The joint relationships of communication behaviors and task interdependence on trust building and change in virtual project teams

Abstract. The study presented in this article examined how specific communication behaviors among team members interacted with task interdependence in relation to the building and changing of trust within 53 virtual project teams. At the mid-point of the teams’ projects, our results showed that task-oriented communications among team members related significantly to trust, and that communications conveying enthusiasm related to trust only under conditions of low task interdependence. At the end of a team’s project, trust among team members related positively to predictability of communications and substantive responses under higher levels of task interdependence. These findings develop extant trust theory in virtual teams, suggesting some useful guidelines to better understand and manage trust processes.

Key words. Communication behaviors – Task interdependence – Trust – Virtual teams

Résumé. Cette étude se propose d’examiner comment, dans 53 équipes de projets virtuels, les comportements spécifiques de communication entre les membres d’une équipe interagissent avec l’interdépendance des tâches et sont corrélés à la construction de la confiance. Les résultats montrent, qu’à mi-parcours du projet, les communications entre les membres de l’équipe axées sur la tâche sont liées de manière significative à la confiance. Les communications qui transmettent de l’enthousiasme ne sont liées à la confiance que dans des conditions de faible interdépendance des tâches. En fin de projet, la confiance entre les membres de l’équipe est...
During the last two decades, organizations have been innovating, diversifying activities and collaborating at a growing rate in response to the increasing requirements of the competitive global market. These demands, which are linked to the technological developments that allow long-distance communication and remote collaboration, have created the appropriate conditions for organizations to adopt structural designs based on teams that operate with different degrees of virtuality (Townsend, DeMarie & Hendrikson, 1998; Snow, Lipnack & Stamps, 2001; Kirkman & Mathieu, 2005).

Virtual teams are made up of people whose interaction is mediated by different information technologies (e.g. email, videoconferencing, groupware), which allow them to work together while separated across space and time. Virtual teams have clear advantages for organizations, such as capitalizing sparse talent and saving travel between sometimes-distant places (Kirkman et al., 2002; De Rosa et al., 2004).

Nevertheless, virtual teams have to cope with a task context characterized by the lack of opportunities to physically meet teammates and share experiences or reciprocal disclosure. Meanwhile they used to be temporary units, which means team members have little experience of working together and the scope for such collaboration is limited, and they lack a common past or future (Jarvenpaa & Leidner, 1999; Wong & Burton, 2001; Baskerville & Nandhakumar, 2007; Bosch-Sijtsema, 2007). Consequently, virtuality challenges team coordination and the establishment of social capital through personal relationships between team members (Oh, Chung & Labianca, 2004), making it necessary to overcome cultural and communication barriers through the use of new communication technologies (Gibson & Manuel, 2003; Martins, Gilson & Maynard, 2004).

In this task context, trust building has been identified as a critical process for virtual team effectiveness (Handy, 1995; Rousseau et al., 1998; Dirks & Ferrin, 2001; Aubert & Kelsey, 2003). Trust is defined as the willingness of a team member to be vulnerable to the actions of other team members based on the expectation that they will perform an action that is important for the trustor irrespective of his/her ability to monitor or control developments (Mayer,
Davis & Schoorman, 1995). Trust has a strong influence on interpersonal and team behavior (Golembiewski & McConkie, 1975), represents a basic source of social capital (Adler & Kwon, 2002), and facilitates knowledge sharing and collaboration in virtual contexts (Newell, David & Chand, 2007). In addition, trust and social capital are the core ‘social characteristics’ of different types of knowledge creation and transfer activities (Smedlund, 2008).

Previous research on trust development in teams points to risk perceptions and interdependence as basic antecedents of trust (Rousseau et al., 1998). The main source of risk in virtual team settings is ‘behavioral invisibility’ (Wilson, Strauss & McEvily, 2006). This invisibility is channeled through communication technologies that mediate team-member communications. Thus communication behaviors (Jarvenpaa & Leidner, 1999) are a key antecedent for trust building between team members (Butler & Cantrell, 1994; Gibson & Manuel, 2003; Coppola, Hiltz & Rotter, 2004; Wojnar & Uden, 2005).

In addition, trust development requires interaction and information exchange (Gibson & Manuel, 2003), pointing to task interdependence as another key antecedent. Task interdependence is defined as the degree to which team members’ task performance depends on the efforts and skills of others to attain their goals (Campion, Medsker & Higgs, 1993; Wageman & Baker, 1997). It increases interaction and information-exchange needs between team members (de Jong, van der Vegt & Molleman, 2007), and has been positively related with trust in teams (Dirks & Ferrin, 2001).

A proper understanding of team trust also requires the analysis of patterns of team interaction over time (Tyler & Kramer, 1996; Hinds & Bailey, 2003), because (1) time is a conduit for communication (Harrison et al., 2002); (2) mid-point team transitions change team structures (Gersick, 1988, 1989); and (3) the factors and processes by which trust is built are not necessarily the same in the different phases of team development (McKnight, Cummings & Chervany, 1998; McKnight & Chervany, 2006).

In light of the above, trust in virtual teams may be properly addressed by examining how communication behaviors associated with trust building and change (Jarvenpaa & Leidner, 1999) interact with task interdependence over time. To the best of our knowledge, this research question remains unexplored. Our study aims to fill the gap, contributing to trust theory and research in virtual teams. Taking earlier work by Jarvenpaa & Leidner (1999) and Jarvenpaa, Shaw & Staples (2004) as our starting point, we examine how specific communication behaviors (task- and socially oriented communication, enthusiasm, predictable communication and substantive responses) interact with task interdependence to impact trust building and change in virtual project teams (VPTs). In doing so, we carried out a cross-sectional quasi-panel study with 53 software development VPTs in a software multinational operating in Latin America.
Background and hypotheses

Communication behaviors, trust building and change in virtual project teams

Communication is at the core of any virtual team process (Powell, Piccoli & Ives, 2004) and is a key antecedent of trust building in virtual teams (Williams, 2001; Gibson & Manuel, 2003). Prior research on trust formation has been built on attribution theory, which assumes the role of trust in reducing uncertainty in social perceptions and allowing collaborative efforts among team members. Different approaches have been used to unpack trust development. While McKnight, Cummings & Chervany (1998) centered on the role of situational factors and trustor characteristics as antecedents, Dirks & Ferrin (2001) considered the consequences of trust. Building on these approaches, the proposals of Jarvenpaa & Leidner (1999) and Jarvenpaa, Shaw & Staples (2004) have focused on the process of trust development itself, taking swift trust (Meyerson, Weick & Kramer, 1996) and especially the punctuated-equilibrium model of team development (Gersick, 1988) as the basic foundations for explaining how trust emerges and lasts in teams that operate virtually.

Gersick’s punctuated-equilibrium model proposes that the way a project team approaches its project presents two stable periods of activity interrupted by a short transition period that is triggered by the mid-point in project completion. The first stable period that occurs before the transition period is characterized by the adoption of a fixed action course, with little discussion and clarification about team plans, roles and goals. Team members have different understandings of common goals, and they do not properly connect new information and ideas with the execution of the team task. After the transition, members become more conscious of the need to make progress toward the goal, since an important part of the time available has been consumed. Team discussions about performance expectations and goals establish shared goals and stronger work structures, allowing members to refocus their efforts on project task requirements. This pattern has been found in teams operating in lab contexts and in real work settings (Gersick, 1988, 1989).

Within this framework, the findings obtained by Jarvenpaa & Leidner, in a qualitative study with newly formed student teams, suggest that trust can be imported but that it is also created through communications among team members. In addition, they found specific communication behaviors that allow trust building during the first stable period of team development and trust maintenance in the second stable period. Early on (from the project starting-point to one week before the project mid-point), the communication...
behaviors associated with trust are characterized by a combination of socially and task-oriented communications and the conveyance of enthusiasm. Later on (from the project mid-point to the project end), communication behaviors associated with trust are those that create a sense of predictability in the interaction (through regular patterns of communication and appropriate warning of absences) and offer substantive responses. However, these findings have not been tested in VPTs in field settings, although results from a later study (Jarvenpaa, Shaw & Staples, 2004) support the critical link between communication behaviors affecting trust early on in the VPT’s lifecycle and the role of time in trust building. Thus our main research goal is to challenge the temporary pattern of relationships found by Jarvenpaa & Leidner in organizational VPTs, while considering the potential moderating role of task interdependence.

Effects of socially oriented vs. task-oriented communication behaviors on trust early on. Communication in a team can be task or interpersonally oriented, because team members satisfy social and goal accomplishment needs through membership. Both of these needs are critical for the continued maintenance of the team (Fiedler, 1964; McGrath, 1991). Task-oriented communication helps cope with task demands early on and avoid unnecessary ‘process losses’ (Steiner, 1972). Task-oriented communications also create a base from which to develop and review our assumptions about others, especially regarding the ability of our partners (Mayer, Davis & Schoorman, 1995), which is essential for trust. Prior research suggests that social communication that complements rather than substitutes task-oriented communication may strengthen trust (Jarvenpaa & Leidner, 1999). Members of VPTs presenting both socially and task-related communication patterns tend to devote time to team wellbeing and support (McGrath, 1991), helping smooth progress over problems and conflicts. In addition, socially oriented communication encourages collaboration and mutual support (Levine & Moreland, 1990), reinforcing the team’s capacity to cope with task demands and building a true circuit of positive feedback. Accordingly we make the following hypotheses:

Hypothesis 1a: Task-oriented communications will be positively related to trust before the mid-point of a VPT’s project completion.

Hypothesis 1b: Socially oriented communications will be positively related to trust before the mid-point of a VPT’s project completion.

Effects of enthusiastic communication on trust early on. Communication behaviors that convey enthusiasm create a kind of ‘social gravity’, which encourages team members to interact and fosters a sense of common identity. Research has shown that behaviors contributing to a sense of community in virtual teams (e.g. exchanging support, creating identities, reinforcing members’
self-concept) are similar to those found in non-virtual teams (McKenna & Green, 2002; Blanchard & Marcus, 2004). Considering that trust is effectively established through mechanisms that increase social interaction (Baskerville & Nandhakumar, 2007), enthusiasm may fuel trust in VPTs.

Communicating with enthusiasm is a sign of involvement, attachment and affection (Jarvenpaa & Leidner, 1999). In the social-cues-lean environment of virtual teams, expressing enthusiasm will reinforce reciprocity and establish the appropriate information flow, which creates a trusting environment (Das & Teng, 1998). Consequently, we posit that:

**Hypothesis 1c**: Enthusiasm of communication will be positively related to trust before the mid-point of a VPT’s project completion.

**Effects of predictable communication on trust later on.** Predictability of communication is a key dimension that fosters trust (Kasperperson, Golding & Tuler, 1992) and allows virtual teams to perform effectively (Maznewski & Chudoba, 2000). Predictable communication in a VPT creates a sustained interaction pattern that holds team members together (Gibson & Manuel, 2003), enabling strong feelings of affection for others (Lawrence & Mongeau, 1996). More importantly, predictability can prevent trust decline upon the completion of team projects, because it helps to properly attribute others’ intentions. Past research supports this prediction by: (1) showing how team members’ failure to do what is expected of them during the later phases of a project causes trust to decline dramatically (Piccoli & Ives, 2003); (2) revealing that irregular and unpredictable communication inhibits trust later on in VPTs’ lives; and (3) demonstrating that teams that keep a high level of trust manage their communications in a predictable pattern during the crucial project periods (Jarvenpaa & Leidner, 1999). Thus a predictable communication pattern seems to be important in understanding change in trust as a VPT moves toward completion of its project (Meyerson, Weick & Kramer, 1996). Accordingly we posit that:

**Hypothesis 2a**: Predictable communication will be positively related to trust change at the end of a VPT’s project completion.

**Effects of substantive communication on trust later on.** Effective decision-making has been related to the engagement of team members in substantive communications (i.e. responses that are detailed and elaborated enough to help team members contribute to others’ work), enabling teams to constructively address conflicts (Gouran, 2003). Past research on VPTs has revealed that the key differences between teams that reach a high level of trust through project completion and those that do not are the amount of explicit and prompt feedback and the substantive responses that team members receive
about their contributions (Jarvenpaa & Leidner, 1999). These differences have also been supported by recent research evidencing partial mediation of interpersonal trust on the feedback–performance link (Geister, Konradt & Hertel, 2006). Where electronic media provide delayed, scarce feedback during the work process, there is an ‘intense need of response’ (Hawisher & Moran, 1993), which can be satisfied by responding substantively to others’ messages. Furthermore, these responses will be especially effective in collecting evidence about others’ credibility (Gibson & Manuel, 2003) and in developing a common understanding between team members (Olson & Olson, 2001). Thus substantive responses help enhance levels of team trust (Geister, Konradt & Hertel, 2006). Therefore, we expect that:

Hypothesis 2b: Substantive communication will be positively related to trust change at the end of a VPT’s project completion.

Communication behaviors, task interdependence, trust building and change in virtual project teams

Developing trust requires opportunities to interact and exchange information, which depends on team task-interdependence levels (Gibson & Manuel, 2003). Recent research (de Jong, van der Vegt & Molleman, 2007) has shown that task interdependence is a key characteristic of trust development (Rousseau et al., 1998). High task interdependence relates to increasing needs for communication, coordination, mutual adjustment and common decisions (Guzzo & Shea, 1992), creating an appropriate work environment for trust building in VPTs (Wilson, Strauss & McEvily, 2006). On the contrary, low task interdependence has been related to low trust in teams (Langfred, 2007). Past research suggests that members of virtual teams cope with coordination threats by reducing interdependence (Galegher & Kraut, 1994). This foments a low-trust environment where members limit risky interactions by reducing task interdependence with potentially unreliable teammates (Jones & George, 1998). The pattern causes a vicious circle in which low levels of interdependence restrict interaction, and this in turn inhibits opportunities to trust development (Wilson, Strauss & McEvily, 2006).

In this study, we argue that task interdependence will amplify the effects of communication behaviors on trust in VPTs over time. Virtual interactions lack critical non-verbal social-context cues (Culnan & Markus, 1987). Social-presence theory predicts that people working in highly virtual teams experience psychological and relational distance from their co-workers because the social salience of others is drastically reduced (Short, Williams & Christie, 1976). Consequently team members may experience social
isolation (Straus & McGrath, 1994; Cascio, 2000) and encounter difficulties in projecting themselves socially into the team (Rourke et al., 2001).

Given the relational consequences of task interdependence in terms of cooperation and interaction requirements, it will reduce members’ feelings of isolation by increasing social presence and attention to others’ behaviors. As Woods & Baker (2004) noted, interdependent work in virtual contexts increases opportunities for positive ‘social penetration’ encompassed by greater breadth and depth of social information exchange (Taylor & Altman, 1987). The increased social interaction baseline helps VPTs create a shared perception of social connectedness among team members, thus raising trust levels. The impact of communication behaviors on trust should therefore be higher under high task-interdependence conditions.

To sum up, we propose that the relationships we have posited between socially oriented, task-oriented and enthusiastic communications and predictable and substantive responses on trust levels early and later on in a VPT’s project completion will be stronger when the team operates with high task interdependence. Stated formally:

Hypothesis 3: Team task interdependence will moderate the effects of communication behaviors on trust at different points of a VPT’s project completion:

– Before the mid-point of a VPT’s project completion, the relationships of socially oriented (H3a), task-oriented (H3b) and enthusiastic communications (H3c) on trust will be stronger when task interdependence is high than when task interdependence is low.

– At the end of a VPT’s project completion, the relationships of communication predictability (H3d) and substantive responses (H3e) on trust will be stronger when task interdependence is high than when task interdependence is low.

Method

Procedure and sample

Data were collected from 53 VPTs, which included 187 professional, paid employees from a multinational software development firm operating in Latin America. Teams were in charge of developing software solutions for end-user clients operating, inter alia, in the electronics, energy and food sectors, as well as in government agencies. All teams were located in the same country, although members worked together through the use of communication technologies. The sample was 29% female, and 82% South American. The average age was 29.04 years (s.d. = 9.21), and average job tenure was 6.43 years (s.d. = 5.73). Participants were contacted through personal contact with the firm’s geographical supervisor. Teams were invited at the
beginning of their projects to participate via email and a link to our research questionnaires, which were posted on the firm’s intranet. Following Jarvenpaa & Leidner’s study, we used a cross-sectional quasi-panel research design, which requires the measurement of different variables at different time points: at project beginning, before project mid-point and after project accomplishment (see Table 1).

**Measures**

Responses were rated on a five-point scale ranging from ‘completely disagree’ (1) to ‘completely agree’ (5), and were averaged to form unitary variable scores.

*Task interdependence* was measured using van der Vegt & Janssen’s (2003) self-report five-item scale. A sample item is: ‘Employees in this unit need information and advice from their colleagues to perform their jobs well’ ($\alpha = .89$). This variable was measured twice – at the project mid-point and the project end – to analyze its potential moderating effects in different project periods.

*Communication behaviors* were measured using five different three-item scales. The items had been generated and validated in a previous study (Hadjimihisostos & Rico, 2003), based on Jarvenpaa & Leidner’s qualitative work. Confirmatory factor analyses (CFA) using Amos 6 were performed on these scales using Unweighted Least Squares (ULS) discrepancy function. Considering the ordinary nature of the items, we chose this function because it is not built on the assumption of multivariate normality of data. The measurement model distinguishing between the five factors showed $\chi^2 = 148.56$ (d.f. = 80, $p < .01$). However, the ratio of $\chi^2$/d.f. = 1.85 indicated a good fit (Wheaton et al., 1977). Additional fit indices from the CFA showed that the measurement model had a reasonable fit to the data: Goodness of Fit Index (GFI) = .90; Parsimony Normed Fit Index (PNFI) = .69; Root Mean Squared Error of Approximation (RMSEA) = .06. Examples from the different scales

<table>
<thead>
<tr>
<th>Project start</th>
<th>Before project mid-point</th>
<th>Project end</th>
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<tbody>
<tr>
<td>Team size</td>
<td>Trust 1</td>
<td>Trust 2</td>
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<tr>
<td>Trustworthiness</td>
<td>Task interdependence 1</td>
<td>Task interdependence 2</td>
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<td>Project length</td>
<td>Socially oriented communications</td>
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<td>Enthusiasm</td>
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**Table 1**

Measures and data collection timeline

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<tr>
<th>Project start</th>
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are: task-oriented communication – ‘From the beginning, our communications were centered on the task’ ($\alpha = .82$); socially oriented communication – ‘Our communications regarding this project incorporated personal issues (leisure time, family…)’ ($\alpha = .75$); communication enthusiasm – ‘Our messages regarding our activity were full of optimism’ ($\alpha = .78$); predictable communication – ‘Our communication followed a pattern that allowed us to know when the other team member would respond’ ($\alpha = .89$); and substantive communication – ‘The responses we received from other team members were enough to let the team advance’ ($\alpha = .73$). Appendix 1 shows all the items for all the scales.

*Trust.* Schoorman, Mayer & Davis’s (1996) four-item scale was used to measure trust. An sample item is: ‘I would be comfortable giving the other team members complete responsibility for the completion of this project’ ($\alpha = .72$). This variable was also measured twice – at the project mid-point and the project end – to examine its variation in different project periods.

*Control variables.* We controlled for the potential effects of team size and project length, trustworthiness and virtuality perception on trust. Team size was controlled because it has been related to cognitive and affective team processes (Amason & Sapienza, 1997) such as conflict, which may affect trust levels. Team size was measured by the number of members comprising each team, and project length by the number of weeks the project takes to be completed. Although Gersick (1988) found that the punctuated-equilibrium model was supported independently of the project length, we controlled for this variable in our analyses as an additional precaution in view of the great variability observed.

We also controlled for trustworthiness, because this variable can affect initial levels of trust within the team early on (Meyerson, Weick & Kramer, 1996; Jarvenpaa, Shaw & Staples, 2004). Trustworthiness is an attribute of the trustee target, which determines the degree of trust (Mayer, Davis & Schoorman, 1995). It is thus a belief that precedes trust (McKnight, Cummings & Chervany, 1998). We focused on trustworthiness as it captures members’ belief in the trustworthiness of the team before it starts work. Trustworthiness was measured at the beginning of the project, using the six-item scale developed by Pearce et al. (1992). An example is: ‘I will be able to rely on those I work with in this team’ ($\alpha = .81$). Finally, although all teams considered themselves to be virtual, we controlled for degree of virtuality by means of Gibson & Cohen’s (2002) modified scale, which measures the use of different communication media in terms of reliance on them. The scale makes it possible to quickly rank a team on a scale from less to more virtual. This variable was measured only at the project end to identify the final team perception of virtuality.
Aggregation data

All scores were averaged to create team-level variables. In line with prior research, we followed a consistency-based approach (computation of the Intraclass Correlation ICC(1)), representing the amount of individual-level variance due to group membership, in combination with a consensus-based approach (computation of $AD_{MJ}^J$ index), representing a direct measure of within-team variability. Table 2 shows that the ICC(1) means were above the .25 acceptable level, and the values of the $AD_{MJ}^J$ were below the .83 acceptable level (González-Roma, Peiró & Tordera, 2002). In addition, all ICC(2) values (i.e. measuring whether groups can be differentiated from each other in the variables assessed) were above the suggested cutoff (Bliese, 2000). We also conducted a one-way ANOVA, predicting each variable score on the basis of team membership (see Table 2). This showed that the different scales discriminate sufficiently between teams. Taken together, these results suggest that the scales present an adequate within-team agreement and between-team differentiation to be aggregated to the team level.

Analysis

We conducted hierarchical multiple regression analyses to test our hypotheses and used change in the amount of variance explained ($\Delta R^2$) to test the interaction effects (Cohen et al., 2003). All independent variables were standardized to reduce potential multicollinearity and to facilitate interpretation.
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<tr>
<th></th>
<th>Mean</th>
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<tr>
<td>13. Trust T2</td>
<td>3.22</td>
<td>.92</td>
<td>−.14</td>
<td>.08</td>
<td>−.11</td>
<td>.05</td>
<td>.27</td>
<td>−.11</td>
<td>.14</td>
<td>.32*</td>
<td>.25</td>
<td>.35*</td>
<td>.13</td>
<td>.09</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01. Note. T1 indicates values obtained at project mid-point. and T2 indicates values obtained at project end.
Results

Table 3 presents means, standard deviations and zero-order Pearson correlations between the study variables. To test our hypotheses, we ran two different linear regression analyses. The first was aimed to test Hypotheses 1a, 1b, 1c and 3a by regressing socially oriented, task-oriented and enthusiasm communications and their interactions with task interdependence on trust early on (before the project mid-point), while controlling by team size, project length, virtuality and trustworthiness (see Table 4). Results show that, early on, socially oriented and enthusiasm communications do not have direct effects on trust. This does not support Hypotheses 1b and 1c. On the contrary, task-oriented communication is strongly related to trust at Time 1. This result provides support for Hypothesis 1a.

Regarding the hypothesized interactive effects, results show that the effects of enthusiastic communication on trust depend only on task interdependence early on. Thus enthusiastic communication relates positively to trust early on when teams perform at low levels of task interdependence and negatively when teams perform at high levels of task interdependence (see Figure 1). In short, we did not find support for Hypotheses 3a, 3b and 3c.

Although we did not formulate a specific hypothesis on the effect of trustworthiness on trust before the mid-point project transition, our results
indicate a significant positive relationship between these variables. In addition, task interdependence is not related to trust before the project mid-point.

Our second regression model can be considered a statistic-score or conditional-change panel model (Finkel, 1995). In this model, the regression coefficient estimating the relationship between communication predictability and substantive responses on trust all measured at the project end, while controlling for the stability effects of trust measured before the project mid-point, can be interpreted as the relationship between our predictors and change in the criterion (trust) over time (Finkel, 1995). In addition we controlled for trustworthiness because it was a clear predictor of trust before the project mid-point. Thus the results indicate that communication predictability is positively related to trust later on (see Table 5). This finding supports Hypothesis 2a. However, contrary to Hypothesis 2b, substantive responses are not related to trust later on.

Regarding the interactive effects posited, the results do not reveal a moderating effect of task interdependence on the relationship between communication predictability and trust later on. Thus Hypothesis 3d was not supported. However, the results show the expected moderating effect of task
interdependence on the relationship between substantive responses and trust later on. Substantive communication relates positively with trust change only when task interdependence is high (see Figure 2). This provides support for the augmentative effect predicted in Hypothesis 3e.

Overall, our results indicate that, at the project end after controlling for initial levels of trust and trustworthiness, the predictability of communications and the substantive responses under high task interdependence lead to a positive change in trust between the mid-point and the end of the virtual project completion. Interestingly, the results also show that task interdependence relates to trust at the project end, and that trustworthiness and trust early on do not predict trust later on.

Complementary analysis

Following Jarvenpaa & Leidner’s findings, we do not explicitly state hypotheses regarding the effects of enthusiastic, task- and socially oriented communications on trust change later in the project. However, to explore the relationships of those communication behaviors with change in trust levels from the mid-point to the project end, we regressed the predictors and their interactions with task interdependence before the project mid-point on team

**TABLE 5**

Regression analysis for communication behaviors and task interdependence on trust at the end of project completion

<table>
<thead>
<tr>
<th>Steps and variables</th>
<th>β</th>
<th>F</th>
<th>R²</th>
<th>ΔR²</th>
<th>VIF</th>
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</thead>
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<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team size</td>
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<tr>
<td>Project length</td>
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<td>.04</td>
<td></td>
<td>1.04</td>
</tr>
<tr>
<td>Virtuality</td>
<td>−.09</td>
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<td>.03</td>
<td></td>
<td>1.03</td>
</tr>
<tr>
<td>Trustworthiness</td>
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<td></td>
<td>1.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust time1</td>
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<td>1.19</td>
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<tr>
<td>Overall</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication predicability (CP)</td>
<td>.46*</td>
<td>.27</td>
<td>.23**</td>
<td>2.15</td>
<td></td>
</tr>
<tr>
<td>Substantive responses (SR)</td>
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<td></td>
<td></td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>Task interdependence 2 (TI2)</td>
<td>.42**</td>
<td></td>
<td></td>
<td>1.28</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP X TI</td>
<td>−.14</td>
<td>.47</td>
<td>.19**</td>
<td>2.37</td>
<td></td>
</tr>
<tr>
<td>SR X TI</td>
<td>.40*</td>
<td></td>
<td></td>
<td>2.18</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05; **p < .01.
trust at the project end, while controlling for previous levels of trust and trustworthiness. Interestingly, results show that task-oriented communication is positively related, while enthusiastic communication is negatively related, to trust over time (see Table 6). Neither social-oriented communication nor interactive effects with task interdependence before the project mid-point predicts trust when comparing measures taken early on and later.

Discussion

In this study, we examined the relationships between specific communication behaviors, and trust building and change in VPTs, as well as the moderating role of task interdependence on these relationships. We found mixed support for our hypotheses regarding the main effects of communication behaviors. The results showed that: (1) trust before the project mid-point is associated with task-oriented communications and, contrary to our expectations, with enthusiastic communications but only when task interdependence is low; and (2) trust from mid-point to project end is positively associated with predictable communication and with substantive communications when task interdependence
is high. As an extension of our initial hypotheses, additional analyses indicate that trust later on is also positively associated with task-oriented communication and negatively with enthusiastic communications occurring before the project mid-point. These findings contribute in several ways to advance current theory and research on trust by providing evidence for the communication mechanisms that enable VPTs to establish trust over the course of a project.

First, our findings extend and refine prior research on trust. Contrary to Jarvenpaa & Leidner’s work, we did not find that trust in organizational VPTs is built before the mid-point of a project’s completion from socially oriented communication, but rather from task-oriented communication. Differences in the samples used in these studies (student/field teams) may partially explain these differences. It is likely that organizational settings place a premium on task-oriented communication, enabling teams to perform quickly. In addition, task-oriented communication is a rich source of information regarding teammates’ abilities. This information can be the main driver of initial trust formation in a team (Aubert & Kelsey, 2003). The observation that task-oriented communication early on is positively related to trust later on extends Jarvenpaa & Leidner’s findings. This calls our attention to the importance of task-oriented communication for project teams, and the role that competence-based trust updated around competent work performance (Barber, 1983) plays in trust levels over time. Furthermore, our results partially support Jarvenpaa &

### TABLE 6

Regression analysis for communication behaviors before mid-point project completion and task interdependence on trust at the end of project completion

<table>
<thead>
<tr>
<th>Steps and variables</th>
<th>$\beta$</th>
<th>$F$</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>1.02</td>
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<tr>
<td>Project length</td>
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<td>1.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtuality</td>
<td>-.09</td>
<td>1.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trustworthiness</td>
<td>-.01</td>
<td>1.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust time 1</td>
<td>.12</td>
<td>1.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>2.14*</td>
<td>.30</td>
<td>.25**</td>
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<td></td>
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<td>Socially oriented communication (SOC)</td>
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<td>Task-oriented communication (TOC)</td>
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<td>1.73</td>
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<td>Enthusiastic communication (EC)</td>
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<td>1.64</td>
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<td>Task interdependence 1 (TI1)</td>
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<td>1.36</td>
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<td></td>
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<tr>
<td><strong>Step 3</strong></td>
<td>2.73*</td>
<td>.45</td>
<td>.15*</td>
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<td></td>
</tr>
<tr>
<td>SOC X TI</td>
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<td>2.21</td>
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<td>TOC X TI</td>
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<td>1.18</td>
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<td></td>
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<td>EC X TI</td>
<td>-.26</td>
<td>2.70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05; **p < .01.
Leidner’s work regarding the impact of communication behaviors on trust at the project end. We found support only for the relationship between communication predictability and trust later on. This is consistent with prior research showing the importance of predictable communication patterns for trust maintenance in VPTs, especially during the later stages of a project (Maznewski & Chudoba, 2000; Piccoli & Ives, 2003).

Second, our results reveal the key role of task interdependence in trust building (Rousseau et al., 1998). Task interdependence has not only direct but also moderating effects on the relationship between enthusiastic and substantive communications and trust at different times. In line with prior work (Ferrin & Dirks, 2003; de Jong, van der Vegt & Molleman, 2007; Langfred, 2007), task interdependence later on predicts trust over time. The lack of relationship between task interdependence and trust early on can be explained by the role played by trustworthiness before the project mid-point transition. This unexpected finding clearly deserves more research. Further, the moderating role that task interdependence exerts over enthusiastic communication and substantive responses provides a more contingent view of the impact of task characteristics on trust in VPTs. In this regard we based our arguments on the potential increments in the levels of social presence and social penetration that high interdependence has on team operations. However, the unexpected relationships we found for enthusiastic communications – both early and later on – make us wonder if these relational effects are interpreted in different ways by different team members, which turns our attention to attribution theory. In contrast to student VPTs, organizational VPTs can consider high enthusiasm distilling from co-workers’ communications as distracting, inappropriate or even suspicious. As others have found, some actions that are supposed to increase trust, such as delegating authority, can have the opposite effect (Piccoli & Ives, 2003; Wilson, Strauss & McEvily, 2006). Following Serva, Fuller & Mayer’s (2005) reflections, we believe that progress toward a more nuanced understanding of trust dynamics in teams requires supplementing the observation of specific behaviors with close attention to parties’ perceptions of these behaviors.

Finally, the results support our underlying assumption that time plays a critical role in understanding trust in VPTs (Gibson & Manuel, 2003; Jarvenpaa, Shaw & staples, 2004; Serva, Fuller & Meyer, 2005; Wilson, Strauss & McEvily, 2006). Our study shows that different communication behaviors relate with trust levels at different stages of VPT’s development. This could be understood from the swift-trust paradigm (Meyerson, Weick & Kramer, 1996; Wilson, Strauss & McEvily, 2006). Early on trust seems to be imported mainly from trustworthiness and developed relying on task-oriented communication. Later on initial trustworthiness and trust early on did not predict trust at final stages of team project completion. In contrast,
other members’ actions, such as predictability of communication, fuelled trust over time. This temporary pattern suggests the value of further research to examine whether or not trust development and its associated adaptation mechanisms in VPTs follow the punctuated-equilibrium model (Gersick, 1988). To put this another way, it may be that long periods of stability are broken by short periods of change.

Practical implications

This study offers some useful implications for the management and development of VPTs in organizational settings. Our findings support a swift-trust framework, which suggests that managers should choose good specialists when forming VPTs, not only because trust is built on task-oriented communication at the early stages but also because it is imported, and positive perceptions of others’ abilities can increase trustworthiness and trust among team members (Mayer, Davis & Schoorman, 1995).

Our findings may also be useful for managerial decision-making regarding team task design. In well-structured work situations, such as those emerging after the project mid-point transition, increasing task interdependence can strengthen trust over time (Gibson & Manuel, 2003). Although task interdependence sometimes comes fixed to a certain level by technology, team members can perform the same task at different levels of perceived interdependence (van der Vegt & van de Vliert, 2005). Task interdependence can be increased by both changing the task and training people to really collaborate to reach the common goal. In this sense, van der Vegt and van de Vliert’s (2002) four-step decision tool can be useful for deciding whether and how the degree and type of team interdependence can be changed. Ignoring the role of task interdependence can lead to perverse and dysfunctional team designs that erode team process and outcomes (Langfred, 2005). Moreover it can create a vicious circle, thus reducing opportunities for trust development (Wilson, Strauss & McEvily, 2006).

Finally, our findings may be useful when training employees to work in VPTs. Just as it has been verified that an increase in ease of communication and availability of routines in the virtual context improve team performance (Wong & Burton, 2001), we have shown the importance of establishing a predictable communication pattern among team members in maintaining trust over time. No less important is the need to adapt other relevant communication behaviors, such as enthusiastic communications and substantive responses, contingently to task interdependence. If a VPT carries out a project with low task interdependence as a result of initial low trustworthiness (Wilson, Strauss & McEvily, 2006),
enthusiastic communications can help team members build mutual trust before the project mid-point transition, while raising task interdependence at the same time. Once task interdependence is present at the project’s final stages, substantive responses will push trust higher, enabling the team to deal with the critical moment when deadlines loom (Piccoli & Ives, 2003).

**Limitations and future research**

This study has a number of limitations that need to be considered. First, we gathered our data in a field setting from a particular type of team – VPTs. This extends previous lab research to real organizations, which is important, but it means that our results cannot be directly generalized to ongoing virtual teams or conventionally led teams. In this regard, recent research suggests the importance of prior links between team members for trust development (Costa, Bijlsma-Frankema & de Jong, 2006), which appears as a critical variable influencing monitoring, cooperation and performance in project teams. Future research is needed to test the role of prior links as a key driver for trust development in virtual teams.

Second, the size of our sample is limited (N = 53), which may affect our findings. In addition, since our main goal was to challenge Jarvenpaa & Leidner’s study, we did not measure all the variables at all the times during project completion. This limits our capacity to explore whether predictable and substantive communications relate to trust building before the project midpoint. Future trust research in field settings would clearly benefit from larger samples and other longitudinal designs, such as cross-lagged, which improve our understanding of the reciprocal relationships between trust antecedents over time.

Third, team size and project length were measured before the projects started. Although there was no news of team membership changes during project accomplishment, and deadlines were imposed by the company, we cannot be completely sure about possible variations in these variables. We should therefore be cautious about generalizing our findings.

Fourth, past team research indicates the paramount importance of understanding team process and outcomes stemming from task characteristics. Our contingent approach to trust dynamics, which considered the role of task interdependence, could be enriched by further examination of other task characteristics, such as task autonomy, routineness or goal interdependence (Langfred, 2004; Wilson, Strauss & McEvily, 2006).

Fifth, the relationship of trust with other social and team process should be researched. For example, it is necessary to explore links between trust, team
learning process and social capital in the effectiveness of knowledge transfer (Rhodes et al., 2008), since recent work has found consistent relations between trust and social capital in the creation and transfer of explicit, tacit and potential knowledge in organizational contexts (Smedlund, 2008).

Finally, the measurement of some perceptual variables that we have not measured, such as social presence and interpretations of others’ communication behaviors, could contribute to refine the explanation of our findings. Future research should test the potential mediating role of team members’ attributions in trust development (Aubert & Kelsey, 2003; Ferrin & Dirks, 2003; Kim et al., 2004; Serva, Fuller & Mayer, 2005). This would contribute to integrating trust literature, which is currently plagued by contradictory findings and cannot be compared for lack of a common theoretical framework (Schiller & Mandiwalla, 2007).

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Appendix 1

Task-oriented communication

- From the beginning, our communications were centered on the task.
- Our initiative to communicate task-related issues was really high.
- Our communications were centered on asking ourselves what to do, but nobody was pushing for the task (reverse coded).
Socially oriented communication

– Our communications regarding this project incorporated personal issues (leisure time, family...).
– Our communications paid attention to the needs other team members had while completing the project.
– Our messages were more centered on norms and procedures than on feelings and emotions (reverse coded).

Communication enthusiasm:

– Our messages regarding our activity were full of optimism.
– Our messages transmitted a positive tone about our work.
– Our messages contained a pessimistic tone about our activity (reverse coded).

Predictable communication:

– Our communication followed a pattern that allowed us to know when other team members would respond.
– The lack of structure in our communications leads the team to suffer unnecessary problems (reverse coded).
– Our communications followed a predictable path.

Substantive communication:

– The responses we received from other team members were enough to let the team advance.
– The messages we exchange required a lot of additional messages to obtain the necessary information to reach our goals (reverse coded).
– The responses received from other team members were detailed enough to solve the problems we deal with.

Trustworthiness:

– We will have confidence in one another on this team.
– I will be able to rely on those I work with in this team.
– There will be a noticeable lack of confidence among those I will work with.
– Overall, the people will be very trustworthy.
– We will usually be considerate of one another’s feelings in this team.
– The people in my team will be friendly.
Virtuality:

For carrying my duties in this team, I rely on:

- Electronic mail.
- Posting / bulletin board systems.
- Knowledge repositories.
- Telephone calls (r).
- Video-conferences (r).

References


