Factors Contributing to the Development of Trust in Virtual Teams

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ABSTRACT

The current study replicates methodology by Pavlova, Coovert, and Bennett (2012) investigating team satisfaction and trust development in distributed virtual teams. In addition to the original measures of trust and satisfaction, we examine the influence of feedback orientation, feedback reactions, task engagement, and workload in relation to trust development in virtual teams. Teams of four completed three search and rescue scenarios in the Distributed Dynamic Decision-Making (DDD) virtual environment. In each scenario, physically distributed participants worked together to complete their mission objectives by coordinating resources amongst team members while relying solely on text-based chat for communication. Team satisfaction and trust development results are consistent with previous findings. Trust amongst teammates developed in a short amount of time with an increase in agreement in trust ratings among team members as scenarios progressed. Measures of feedback orientation and feedback reactions positively related to task engagement and trust development. Implications for real-world distributed teams, future studies, and design of feedback based on team member feedback orientation for teams working in virtual environments are discussed.

ABOUT THE AUTHORS

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INTRODUCTION

Virtual Teams

The rapid development of computer and digital communication technologies are quickly increasing the cost effectiveness, feasibility and demand for long distance communication and teamwork amongst distributed team members (DeSanctis & Monge, 1999). Technology has allowed for flexibility in team composition, geographic location, cost, and access to experts that were not previously available (DeRosa, Hantula, Kock, & D'Arcy, 2004; Thompson & Coovert, 2006). The majority of past research on teams involves face-to-face teams; however, virtual teams and face-to-face teams have been found to differ in a number of critical ways. Virtual teams have significantly lower performance and lower effectiveness than face-to-face teams (Thompson & Coovert, 2006). There is often little or no prior experience or interpersonal contact with virtual team members as a majority of virtual teams are formed to complete a specific task and disband when the task is completed (Grenier & Metes, 1995). The dynamics of teams in virtual environments, compared to face-to-face team interactions, are more limited in communication cues and provide less interpersonal contact, which could affect the development of constructs crucial to team efficacy, such as trust. With general budgetary concerns and the recent USAF sequestration, travel options have been drastically reduced for military and government personnel. The increasing trend towards distributed teams due to the cost effective nature of virtual teams means that a growing number of tasks that were typically face to face will now be completed solely in a distributed environment. It is important that we understand how these interactions will differ and what potential limitations will be present in order to maximize their efficiency and minimize any roadblocks to successful teamwork.

Trust Development

Trust has been found to be an important part of team effectiveness, performance, satisfaction, and commitment in face-to-face teams (Dirks, 1999; Mach, Dolan, & Tzafrir, 2010). According to McAllister (1995) trust is "the extent to which a person is confident in, and willing to act on the basis of, works, actions and decisions of another" (p. 25). There are two related but separate components to trust that McAllister distinguishes. These are cognition-based trust grounded in reasoning, perception of competence and responsibility, and affect-based trust which is developed based on emotional relationships. Trust has been found to be positively related to performance, satisfaction, and commitment and negatively related to stress (Costa, Roe, & Tailleu, 2001). Additionally it is shown to be central to alliance building (Smith & Barclav, 1997), group participation (Bandow, 2001) and willingness to share information (Jones & George, 1998). These findings were grounded in face-to-face team dynamics but research suggests that trust also plays an important role in virtual teams (Handy, 1995; Iacono & Weisband, 1997; Jarvenpaa, Knoll, & Leidner, 1998).

Pavlova, Coovert, and Bennett (2012) conducted a study to examine both cognition-based and affect-based trust development in virtual teams. The goal of their study was to: 1) assess the bi-directional relationships between trust and effectiveness, 2) identify potential antecedents of trust, and 3) test the structure of trust in virtual teams. Teams of four were tasked with completing virtual search and rescue scenarios. Results showed that teams can overcome challenges posed by the technological medium relatively quickly and trust can grow over a short amount of time despite the distributed nature of the task. The majority of existing research focuses on how trust is developed and factors that influence trust maintenance (Iacono & Weisband, 1997; Jarvenpaa & Leidner, 1998). Their findings

support those of Dr. Coovert and his team but they differ in the aspect that they are usually conducted over several days to months. Pavlova, Coovert and Bennett's (2012) findings are unique in the fact that they were able to show trust development in only a few hours and, to date, no other studies have looked at affect-based and cognition-based trust dimensions within the virtual team setting. Previous research has shown that feedback can lead to higher level of trust in global virtual teams (Jarvenpaa & Leidner, 1998). However, it has not been shown how individual differences towards feedback affect the development of trust.

Feedback

Feedback is an essential measurement tool that can provide information about a learner's prior performance and direct an individual's motivation and future performance (Ilgen, Fisher, & Taylor, 1979). Feedback orientation is a multi-dimensional construct that describes how receptive an individual is to feedback. This is done through metrics such as utility (how useful feedback is for goal attainment), accountability (how obligated one feels to react to and follow up on feedback), social awareness (one's tendency to use feedback to gain awareness of how others see oneself), and feedback self-efficacy (defines how competent an individual feels to interpret and respond to feedback appropriately) (Linderbaum & Levy, 2010; London & Smither, 2002). Research suggests that one's feedback orientation influences how feedback is received, interpreted, and used over time (London & Smither, 2002). Understanding individuals' feedback orientations can also provide insight as to who will be more receptive to feedback information and whether feedback should be tailored to individuals to ensure that performance goals are achieved. Although the efficacy of feedback orientation in predicting performance outcomes has been discussed in the literature (e.g., Levy & Williams, 2004; London & Smither, 2002), few studies have explored the effects of different feedback orientations on training outcomes (especially in team settings) and reactions to feedback.

Reactions to feedback can provide key information about an individual's perception and interpretation of feedback information during training. Reactions include individuals' perceived satisfaction with (or acceptance of), accuracy of, and utility of feedback (Albright & Levy, 1995; Stone & Stone, 1985), all of which have been found to be correlated with performance (Anseel, Van Yperen, Janssen, & Duyck, 2011). Lower receptivity to feedback may result in a lack of behavioral change in the trainee, whereas greater receptivity toward feedback may indicate greater self-awareness and more willingness to change and improve performance (Ryan, Brutus, Greguras, & Hakel, 2000). Meta-analytic findings suggest that utility reactions to training are related to immediate learning and subsequent transfer of training, implying that feedback reactions may be indicators of training effectiveness (Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997). Support has also been found for the essential role of feedback reactions in improving job performance and the effectiveness of a performance appraisal system (Brett & Atwater, 2001; Keeping & Levy, 2000; O'Reilly & Anderson, 1980). Feedback reactions can also indicate the need for different approaches to generating feedback for trainees (Ryan et al., 2000). Hence, feedback reactions may predict training and transfer outcomes and gauge the adequateness of feedback information in guiding trainee behavior.

The literature suggests that feedback orientation influences reactions to feedback (DeNisi, Cafferty, & Meglino, 1984; London & Smither, 2002). Yet in order for feedback to influence reactions, a recipient must first accept or reject that feedback information (Tonidandel, Quinones, & Adams, 2002). Therefore, preliminary measurements of individuals' feedback orientations may indicate the likelihood of their utilizing and finding value in feedback. As London and Smither (2002) note, individuals with high feedback orientations will seek meaning in feedback that can assist in improving performance. Subsequent reactions to feedback can be informative of whether or not trainees used the feedback. Because the literature supports that feedback reactions are predictive of performance outcomes, a relationship may be found between feedback orientation, feedback reactions, and consequent performance.

Furthermore, no other study, to our knowledge, has found a relationship between feedback orientation, feedback reactions, and team training outcomes. The goal of including feedback orientation and feedback reactions measures is to examine whether or not they are predictive of specific outcomes of cognitive and affective trust, task engagement, and performance in team-based training scenarios. Understanding how these predispositional variables impact individual and team-level outcomes can provide a richer understanding of how training virtual teams can be designed to more effectively suit the needs of distributed team members for more effective development of complex team knowledge (e.g., for performance) and skills (e.g., cognitive and affective trust).

Engagement and Workload

Task engagement is a psychological dimension that describes effortful commitment to task goals (Fairclough, Ewing, & Roberst, 2009). Individuals with higher task engagement have been shown to have high levels of task performance (Helton & Warm, 2008). More engagement in a task has been found to be related to individuals reporting higher controllability, focus, and effort in tasks that involve short vigilance, stress, and rapid information processing (Langheim et al., 2007; Matthews, Warm, Reinerman, Langheim, & Saxby, 2010). Task engagement may be useful as a correlate of training effectiveness such that training effectiveness could mediate or moderate effects of a variety of external stressors on task performance (Helton & Warm, 2008; Langheim et al., 2007; Matthews et al., 2010).

The NASA Task Load Index (NASA-TLX) is a multidimensional assessment tool used to measure workload. The NASA-TLX measures workload in two sections: weighted and scale. Weighted measurements involve forced comparisons between all dimensions of workload to calculate weightings, and the scale measurements require individuals to rate their workload from very low to very high for the dimensions of Mental Demand, Physical Demand, Temporal Demand, Performance (reversed), Effort, and Frustration. The NASA-TLX as a measure is validated, sensitive to changes in workload, has high diagnosticity, and is used in a variety of applied and academic settings (Hill, Iavecchia, Byers, Bittner, Zaklade, & Christ, 1992; Hart, 2006). Workload is potentially useful as a moderator of relationships between trust and team effectiveness; additionally, it may validate manipulations of task complexity and further examine perception through self-reported performance (Hart & Staveland, 1988; Hart, 2006). It is common to use measures of task engagement in conjunction with the NASA-TLX as a manipulation check of task demand levels (Grier, Warm, Dember, Matthews, Galinsky, Szalma, & Parasuraman, 2003; Hart, 2006; Matthews et al., 2002). Using validated measures of both workload and engagement will allow for greater understanding of these constructs' influence on performance outcomes in a virtual environment.

Hypotheses

The goal of the current study is to replicate Pavlova, Coovert, and Bennett's (2012) study as well as to validate additional measures in simulated task environments and examine predictors of team/training effectiveness and trust development. In addition to trust, the current study examined feedback orientation, feedback reactions, task engagement, and workload. Task engagement and workload have been validated in teams outside of the virtual environment and therefore hold value to being examined and validated within the dynamics of virtual teams. Little to no research has been done looking at feedback orientation in a team setting; however, London and Smither (2002) suggest that there are positive implications for team effectiveness.

It is expected that this study will replicate the findings of Pavlova, Coovert, and Bennett (2012). Specifically, we expect the following:

Hypothesis 1. Trust will remain a two-factor construct throughout the course of the study (affective and cognitive).
Hypothesis 2. Both types of trust, cognition-based and affect-based, will increase between the first and last scenario.
Hypothesis 3. Cognitive trust will be greater than affective trust.
Hypothesis 4. Agreement in trust ratings among team members will increase as they worked together.

In addition, based on previous research, we expect the following:

Hypothesis 5. Feedback orientation will be positively related to feedback reactions, such that a strong feedback orientation will lead to more positive feedback reactions from participants.
Hypothesis 6. Feedback orientation will be positively related to outcomes of: (a) trust (b) performance and (c) task engagement.
Hypothesis 7. Feedback reactions will be positively related to outcomes of: (a) trust (b) performance (c) task engagement and (d) workload.
Hypothesis 8. Task Engagement will be positively related to performance.
Hypothesis 9. Workload will be negatively related to (a) affective trust (b) cognitive trust and (c) performance.

METHOD

Participants

70 individuals (31 females and 39 males) between the ages of 19 and 44 (M = 23.85) participated in the study. These participants were recruited from the general population of students attending Wright State University in Dayton, Ohio. Participant screening requirements included normal or corrected to normal vision, basic written and spoken English language competency based on prescreening evaluation, and that participants be 18 years of age or older. All three of these criteria serve to ensure that all participants were able to experience the gaming environments and team communication/interaction to an adequate level for meaningful data collection.

Apparatus

All study conditions were run on the same five computers; four computer stations for participants and one computer for the experimenter. Computers were equipped with an Intel Core i7 processors, 6GB ram, dedicated graphics, and a 27-in. monitor. The study used Aptima's Distributed Dynamic Decision-making (DDD) Task software, which provides an overhead view of the Antarctic terrain that participants navigated through to complete the scenarios. Three separate scenarios with similar objectives were used for each team, and these were the same used in the previous study. All chat communication was distributed via the DDD software and headphones were worn by participants during the scenarios. The goal was to simulate a distributed environment while remaining in the same physical room.

Measures

Participants were evaluated with the same measures used by Pavlova, Coovert, and Bennett (2012) including trust and cooperation. Additionally, measures of feedback orientation (Feedback Orientation Scale, or FOS; Linderbaum & Levy, 2010), feedback reactions (Feedback Reaction Scale, or FRS; Anseel et al., 2011), engagement (Short Stress State Questionnaire, or SSSQ; Helton, 2004), and workload (NASA-TLX; Hart & Staveland, 1988) were also collected from participants. The performance metric used for this study consisted of an aggregate performance score of each individual player generated by DDD based on completion of objectives. This performance score was used as the feedback to each participant and was presented to them in the upper left corner of the screen at all times.

Procedure

Participants were brought into the experiment area and seated in their cubicle individually, attempting to keep any potential interaction between teammates to a minimum. Each participant was located in a separate cubicle in to simulate a distributed team. There were five reference guides available in each cubicle throughout the study: a reference card defining dimension of the NASA-TLX workload scale and four guides containing information about the individual training missions. At the start of the study participants completed a personality assessment, the feedback orientation scale, and a trust assessment. They then watched a twenty minute DDD tutorial video and completed a demographics form. For participants to become familiarized with DDD, they completed a role introduction and a training session during which they were trained to proficiency. By the end of the training materials participants were familiar with all the team roles, the game mechanics, and the objectives of the task.

The DDD task is a search and rescue task requiring participants assigned to different roles to coordinate resources to find and rescue a lost party. Participants were randomly assigned to one of the four roles: Green Snowcat Operator, Purple Snowcat Operator, Red Snowcat Operator, or Blue Controller. The primary role of the Blue Controller was to communicate external messages and restock resources, such as fuel and people, for the Green Snowcats. The primary role of the Snowcat Operators was to locate a lost party that originated at the station. Snowcat Operators needed to track the path that the lost party took and ultimately locate and help them, while accomplishing several different medical, repair, and emergency tasks along the way to accumulate as many points as possible. The points they received were presented as a total score that was updated as they completed each objective. Feedback was only provided on an individual level, such that participants had no knowledge of their teammates' scores and no team

score was provided. All communication between team members was completed through text using a chat box in the main DDD window.

Teams completed three missions in randomly assigned order. Each team was provided a maximum of 40 minutes to complete each mission. The SSSQ was administered prior to the start of each mission. At the conclusion of each mission, participants completed the NASA-TLX, trust assessment, and team satisfaction survey. Performance was measured by their final score at the end of each mission, this score was only given on an individual level; team performance was not measured. The feedback reactions scale was administered at the end of the study.

RESULTS

A total of 18 four-member teams completed the task. Affective and cognitive trust was measured at four different times (Time 1, Time 2, Time 3, and Time 4) and workload and engagement were measures at three time points (Time 1, Time 2, and Time 3). Time 1 measurements for cognitive and affective based trust were taken prior to the completion of any task as a team. Engagement was measured prior to the start of the three missions that were completed. Workload and trust at Time 2, Time 3, and Time 4 were measured at the completion of each mission. Composite scores were used for all measures for both individual times and overall scores. Analyses were performed on paired time scores as well as overall scores for performance results.

To test hypothesis 1, that trust will remain a two-factor construct, Lisrel 9.1 was used to analyze a two factor model. Based on item content and prior research, the four trust questionnaire items were expected to load on one factor (affect-based trust) and five were expected to load on the second factor (cognition-based trust). The model fit the data at Time 1 ($\chi^2 = 49.96$, $df = 26$, $p < .01$, RMSEA = .11, 90% CI = (.06, .16), ECVI = 1.25, 90% CI = (1.0, 1.6)) and again at Time 4 ($\chi^2 = 133.66$, $df = 26$, $p < .01$, RMSEA = .18, 90% CI = (.15, .20), ECVI = 1.3, 90% CI = (1.1, 1.6)), therefore supporting the first hypothesis, that trust would remain a two-factor construct.

A repeated measures ANOVA was used to examine the mean differences in cognition-based and affect-based trust across the four trust measurements. Mean trust scores for cognitive and affective trust over the four measurement instances are shown in figure 1. A significant difference for time was found for cognitive -based trust, F (3, 189) = 6.12, $p < .01$, and for affect-based trust, F (3, 189) = 5.92, $p < .01$. A Bonferroni post hoc analysis indicated that there were significant differences between Time 1 and Time 4 for both cognition-based (M = 3.56, SD = 0.49; M = 3.83, SD = 0.62) and affect-based trust (M = 3.34, SD = 0.66; M = 3.66, SD = 0.82), supporting hypothesis 2 that both cognition-based and affect-based trust would increase. A paired samples t-test for the means of cognitive and affective trust at Time 4 was significant, $t(68) = 2.51$, $p < .05$, supporting hypothesis 3 that cognition-based trust (M = 3.83, SD = 0.62) would be greater than affect-based trust (M = 3.66, SD = 0.82). Standard deviations of trust scores were calculated on the team level at the four measured times. A paired samples t-test also found a significant decrease in the standard deviation between Time 1 and Time 4, $t(17) = -2.37$, $p < .05$, indicating an increase in agreement within each team and supporting that agreement in trust rating would increase as team members worked together (hypothesis 4).

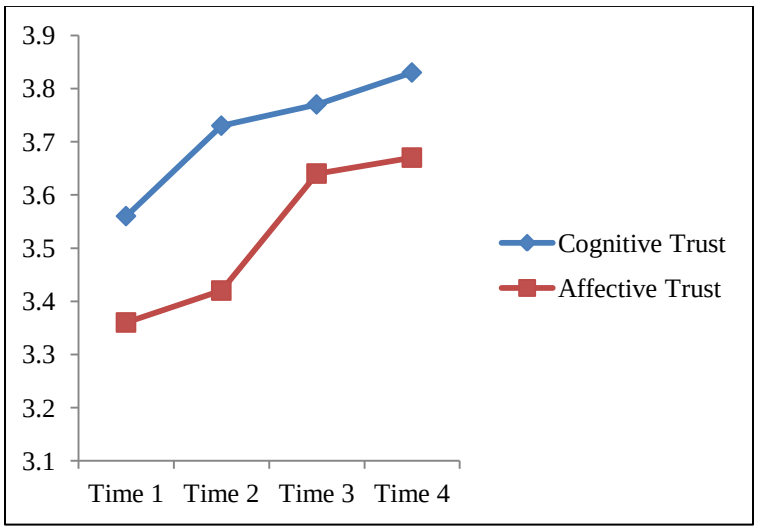

Figure 1. Mean Scores for Cognitive and Affective Trust at Times 1-4.

A series of regression analyses were conducted to test the relationships of the various measures. Regression results for the feedback measures are shown in Table 1. Feedback orientation significantly predicted feedback reactions (R^2 = .44, p < .01) such that a stronger feedback orientation predicted more positive feedback reactions from participants, therefore supporting hypothesis 5. Hypotheses 6 and 7 were partially supported. Feedback orientation and feedback reactions had a positive relationship to task engagement (R^2 = .08, p < .05; R^2 = .24, p < .01), cognitive, affective, and overall trust (R^2 = .13, p < .01; R^2 = .37, p < .01). Feedback reactions and feedback orientation were found to be positively related with performance (R^2 = .007, p > .05) and feedback reactions was found to be negatively related to workload (R^2 = .02, p > .05) but neither of these relationships were significant.

Table 1. Regression Results

	Feedback Reactions			**Trust (Overall)**			**Engagement**			**Workload**			**Performance**		
Variable	*β*	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*
Feedback Orientation	.440	4.02	.000	.355	3.13	.003	.289	2.49	.015	.090	.740	.462	.156	.1.135	.261
Feedback Reactions	-	-	-	.604	6.20	.000	.486	4.55	.000	-.155	-1.27	.208	.118	.849	.400

The regression analysis did find a significant positive relationship between overall task engagement and individual performance (β = .30, t(53) = 2.27, p < .05; R^2 = .24, p < .05), supporting hypothesis 8. The predictions related to workload (hypothesis 9) were not supported. Although overall workload was negatively related to trust (β = -.05, t(68) = -0.41, p > .05) and individual performance (β = -.26, t(53) = -1.92, p > .05), these relationships were not significant.

DISCUSSION

One of the goals of this study was to replicate the findings of Pavlova, Coovert, and Bennett (2012). This was tested by the first four hypotheses, all of which were supported. For the first hypothesis, it was originally hypothesized that trust was a one-factor model, however Dr. Coovert's team found that it was a two-factor model. They explained this finding using the conceptualization of trust development by McAllistar (1995), which originally had two dimensions. Our finding that trust began as, and remained, a two-factor construct supports their finding. Results related to the second and third hypotheses showed that levels of cognitive trust and affective trust increased between

the first and last scenario, with higher levels of cognitive trust than affective trust. The significant increase in trust is in line with prior research but also shows that trust among teammates can develop in a short amount of time. There is also a higher emphasis on cognitive trust in teams where cues for affective trust are limited. Finally, team members appeared to be in greater agreement with regard to trust ratings as the task progressed.

The last five hypotheses focused on additional measures introduced in this study: feedback orientation, feedback reactions, workload, and task engagement. A positive relationship was found between feedback orientation and feedback reactions. Positive relationships were also found between feedback orientation and outcome measures of trust and task engagement. However, the relationship between feedback orientation and performance was not significant. Similarly, positive relationships were also found between feedback reactions and trust and between feedback reactions and task engagement but not performance or workload. This suggests that having a higher feedback orientation has positive implications for building trust in teams and individuals' engagement in team-based training tasks. Individuals with a high feedback orientation may be more responsive not just to feedback about their own performance but also performance that impacts the group as a whole.

FUTURE RESEARCH

While there were no significant findings in relation to workload and any dependant variables, we suspect this is due to the difficulty of the task resulting in a ceiling effect. The reported values for difficulty, specifically mental workload, support this along with verbal participant feedback indicating a high level of difficulty even by the third trial. Future research should assure training to proficiency with potentially more than one practice trial. There was also a lack of performance findings which could be due to a non-diagnostic scoring method that provided no task-specific feedback, only presenting the participant with an overall score.

Although there were no significant findings for the direct relationships between feedback measures and performance, positive relationships with task engagement and affective and cognitive trust suggest that feedback has positive implications for relevant team training goals. Therefore, future research should continue to explore the impact of individual and even team-level feedback orientation and reactions on training performance and transfer. Smither, London, and Reilly (2005) suggest that feedback orientation may be a key determinant of goal setting, behavioral change, and performance improvement, particularly after receiving multi-source feedback. Therefore, those with high feedback orientations may be more responsive and receptive toward team communications and forming trusting relationships, and may perceive coordination activities with the team as indicators of performance improvement. In line with Ryan and colleagues (2000), individuals with more positive feedback reactions may be more self-aware, open to change, and as indicated in our findings, may be more receptive towards team collaboration. Altogether, these findings support the notion that feedback can build an understanding of how teams build communication and/or coordination skills (Prince & Salas, 1993). These findings suggest that training systems could induce or promote high feedback orientation (which can lead to positive feedback reactions) to facilitate better collaboration and performance in both team and individual training programs (Helton & Warm, 2008). Being that this is the only study to the best of our knowledge that has explored these feedback constructs of orientation and reactions in a virtual team-based setting, research on virtual teams should continue to examine how feedback processes influence relevant training and transfer outcomes among team members in distributed environments.

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