

The Impact of Virtual Agent Personality on a Shared Mental Model with Humans during Collaboration (Extended Abstract)

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ABSTRACT

The development of a Shared Mental Model (SMM) between team members and effective communication of the shared knowledge have been found to improve teamwork performance. However, humans may differ in how they produce and perceive communication acts according to their personality traits and this will affect development of the SMM. Whether, this is true of heterogeneous teams involving human and intelligent virtual agents (IVAs) is unknown. In this paper, we explore the impact of IVA's with two different combinations of personality traits, i.e. extraversion and agreeableness, on the development of a SMM with human teammates. Additionally, this study investigated the influence of the match in the two personality traits between IVAs and humans on the development of a SMM. The results showed that agreeable IVAs positively impacted on the development of taskwork and teamwork SMMs; whereas extraversion did not influence development of the SMM. Moreover, when the collaborating human and IVA had matching agreeableness personality traits there was a positive influence on the SMM between them and better performance outcomes.

Categories and Subject Descriptors

I.2.11 [Artificial Intelligence]: Distributed Artificial Intelligence—*intelligent agents, multiagent systems.*

Keywords

Personality Traits, Big Five, Extraversion, Agreeableness, Shared Mental Model, Human-Agent Teamwork.

1. INTRODUCTION

Due to the increasing interest in heterogeneous human-intelligent virtual agent (IVA) teams, we investigate the role that IVA personality plays in the development of a Shared Mental Model (SMM) and team performance. A SMM is the state among team members where the members have overlapping knowledge and beliefs [4]. Many researchers who have been studying SMM classified the shared knowledge into two categories: knowledge about the team and knowledge about the task [4].

Among the measures of personality traits, the Big Five Factors (BFF) of personality has proven to be a robust tool for understanding personality variations across individuals. BFF

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claims that personality differs on five factors: Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. Openness means being open to experience new things, being imaginative, and intelligent. Conscientiousness indicates responsibility, reliability and tidiness. An Extravert is outgoing, sociable, assertive and energetic. Agreeableness means a person is trustworthy, kind and cooperative by considering others' goals. A neurotic character is anxious, nervous, prone to depression and lacks emotional stability.

Extraversion and agreeableness were selected in our study because they have been shown to be predominant traits in collaboration and teamwork [3]. In order to understand the relationship between IVAs' personality as represented in its multimodal communication and the development of a SMM with humans while they achieve a collaborative task, the following research questions are proposed:

1. Do the IVA's personality traits, i.e. extraversion and agreeableness, significantly influence the humans' perception of the taskwork and/or the teamwork SMM?
2. Does a match in human-IVA personality traits, i.e. extraversion and agreeableness, influence the humans' perception of the taskwork and/or the teamwork SMMs with the IVA?
3. Do taskwork and/or teamwork SMMs affect human-IVA team performance?

2. APPROACH

To answer the research questions, an experiment was conducted. The experiment consisted of five different treatments with the same virtual scenario but the IVA had different personalities. One treatment was a control, while the other four treatments had the four combinations of the two studied personality traits.

In this study, we implemented the verbal features of verbosity restatements, request confirmation, emphasis hedges, negation and filled pauses as suggested by Neff et al. [9]. The non-verbal features implemented were spatial extent, temporal extent, repetitiveness and body position as proposed by Doce et al. [5].

In the collaborative virtual environment created for our study, the goal is to pass a sequence of four obstacles to reach a given target (scientific laboratory). The four obstacles included a brick wall, wooden gate, bush and hill. In order to get over each of these obstacles both the human and IVA have to select a pair of tools from a toolbox that contains 12 tools (pruning shears, bush hook, hammer, chisel, ladder, rope, matchsticks, matchbox, screwdriver, nipper, shovel and mattock). These pairs of tools were chosen to be complementary and require the team members to communicate.

3. RESULTS

The first research question inquired whether the participants' perception of the IVA's personality traits, i.e. extraversion and agreeableness, influenced their perception of the SMMs for taskwork and teamwork. The results did not show any significant difference between the perception of either taskwork or teamwork SMM according to the IVA's extraversion personality. The results of ANOVA test showed that there was a significant difference $p < 0.01$ [$F(2, 52) = 4.312$, $p < 0.01$, $\eta^2 = 0.14$] between the groups of participants in their perception to taskwork SMM according to the IVA's agreeableness/antagonism personality trait. The results of ANOVA test showed that there was a significant difference $p < 0.01$ [$F(2, 52) = 6.942$, $p < 0.01$, $\eta^2 = 0.21$] between the groups of participants in their perception of teamwork SMM according to the IVA's agreeableness/antagonism personality trait.

The second research question inquired whether the match in personality traits, i.e. extraversion and agreeableness, between the participants and the IVAs significantly influenced their perception of the SMM. The results did not show any significant difference between in the perception of either the taskwork or teamwork SMM according to the match in extraversion personality between the human and the IVA teammate. The results of ANOVA test showed that there was a significant difference $p < 0.05$ [$F(2, 52) = 5.224$, $p < 0.05$, $\eta^2 = 0.09$] in the perception of a taskwork SMM between the participants who had a match in the agreeableness personality ($M = 3.80$, $SD = 0.48$) with the IVA and those who were in mismatch with the IVA ($M = 3.40$, $SD = 0.75$).

The third research question investigated the influence of taskwork and teamwork SMMs on human-IVA team performance. The result of multiple regression showed that both taskwork and teamwork SMM was able to predict the overall team performance to achieve the common goal $R^2 = 0.309$, $F(2, 52) = 13.068$, $p < 0.001$. Thus, we can say that the existence of taskwork and teamwork SMMs do influence human-IVA team performance in answer to the third research question.

4. DISCUSSION

Although the literature of human-agent interaction has not studied the influence of an IVA's personality on the perception of SMMs with IVA, some researchers in human teams reported a significant interaction between the trust facet of agreeableness in predicting a shared mental model between team members [6]. Barrick et al. [2] suggested that an agreeable personality may predict working well in teams; although no direct relationship between agreeableness and team performance was found. While our results did not report a significant impact of extraversion on the development of a SMM, some other studies found extraversion an effective factor.

Studies in human teams indicated that the composition of members' personalities influence team interaction and performance. However, these studies have not agreed on whether the variation or similarity in personality have a positive effect on teamwork. Some researchers claimed that variation in personality is likely to be associated with variant skills [8]. Other studies argued that homogeneity in personality traits among team members tends to improve team performance [1]. These contradictory results concerning the role of variation of personality in teams may be due to the nature of the task in which the team members are involved.

Many studies found a positive correlation between the development of a SMM between team members and their team

performance [7]. Although some studies have found the strongest correlation is between teamwork SMM and team performance, other studies reported the strongest positive correlation is between taskwork SMM and team performance.

5. CONCLUSION

This paper described a study of the influence of an IVA's personality traits on the establishment of a SMM with a human teammate. Additionally, this study investigated whether the match between IVAs and humans in personality traits impacts on the establishment of taskwork and teamwork SMMs. It was found that designing an IVA incorporating personality traits is likely to improve the performance of the human-IVA team. Additionally, these findings indicated that the personality of the human and the IVA teammate could to be taken into consideration to foster team productivity.

6. REFERENCES

- [1] Anderson, M.H., 2009. The Role of Group Personality Composition in the Emergence of Task And Relationship Conflict within Groups. *Journal of Management and Organization* 15, 82-96.
- [2] Barrick, M.R., Mount, M.K., and Judge, T.A., 2001. Personality and Performance at the Beginning of the New Millennium: What Do we Know and Where Do we Go Next. *International Journal of Selection and Assessment* 9, 9-30.
- [3] Bosch, K., Brandenburgh, A., Muller, T., and Heuvelink, A., 2012. Characters with Personality! In *Intelligent Virtual Agents*, Y. Nakano, M. Neff, A. Paiva and M. Walker Eds. Springer Berlin Heidelberg, 426-439.
- [4] Cannon-Bowers, J.A., Salas, E., and Converse, S., 1993. Shared Mental Models in Expert Team Decision-Making. In *Proceedings of the Individual and group decision making*, 221-246.
- [5] Doce, T., Dias, J., Prada, R., and Paiva, A., 2010. Creating Individual Agents through Personality Traits. In *Intelligent Virtual Agents*, J. Allbeck, N. Badler, T. Bickmore, C. Pelachaud and A. Safonova Eds. Springer Berlin Heidelberg, 257-264.
- [6] Fisher, D.M., Bell, S.T., Dierdorff, E.C., and Belohlav, J.A., 2012. Facet Personality and Surface-Level Diversity as Team Mental Model Antecedents: Implications for Implicit Coordination. *J Appl Psychol.* 97, 4, 825-841.
- [7] Hanna, N. and Richards, D., 2014. The Impact of Communication on a Human-Agent Shared Mental Model and Team Performance. In *Proceedings of the the 13th international conference on Autonomous agents and multi-agent systems (AAMAS'14)* (Paris, France), 1485-1486.
- [8] LePine, J.A., Buckman, B.R., Crawford, E.R., and Methot, J.R., 2011. A review of research on personality in teams: Accounting for pathways spanning levels of theory and analysis. *Human Resource Management Review* 21, 311-330.
- [9] Neff, M., Wang, Y., Abbott, R., and Walker, M., 2010. Evaluating the effect of gesture and language on personality perception in conversational agents. In *Proceedings of the the 10th international conference on Intelligent virtual agents (IVA'10)*, Springer-Verlag, 222-235.