

The Effect of Rapport on Delegation to Virtual Agents

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ABSTRACT

This paper presents the initial results of a study exploring whether the perceived rapport with a virtual agent can influence users' decisions on delegating critical tasks to the agent. We hypothesize that users are more likely to delegate to virtual agents that attempt to build rapport with users than to agents that avoid building rapport. The samples we collected so far still need to validate the hypothesis fully. Nevertheless, we found that the perceived rapport with a virtual agent is highly relevant to trust in the agent.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; *Virtual reality*.

KEYWORDS

Rapport, delegation, virtual agents, virtual reality

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1 INTRODUCTION

With their ability to involve different human communication channels, including verbal and non-verbal behaviors, virtual agents can more effectively establish social connections with users than via traditional WIMP (windows, icons, menus, and pointer) interfaces [11, 12]. The present study investigates how such social connections may influence users' decisions on delegating critical tasks to virtual agents. We particularly look into *rapport*, an individual's subjective experience of having a "click" with others [14]. Rapport plays a role in many interpersonal activities, which, as mentioned in [3], include persuasion, establishing identity and social bonds, conflict resolution, and more. Recent research shows that virtual agents can build rapport with users by utilizing human communication channels –such as head nodding and facial expressions– during their interactions with users [4, 5, 15]. The established rapport can, in turn, influence the user-agent interaction [1, 7–9]. In the same vein, we hypothesize that *users are more likely to delegate to virtual agents that attempt to build rapport with users than to the agents that avoid building rapport with users*. To validate the

hypothesis, we conducted a between-subject experiment contrasting a rapport-building and a rapport-avoiding virtual agent in a delegation-related scenario.

2 EXPERIMENT

During the experiment, participants play against a computer program in a dyadic game adapted from the Colonel Blotto game. The game, taking place in a virtual environment experienced through a virtual reality (VR) headset (Meta Quest 2), has an economic context where two beverage companies (i.e., the two players) compete for three different markets. Each player is initially endowed with the same amount of resources –ten trucks of the company's beverage product– and is tasked to distribute and send these trucks to the three markets. A player wins a market if the player has sent more trucks to the market than the other player. A player wins the game if the player has won two markets. To render the game critical, we claimed that the participants' monetary reward comprises two parts: a small basic reward plus a bonus whose amount can be much higher than the basic reward but depends on the participants' performance. Eventually, all participants are treated equally and receive the same remuneration.

The experiment consists of three phases, from an *exercise phase*, over a *training phase*, to a *playing phase*. In the exercise phase, participants are co-located with a virtual agent face-to-face in the virtual environment. Participants will hear a series of words from a voiceover in the virtual environment. When hearing the word "forward" or "sideways", participants are asked to lift their arms forward or sideways to specific positions as depicted in Figure 1a and Figure 1b, respectively, and then put down their arms once their arms have reached the designated position. The goal of the exercise phase is to manipulate the perceived rapport with the agent. Participants are divided into two groups. In the rapport-building group, the agent moves its arms as the voiceover instructed, synchronizing its arm movements with the participants' arm movements. Besides the synchrony, the agent also has a smiling face and keeps eye contact with participants by gazing at them. These three behaviors constitute the three core components of rapport defined in [14], including the signal of positivity (smiling), mutual attentiveness (gaze), and coordination (synchrony). In the rapport-avoiding group, the agent keeps a relatively neutral facial expression and always looks straight ahead instead of maintaining eye contact with participants. When hearing a word, the agent moves its arms in the other direction (e.g., moving its arms sideways when hearing the word "forward") with a random delay ranging from two to four seconds.

In the training phase, participants practice the game with the agent they just interacted with. Since participants can still see the agent during the practice (cf. Figure 1c), some of the rapport-related cues used in the exercise phase –smiling and gazing– are kept in this phase to sustain the perceived rapport. Participants play eight

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Figure 1: Three third-person perspective screenshots of the virtual environment at different points during the experiment. The white half-body mannequin is the participants' avatar. The agent is embodied in a virtual female. Figure 1a shows the exercise with the rapport-building agent, where the agent's and participant's arm movements are synchronized. Figure 1b conversely shows the exercise with the rapport-avoiding agent, where the agent moves its arms differently from the participant's arm movements. In Figure 1c, a participant is playing the game against the agent.

rounds of the game against the agent for training purposes. The game outcomes are manipulated so that the agent always wins four rounds and loses the other four rounds in a fixed sequence for each participant. After finishing the training, participants are informed that they are about to enter the playing phase, during which they will play against a computer program, and that their performance determines the amount of the bonus they will receive. Before they enter the playing phase, participants are offered an opportunity to delegate the playing phase to the agent they just exercised and practiced with. Once they delegated, the agent would take over complete control and play all the game rounds in the playing phase on behalf of the participants. After having made the decision, participants are administered a questionnaire that measures their perception of co-presence[2], social presence[2], accountability for the game outcomes, the trustworthiness [6] and performance of the agent, and the criticality and difficulty of the task on a 7-point Likert scale, with 1 denoting strongly disagree and 7 denoting strongly agree. A manipulation check comprising eight items on the perceived rapport is added at the rear of the questionnaire.

The experiment ends once participants have finished answering the questionnaire. The playing phase will not be administered as the actual playing does not influence the experiment results. Participants are briefed about the purpose of the study and asked an open question about the rationales behind their delegation decisions.

3 RESULTS AND DISCUSSION

So far, we have recruited 22 participants for the experiment. The data of seven participants were excluded from the results since they chose not to delegate because they enjoyed the VR session and wanted to play more. Out of the 15 remaining participants (mean age = 24.5, nine males and six females), ten interacted with the rapport-building agent, whereas the other five interacted with the rapport-avoiding agent. Only one participant from the rapport-avoiding group chose to delegate. The other 14 participants decided not to delegate for various reasons, including the agent's algorithm being obscure, the agent's performance being inferior, being confident in

themselves, wanting to retain control, or wanting to be responsible for their own choices.

The Cronbach's α of the manipulation check is 0.67. To improve its internal consistency, we removed three items from the manipulation check based on an analysis of item-total correlations. The remaining five items have a Cronbach's α of 0.89. The rectified manipulation check shows that participants generally felt a low level of rapport with the agent. Both groups have reported a mean level of rapport below 4.00 (i.e., the neutral point), although it is higher in the rapport-building group than in the rapport-avoiding group (3.52 vs. 2.52). This seemingly unsuccessful manipulation indicates that the combination of the rapport-building behaviors used in the experiment –including behavioral synchrony, eye gaze, and smiling– may not be effective for virtual agents to establish rapport with users in a brief interaction regarding critical tasks.

The differences in other factor assessments (trustworthiness, copresence, etc.) between the two groups are neither considerable nor statistically significant. Nevertheless, through an analysis of the entire dataset, we found a monotonic relationship between participants' trust in and rapport with the agent ($\rho = 0.535, p = 0.040$), though this relationship is somewhat non-linear ($r = 0.442, p = 0.099$). Given the relevance between trust and delegation [10, 13], this result still points to the possibility that rapport influences delegation to virtual agents. This influence was not observed in our experiment, possibly due to several reasons, including the insufficient and imbalanced samples, the seemingly unsuccessful manipulation, or the overshadowing effect of other factors.

Thus, we will continue investigating this topic by, for example, attempting other approaches to manipulate the perceived rapport. Some factors –such as agent performance or task difficulty– may need to be further adjusted to avoid their potential overshadowing effects. We might also change the delegation measure from binary to more fine-grained behavioral or self-report measures. Another interesting line of inquiry is to study delegation to virtual agents in less critical contexts, where the effects of performance-related factors may become weaker, allowing other factors (e.g., rapport) to unfold their impact on delegation.

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