The effects of an agent asking for help on a human's trustworthiness

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Abstract

AI systems have the ability to complete tasks with greater precision and speed than humans, which has led to an increase in their usage. These systems are often grouped with humans in order to take advantage of the unique abilities of both the AI and the human. However, to make this cooperation as efficient as possible, there needs to be a mutual trust between humans and AIs. While there has been much research concerning the topic of human trust, there is a lack of work done concerning the trust that an artificial agent has toward its human partner. Given that a human must appear trustworthy to an artificial agent in order for that agent to trust him, and that demanding and offering help are important parts of a collaboration, the following research question has been formulated :*How does an artificial agent asking a human for advice or help affect that human's trustworthiness ?* To answer this research question, an experiment was conducted through an urban search and rescue game using the MATRX Software. Through this game, participants had to collaborate with a robot partner in order to accomplish the task of finding and rescuing 8 victims and delivering them to the correct drop zone. The participants were divided into a control group, who worked alongside a basic rescue robot, and an experimental group, which had a help-seeker robot as a partner. The help-seeker robot differed from the basic robot in its ability to ask the participant for advice, such as asking which room it should search for victims to rescue. Following the experiment, no significant results indicating a positive or negative effect on human trustworthiness by the help-seeker agent's behaviour were found.

1 Introduction

Nowadays, an increasing amount of Artificial Intelligence Systems are being used due to their ability to smoothly, and precisely complete their task, as well as their ability to continuously work without rest. These systems are used alongside humans in order to make use of both of their unique skill sets in order to bring about a collaboration, increasing the speed and efficiency at which tasks are completed. However, for this collaboration to come about efficiently, there is a need for some form of mutual trust to exist [13]. In other words, the human should be able to trust the agent, and the agent should similarly trust the AI. Trust between humans is a subject on which multiple researches have already been conducted and for which an overview of the related concepts has already been given [14]. Hence, the concept of trust and trustworthiness were defined, the factors influencing trust were identified, and the dynamics governing trust were also explained. In order to computationally reason about trust, multiple models of trust were proposed, such as the swift trust model [5] and the ABI model [8]. These models were then applied in the context of human-AI teams and the effects of trust in automation were studied. From these studies, it was determined that trust in automation helps regulate the usage of technology [12] such that no misuse or disuse occurred and the factors influencing the trust of humans into artificial agent have been identified [7] in order to properly calibrate that trust in automation.

While human trust is a subject on which much research has already been done, there is a lack of research concerning artificial agents trust towards humans. For an agent to trust a human, it is essential that this human appear trustworthy to the artificial agent. Given this, investigating how the artificial agent's behaviour may influence the human's trustworthiness would be a step towards achieving this objective. Furthermore, knowledge on this topic may improve the quality and efficiency of human-AI teams. Since offering and requesting help or advice are important aspects of collaboration and cooperation, the following research question has been formulated and will be attempted to be answered by this paper: *How does an artificial agent asking a human for advice or help affect human trustworthiness?*. The hypothesis that will be tested in this paper is that the trustworthiness of the human increases when he receives requests for help from the artificial agent.

This research paper is structured as follows. First, the background and literature will be presented in section 2. Then the methodology used during the research will be given in Section 3, followed by the results of the experiment and the analysis of these results in Section 4. Section 6 will be about responsible research. Finally, a discussion and a conclusion will follow in sections 5 and 7.

2 Literature and Background

2.1 Human-AI Teams

The focus on an "autonomy-centered" approach to create new systems and artificial agents, which has lasted until recently, appears to be misplaced [6]. Systems were created with the objective of them being intelligent and adaptive enough that human intervention became unneeded. However, on account of these systems being developed by humans, they will always be inherently imperfect and unable to respond to every possible situation. Therefore, there is a need to switch focus to an approach that makes use of teamwork and includes humans to overcome these shortcomings.

Humans and artificial agents possess different categories of skills [2]. For instance, humans are more capable than machines at tasks that require judgement and improvisation, while machines are more suited to tasks requiring demanding computation and high levels of precision. While this may give the idea that tasks must be divided according to the respective capabilities of the team members, researches showed that the tasks must instead be shared by both humans and agents and the focus should be on improving performance using interactions between the agent and the human and coactivity.

For the interaction and teamwork of a team to be as effective and efficient as possible, there needs to be some form of trust between the members of the team [13]. Working in collaboration with someone inherently includes some risk as it involves being vulnerable to the actions of the other teammate, which accentuates the need for trust between team members. Trust is a factor that improves team performance and other processes of a team such as team member retention, while lack of trust has been associated with poor working relationships resulting in low performances [1]. Therefore, trust is essential for a human-AI team to perform efficiently.

2.2 Trust

Trust is a social construct that affects humans daily and has been 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" [8, p. 712]. Hence, for trust to arise, there needs to be some amount of risk in the situation at hand of which the trustor must be aware of, given that it serves to mitigate that uncertainty and risk by anticipating that others will act in the best interest of the trustor. Trust has been said to be further influenced by factors characteristic of either the trustor or the trustee : the propensity to trust of the trustor and the trustworthiness of the trustee. While the propensity to trust is a generalized trust of others and indicates how likely it is for the trustor to trust another party prior to receiving any knowledge about that party, trustworthiness is about the willingness and competence of the trustee to perform the task that is demanded of him.

Trust does not only affect humans, but it also influences the performance of automated systems. In highly automated systems, the human operator takes the role of supervisor and has the task of choosing between automatic and manual control according to the situations. In order to not lower the performance of the system, the appropriate choice must be made by the human operator. One important component that affects this decision has been said to be the amount of trust that the human operator has in the system [11]. Hence, an inappropriate amount of trust in the automated systems can thus lead to either disuse or misuse of said system [12]. Misuse refers in this case to an overreliance of the system by the human operator due to an excessive amount of trust placed on the machine, whereas disuse refers to an underutilization of the system caused by a lack of trust. For the system to perform adequately, there is a need for the trust of the human operator to be properly calibrated.

In order to mathematically reason about trust, a model of trust based on the concepts of Ability, Benevolence, and Integrity was presented [8]. Ability refers to the trustee's skills and capability to accomplish the task that is required of him. Benevolence is about the desire of the trustee to do good by the trustor regardless of the potential benefits and profit that he may gain from the situation. Finally, in order for the trustor to have integrity, he must possess a set of principles acceptable to the trustor in the context of the situation. Accordingly, a human is only considered trustworthy when he possesses high values of ability, benevolence, and integrity. To appropriately trust an agent and avoid misplaced trust or distrust, these values must hence be correctly evaluated. Furthermore, the trustworthiness of a human is not static and can be subject to changes through various means.

2.3 Theory of Delegation and commitment

It has been claimed that the act of relying on and trusting an agent by delegating a task may influence that agent's trustworthiness, and in some cases, improve it [3, 4]. Since both agents of a human-AI team must collaborate and work together, it is more likely for explicit delegations to take place. As such, only the case of an explicit delegation will be considered. This would happen when two agents, A and B, enter into an agreement concerning a task delegation from agent A to agent B. The trustworthiness of agent B to whom the task is delegated to would then either increase, if this task delegation is able to serve a further motivation for agent B thus improving its overall degree of willingness, or decrease due to agent B losing motivation when it has to accomplish a task by contract instead of spontaneously. Generally, this type of task delegation is said to increase the trustworthiness of the delegee thanks to commitment.

When elicited, commitment, or the sense of commitment, can improve cooperation between agents as well as their motivation towards accomplishing an objective. One important function of commitment is that it helps reduce uncertainty in joint actions, such as the one relating to motivation [9]. Therefore, when humans develop a sense of commitment towards another agent, they may become more willing to work towards a goal and do tasks that they would not have done otherwise. In other words, the sense of commitment may improve the willingness of the human to accomplish certain tasks. This sense of commitment between agents can be elicited by one agent relying on another agent [10]. Hence, explicitly delegating a task to another agent will increase that agent's sense of commitment, increasing its willingness and trustworthiness.

3 Methodology

3.1 Experimental Setup

To test the hypothesis that an agent asking a human for help increases that human's trustworthiness, an experiment was conducted. This experiment makes use of the MATRX platform[1] to run an urban search and rescue game. The goal of this game is to rescue 8 victims by finding and dropping them to a specified location in a specified order with the collaboration of an artificial agent. To be completed, the victims must be rescued in under 10 minutes. Furthermore, the human agent has the possibility of communicating with the artificial agent using specific buttons to inform it of his current actions, and can receive similar messages from the robot through the chat. Since the artificial agent possesses some limitations, namely not being able to recognize the gender of babies and not being able to pick up critically injured adults, it is imperative for it to communicate with the human agent and request assistance if necessary. As this game promotes the cooperation of both agents and enables the agent to communicate with the human, it will help study the effects that changing the artificial agent's behaviour has on the human.

The experiment was conducted with a control group and an experimental group. The control group worked alongside a basic robot whose behaviour did not extend further than asking for help when encountering some of its limitations and giving suggestions to the human agent when appropriate. On the other hand, the experimental group played through the game while collaborating with a help-seeker agent whose implementation was identical to that of the basic agent, with the exception that the help-seeker agent would ask for advice or help even in situations where it was not necessity. Thus, the help-seeker agent would ask the human participant for advice on which room to search for victims next. In case the human refused to give any advice to the agent or did not give any response whatsoever to the request, the agent would default to its basic behaviour. Additionally, when exploring larger rooms, the help-seeker agent would ask for assistance in exploring the room. Finally, messages sent by the agent when facing its limitations, were rewritten to sound more like requests than orders. Through this implementation of the help-seeker agent, the effects of requesting assistance could then be measured.

3.2 Measures

Two types of measures were used during the experiment : objective measures and subjective measures. The objective measures consist of data retrieved from the game logs, like the number of messages sent by the human agent or the number of ticks taken to successfully complete the game. A list of the objective measures used during the experiment can be found in table 1. These values were then normalized if necessary and aggregated into a specific score, such as a communication score or a responsiveness score. Moreover, these scores were further aggregated into values representing the benevolence, ability, and integrity of the participant following the ABI model. On the other hand, the subjective measures consist of a single questionnaire given to the participant at the end of the game used to measure the ability, benevolence, and integrity of the participant from that participant's own point of view using a 7-point likert scale. The questionnaire is composed of 20 questions in total,

[1] https://matrx-software.com/

Figure 1: Urban Search and Rescue

Metrics	ABI
Amount of ticks Amount of victims saved (placed in the correct position) Number of Rooms visited Number of Victims picked up	Ability
Number of times the gender of a baby is identified Number of Yes communicated Number of communicated action Number of robot's advice followed Average number of ticks to respond to robot	Benevolence
Number of promises kept (after accepting robot's suggestion) Number of truthful communication	Integrity

Table 1: List of objective measures

with 5 questions for ability, benevolence and integrity each and 5 questions used to describe the sample group. In this way, trustworthiness is measured from two different points of view, offering a more detailed view of how the trustworthiness of the human was affected by the agent's behaviour.

Two confounding variables were taken into account during the experiment, namely the expertise in computer games of the participants and their language proficiency. As the experiment is done through the medium of a video-game, participants who are more familiar with computer games will have an advantage over those who do not possess the same expertise. It is then possible that this difference in expertise may interfere with the results concerning the ability score of the participants. Similarly, participants with significantly lower proficiency with the language used during the experiment could have been more likely to have lower performance scores than those with higher levels of proficiency.

The hypothesis will be tested using either an independent T-test or a Mann-Whitney Test. The choice of which test to use will depend on whether the data has a normal distribution or not. This will be tested using the shapiro-walk test, as there are less than 20 participants in each group. If the data follows a normal distribution, then the T-test will be used. Otherwise, the Mann-Whitney Test will be used. As for the subjective measure, each answer to the questionnaire was encoded with values between 1 and 7. Once the values from the questionnaire have been aggregated into scores for ability, benevolence and integrity, the same procedure as for the objective measures will be used.

4 Results

4.1 Sample Groups

Fig 2, 3 and 4 shows details about the distribution of participant in the control group. Overall, the control group was composed of participants in the 18 to 24 age group with only 2 participants older than 44 years old. Furthermore, the majority of the participants in this group have an above average experience in computer games except for three participants who reported having low to no experience. Finally, all the participants in the control group had at least an average proficiency with the language used during the experiment.

Fig 5, 6 and 7 shows the demographic of the participant in the experimental group. There

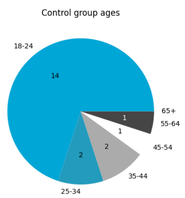

Figure 2: Control Group Ages

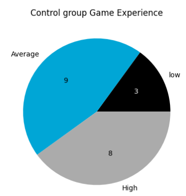

Figure 3: Control Group Game Experience

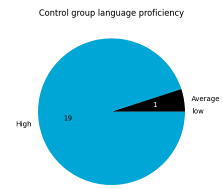

Figure 4: Control Group Language proficiency

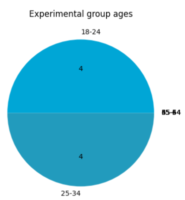

Figure 5: Experimental Group Ages

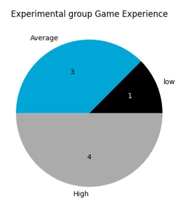

Figure 6: experimental Group Game Experience

Figure 7: Experimental Group Language proficiency

is an equal number of participants in the 18 to 24 age group as in the 25 to 34 age group. Furthermore, the majority of the participants in this group have an above average experience in computer games, except for one participant who reported having low to no experience. Finally, all the participants in the experimental group had high levels of proficiency in the language used during the experiment.

4.2 Objective and Subjective Measure

Table 2 and table 3 present the results of the Shapiro-Wilk Test on the objective measure and the subjective measures, respectively. In the objective measures, only the Ability score and Integrity score of the control group as well as the integrity score of the experimental

	P-value	Normality
Ability (control)	0.010559506714344025	Not Normally distributed
Benevolence (control)	0.42499831318855286	Normally distributed
Integrity (control)	0.0029007578268647194	Not Normally distributed
Trustworthiness (control)	0.40076127648353577	Normally distributed
Ability (experimental)	0.09802190959453583	Normally distributed
Benevolence (experimental)	0.8010546565055847	Normally distributed
Integrity (experimental)	0.009241709485650063	Not Normally distributed
Trustworthiness (experimental)	0.0830848217010498	Normally distributed

Table 2: Result of the Shapiro-Wilk test for the objective measure

	P-value	Normality
Ability (control)	0.4781697690486908	Normally distributed
Benevolence (control)	0.06619922071695328	Normally distributed
Integrity (control)	0.008086475543677807	Not normally distributed
Trustworthiness (control)	0.4010883867740631	Normally Distributed
Ability (experimental)	0.18043512105941772	Normally distributed
Benevolence (experimental)	0.2850266396999359	Normally distributed
Integrity (experimental)	0.023028716444969177	Not normally distributed
Trustworthiness (experimental)	0.23086009919643402	Normally distributed

Table 3: Result of the Shapiro-Wilk test for the Subjective measure

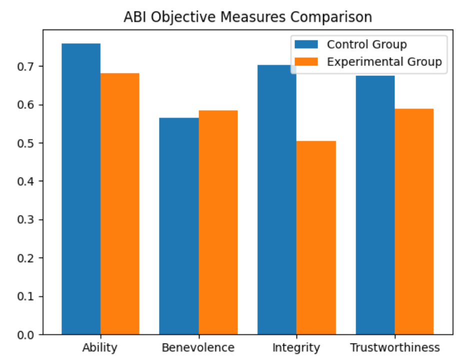

Figure 8: ABI Objective measure comparison

group do not follow a normal distribution, while the other objective measures are normally distributed according to the test. On the other hand, the integrity score of the control and experimental groups are the measures that do not follow a normal distribution for the subjective measure. Thus, a Mann-Whitney test will be used on the scores, while a two-sided T-test will be used on the normally distributed measures.

The aggregated ABI score of the participants based on the objective measures are presented in fig 8. The control group (Mdn = 0.79) had higher objective ability scores than the experimental group (Mdn = 0.745) however a Mann-Whitney Test revealed that this difference was not statistically significant : $U(N_{control} = 20, N_{experimental} = 8) = 95.5$, p >0.05. There was no significant effect on benevolence from the agent asking for help, t(26) = -0.22, p = 0.82, despite the experimental group (M = 0.58, SD = 0.16) attaining higher objective benevolence values than the control group (M = 0.56, SD=0.20). Similarly, while the control had greater integrity values than the experimental group, a Mann-Whitney Test indicated that this difference was not statistically significant as well, $U(N_{control} = 20, N_{experimental} = 8) = 111.5$, p >0.05. Lastly, the trustworthiness scores of the control group (M=0.675, SD = 0.68) were higher than those of the experimental (M = 0.59, SD = 0.15), but a T-Test showed that this difference was not statistically significant, t(26) = 1.19, p = 0.25.

Fig 9 shows the results gained from the questionnaires given to the participant at the end of the experiment. The 8 participants who collaborated with the help seeker agent (M = 0.74,

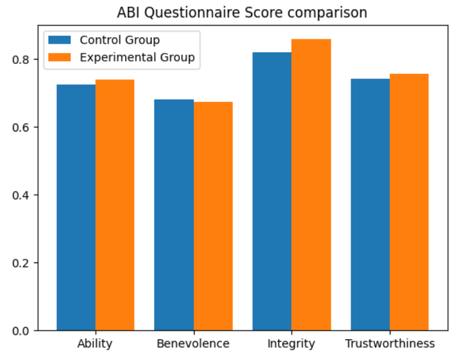

Figure 9: ABI Subjective measure comparison

SD = 0.12) compared to the 20 participants in the control group (M = 0.725, SD = 0.14) did not demonstrate a significantly higher subjective ability score, t(26) = =-0.22, p = 0.82. Additionally, there was no significant effect from the agent asking for help, t(26) = 0.219, p = 0.83, despite the experimental group (M = 0.76, SD = 0.14) attaining higher subjective trustworthiness scores than the control group (M = 0.74, SD=0.17). Furthermore, the subjective integrity scores of the experimental group (Mdn = 0.83) were higher than those of the control group (Mdn = 0.935), but a Mann-Whitney Test indicated that this difference was not statistically significant, $U(N_{control} = 20, N_{experimental} = 8) = 73.5$, p >0.05. Finally, the experimental group (M = 0.675, SD = 0.21) had lower subjective benevolence score than the control group (M = 0.68, SD = 0.26) but no statistically significant difference was found by the T-Test, T(26) = 0.055, p = 0.96.

5 Discussion

5.1 Analysis

No effect on human trustworthiness by the agent asking for help has been found during this experiment from the objective measure. It is possible that this behaviour from an artificial agent has no effect on a human's ability, benevolence, and integrity. While the goal of having the agent ask for help was to elicit a sense of commitment from the human participant towards itself, it is possible that either this sense of commitment can not be elicited towards a robot partner, or asking for help is not enough to elicit it. In which cases, the behaviour of the robot will have no effect on its human partner's willingness to accomplish the current objective.

From the perspective of the human, there were also no significant changes to their trustworthiness. This result is unexpected given the behaviour of the agent. Since it is asking for help and advice, it would be expected that the human's perception of is benevolence would increase instead if they did offer the requested help throughout the game. This may be due to a bias that the participant had towards robots with this type of behaviour in which they may view these requests for help as normal, making them not perceive themselves as more benevolent because of it.

5.2 Limitations

During the experiment, no significant results were found indicating an effect of the help-seeker agent behaviour on the trustworthiness of the participant. This could be due to the length of interaction between the robot and the human. This experiment was run with the assumption that the effect of the agent's behaviour would be noticeable over a short period of time. There exists the possibility that the artificial agent's behaviour takes a long period of time to have a noticeable effect on a human trustworthiness, which this experiment would not be able to record.

While this paper makes use of the ABI trust model [8], there also exist other trust models. It is possible that the trust model chosen to record the trustworthiness of the participant may not have been suitable in this particular context and resulted in the failure to record any potential effect that the agent may have had on the participant. Since the participant's interaction with the agent does not last more than 10 minutes, a trust model which focuses on trust created over a short period of time, such as the model of swift trust [5] may have been more appropriate.

The experiment group used during the experiment as well as the game may have been factors as to why no significant results were found during the experiment. Since the experimental group was composed of only 10 participants compared to the 20 participants of the control group, the sample may not have been large enough to record any existing significant difference. Furthermore, the behaviour of the help-seeking agent and the software used may have not been suitable for the experiment. The most notable difference between the help-seeking agent and the normal agent used in the control group is that the help-seeking agent asks for advice from the participant concerning which room to search before making that decision. This is partly due to the game not having more opportunities for the agent to request advices from the human without it having some unwelcomed effect on the recorded ability score.

5.3 Future Work

Future work should try to give the participant and the robot a longer period of time to interact in order to see if a possible agent's behaviour effect on the human trustworthiness is more pronounced over time or not. Another idea to explore would be testing other trust model such as the swift model to test how whether the choice of trust model would change the results in some way or not. Additionally, during the computation of the ABI scores, the metrics were only averaged without any weights attached to them. It would be interesting to explore which metrics impacts the ABI scores more and come up with weight values to compute a more accurate trustworthiness score.

6 Responsible Research

In this research, the experiment was carried in an ethical manner. The data received from the experiment were anonymized to avoid identification and stored until aggregation of the data, after which it was destroyed. Participation in the experiment was entirely voluntary, and the possibility of withdrawal at any stage of the experiment was given to the participant. It was required that each participant read and accept an informed consent form explaining the risks of the experiment as well as the aforementioned measures taken to alleviate these risks before they were allowed to participate in the experiment (add form in appendix).

In an effort to conduct a responsible research, all data and information about the experimental setup were presented. The data gained from the experiments were not cherry-picked nor manipulated, and all the results were either discussed or presented in this paper, regardless of their nature. Furthermore, to make this research reproducible by a reader, details about the setup of the experiment were given during the report. As such, the software containing the game used during the experiment was given alongside the altered behaviour of the help-seeking agent. Furthermore, a description of the participants selected to participate in the experiment was also given. On account of this, it should be possible for a reader to reproduce the experiment and verify the results presented in this report.

7 Conclusions

In this paper, we attempted to find what effects does an agent asking a human for help has on that human's trustworthiness. More knowledge on this topic would be a step forward toward creating mutual trust in human-AI teams, and improving their efficiency. To answer this research question, a controlled experiment was run using an Urban Search and Rescue game using the MATRX software, through which participants were paired with a robot. During this experiment, the participants had to work alongside the rescue robot to find multiple victims across a map and deliver them to the appropriate drop zones. The control group worked alongside a robot with basic capabilities, while the experimental group had a help-seeker robot able to request advice and help from the human participant as a partner. No significant results that indicate any particular effect that the agent's behaviour may have on human trustworthiness were found through this experimentation. Possible improvements as well as future researches were also proposed in this paper.

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