Who is a Better Tutor? Gaze Hints with a Human or Humanoid Tutor in Game Play

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ABSTRACT

In this paper, we present a study that analyses the effects of robot or human gaze hints on people's choices in a card game. We asked human participants to play a matching card game in the presence of a human or a robotic tutor. Our aim was to find out if gaze hints provided by the tutor can direct the attention and influence the choices of the human participants. The results show that participants performed significantly better when they received gaze hints from a tutor than when they did not. Furthermore, we found that people identified the tutor hints more often in robot condition than in human condition and, as a result, performed significantly better.

Keywords

Gaze-based interactions; gaze perception; games for social robots; directed attention; facial orientation.

1. INTRODUCTION

In human interactions, people rely on non-verbal cues such as gaze, gestures, body language, and facial expressions to communicate meaning. Among non-verbal behaviors, the gaze is a primary source of information [1]. Gaze facilitates a range of essential social functions including directing attention, turn taking and communicating emotions and intentions [3, 4]. Studies show that humans develop sensitivity to the gaze at a very young age. Therefore, perhaps, one of the most significant roles of eye-gaze, is its capability to direct attention to objects of interest in the environment [5]. What is more, reading and the following gaze facilitates the formation of joint visual attention and shared interaction [5]. In this study, we focus on the non-verbal hints that arise from the eye - gaze behavior. Our assumption is that knowing where an agent is looking at provides cues that can direct attention, and enhance the performance of an individual in a task. Prior research in human - robot interaction has demonstrated how gaze can be used to build better interactions with robots [2, 6].This study builds upon previous successes in designing social gaze behaviors for robots, and our goal is to examine, whether hints arising from robot gaze can facilitate the performance of a task with robots and whether humans can read these cues and accept help from a robot. To explore the questions mentioned above, we designed an experimental study to evaluate the effects of gaze hints in the context of the educational gameplay. Particularly, in the present study, the aim was to determine if gaze hints from a tutor (either a human or humanoid) can direct attention and in turn influence the choices of the participants.

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2. METHOD

2.1 Participants & Experimental Procedure

Twenty university students (eleven males, nine females), were invited to play a card game called 'Memory', in the presence of either the robot or the human tutor as shown in Figure 1. In the beginning, the cards were laid face down on the board, and then the player selected a card and tried to find a matching card. If the cards turned face up were similar (a pair of matching cards), then the player continued to match the cards; otherwise, the participant turned the cards faced down and made a new try/move. The goal was to find all pairs in the smallest number of moves/tries, and shortest time, possible. An attempt (try) consists of choosing two cards; the game ended when the participant found all the matching pairs.

Figure 1. The setup; Human - Robot Setup (Left); Human - Human Setup (Right).

The tutor who is on the right side of each image in Figure 1 and the participant (on the left side) sat across the table approximately 160 cm apart; there were fourteen (14) cards arranged in a rectangular board layout placed on a table. The arrangement of the cards on the table was informed by our prior work, where we first examined whether people can perceive gaze and head angles directed at different card locations on the board layout [7]. Both, the human and the robot tutors followed a pre-defined protocol of steps that detailed the rules of how to introduce the game and the sequence of how to shift gaze during the game. The human tutor used a printed photo of the card locations, to guide the participants to the matching cards. For the robot setup, we used the humanoid NAO developed by Aldebaran. Each card was labeled with a unique card code and placed in a fixed position on the board layout marked with a head pitch and yaw angle on the layout. The algorithm was applied such that, after scanning the code of the selected card, the robot head angles shifted to the card position of the chosen card, then to the face of the participant, and then to the location of the matching card.

2.2 Study Design

The study followed a two - by - two (Tutor_Type: Human or Robot) and (Help_Type: Help vs No_Help) mixed factorial design. The Tutor_Type variable was manipulated as a between - participants and the Help_Type as a within - participants. During the help condition, the tutor provided gaze hints to help the participant find the matching cards, when the participant turned up the card, the tutor gazed at the flipped card and continued to look at the matching card. In the No_Help Condition, the tutor only looked at the participant. We hypothesized (H1) that participants would perform better with gaze hints from the tutor than without gaze hints, and (H2) participants would notice the help hints from the robot tutor more often compared to the human tutor, accordingly, we expected that participants would perform better when the robot was helping than when the human tutor was helping. Each participant interacted with the tutor in both conditions, and the order of conditions was counterbalanced across trials.

2.3 Measurements

To evaluate the effects of gaze hints on people's behavior, we identified two objective measures that are notably used to measure performance in a memory game:- **Duration:** This is the time it took the participants to find all matching cards on the table. We obtained the duration from video recordings, this being the period between the participant starting to play the game and completing it. We recorded both the Help and No-Help durations, i.e., the time it took participants to identify the cards with or without gazing cues from the tutors, respectively. **Number of tries:** A try consists of choosing two cards. We counted the number of tries that participants used, with or without gaze cues from the tutor from the video recordings.

3. RESULTS & DISCUSSION

A higher number of participants reported recognizing the help gaze hints in the robot condition (60%) compared to the human condition (20%). Table 1 summarizes the results:-

Table 1. Mean Duration and Number of tries

Mean Duration	**Help_Type**		
Tutor_Type	**Help**	**No_Help**	**Average**
Human	118	118.70	**118.35**
Robot	124.40	145.10	**134.75**
Average	**121.20**	**131.90**	**126.55**
Mean Number of tries	**Help_Type**		
Tutor_Type	**Help**	**No_Help**	**Average**
Human	16.20	19	**17.60**
Robot	11.30	17	**14.15**
Average	**13.75**	**18**	**15.87**

We conducted a mixed-model repeated measures ANOVA, with Help_Type as the within - subject factor and the Tutor_Type as the between - subject factor.**Tutor_Type**: We found no significant main effect of Tutor_Type on duration (F (1, 18) = 0.913, p = 0.352). However, there was a significant main effect of Tutor_Type on the number of tries (F (1, 18) = 5.253, p = 0.034). **Help_Type**: We found a significant main effect of Help on number of tries (F (1, 18) = 7.009, p = 0.016). However, there was no significant difference in duration (F (1, 18) = 0.428, p = 0.521) as well. For the human condition, we found no significant effect of Help for both performance measures: -duration (p = 0. 976) and number of tries (p = 0. 233). For the robot condition, there was still no significant difference in duration between Help and No-Help (p = 0. 383). However, we found a significant mean difference in number of Tries (p = 0.022). Pairwise comparisons between both groups reveal that participants used significantly fewer number of tries with help from the robot tutor compared to the human tutor (p = 0.018, Two-tailed). However, there was no significant differences in the number of tries for the two groups in the No_Help condition (p = 0. 430, Two-tailed). Comparing both groups on duration, we found no significant differences in both Help (p = 0. 674, Two-tailed) and No_Help (p = 0. 391, Two-tailed).As expected in (H1), participants performed significantly better, using fewer number of tries with help from the tutor than without help.Participants also identified all the pairs of matching cards with significantly fewer number of tries, with help from the robot tutor than without help (H2). However, there was no significant difference in the number of tries with or without help in human tutor condition. The significant difference in the number of participants who noticed the gaze hints between the human or the robot tutor may relate to a number of factors; first, we assume it could be due to curiosity and the attractiveness factor with the robotic agent. Second, the noise from the robot head motions could have also triggered the participants to look at the robot more, and thirdly robots are more predictable regarding their behavior compared to humans.

4. CONCLUSION

The results show that participants were more able to read and accept help from the gaze of the robot tutor compared to that of a human tutor in a game setting. Further analysis of the gaze behavior of the participants, collected during the experiment is expected to reveal more details of the participant's interaction in tutoring interactions. In future, we are planning to experiment with a robot with more human-like eyes to find out how more articulated eyes would influence the interaction.

5. ACKNOWLEDGMENTS

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