis of their case study analysis, Armstrong and Cole (1995: 212), for instance, found that "distributed work groups are very sensitive to the structural features of their host organization" and reasoned that this might be due to the difference in site cultures and emerging resource conflicts between locations.

However, there is still a sizable gap in researchers' knowledge of the role that contextual factors play in shaping team processes and performance (e.g., Ilgen et al., 2005; Jackson et al., 2004; Kozlowski et al., 2003; Tasa, 2008). For example, Kozlowski and Bell (2003) stated that "we still know relatively little about the effects of organizational context on team functioning" (p. 362), and that "team research needs to incorporate the effects of major organizational context factors specified in models of team effectiveness" (p. 363). Specifically, the impact of the organizational context on team functioning and performance has been largely unexplored in respect of virtual teams (Caya et al., 2008b).

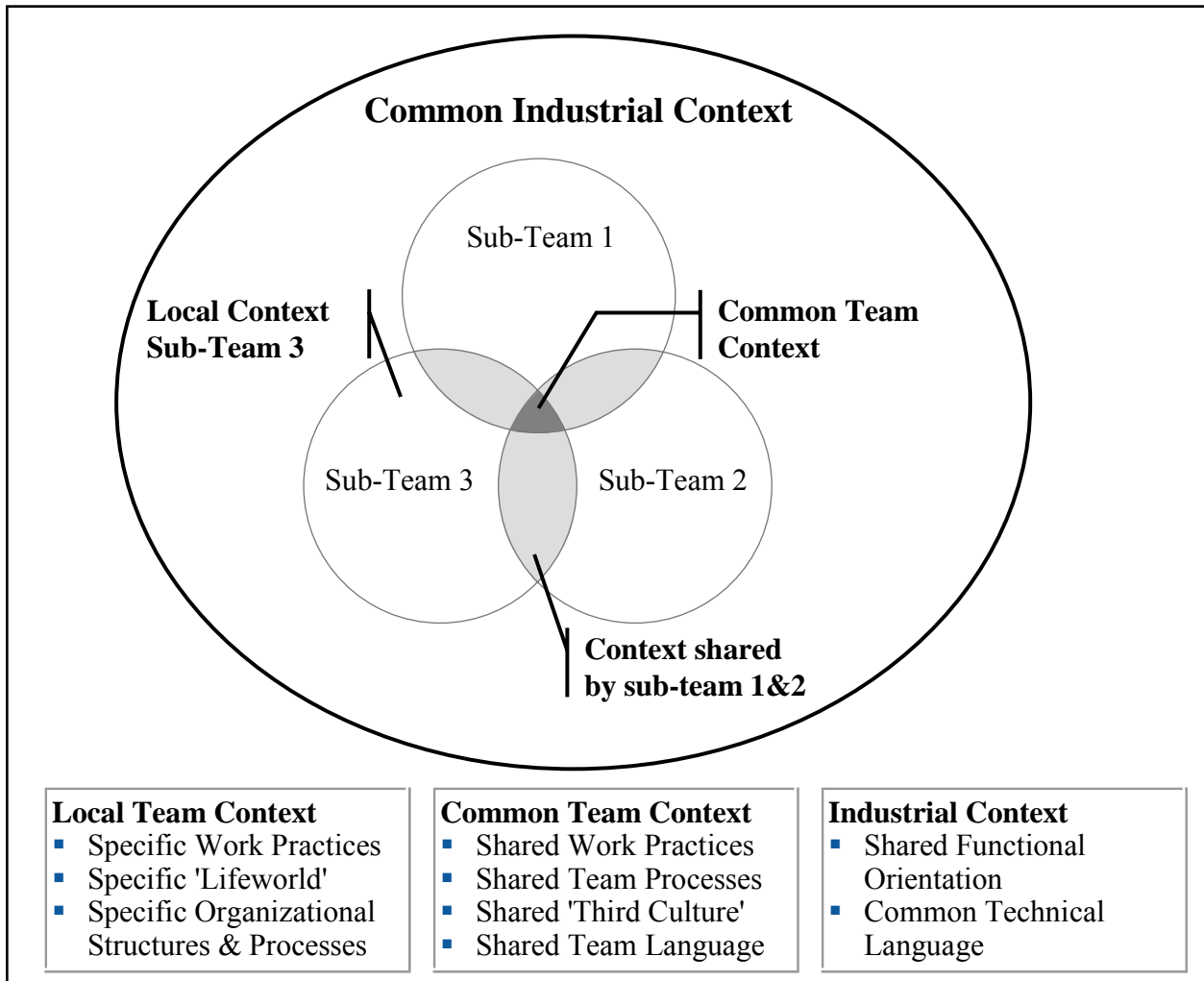
The present study has addressed this research gap and revealed that the effect of the organizational context on virtual team effectiveness is at least twofold: First, the organizational context can serve as an enabler for the development of proximity perceptions through the establishment of an environment characterized by innovativeness, stability, and boundaries that are permeable for inter-site contact. Second, dispersed collaboration effectiveness is facilitated in organizational environments that emphasize a global mindset, provide clear ground rules for collaboration, and include organizational team support practices specialized on global team activities. The significance of cross-level effects for virtual team dynamics is further indicated by the magnitude of team variance explained at this higher level. In both HLM analyses, organization-level variables explain more than 20% of the team-level variance (see chapter 4 and 6).

These findings make it apparent that the organizational context is an essential element for understanding virtual team dynamics and explaining their performance. Additional cross-level research is needed to further scholars' knowledge of how the organizational context sets the frame for dispersed team functioning. In particular, the results of this study raise two fundamental questions for future research that are not sufficiently addressed in the present work and have been widely neglected in prior research: (1) what is the *contingent* impact of the context upon the link between dispersion and virtual team dynamics?; and (2) what is the referential context for teams belonging – per definition – to *multiple contexts*?

The first question links directly to the research results presented in chapter 5, highlighting that dispersion is not detrimental to all teams but only to those with weak team processes. This finding is in line with the findings by Hoegl, Ernst, and Proserpio (2007a), who showed that teamwork matters more as dispersion increases. Thus, virtual teams apparently need an internal fit between their level of team processes and their level of geographic distance to achieve high performance. Most likely, the same rationale holds for the team context, in that specific context variables are more relevant for virtual teams than for co-located teams. Thus, for distributed teams to be successful, the level of team processes should match increasing demands due to team member distance (internal fit) and, in addition, the context should create an environment supportive of virtual team dynamics (external fit). Comparing these two perspectives, Sinha and Van de Ven (2005: 397) argued that “in addition to internal fit ... a high-performing work design pattern must also achieve an external fit with its environment or context.”

Such an external fit perspective will help to reveal whether some organizational design attributes are more beneficial for dispersed teams than for co-located teams (Hambrick et al., 1998; Jehn et al., 1999). In this research, however, a direct relation has been adopted between organizational context variables and team dynamics under the assumption that the same context elements will be beneficial for either type of team. The effect of organizations' formalized rules on team members' perception of distance, for instance, has been investigated by assuming a direct relation between both levels of analysis (see chapter 4). In this respect, the results of the present study allow for the interpretation that a higher level of formalization leads – on average – to higher levels in proximity perceptions, regardless of teams' actual degree of dispersion. However, this result does not indicate – although it seems intuitively plausible – that a higher level of formalization is more beneficial for proximity perceptions in dispersed teams than in co-located teams. Hence, future research is encouraged to reveal such contingencies or even whether it is possible to articulate universal design principles that yield positive team outcomes, regardless of the actual degree of dispersion.

A second issue to be addressed in future research is the question of the appropriate team context in virtual teams. In particular, members of virtual teams participate in various local contexts and assigning distributed team members to one organizational context can be ambiguous. In the present study, team members were assigned to the organizational context of the laboratory to which most of the team members, or the team leader (in case of balanced membership across sites) belonged. In this study, such an assignment procedure was justified since all laboratory affiliations represented in the team were under the roof of the same software company. Thus, team members belonged to different laboratories but were largely exposed to the same organizational context attributes such as the same infrastructure and organizational processes. However, when studying virtual teams pertaining to various local contexts with different organizational characteristics, the assignment of one specific context may be inadequate. In buyer-supplier collaborations, for instance, in which virtual team members originate in equal numbers from the buyer and the supplier, the question is: what is the reference context of this team?



*Figure 8-2: Virtual Team Context – Identification of the Respective Team Context*

Virtual team members are participants in both the virtual team context and the local contexts in which they are physically located (see Figure 8-2). The initiation of a virtual team can be viewed as the emerging of a new organizational context in which shared meaning, new organizational structures, and work practices need to be negotiated and enacted (Weick, Sutcliffe, & Obstfeld, 2005). Some researchers already mentioned that a third culture may develop – a culture that is uniquely held by the team (Bell et al., 2002). Bjørn and Ngwenyama (2008) contend that the organizational context of a virtual team is a conglomeration of pieces related to lifeworlds (individual experiences and beliefs that guide peoples' attitudes and behaviors), organizational structures, and work practices (profession-specific norms, collaborative practices held by the team, and technical language spoken by team members) that participants bring from their local organizational contexts.



Thus, researchers face a dilemma. On the one hand, it is necessary to capture the immediate team context that is likely to be most relevant for team dynamics. In this case, the organizational context descends to the *team level* as each team has its own immediate and specific context. A cross-level analysis would, consequently, no longer be possible under this assumption. On the other hand, researchers may look for the '*lowest common denominator*' by moving to the next higher context level in which all team members are nested. In buyer-supplier collaborations, the '*lowest common denominator*' may be the industry sector to which both parties belong (see Figure 8-2). However, it is doubtful whether this context would have enough relevance for such a team to explain team dynamics.

Nevertheless, studying virtual team contexts is absolutely worthwhile despite the conceptual challenge of identifying the appropriate context for a virtual team and assessing this context on an adequate level. Scholars should therefore not only extend their research focus to the team context because "like Everest, it is there" (Johns, 2001: 34), but also because it seems to matter. This research has shown that the organizational context seems to provide virtual teams with an environment in which certain team processes and mental states are more supported than others, which has consequences for team functioning and performance. It is essential that future research learns more about the contextual influences on virtual team dynamics, as it is the context that provides team members with the purpose, resources, social cues, norms, and meanings that shape behaviors (Jackson et al., 2003). Several inconsistencies found in virtual team research to date may be due on the largely unexplored effect of the surrounding context. Consequently, future research that addresses this blind spot of virtual team research may be ultimately richly rewarded.

### **8.3 NEW THEORIES FOR VIRTUAL TEAMS?**

In order to develop a deeper understanding of how virtual teams experience distance, perform teamwork, and achieve high-level outcomes, much more theoretical work is necessary in future research. The development of a comprehensive theoretical underpinning to explain virtual team dynamics is indispensable, since only theory allows researchers to understand and predict outcomes of interest and prevents scholars from being dazzled by the complexity of the empirical results (Colquitt & Zapata-Phelan, 2007; Sutton & Staw, 1995). Specifically, the – in part – fragmented empirical results obtained on virtual teams to date call for more integrating theory (Schiller & Mandviwalla, 2007). This is also true for the research results of this study.

The presented results shed light on the antecedents of virtual team performance from very different angles but there is still no theoretical framework into which all these findings could be integrated. A question of interest is therefore: to what extent are scholars able to rely on existing team theory when aiming at piecing together the puzzle of current research? The existing models of team processes and effectiveness were largely constructed with traditional, not virtual, teams in mind (Ancona & Caldwell, 1992a, b; Cohen et al., 1997; Hackman, 1987; McGrath, 1984; Sundstrom et al., 1990). Hence, it is not yet clear whether or not, and how, the dynamics of distributed teams can be predicted by existing team models that are based on decades of research on co-located teams.

The academic discussion on this topic is divided between the epistemological faction who believes existing team theory must be abandoned in favor of new theories specific to the characteristics of virtual teams, and the other who has more faith in the timelessness and robustness of established theoretical models (Tiwana, 2002). Authors with a pessimistic view doubt the validity of traditional models to explain teams that work across distance, use technology to communicate, and hardly ever work in a commonly shared context. These authors believe that most technologically enabled groups are inherently different from face-to-face groups, and that they are worthy of study as entities in their own right, rather than simply being benchmarked against equivalent face-to-face groups (Hollingshead & Contractor, 2005; Shapiro, Furst, Spreitzer, & von Glinow, 2002). Shapiro et al. (2002), for instance, observed that the salience of team identities is reduced in virtual teams, leading to an increase in team members' propensity to withhold performance-effort. From their results, the authors concluded that "there is a need to extend existing theories of groups and to develop comprehensive new theories of leadership and management to maximize TNT (transnational team) effectiveness" (Shapiro et al., 2002: 464).

Other authors, however, questioned whether distributed teams are fundamentally different from co-located teams and, thus, are deserving of separate study (Hinds et al., 2005). Armstrong and Cole (1995: 184), for example, pointed out that they "do not consider distributed work groups to have qualitatively different dynamics than co-located groups. Many of the integrating practices are the same for both, such as gaining commitment to shared goals and articulating and monitoring norms."

In spite of not being an explicit research question of this study, the presented research results provide some evidence for this basic comparison between distributed and co-located teams as a means of shedding light on their similarities and differences. The results suggest that distributed teams apparently do not require models that differ from those of their co-located counterparts. It has been shown, for instance, that over all studied teams, an organizational context can elicit feelings of proximity through the reduction of uncertainty, the facilitation of interpersonal contact, and the provision of an open communication climate. These cross-level effects have been hypothesized relying on mechanisms such as intergroup contact and uncertainty reduction, hence social psychological ground rules that are known for decades of research to increase intimacy and interpersonal closeness in co-located dyadic interaction situations (Berger & Calabrese, 1975; Kiesler et al., 2002).

In addition, there is no evidence in the data that co-located teams and virtual teams differ fundamentally in their reactions to the study variables. Both types of teams, for example, benefited from higher levels of task-related team processes, but as the interaction plot in Figure 1-1 clearly shows, distributed teams benefited more. This finding is further mirrored by the findings of other researchers, who showed that teamwork matters more as distance increases (Cummings, 2007; Hinds et al., 2005; Hoegl et al., 2007a). In addition, traditional teams also appeared to be susceptible to feelings of distance despite their physical co-location (see Figure 7-4). Thus, the concept 'perceived distance' seems to be relevant for both types of teams, but more so for virtual teams.

In addition, the more-and-less susceptibility of virtual teams to team design variables, team processes, or the moderating influences of third variables are worth studying in order to learn more about virtual teams and the prerequisites for their success. Thus, to reflect this new type of team, existing team models may need to be augmented with those factors that remain undetected in co-located teams because of their weak effects. In their research, Webster and Staples (2006), for example, maintained that empirical models should increasingly include dispersion as a moderator variable to determine the applicability of traditional models on this advancing team format. Such a research approach may be helpful to explain the relative importance of newer concepts like 'mental models' (commonly held knowledge structures; see Levesque, Wilson, & Wholey, 2001) or 'transactive memory' ("a shared sense of who knows what on a team;" Reagans, Argote, & Brooks, 2005: 871) for performance in virtual and traditional teams. This research would also complement the insights from this study, as mental models and/or

transactive memory may be the missing link that could explain why task-related processes are more relevant for virtual teams; and additionally, why virtual teams' performance does not seem to be contingent on teams' level of socio-emotional processes (see chapter 5).

Nevertheless, future virtual team research is required to identify the appropriation of existing theories to explain virtual team dynamics. This research could be optimally complemented by efforts to adopt theories from a broad range of other scientific disciplines such as psychology, sociology, or computer systems. Broadening the scope to related domains has already yielded noteworthy theoretical frameworks such as the media synchronicity theory (Dennis, Fuller, & Valacich, 2008), which provides a theoretical synopsis of technological input factors such as 'media transmission velocity' and communication effectiveness as behavioral outcome in virtual teams. Likewise Maes, Flache, and Takács (2008) have recently brought the sociological concept of criss-crossing agents to virtual team research, a concept that questions the stability of faultline dynamics in the long term. Finally, theory building in virtual team research will not only benefit from broadening its conceptual underpinning, but also from creating meta or combinatory theory. As is often the case with early research on a complex phenomenon, the investigations of virtual teams have so far tended to be piecemeal inquiries into selected relationships, with little synthesis or integration having been achieved. Thus, further research is necessary to piece together the fragmented knowledge of current research (Schiller et al., 2007).

## **9 Managerial Implications and the Resolution of Apparent Paradoxes**

There are many advantages to setting up a virtual team, such as increased knowledge resources (Cummings, 2004), innovation capacity (Singh, 2008), and flexibility in work arrangements (Kolb, 2008). However, as the presented research results in chapter 3 have shown, dispersion can create great opportunities if dispersed teams are set up and managed effectively. Dispersed teams with superior task-related team processes, such as mutual support, effort, task coordination, balanced contributions, and task-related communication, outperform co-located teams. However, the study results also demonstrate that the implementation of virtual work teams does not always result in a success for the organization. Dispersed teams with low levels of task processes clearly underperform teams working in proximity with the same process levels. In fact, virtual teamwork, while critical for team success, is associated with serious challenges and it is apparently not enough to put individuals from different locations together and expect them to automatically know how to work as a distributed team (Bachmann, 2006). These results are in line with research evidence from other authors, who found that despite the purported advantages of virtual team work, more virtual teams fail than succeed (Potter & Balthazard, 2002; Rosen, Furst, & Blackburn, 2006).

Reviewing the presented results of this dissertation, there is no one best way for managers to lead virtual teams to success, but several possible starting points that may contribute to higher virtual team performance. Most challenging, the identified starting points to leverage virtual team performance are inconsistent with regard to their influence on team dynamics. Managers and team leaders seem to face a paradoxical situation in which an action is likely to facilitate some aspects of virtual collaboration but – at the same time – makes it nearly impossible to reap the full potential from other starting points.

To address this complexity in a comprehensive but straightforward way, the following discussion focuses on four strategies to improve virtual team performance. To emphasize the ambivalence of effects, these four possible strategies to virtual team effectiveness are formulated as paradoxes; that is, each strategy states that two conditions exist simultaneously, even though this seems logically impossible (Druskat & Wheeler, 2003). Using ‘paradoxes’ as a conceptual lens with which to view the success factors of virtual collaboration not only helps practitioners understand the ambivalent nature of virtual teams, but also provides practical guidance to how seemingly opposed effects can exist together and can be managed effectively (Dubé & Robey,

2008). To enrich the present discussion, a synopsis will be provided of the presented results of this study, of qualitative interviews with managers during post-study workshops, and of research results from prior studies on virtual teams.

*Paradox 1 – dispersed teams require proximity*

Although information and communication technologies are commonly acknowledged as the key enablers of virtual teamwork by helping to bridge spatial and temporal discontinuities, researchers as well as practitioners continue to maintain that considerable face time or temporary co-location is the gold standard for virtual team collaboration (Crowston et al., 2007; Geber, 1995; Leonardi et al., 2004). This claim exemplifies the first paradox, since virtual teams are defined as geographically distributed, and members cannot be physically present and distant at the same time.

Despite this apparent impossibility, the present research has shown that virtual teams can find ways to establish a perception of proximity through a more social interpretation of their environment (see chapter 6). Furthermore, this *experience* of distance has been shown to be more relevant for virtual team processes than objective distance (see chapter 3). Managers as well as team leaders can, thus, facilitate virtual collaboration without solely relying on traveling or temporary relocation. As this research suggests, there is a multitude of different solutions at hand that help practitioners to elicit feelings of proximity, despite physical distance:

- Managers can create an organizational environment characterized by structural assurance, an innovation-driven culture, and organizational boundaries that are permeable for inter-personal contact. Structural assurance, for instance, can be achieved by standardizing the tools for personnel selection and development, or by establishing common routines for administrative processes (Kiesler et al., 2002; Wilson et al., 2008). An innovation culture is facilitated through the encouragement of entrepreneurship and the renouncement of punishment for risk taking or failure (De Brentani et al., 2004). Furthermore, permeable organizational boundaries may be achieved through interpersonal forums, periodic department meetings, social events, or virtual meetings (Raghuram et al., 2001). These actions are applied on the organizational level and allow for an organizational environment that has been shown to be effective for the development of proximity perceptions despite physical distance.

- On the team level, perceptions of proximity may be strengthened by the establishment of a commonly shared team identity. As identification is a process of self-categorization with respect to others (Dutton, Dukerich, & Harquail, 1994), a team identity shared by all team members is likely to establish proximity perceptions among team members (Wilson et al., 2008). Face-to-face meetings are widely assumed to be an effective tool to foster a team identity early in the project since this is when the greatest diversity of opinions and views occur (Webster et al., 2006). In addition, face-to-face meetings have been shown to strengthen interpersonal bonds and promote the creation of a shared vision (Armstrong et al., 1995; Kraut et al., 2002). As this research has shown that perceptions of interpersonal proximity are very susceptible to diversity in the team, early face-to-face meetings may, in fact, be very effective in supporting the experience of proximity. However, caution should be exercised as personal contact does not only undermine the advantages of perceived proximity as a means to leverage group performance without relying on co-location, it also amplifies surface-level diversity and should therefore be carefully monitored (Webster et al., 2006).
- Another way of establishing a sense of proximity is to build personal contacts through virtual communication. Information and communication technology has been shown to be effective in integrating personnel who are widely dispersed across far-flung locations (De Meyer, 1992; Kim et al., 2003). Information systems research has also revealed that technology can help to build interpersonal closeness (e.g., friendship) over distance (Haythornthwaite & Wellman, 1998) and that these perceptions of interpersonal closeness can show off high levels of stability and balance (Krackhardt & Kilduff, 1999). However, while virtual media are effective for achieving information exchange across distance and increase the experience of social presence, the establishment of a 'virtual co-location' seems to be fiction. Technology is still not able to fully close the physical gap in distributed teams (Fiore et al., 2003).

In summary, the establishment of a sense of proximity among dispersed team members is a promising strategy for practitioners to cope with the paradox that virtual teams require physical presence. As managers' preferred work modus and means to establish interpersonal bonds, face-to-face contact is not only controversial with regard to its consequence, but is also expen-

sive and time consuming (Dubé et al., 2008). Taken to an extreme, holding face-to-face meetings could actually remove the advantages that motivated the initial formation of the virtual team. A balanced use of technological support, a supportive organizational context, and a conscious use of face-to-face contact in the course of the project seems to be the best strategy to cope with this first paradox.

*Paradox 2 – the flexibility of virtual teams is aided by structural assurance*

Virtual teams are often praised for their flexibility in work arrangements realized in terms of the rapid acquisition of dispersed information, the orchestration of diverse ideas and expertise, and follow-the-sun development around the globe (Carmel & Agarwal, 2001). However, the results of this study consistently revealed the need for organizational practices that add structural assurance to support virtual teamwork and the perception of proximity (see chapters 4 and 6). Paradoxically, reaping the benefits of flexibility seems to require a great deal of structure in organizational systems and procedures, potentially threatening the effects of creativity, innovation, and responsiveness (Dubé et al., 2008). Thus, the challenge for managers is to support virtual team dynamics with structural assurance while maintaining their flexibility. In the following, strategies are proposed that may achieve this seemingly paradoxical objective:

- One way to give virtual team members a sense of stability and assurance is through the introduction of collaboration tools that foster intra-team collaboration, yet retain the team's flexibility. Owing to flexible work hours and time zone differences, members of a far-flung project team are notorious for being difficult to reach, making it impossible for them to react quickly to short-term needs. Shared team calendars and presence awareness tools are technology-based methods that have been developed to simplify cross-border collaboration (Kankanhalli et al., 2006). A shared team calendar, for instance, contains information about national holidays, time zones, and other important information about the different sites in which a team operates. With such tools it is easier to locate all members of the team quickly and to disseminate information accordingly. While these tools do not represent the holy grail of virtual collaboration, managers reported positive experiences with these tools in a follow-on workshop to this study.
- Another way to facilitate structural assurance while retaining flexibility begins with the selection of team members before the project starts. The requirement for both,



flexibility and structure, should be addressed by selecting team members accordingly. Team members who can cope with the ambiguities of flexible work and possess the ability to structure work flows are best-suited to simultaneously work with flexibility and structure (Staples et al., 2004; Staples et al., 2008b).

- In virtual environments with a lack of transparency and control, structural assurance may be provided by the team leader. Team leaders can initiate structure by insisting on the maintenance of standards, requesting that deadlines be met, and determining tasks and how these should be executed (Judge, Piccolo, & Ilies, 2004). On the other hand, team leaders can maintain flexibility through considerate behavior such as offering positive reinforcement of self-directed working and shared leadership (Pauleen, 2003). That is, team leaders are assigned the challenging task of finding a balance between the needs for flexibility and structure in virtual team collaboration.

In summary, the results of this study have shown that high performance in flexible, virtual team arrangements is most probable if structure is added. Consequently, practitioners are asked to formulate strategies that simultaneously fulfill the objectives of flexibility and structural assurance. While three suggestions are proposed above, it should be noted that the strategies formulated to cope with this second paradox may need to be detailed and adjusted if the team conditions change. Furthermore, the contextual effects on virtual team dynamics are likely to change from team to team, and team leaders have to react accordingly (Shin, 2004).

### *Paradox 3 – interdependent work in virtual teams is accomplished by independent sub-teams*

In interviews with managers before the data collection of this study, most interviewees reported that they expected – among others – their reliance on distributed team members to produce superior team effectiveness. However, research from various industrial sectors has shown that virtual teams often fall short of manager expectations. In practice, virtual teams collaborate by means of loosely coupled work arrangements that achieve project goals by adding individual efforts (Olson et al., 2000). Likewise, the results of this study revealed a prevalence of multi-team systems in which tasks are assigned to different sub-teams as indicated in Figure 7-3. Companies expect advantages from the modularization of R&D activities, so that chunks of the work can be done by offshore sub-teams whose working mode is predominantly face-to-face

(Sinha et al., 2005). But organizing virtual teams into independent, loosely-coupled collections of individuals has two sides. While the decomposition of tasks for execution by virtual software teams may achieve more co-located work arrangements within each sub-unit (Gorton & Motwani, 1996), it may also produce suboptimal results by motivating commitment to individual tasks instead of the project as a whole (Dubé et al., 2008). Thus, paradoxically, while virtual teams should function as knowledge integrating units (Alavi et al., 2002), they are often designed to reduce task interdependence between members as much as possible (Dubé et al., 2008). In the following, strategies are formulated that help to find a balance between the opposing needs for sub-team autonomy and interdependence:

- A first strategy to address this paradox is the definition of a team design that optimally balances the needs for co-location with the benefits of dispersion. As a pre-condition for such a team design, the team task has to be subdivided into different modules and worked on separately by co-located groups with a high intra-team interdependence. For this strategy to be successful, team leaders are challenged to guarantee high-level teamwork both within and between teams. Research on co-located teams consistently suggests that intra-team processes are best supported with more informal mechanisms such as social ties between team members (Balkundi & Harrison, 2006). For inter-team collaboration, however, research suggest that a formalized context with specified rules for interaction is the most effective (Montoya-Weiss et al., 2001). In particular, the overall group has to define milestones or hand-off points for which a considerable level of communication and coordination is required between sub-teams. The research by Grinter, Herbsleb, and Perry (1999) on dispersed product development teams at Lucent Technologies, for instance, showed that formal coordination mechanisms such as stable project plans, clear interfaces, formal handoffs, and product documentation are more effective for inter-team collaboration than informal ones. This finding provides further support for the second paradox that dispersed team collaboration is aided by structure.
- Despite the proven effectiveness of highly structured mechanisms for inter-team collaboration, unexpected and ambiguous events can cause severe problems for teams organized in such a modularized way (see also Grinter et al., 1999). When team members violate coordination mechanisms by, for example, missing deadlines, being absent from meetings, or sending incorrect documents, they further hinder efforts to

successfully facilitate interdependence. Thus, while formal mechanisms may be superior for coordinating work between members working on different sub-tasks in different locations, they are not immune to problems caused by uncertainty, misunderstanding, or a lack of monitoring (Hinds & Bailey, 2000). In these cases, dense networks of social relationships may be supportive beyond any formalisms (Burns & Stalker, 1961; Hinds & McGrath, 2006). Team members, for example, find it easier to contact people who work in a subsidiary many miles away if they know them, or at least know their colleagues (Armstrong et al., 2002a). Additionally, informal networks have been shown to be indispensable for the sharing of know-how, the application of tacit knowledge embedded in team members' functional expertise, and, hence, the facilitation of innovation (Obstfeld, 2005; Reagans, Zuckerman, & McEvily, 2004).

In summary, a strategy with which to confront the paradox of autonomy while being interdependent is to split the team task into separate chunks of work and to decouple the team design accordingly. This strategy is assumed to maximize opportunities when the right balance is found between the needs for co-location (where there must be dependence) and dispersed interaction (where efforts should be aligned). However, as the discussion shows, the decomposition of an overall team into various sub-teams necessitates a great deal of informal and formal coordination. In this study, this strong coordination effort has been shown to result in lower efficiency scores as illustrated in Figure 7-3. Thus, managers are well-advised to only choose such a complex team design after careful consideration of the costs, the benefits, and whether the scope of the project requires it (for an extensive review of costs and benefits of modularization see Brusoni, Marengo, Prencipe, & Valente, 2007).

#### *Paradox 4 – task-related teamwork succeeds through social interaction*

Work in virtual teams is often associated with an increased task focus and a corresponding reduction in socio-emotional interaction. The dominant task orientation is explained by virtual teams' reliance on virtual media and the more depersonalized interaction between remote team members (Jarvenpaa et al., 1998). As this research has shown, the increased task-focus of virtual teams seems to be best complemented by high-level, task-related team processes (chapter 5). However, prior research has shown that socio-emotional team processes are also necessary for virtual teams to establish a common ground for collaboration and to build personal bonds – a basis on which to establish high-level, task-related processes (Espinosa et al., 2006b).

However, in practice, team members were torn between getting on with the task and taking the time to develop important relational ties (Dubé et al., 2008). Owing to information and communication technology reducing the amount and richness of the information that could be exchanged, virtual teams had more difficulty completing relationship-building activities (Pauleen, 2003). Focused on task orientation through virtual communication demands, it appeared contradictory to take time to get to know one another. The following strategies may be effective in coping with this paradox:

- A first strategy to support socio-emotional processes without relying on face-to-face contact and without threatening task processes is to establish a sense of proximity among virtual team members. As has been shown in chapter 3, socio-emotional team processes are supported by facilitating perceptions of proximity among dispersed team members. This means that all actions described with respect to the first paradox, such as structural assurance and permeable organizational boundaries, should also promote socio-emotional team processes.
- A second strategy to support social interaction without losing the task focus begins before the project kick-off with the selection of team members. The development of social bonds can be bypassed by staff team members with a common work history. Team members who already know one another establish a common ground for successful collaboration right at the beginning of the project, instead of struggling with disruptive processes such as initial distrust (Muethel et al., 2007) or faultline dynamics (Lau et al., 1998). Drawing upon Tuckman's (1965) famous model to describe the team building process in four phases ('forming,' 'storming,' 'norming,' and 'performing') teams with a shared history are able to start working right at the performing stage. In addition to selecting members with past common experiences, organizations can facilitate communication effectiveness and the development of a common team identity by holding out the prospect of future or long-term collaboration (Walther, 1992). Anticipated future interaction has been shown to contribute to the relationships between telecommuting team members becoming more personal, which is an important requirement for high level task processes (Tidwell & Walther, 2002).

- Managers can also contribute to supporting the development of social bonds between team members by providing a context that promotes a global mindset, in which people regard themselves as a part of an international network. The establishment of a diversity-friendly environment is crucial for social relationship building, as national diversity has been shown to be a serious threat for socio-emotional team processes (chapter 3). It is therefore important for managers and team members to recognize and frame the organization in a global sense, communicating the global nature of the company's operations and markets. Human resource strategies such as temporary staff assignments at international locations and inter-cultural trainings may be helpful in complementing these organizational strategies (chapter 6).

In summary, task-related and socio-emotional team processes should not be viewed as an *either/or* for managers but rather as two cornerstones of virtual team success. Beyond task-related processes, it is also essential that all team members commit to the overall team goals, identify with the team, and actively support a team spirit; that is, sound social processes. Especially in teams with geographically distant team members, interpersonal differences can endanger the social stability of the team due to restricted coping possibilities. Such difficulties, in turn, prevent team members from fully contributing to task accomplishment and consequently jeopardize team performance. For a virtual team to realize the full potential inherent in its structural, cultural, and functional diversity, the members first and foremost need to stay together to establish a basis for the exchange of differing perceptions. Or, as Adler (2002: 148) stated: “diversity becomes most valuable when the need for the team to reach agreement (e.g., cohesion) remains low relative to the need to invent creative solutions.”

In conclusion, the presented managerial implications are derived from the results of this research and aim at answering the basic question of this dissertation: ‘how to optimally leverage dispersed team performance.’ This research demonstrated the ambivalent nature of virtual teams and made the inherent challenges involved in managing teams of telecommuting individuals salient. While this research showed the upside potential of virtual teams, practitioners working with virtual teams are seemingly confronted with paradoxes, which frequently prevent them from reaping these benefits. But instead of avoiding paradoxes by removing some of the characteristics that make teams virtual, a number of strategies have been defined that directly confront each paradox and offer ways to manage virtual teaming more effectively. Reviewing all proposed actions, it becomes apparent that managers have a considerable variety of possible

starting points to foster virtual team performance. These actions take place at different organizational levels and range from the establishment of a supportive environment for virtual collaboration to the support of coordinated human resource practices, effective team leadership, and opportunities for social contact between individuals.

However, practitioners should be aware of the strong effort that is needed to create a team context that optimally leverages virtual team performance. Thus, an important question for managers is whether this effort is worthwhile. While the outlined set of actions to increase virtual team performance is promising, it is unlikely to become a universally applied tool to increase virtual team performance. When staffing a new team, managers will not only consider the potential benefits of high-level teamwork in virtual team settings, but will also consider the costs of doing this. Hence, managers will, explicitly or implicitly, use a check list to guide their decision on how the team setup should be organized.

Some of the items that should be included in this checklist are (1) the motivation for building up the team, (2) the structure of the team task, and (3) the length of the project. If a work group is, for example, split up for cost reasons into one sub-team in a European headquarters and another in an Asian subsidiary working on rather independent sub-task, it may be best-practice to decouple the work, to install two team leaders, and to ascertain coordination via formalized mechanisms. But if the same team works on a complex task with highly interdependent sub-tasks for a longer time, the best strategy may be to follow the recommended procedures outlined above: facilitate high-level teamwork. While such a decision process is certainly not as mechanistic as exemplified here, it should give an impression of the complexity that managers face when making team design decisions. Future studies and practitioner reports will show whether the proposed actions formulated on the basis of new evidence from this research, meet managers' expectations of high-level virtual team performance.

## 10 Final Conclusion and Future Research

This dissertation is based on the research question on how virtual team performance can be leveraged. This question is more relevant than ever as companies increasingly staff their team members from locations throughout the world and in accordance with their know-how and expertise, regardless of their physical location (Staples et al., 2008b). However to date, managers have only been able to rely on spurious research knowledge regarding the optimal design of virtual work. This dissertation has therefore investigated how distributed teams can overcome the burdens of distance and, thus, increase their performance. By exploring the antecedents of virtual team performance, this study challenges some fundamental myths of virtual team functioning:

The first myth pertains to managers' conventional wisdom that team performance suffers with increasing levels of dispersion (Kirkman et al., 2005). Dispersion is therefore often viewed as a liability rather than an opportunity. However, this research has shown that dispersion can create considerable opportunities if dispersed teams are set up and managed in the right way. Specifically, dispersed teams with superior task processes can outperform co-located teams with the same level of processes. This result calls into question the common practice of staffing teams solely on the basis of the team members' expertise and availability, instead of further considering the team's ability to establish sound team processes.

As a second myth, managers believe that the provision of technological equipment is the missing link that virtual teams need to collaborate effectively across distance (Kozlowski et al., 2006; Olson et al., 2000). However, while the potential of technological systems to enhance team-interaction effectiveness is not negligible, this study has revealed that virtual teams face significant challenges despite their access to technology. It seems that access to technology is a precondition for dispersed team collaboration rather than a sufficient precondition to fully close the physical gap in distributed teams (Fiore et al., 2003). Instead, teams first and foremost need to establish high levels of teamwork across distance. In this respect, technology seems to have a more indirect link to virtual team performance by facilitating high levels of teamwork. Thus, the technological development of complex communication tools should not outstrip a team's behavioral integration as is often the case (Kozlowski et al., 2006).

A third myth refers to managers' widespread belief that good collaboration is only possible if costly and time consuming activities support team interactions such as frequent travels to

meet face-to-face (Espinosa et al., 2006b). Manager beliefs are often predicated on the assumption that dispersed teams offer many advantages to organizations, but that dispersion itself is negative and face-to-face interaction is the gold standard (Geber, 1995). However, this research suggests that the perception of distance is more significant for virtual team interaction than physical distance, and that managers have various instruments at hand to manage distance perceptions effectively. A well-designed organizational context has been specifically shown to be effective for the development of proximity perceptions despite physical distance.

Finally, managers are often convinced of the myth that the negative aspect of distance is distance. In follow-on workshops to this study, practitioners tended to interpret the problems of virtual team collaboration unilaterally with regard to its geographic dimension. However, this study has echoed prior research and showed that national diversity is closely linked to geographic distance and exerts unique effects on virtual team dynamics (Cummings et al., 2008). Thus, the challenge in virtual teams is not only to bridge geographic distances, but also to manage diversity. Only management approaches that take both spatial distance and demographic heterogeneity into consideration can deal with the complexity of virtual teams' reality.

In addition to these managerial implications, the present research offers several contributions to the existing research on virtual teams and paves the way for future research endeavors. As a first contribution, this study has empirically shown that the conceptual and empirical significance of perceived distance is a new construct in virtual team research (Wilson et al., 2008). Broadening dispersion by means of its subjective dimension does not only enrich scholars' theoretical understanding of distance, but may also help to reconcile the inconsistent and conflicting findings regarding the effect of distance on processes and performance (see chapter 5). Second, this research has examined the conditions under which dispersion can be beneficial and detrimental for team performance. Specifically, the current work has provided insight into the ongoing dispersion-performance debate in that it has identified teams' task processes as the critical link for superior virtual team performance. Third, the organizational context has been addressed as a widely neglected input variable of virtual team dynamics in this research. The results have shown that the organizational context sets the stage for the perception of proximity as well as for high-level, dispersed collaboration. By adopting this cross-level perspective on virtual team dynamics, the current research does not only enrich scholars' understanding of the conducive or obstructive characteristics of the virtual team environment, but also paves the way for more theoretical insight into virtual team dynamics.



With regard to future research on dispersed team functioning, there are several issues that should be addressed to complement this study. Additional research endeavors are necessary, for instance, to explore the cognitive and affective dimensions of physical distance in more detail. While this research is a first step in this regard, the extent to which the consequences of geographic dispersion are due to reduced feelings of proximity (Wilson et al., 2008), demographic diversity (Van Knippenberg et al., 2007a), unshared context (Zellmer-Bruhn et al., 2006), weakened social impact (Latane, Liu, Nowak, Bonevento, & Zheng, 1995), and other factors that undermine effective teamwork at a distance (Cummings, 2007) is still unclear. There are certainly more complex and interactive paths at work when geographic dispersion unfolds its effect and future research may provide an important contribution by disentangling the magnitude and mechanisms of these different paths.

Finally, the focus of future research should be extended from single-level research to multi-level investigations. Although there are notable exceptions, research to date largely relies on one level of analysis. Future team models would do well by paying greater attention to the role that the context as well as the individual plays in shaping dispersed team processes and effectiveness. Furthermore, the conceptual approach used in this research to identify possible levers of virtual team performance begins by addressing the direct liabilities of dispersion (see Figure 7-1). This research focus has revealed that overcoming distances' liabilities ('perceived distance,' 'impaired team processes,' and 'unshared context') can lead to superior performance in virtual teams. However, there is still much to learn about how these starting points to virtual team performance can be optimally managed by HRM concepts such as virtual team leadership or specific incentive systems. These and many other areas of future research will help to piece together the puzzle of virtual team performance and its antecedents.

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