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How team feedback and team trust influence information processing and learning in virtual teams: A moderated mediation model

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ABSTRACT

This study examines a moderated mediation model in which team trust moderates the indirect effect of team feedback on team learning through group information elaboration in virtual teams. An experimental study in a laboratory was conducted with 54 teams randomly assigned to a team feedback condition or a control condition. Results provided empirical support to the moderated mediation model. We found that the indirect effect of team feedback on team learning via group information elaboration occurred in virtual teams with a high level of team trust. However, this indirect effect was not statistically significant in virtual teams with lower levels of team trust. Additionally, we also found that group information elaboration and team learning were positively related in virtual teams. Therefore, our findings suggest that team feedback is effective to improve group information elaboration and learning in virtual teams when team trust is high.

1. Introduction

Globalization and the availability of computer-mediated communication have increased the use of virtual teams (Cramton & Webber, 2005). Virtual teams are two or more persons who are generally geographically dispersed and work interdependently toward common goals using technology to communicate and collaborate across time and space (Hertel, Geister, & Konradt, 2005).

Using teams over individuals in current organizations aims to facilitate an integration of information that results in more informed decisions and more coordinated effort that can improve performance (Deeter-Schmeltz & Ramsey, 2003). Teams are viewed as information processors that process relevant and available information to perform a variety of cognitive tasks such as problem solving, judgment, inference, and decision-making (Hinsz, Tindale, & Vollrath, 1997). According to these authors, information processing at group level involves information, ideas, and cognitive structures that are shared, and are being shared, among the team members, and how this sharing of information affects both individual- and team-level outputs. In this process, it is not only important the information already shared among team members, but also the degree to which distributed information is exchanged and integrated. Research on group elaboration of information has shown that groups that engage in more information elaboration and integration reach better decisions (van Ginkel & van Knippenberg, 2008). In virtual teams, knowledge sharing is positively related with job effectiveness (Lin, 2011) and perceived job effectiveness (Lin, Wang, Tsai, & Hsu, 2010). In this study, we extend this research examining the relationship between group information elaboration and team learning, since team learning is a precursor for effectiveness in teams and organizations (Edmondson, 1999).

The growing prevalence of virtual teams in current organizations is due to the rapid development of information and communication technology (ICT) and the advantages of using this type of teams (Hertel et al., 2005). ICTs offer numerous interactive applications (e.g., virtual communities of practice, wiki, forums or 3D virtual world) designed to create virtual learning environments (Tolosa, Labra, Martínez, Méndez, & Ordóñez de Pablos, 2010; Zhang, Ordóñez de Pablos, & Zhu, 2012; Zhang et al., 2014), which can provide team members with an opportunity of virtual learning experiences. However, despite the advantages of virtual teams, they are often less effective in making group decisions, need more time to reach decisions, and their members are less satisfied in comparison to face-to-face teams (Baltes, Dickson, Sherman,

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Bauer, & LaGanke, 2002). Past research has acknowledged the importance of developing interventions (such as training, kick-off meetings, or team feedback) to overcome some of these problems (Hertel et al., 2005). According to this, we have developed a team feedback intervention to examine how to improve group information elaboration and learning in virtual teams. In a team feedback intervention, we provided outcome and process feedback to teams. After receiving feedback, teams had a period of reflection to think about the feedback obtained immediately. We incorporated this period of reflection based on a study by Anseel, Lievens, and Schollaert's (2009) showing that feedback combined with reflection is more effective to improve performance.

Past research has investigated the effects of team process feedback on motivation and subsequently on performance and the effects of outcome feedback on performance in virtual teams (Geister, Konradt, & Hertel, 2006; Shepherd, Briggs, Reinig, Yen, & Nunamaker, 1996). However, little is known about the effects of team feedback on information processing and learning in virtual teams. In this study, we propose to examine this relationship based on the social exchange theory (Blau, 1964). Information processing and learning at the team level not only involves individuals' cognitions and information processing, but also a social exchange interaction among team members. Unlike economic exchanges, social exchanges are not based on contractual obligations stipulated in advance, but on expected and actual returns (Staples & Webster, 2008). Taking into account the social exchange nature of information processing and learning in teams, we consider that team trust may play a relevant role in this relationship.

In sum, the present study aims to investigate a moderated mediation model in which team trust moderates the indirect effect of team feedback on team learning through group information elaboration in virtual teams.

1.1. Information processing and learning in virtual teams

Team learning is conceptualized as a process of reflection and action aimed to discover gaps in teams' plans and make changes accordingly (Edmondson, 1999). According to this author, this process is characterized by a set of team learning behaviors that team members show, such as asking questions, seeking feedback, experimenting, reflecting on results, and discussing errors or unexpected situations. Team learning involves an open discussion with other team members in order to reflect on teams' functioning.

Some authors have studied collective learning by focusing on the common and shared understanding and meaning about the learning process, and in the new knowledge that is developed as a result (Gubbins & MacCurtain, 2008). In this sense, team learning can be conceived as a collective form of learning that involves a process of social interaction among the members of a team. Unlike individual learning, team learning is supported by team members' sharing and integration of information.

Team learning requires obtaining and processing information in order to detect errors, reflect on results, and adapt to the environment (Edmondson, 1999). Thus, a factor that can be important for team learning is group information elaboration. This process is defined as the exchange, discussion and integration of information and perspectives, including individual-level processing of information and perspectives and the process of feeding back the results of the individual-level processing into the team (van Knippenberg, De Dreu, & Homan, 2004). Research on group information elaboration has shown that the exchange, consideration and integration of distributed information among team members are important to achieve better group decisions (van Ginkel & van Knippenberg, 2008).

According to the groups as information processors framework (Hinsz et al., 1997), teams process relevant and available information in order to perform a variety of tasks. Information and perspectives that are shared have a greater impact on teams' processes and results. An important aspect of information processing in teams is how teams combine and elaborate available information and resources. Dual-process models (Chaiken & Trope, 1999) state that individuals can choose between heuristic and systematic ways of processing information. On the one hand, systematic information processing implies in depth and detailed information processing and a greater cognitive effort. On the other hand, heuristic information processing is characterized by less cognitive effort and the use of simple rules learned from past experiences. Group information elaboration can be considered as an indicator of in-depth processing of task-related information and perspectives, since greater elaboration involves the use of systematic information processing and less reliance on heuristics (Rijnbout & McKimmie, 2012). A greater elaboration of information about the task may lead team members to a better knowledge about their improvements, and to reflect whether the actions taken by the team are effective to accomplish its goals. Despite the lack of empirical research testing the relationship between information processing and learning in virtual teams, we expect that virtual teams will learn more when they reach an in-depth processing of task-related information and perspectives. Accordingly, based on the previous rationale, we propose the following:

Hypothesis 1. Group information elaboration will be positively associated with team learning in virtual teams.

1.2. The effect of team feedback on information processing and learning in virtual teams

Team feedback consists of information provided to a team for the purpose of an increase in performance (Geister et al., 2006). Team feedback can be team-oriented by aggregating individual feedback and presenting it to the whole team. Two forms of feedback are studied in previous literature: outcome and process feedback (Earley, Northcraft, Lee, & Lituchy, 1990). Whereas outcome feedback provides information about performance outcomes, process feedback provides information about how one performs a job and about interpersonal behaviors that can be rated by external observers (Geister et al., 2006).

Shepherd et al. (1996) has shown that providing outcome feedback increases productivity in electronic brainstorming groups by activating social comparison processes, which can be useful to reduce the losses in productivity due to social loafing. These authors based outcome feedback on the number of text lines produced by the team, and presented it on a graph. In the social comparison condition, participants were given the graph and a baseline to which compare their productivity. In the two control conditions, one group of participants received no outcome feedback and the other received outcome feedback but without a baseline in the graph.

In a study investigating the effects of process feedback, Geister et al. (2006) found that virtual teams that received process feedback showed an increase in performance compared to virtual teams that did not. Moreover, these authors found that process feedback has a positive effect on team members' motivation and satisfaction for less motivated members. Process feedback was manipulated by means of providing subjective perceptions of team members about the collaboration to improve their teamwork. Team members rated several items about motivation (e.g., motivation with team goals), task-related content (e.g., participation in planning), and relationship-related content (e.g., satisfaction with cooperation and communication) on a 7-point scale. This information was aggregated on a team level and provided to the team indicating positive and negative evaluations.

Some studies have also shown that a period of reflection after providing feedback may improve the effectiveness of a feedback intervention. Anseel et al. (2009) studied the effects of reflection to enhance employees' task performance in different organizations. Reflection was operationalized by asking participants to provide examples of presumed accurate and inaccurate behavior on the basis of the feedback they received. These authors compared four conditions that combined two factors: feedback vs. no feedback and reflection vs. no reflection. Their results showed that feedback combined with reflection improves performance more than feedback alone. Moreover, there was no improvement in performance either in the 'no feedback/no reflection' condition or in the 'no feedback/reflection' condition. The rationale behind these results is that reflection after receiving feedback stimulates individuals' deeper information processing, directing their cognitive resources toward the feedback received and facilitating learning from experience. In this sense, reflection can enhance the effects of feedback by organizing better the information and integrating it in memory so that it can be applied in subsequent tasks (Anseel et al., 2009). In the present study, we included a period of reflection after providing feedback to the teams. In this period of reflection, an instructor guided teams to reflect on their teamwork and results in order to diagnose potential problems and propose strategies they should implement to achieve improvement.

The inclusion of a period of reflection after providing team feedback allows virtual teams to develop a shared understanding of the task and how the team is working, which is positive to guide group processes and performance (West, 1996). When teams engage in collective reflection, they become aware that the task requires exchange and integration of information (van Ginkel, Tindale, & van Knippenberg, 2009). Members of a virtual team are less aware about others' activities and have more difficulties to develop common ground due to dispersion and reduction of social contact among team members (Geister et al., 2006). According to this, team feedback along with reflection is expected to improve the exchange and integration of task-related information within the team. Such increase in group information elaboration, in turn, leads to greater team learning. Hence, we propose the following hypothesis:

Hypothesis 2. Team feedback will have a positive indirect effect on team learning through group information elaboration in virtual teams.

1.3. The role played by team trust: a moderated mediation model

To study the effects of team feedback on information processing and learning in virtual teams, it is necessary to take into account that these processes can be conceived as a social exchange interaction in which a party gives information to another party (Staples & Webster, 2008). Information processing involves sharing and integrating the distributed information and the diversity of perspectives held by team members in making group decisions (van Ginkel & van Knippenberg, 2008). Team learning is a collective form of learning that involves a process of social interaction among the members of a team. According to social exchange theory (Blau, 1964), social exchanges differ from economic exchanges in that the former involves unspecific obligations. In this type of situations, trust is essential because exchanges are not motivated by contractual obligations stipulated in advance, but by expected and actual returns (Staples & Webster, 2008). Moreover, team trust is even more necessary for cooperation in virtual teams, since traditional forms of monitoring and control are not feasible (Wilson, Straus, & McEvily, 2006).

Interpersonal trust is defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer, Davis, & Schoorman, 1995; p. 712). At team level, we use the term team trust to denote shared generalized perceptions of trust that team members have in their colleagues. In this way, team trust can be conceptualized as a team's emergent state characterized by an acceptance of vulnerability based on positive expectations of other team members' intentions or behaviors.

Trusting other team members may be an important condition to facilitate the effect of team feedback on information processing and learning in virtual teams. Ridings, Gefen, and Arinze (2002) found that participants who trusted other virtual community members were more inclined to provide and request information in virtual communities. As these authors argued, the value of shared information depends on the honesty of the person providing it and their willingness to help. Team trust implies a climate in which team members feel safe to share ideas, opinions and reflections of problems encountered during task execution more openly, and act on the basis of the information provided by team members in virtual teams (Rusman, van Bruggen, Sloep, & Koper, 2010). A climate of safety and the existence of team's supportiveness make team members feel comfortable to speak up and alleviate the excessive concern about others' reactions to potential errors that can be embarrassing or threatening (Edmondson, 1999). Therefore, a climate of trust within the team may lead team members to act more openly and discuss this information in more depth, facilitating the processing of information provided by team feedback.

In sum, we propose a moderated mediation model that relates the variables studied in the present research (see Fig. 1). A moderated mediation model allows assessing how and under what conditions a given effect is produced. The previous rationale suggest that the effect of team feedback on group information elaboration and, subsequently, on team learning will be more likely to occur in virtual teams that have a high level of team trust. When a team trust climate exists, team members are more willing to discuss information more openly without the concern of negative reactions to embarrassing or threatening errors. Accordingly, we propose the following hypothesis:

Hypothesis 3. The indirect effect of team feedback on team learning via group information elaboration will be positive in virtual teams with a high trust climate.

2. Method

2.1. Participants

Participants were 212 undergraduate students enrolled in an Organizational Psychology course at a Spanish University. The average age was 23.91 years (SD = 4.38). The sample was composed of 43 males and 169 females. Participants were randomly assigned to teams of four, except for the effort to balance gender, respecting the existing proportion of men to women among the

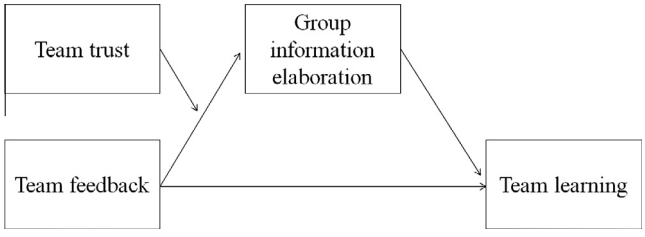

Fig. 1. Theoretical model.

students in the School of Psychology (3 female, 1 male). Participation was voluntary, and it was an alternative way to fulfill the practical classes in the course.

2.2. Procedure

A laboratory experimental study was designed to test the objectives of this research. 54 teams were randomly assigned to either the experimental or the control condition; the former is composed of twenty-eight teams and the latter of twenty-six teams. Experimental and control conditions were equal except that experimental teams received feedback and control teams did not.

Each team went to the laboratory for three consecutive work sessions throughout a period of three weeks. Before starting, in an informative meeting, participants signed a contract declaring that they were committed to participating in the experiment. This agreement also included a norm stating that the participants were not allowed to meet their teammates outside the laboratory while the experiment was going on. This was controlled by checking chat logs.

After the informative meeting finished, we scheduled session1 and session 2 to manipulate team feedback. As it is described below in the team feedback manipulation section, teams assigned to the experimental condition received team feedback during these two sessions. Teams in the control condition did not receive team feedback, although performed the same tasks as teams in the experimental condition in session 1 and session 2. All teams worked in a synchronous CMC setting and team members interacted using Microsoft Office Groove 2007. This program has several tools (chat, notepad, and a shared work space) that allow teammates to work together and exchange information through the computer. Participants were briefly instructed in the use of this specific technology for 15 min. Participants did not know team member composition and each one worked in a separate workstation.

Session 3 was designed to assess the effect of team feedback. In session 3, all the teams performed a *decision-making task* that consisted of elaborating a proposal of products or services for a human resources company portfolio. This task corresponds to the quadrant 2 of the circumflex model of group tasks (McGrath & Hollingshead, 1993). This model classifies group tasks into categories that reflect four basic processes: "generate," "choose," "negotiate," and "execute" (Straus, 1999). The four categories or quadrants results from a two-dimensional space in which the horizontal axis reflects the degree to which the task entails cognitive vs. behavioral performance requirements and the vertical axis reflects the degree to which the task is cooperative or generates conflict.

More specifically, this task simulated a business environment increasing the possibility to generalize the results obtained by real project teams, and it was designed to allow team members to share unique useful information held by each member to elaborate a team proposal. Teams had to select and arrange three human resource products or services from a pool of 12 products or services distributed among team members. Each team member had to present four different products or services to the others. In order to make decisions about which three products or services their company would offer, teams had the option of carrying out a strategic analysis of its strengths, weaknesses, opportunities and threats in creating a human resources company, using the S.W.O.T. technique (Porter, 1991). After performing this task, participants filled out the questionnaire with the measures of team trust, group information elaboration, and team learning.

2.3. Team feedback manipulation

Team feedback intervention was carried out in session 1 and session 2. It was composed of delivering *outcome and process feedback* and a subsequent *period of reflection* upon it. The beneficial effect of this kind of intervention was evidenced in the results obtained by Anseel et al. (2009).

All teams completed *intellective tasks* (quadrant II of McGrath & Hollingshead' model, 1993) in session 1 and session 2. This kind of tasks is frequently used in executive training, allowing to give outcome feedback quickly and to analyze individual and team scores. Specifically, they solved a task called "Lost in the sea" (Gordon, 2003) during their first work session and "Forest fire" (Human Synergistics, 2003) during the second work session. Both tasks consisted of survival situations in which team members had to rank 10 items related to their importance for these contexts. Solutions to the task are developed first on an individual basis and then as a group. These tasks have a definitive solution provided by experts. This provides an objective result with which to compare individual and team rankings.

These two intellective tasks selected required collaboration, coordination and conflict resolution from team members in order to reach a consensus. Thus, both are suitable to deliver outcome and process feedback.

Outcome feedback refers to the decision quality reached by each team and its members. This feedback was provided using a document that showed the individual and team performance scores. Performance scores were computed as differences from expert panel rankings. A sum of the differences scores served as an overall measure of decision quality for individual and team performance.

In order to give team feedback, the same researcher acted as an instructor, who guided the group analysis based on the results received. For instance, comparisons between individual scores and their team's scores indicate whether they were able to use and build their collective knowledge and resources to solve the task better than they could individually. This reflection promoted team shared understanding and how to improve their future performance.

Process feedback is based on individual and group perceptions about the interaction process developed while completing the task. These perceptions were collected through a check-list proposed by Warkentin and Beranek's (1999) and Beranek and Martz's (2005) studies. Team members' rated several items on a 5-point scale. This information was given back to them by means of a graph which represented the levels of these perceptions. The core group processes included were: *planning* (e.g., "At the beginning of team interaction, we have defined the goals"), *coordination* (e.g., "We have established a sequence to speak in turns"), *strategies of written communication* (e.g., "Team members have used direct and short sentences to communicate"), *information sharing management* (e.g., "Team members have shared their information and knowledge"), and *socio-emotional processes* (e.g., "Team members have relied on other team members to solve any problem arisen during the interaction"). The instructor acted as a coach helping the team to analyze their results.

Next, the instructor asked the team to discuss about their strengths and weaknesses in order to design strategies to improve their efficacy in future sessions.

2.4. Measures

2.4.1. Team trust

This variable was measured by three items taken from Jarvenpaa, Knoll, and Leidner (1998). This instrument has been validated with samples of students in virtual teams (Crisp & Jarvenpaa, 2013; Powell, Piccoli, & Ives, 2004; Remidez, Stam, & Laffey, 2007). Example of item was: "I would be comfortable giving the other team members complete responsibility for the completion of this project". The items were measured on a 5-point Likert scale from "I completely disagree" (1) to "I completely agree" (5).

The team score was obtained by aggregating individual responses to the questionnaire at the team level, following a referent-shift consensus model (Chan, 1998). In order to check for the adequacy of aggregating the team members' scores, it is necessary to assess within-group agreement. The Average Deviation Index – $AD_{M(J)}$- (Burke, Finkelstein, & Dusig, 1999) was computed for each team. The $AD_{M(J)}$ is a measure of inter-rater agreement for judges' ratings of a single target on a single occasion. The mean $AD_{M(J)}$ for the entire sample of teams was .63 (SD = .21). This value is below the upper-limit criterion of .83 established by Burke and Dunlap (2002) for the 5-point Likert scale used in this study. We also calculated the Intraclass Correlation Coefficient or ICC (1) suggested by Shrout and Fleiss (1979). $ICC_{(1)}$ can be interpreted as the proportion of total variance that can be explained by group membership. $ICC_{(1)}$ was .08. Finally, a one-way analysis of variance (ANOVA) was carried out to assure whether there was statistically significant between-units differentiation in team trust. Results showed that the differences between-units in team trust was marginally significant ($F_{(53,\ 158)} = 1.35$; $p = .07$). Hence, taking into account all these values, we decided to aggregate individual scores at the team level. Moreover, Cronbach's alpha of aggregated scores was .70.

2.4.2. Group information elaboration

This variable was measured by seven items taken from Sempere, González-Romá, and Peiró (2007) and is based on van Knippenberg et al.'s (2004) definition of information elaboration. Example of item was: "In our team, we analyze different ways of solving problems". The items were measured on a 5-point Likert scale from "I completely disagree" (1) to "I completely agree" (5). Data were aggregated at the team level. Aggregation was justified considering that we obtained the following results: the mean of the $AD_{M(J)}$ was .35 (SD = .13); ICC (1) was .22; and the ANOVA was statistically significant ($F_{(53,\ 158)} = 2.13$; $p < .01$). Therefore, we concluded that the level of within-team agreement and the differences between teams in our sample were sufficient to aggregate group information elaboration scores. Moreover, internal consistency of the scale is high (Cronbach's alpha of aggregated scores was .93).

2.4.3. Team learning

This variable was measured by five items taken from Edmondson (1999). This scale has been validated in previous research about virtual teams (Fransen, Kirschner, & Erkens, 2011; Ortega, Sánchez-Manzanares, Gil, & Rico, 2010). An example of item was: "This team regularly takes time to figure out ways to improve its work performance". The items were measured on a 5-point Likert scale from "I completely disagree" (1) to "I completely agree" (5). Data were aggregated at the team level. Aggregation was justified considering that we obtained the following results: the mean of the $AD_{M(J)}$ was .51 (SD = .13); ICC (1) was .21; and the ANOVA was statistically significant ($F_{(53,\ 158)} = 2.06$; $p < .01$). Thus, aggregation of data to the group level was justified. Furthermore, Cronbach's alpha of aggregated scores was .86, showing a high internal consistency.

2.5. Statistical analysis

Regression analyses were performed using SPSS in three steps. First, Hypothesis 1 was tested by means of correlation analysis. Second, Hypothesis 2 was tested by means of simple mediation analysis. Third, Hypothesis 3 was tested by means of moderated mediation analysis.

We used PROCESS, a macro for SPSS developed by Hayes (2013) to test simple meditation (Hypothesis 2) and moderated mediation (Hypothesis 3). PROCESS allows using 5000 bootstrap estimates for the construction of 95% bias-corrected confidence interval for the indirect effects in simple mediation and conditional indirect effects in moderated mediation. This macro also implements a test of the equality of the conditional indirect effects at different levels of the moderator variable.

The indirect effect in simple mediation is calculated as the product of coefficients from the independent variable to the mediator and from the mediator to the dependent variable. Bootstrapping allow us to infer that the indirect effect is statistically significant when zero is not included between the lower and upper bound of the 95% bias-corrected bootstrap confidence interval generated by PROCESS. In the case of moderated mediation, the indirect effect is calculated for different conditional values of the moderator variable. Conditional indirect effects are statistically significant when zero is not included between the lower and upper bound of the 95% bias-corrected bootstrap confidence intervals generated for different values of the moderator variable.

According to Hayes (2013), this method is preferable to Baron and Kenny's (1986) causal steps approach. First, the causal step approach infers mediation based on the significance of the product of coefficients relating X to M and M to Y individually, but does not quantify the indirect effect and does not apply any inferential test to the product of coefficients. This means that the product of coefficients may be significant, even though the coefficients relating X to M and M to Y are not and vice versa. Second, the causal step approach has lower statistical power and inflated type I error rates (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Third, unlike the causal step approach, bootstrapping does not assume that "...one must first establish that there is an effect to be mediated, meaning evidence that X and Y are associated" (Hayes, 2013, p. 166). Finally, it leads researchers to think about indirect effects and mediation in qualitative terms, not in quantitative. The causal step approach only permits to conclude whether mediation, partial mediation, or no mediation exists. However, such qualitative thinking makes impossible to conceptualize and test more refined hypothesis such as whether the indirect effect depends on the values of a moderator variable, for example.

Bootstrapping has also some advantages over to the Sobel test, which is also used to test the significance of the product of coefficients in mediation analysis. Unlike the Sobel test, bootstrapping does not assume that the sampling distribution of the product of coefficients is normal and has higher statistical power (Hayes, 2009; Preacher & Hayes, 2008).

In addition, as team feedback was a dichotomous variable, a dummy variable was created to enter team feedback in the regression equations. In the dummy variable, teams in the team feedback condition were assigned a score of one, and the teams in the control condition were assigned scores of zero.

3. Results

3.1. Preliminary analysis

As the variables under study showed moderate to relatively high inter-correlations (see Table 1), we conducted two confirmatory factor analyses to ascertain whether the items from the three constructs measured three correlated but distinguishable factors (discriminant validity). Specifically, we compared the fit of the three-factor model (items load in three different correlated factors: team trust, group information elaboration, and team learning) with the fit of an alternative one-factor model (all items load in a single factor). These analyses were calculated using LISREL 8.30 (Jöreskog & Sörbom, 1999).

Considering that the items were measured in an ordinal scale, we used the Weighted Least Squares method of estimation. As indicated by the following tests and indices, the hypothesized

Table 1
Means, standard deviations and inter-correlations.

Variable	*M*	*SD*	1	2	3
1. Team trust	3.40	.43	–		
2. Group information elaboration	4.40	.34	.57**	–	
3. Team learning	3.89	.42	.31*	.57**	–

* $p < .05$.
** $p < .01$.

three-factor model showed a better fit to data than the one-factor model. The results obtained for the three-factor model were: $\chi^2_{(87)} = 174.72$, $p < .001$, RMSEA = .07, AGFI = .96, NNFI = .96, and CFI = .96. Fit indexes for the alternative one factor model were slightly worse than those obtained for the three-factor model ($\chi^2_{(90)} = 266.19$, $p < .001$, RMSEA = .10, AGFI = .94, NNFI = .91, and CFI = .93). Moreover, the difference between the chi-squared statistics of the two models was statistically significant ($\Delta\chi^2_{(3)} = 91.47$, $p < .001$).

All factor loadings were significantly different from zero at the $p < .01$ level. The factor loadings of the items ranged from .51 to .79 for team trust, from .74 to .96 for group information elaboration, and from .57 to .84 for team learning. The correlations between the factors were positive and significantly different from zero at the $p < .01$ level. The correlation between team trust and group information elaboration was .66, between team trust and team learning was .52, and between group information elaboration and team learning was .80. These results provide support for the three-factor model even if some of the factors were highly correlated.

3.2. Hypotheses testing

Table 1 provides the means, standard deviations and Pearson correlations for the aggregated scores of the variables included in our study. Consistent with Hypothesis 1, group information elaboration positively correlated with team learning in virtual teams ($r = .57$; $p < .01$).

Bootstrap analysis showed that the indirect effect of team feedback on team learning via group information elaboration was not significantly different from zero (estimate of *ab* product term = .01; boot *SE* = .07; 95% confidence interval = −.12 to .14). However, the direct effect of team feedback on team learning was significantly different from zero (estimate of c' = .19; boot *SE* = .09; 95% confidence interval = .00 to .37). Thus, Hypothesis 2 was not supported.

Supporting Hypothesis 3, bootstrap analysis showed that team feedback had an indirect effect on team leaning through group information elaboration in virtual teams with a high level of team trust. Whereas the product term was significantly different from zero at high levels of team trust (estimate of *ab* product term = .10; boot *SE* = .06; 95% confidence interval = .00 to .23), it was not significantly different from zero at low levels of team trust (estimate of *ab* product term = −.17; boot *SE* = .11; 95% confidence interval = −.38 to .03). The common values indicative of high and low levels of the continuous moderator variable are one standard deviation above the mean and one standard deviation below the mean. We also estimated the conditional indirect effects at the 10th and 90th percentiles to test whether we obtained a similar pattern of results at more extreme values of team trust. Results confirmed that the indirect effect of team feedback was significant at the 90th percentile (estimate of *ab* product term = .12; boot *SE* = .07; 95% confidence interval = .01 to .28), but not at the 10th percentile (estimate of *ab* product term = −.21; boot *SE* = .12; 95% confidence interval = −.45 to .02). Moreover, the index of moderated mediation that tests the difference between conditional indirect effects was significantly different from zero with an estimate of .31 (boot *SE* = .15; 95% confidence interval = .03 to .62). This result indicates that the two conditional indirect effects estimated at high and low levels of team trust were significantly different from each other. The positive value of the index of moderated mediation also indicated that the indirect effect of team feedback on team learning through group information elaboration increased with increasing team trust. That is, the indirect effect of team feedback was positively moderated by team trust. We also found that the direct effect of team feedback on team learning was significant (estimate of c' = .18; boot *SE* = .09; 95% confidence interval = .00 to .37).

4. Discussion and conclusions

The aim of this study was to test a moderated mediation model in which the indirect effect of team feedback on team learning through group information processing was moderated by team trust. In the following pages we discuss the results obtained according to the hypotheses formulated.

We found that group information elaboration and team learning were positively related in virtual teams. This result supported Hypothesis 1. The theoretical approach that considers groups as information processors (Hinsz et al., 1997) argues that information processing at the group level involves information, ideas, and cognitive structures that are shared, and are being shared, among the team members. In the present study, we focused on group information elaboration to reflect the degree in which team members have collectively shared and elaborated available information within the team. Recent research has shown that groups make decisions of higher quality when they exchange and integrate distributed information, and not merely base their decision on a common ground (van Ginkel & van Knippenberg, 2008). We found that group information elaboration is also relevant for team learning in virtual teams. When team members shared and used distributed information to solve the task, the team experienced an increment of team learning. Therefore, in line with Edmondson's (1999) findings, obtaining and processing task-related information also facilitates the learning process of detecting errors, reflecting on results, and adapting to the environment in virtual teams.

Team feedback did not have a significant indirect effect on team learning via group information elaboration in virtual teams. Thus, Hypothesis 2 was not supported. However, team feedback had a significant direct effect on team learning. On the one hand, the direct effect of team feedback on group information elaboration and, in turn, its indirect effect on team learning may be conditioned to the values of other variables. Previous research has already found that the effect of team feedback in virtual teams can be conditioned by other variables. For example, Geister et al. (2006) found that the effect of team feedback on motivation and satisfaction was conditioned to the level of motivation of virtual team members such that this effect was significant in less motivated members. On the other hand, the significant direct effect of team feedback on team learning suggests that there may be other mediators involved in this relation besides group information elaboration. More research on this is needed.

Supporting Hypothesis 3, our results provide empirical evidence to a moderated mediation model of the effects of team feedback in virtual teams. Extending previous research on team feedback in virtual teams (Geister et al., 2006; Shepherd et al., 1996), our results suggest that information processing and leaning improves when they receive feedback about their actual performance and their processes, but when team trust is high. When virtual team members receive information about their results and processes combined with a period of reflection, they are more aware of

whether the strategy they are following to complete the task is adequate or has to be re-adjusted. However, our findings showed that team feedback enhanced virtual teams' information processing and learning when a high climate of trust within the team existed. The relevance of team trust for this relationship may be due to the social nature of information processing at the team level. According to social exchange theory (Blau, 1964), social exchanges differ from economic exchanges in that there are not specific obligations prescribed in advance. In these circumstances, trust becomes essential because exchanges are based on expected and actual returns (Staples & Webster, 2008). Furthermore, virtual team collaboration adds a particular character to this situation because traditional forms of monitoring and control are not available (Wilson et al., 2006), making trust even more necessary.

Based on this, the moderated mediation model indicates that team trust facilitates team members to share ideas, opinions, and reflections of problems encountered during task execution more openly, and act on the basis of the information provided by team members (Rusman et al., 2010). In sum, the moderated mediation model tested in this study reveled that team trust played a significant role in the study of the effects of team feedback on information processing and learning in virtual teams.

This study contributes to past research in several ways. First, it enriches the study of information processing in virtual teams (Hinsz et al., 1997). Our findings indicate that a deeper information processing increments team learning in virtual teams. Second, we studied how and when team feedback is effective for virtual teams' learning. We found that group information elaboration and team trust are key factors that contributed to explain different mechanisms through which team feedback affects team learning. This extends past research on team feedback (Geister et al., 2006; Shepherd et al., 1996) and reflection (Anseel et al., 2009) in virtual teams. Third, we go forward the knowledge of the social exchange theory (Blau, 1964) by investigating the role of team trust in virtual teams. We found that team trust facilitated the exchange and integration of information provided to virtual teams in a team feedback intervention that included a period of reflection.

4.1. Limitations and future research

This study presents some limitations and implications for future studies. First, this study was conducted with a sample of students in a laboratory setting, which limits the external validity and generalizability of the results to real settings. Thus, to examine the generalization of our results, future studies should attempt to replicate the findings in real organizational contexts and using different types of virtual teams. Second, related to the previous limitation, this study does not analyze the transfer of team feedback to job performance. As in other interventions, such as training, this transfer is important for promoting organizational change (Kraiger, 2003). Future studies should examine the transfer of team feedback or other interventions, in order to assess whether they are effective at improving organizational results. Third, we studied newly formed virtual teams. As in organizational contexts, existing virtual teams can have longer durations, it is also necessary to study the effectiveness of team feedback in existing virtual teams (Geister et al., 2006). However, our results shed light on the understanding of how virtual project-teams process information and learn, and how these processes can be improved using a team feedback intervention. Fourth, the reliability of aggregating team scores for trust is not utterly satisfactory. Finally, in this study all data were collected through self-report surveys, which raise the issue of common method variance as a potential problem in research (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). As noted above, several statistical analysis were executed to reduce, although does not eliminate, this problem (e.g., aggregation of individual responses to group level, a confirmatory factor analyses was developed to test the independence between constructs). The results obtained from these statistical tests showed a good internal validity of this study to face the threat of common method variance.

4.2. Practical implications

The findings of this study suggest some practical implications for organizations. Virtual teams allow them to gain a competitive advantage in the current, complex and global environment. Thus, design strategies addressed to prepare team members to work more effectively in virtual contexts is an important challenge for present organizations.

From a practical approach, team feedback based on self-team reflection improves team learning in virtual contexts in which a climate of high team trust exists. Organizational managers should implement debriefing strategies to deliver feedback in teams that work in virtual contexts. This kind of strategies enhances team learning through shared management information creating a shared understanding of who knows what and how to convey it inside the group.

Our results showed that delivering feedback combined with coached reflection aimed at the team's goals and planning strategies to improve group processes may be a strong human resources management intervention in distributed teams. This practice promotes team members actively engaged in a deep elaboration of information leading to an improvement of team learning. This is especially relevant in a virtual context with narrow information cues. Besides, managers should create and support conditions that foster a climate of intra-team trust. Encouraging initial face to face contact among team members and promoting the use of social networks can be useful strategies for that.

In conclusion, this study shows that team feedback is effective to improve information processing and learning in virtual teams with a climate of high team trust. We also highlighted the importance of the social nature of many group processes such as those studied in the present study.

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References

Anseel, F., Lievens, F., & Schollaert, E. (2009). Reflection as a strategy to enhance task performance after feedback. *Organizational Behavior and Human Decision Processes, 110*, 23–35.

Baltes, B. B., Dickson, M. W., Sherman, M. P., Bauer, C. C., & LaGanke, J. S. (2002). Computer-mediated communication and group decision making: A meta-analysis. *Organizational Behavior and Human Decision Processes, 87*(1), 156–179.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Beranek, P. M., & Martz, B. (2005). Making virtual teams more effective: improving relational links. *Team Performance Management, 11*(5/6), 200–213.

Blau, P. (1964). *Exchange and power in social life*. New York: Wiley.

Burke, N. J., & Dunlap, W. P. (2002). Estimating interrater agreement with the average deviation index: A user's guide. *Organizational Research Methods, 5*(2), 159–172.

Burke, N. J., Finkelstein, L. M., & Dusig, M. S. (1999). On average deviation indices for estimating interrater agreement. *Organizational Research Methods, 2*, 49–68.

Chaiken, S., & Trope, Y. (1999). *Dual-process theories in social psychology*. New York: Guilford Press.

Chan, D. (1998). Functional relations among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology, 83*, 234–246.
Cramton, C. D., & Webber, S. S. (2005). Relationships among geographic dispersion, team processes, and effectiveness in software development work teams. *Journal of Business Research, 58*, 758–765.
Crisp, C. B., & Jarvenpaa, S. L. (2013). Swift trust in global virtual teams. *Journal of Personnel Psychology, 12*(1), 45–56.
Deeter-Schmeltz, D. R., & Ramsey, R. P. (2003). An investigation of team information processing in service teams: Exploring the link between teams and customers. *Journal of the Academy of Marketing Science, 31*(4), 409–424.
Earley, P. C., Northcraft, G. B., Lee, C., & Lituchy, T. R. (1990). Impact of process and outcome feedback on the relation of goal setting to task performance. *Academy of Management Journal, 33*, 87–105.
Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly, 44*(2), 350–383.
Fransen, J., Kirschner, P. A., & Erkens, G. (2011). Mediating team effectiveness in the context of collaborative learning: The importance of team and task awareness. *Computers in Human Behavior, 27*(3), 1103–1113.
Geister, S., Konradt, U., & Hertel, G. (2006). Effects of process feedback on motivation, satisfaction, and performance in virtual teams. *Small Group Research, 37*, 459–489.
Gordon, J. (Ed.). (2003). *Pfeiffer's classic activities for building better teams*. San Francisco, CA: Jossey-Bass.
Gubbins, C., & MacCurtain, S. (2008). Understanding the dynamics of collective learning: the role of trust and social capital. *Advances in Developing Human Resources, 10*(4), 578–599.
Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs, 76*(4), 408–420.
Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis*. New York: Guilford Press.
Hertel, G., Geister, S., & Konradt, U. (2005). Managing virtual teams: A review of current empirical research. *Human Resource Management Review, 15*, 69–95.
Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin, 121*(1), 43–64.
Human Synergistics (2003). *Bushfire survival situation™ leaders guide*. Plymouth, MI: Human Synergistics International.
Jarvenpaa, S. L., Knoll, K., & Leidner, D. E. (1998). Is anybody out there? Antecedents of trust in global virtual teams. *Journal of Management Information Systems, 14*, 29–64.
Jöreskog, K. G., & Sörbom, D. (1999). *LISREL 8.30 for windows [computer software]*. Lincolnwood, IL: Scientific Software International Inc..
Kraiger, K. (2003). Perspectives on training and development. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Eds.). *Handbook of psychology: Industrial and organizational psychology* (Vol. 12, pp. 171–192). London: Wiley.
Lin, C.-P. (2011). Modeling job effectiveness and its antecedents from a social capital perspective: A survey of virtual teams within business organizations. *Computers in Human Behavior, 27*, 915–923.
Lin, C.-P., Wang, Y.-J., Tsai, Y.-H., & Hsu, Y.-F. (2010). Perceived job effectiveness in coopetition: A survey of virtual teams within business organizations. *Computers in Human Behavior, 26*, 1598–1606.
MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*, 83–104.
Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *The Academy of Management Review, 20*(3), 709–734.
McGrath, J. E., & Hollingshead, A. B. (1993). *Groups interacting with technology: Ideas, evidence, issues and an agenda*. Thousand Oaks, CA: Sage.
Ortega, A., Sánchez-Manzanares, M., Gil, F., & Rico, R. (2010). Team learning and effectiveness in virtual project teams: The role of beliefs about interpersonal context. *The Spanish Journal of Psychology, 13*(1), 267–276.
Podsakoff, P. M., MacKenzie, S. B., Lee, J., & Podsakoff, N. P. (2003). Common method variance in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879–903.
Porter, M. E. (1991). Towards a dynamic theory of strategy. *Strategy Management Journal, 12*, 95–117.
Powell, A., Piccoli, G., & Ives, B. (2004). Virtual teams: a review of current literature and directions for future research. *ACM Sigmis Database, 35*(1), 6–36.
Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879–891.
Remidez, H., Jr, Stam, A., & Laffey, J. M. (2007). Web-based template-driven communication support systems: Using shadow networkspace to support trust development in virtual teams. *International Journal of e-Collaboration, 3*(1), 65–73.
Ridings, C. M., Gefen, D., & Arinze, B. (2002). Some antecedents and effects of trust in virtual communities. *Journal of Strategic Information Systems, 11*, 271–295.
Rijnbout, J. S., & McKimmie, B. M. (2012). Deviance in organizational group decision-making: The role of information processing, confidence, and elaboration. *Group Processes & Intergroup Relations, 15*(6), 813–828.
Rusman, E., van Bruggen, J., Sloep, P., & Koper, R. (2010). Fostering trust in virtual project teams: Towards a design framework grounded in a TrustWorthiness ANtecedents (TWAN) schema. *International Journal of Human-Computer Studies, 68*, 834–850.
Sempere, J., González-Romá, V., & Peiró, J. M., (2007, May). *Demographic diversity and performance in work teams: Testing some hypotheses from the Categorization-Elaboration Model*. Poster session presented at the meeting of the European Association of Work and Organizational Psychology, Stockholm, Sweden.
Shepherd, M. M., Briggs, R. O., Reinig, B. A., Yen, J., & Nunamaker, J. F. Jr., (1996). Invoking social comparison to improve electronic brainstorming: Beyond anonymity. *Journal of Management Information Systems, 12*, 155–170.
Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86*(2), 420–428.
Staples, D. S., & Webster, J. (2008). Exploring the effects of trust, task interdependence and virtualness on knowledge sharing in teams. *Information Systems Journal, 18*, 617–640.
Straus, S. G. (1999). Testing typology of tasks. An empirical validation of McGrath's (1984) group task circumplex. *Small Group Research, 30*(2), 166–187.
Tolosa, J. B., Labra, J. E., Martínez, A. B., Méndez, S., & Ordóñez de Pablos, P. (2010). Interactive web environment for collaborative and extensible diagram based learning. *Computers in Human Behavior, 26*, 210–217.
van Ginkel, W., Tindale, R. S., & van Knippenberg, D. (2009). Team reflexivity, development of shared task representations, and the use of distributed information in group decision making. *Group Dynamics: Theory, Research, and Practice, 13*(4), 265–280.
van Ginkel, W. P., & van Knippenberg, D. (2008). Group information elaboration and group decision making: The role of shared task representations. *Organizational Behavior and Human Decision Processes, 105*, 82–97.
van Knippenberg, D., De Dreu, C. K. W., & Homan, A. C. (2004). Work group diversity and group performance: An integrative model and research agenda. *Journal of Applied Psychology, 89*(6), 1008–1022.
Warkentin, M., & Beranek, P. M. (1999). Training to improve virtual team communication. *Information Systems Journal, 9*(4), 271–289.
West, M. A. (1996). Reflexivity and work group effectiveness: A conceptual integration. In M. A. West (Ed.), *Handbook of work group psychology* (pp. 555–579). Chichester, UK: Wiley.
Wilson, J. M., Straus, S. G., & McEvily, B. (2006). All in due time: The development of trust in computer-mediated and face-to-face teams. *Organizational Behavior and Human Decision Processes, 99*, 16–33.
Zhang, X., Ordóñez de Pablos, P., Wang, X., Wang, W., Sun, Y., & She, J. (2014). Understanding the users' continuous adoption of 3D social virtual world in China: A comparative case study. *Computers in Human Behavior, 35*, 578–585.
Zhang, X., Ordóñez de Pablos, P., & Zhu, H. (2012). The impact of second life on team learning outcomes from the perspective of IT capabilities. *International Journal of Engineering Education, 28*(6), 1388–1392.