Gaze-Speech Coordination Influences the Persuasiveness of Human-Robot Dialog in the Wild

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Much work on persuasion focuses on identifying the effects of single, specific interventions. Very few studies address the interplay of several factors, and very little of this work has taken place in human-robot interaction research.

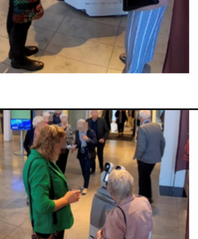
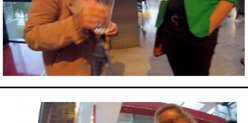
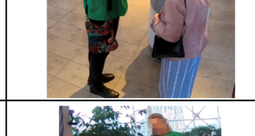
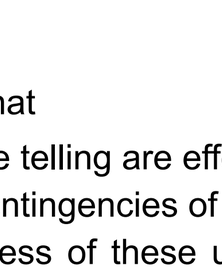
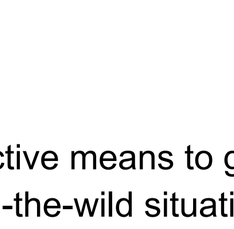
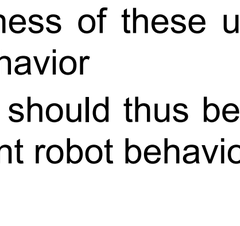
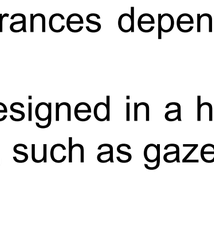
In this study, we investigate to what extent the effectiveness of persuasive robot utterances depends on the robot's gaze orientation. We focus on the effects of:

- toasting (saying *skål (cheers)*)
- joking (a water-related joke when serving water)

We analyze the persuasiveness of these messages depending on the coordination with mutual gaze.

Figure 1: The robot from the perspective of the wizards

Example Interaction

1. Robot initiates: *"I don't mean to interrupt, but…"* *("Nu vil jeg ikke afbryde, men…")* Both participants look at the robot, participant on the right has her back turned		
2. Robot repeats: *"I don't mean to interupt, but…"* *("Nu vil jeg ikke afbryde, men…")* Both participants turn towards the robot, circular arrangement (F-formation) develops		
3. *Robot: "… But would you like something to drink?"* *("…Kunne I tænke jer noget at drikke?")* Participant on the left answers: *"Yes, we actually would"* *("Ja, det kunne vi da godt")*		
4. Robot utters: *" Please take your water"* *("Tag venligst din vand")* and turns. Participant on the left utters: *"Wow…"* *("Nej…")* Both participants reach for glasses on the tray		
5. Both laugh and take a glass *Participant on the left responds:* *"Okay, then… We will then… Thank you."* *(Okay, så… Jamen det gør vi da så… Tak.")* Both participants thank the robot, and look towards the robot's front as it turns back		
6. Robot turns back towards the participants and utters: *"Cheers"* *("Skål")*		
7. Participant on the right look to the participant on the left, as they both respond: *"Cheers!"* *("Skål!")* to the robot		
8. The participants then look at each other and raise their glasses The participants both drink as the robot turns Robot drives away, while uttering: *"Enjoy the show"* *("Nyd forestillingen")*		

Data

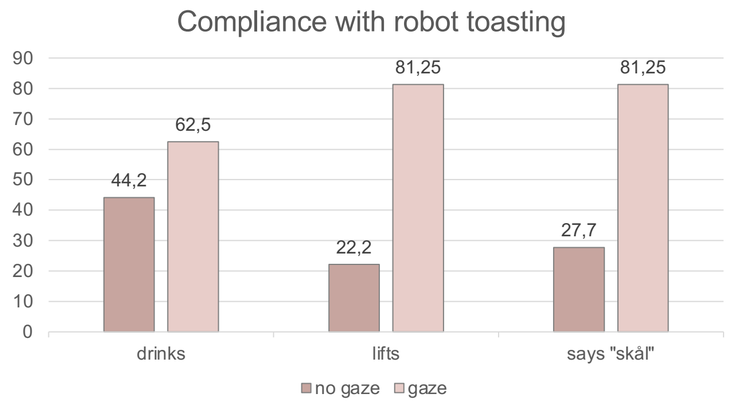
About 200 human-robot interactions were collected at four public events when people were gathering to be admitted into a concert hall. Participants are members of the general public, many of whom are older adults.

Method

While people were slowly gathering, the robot was driving around offering water to people sitting or standing. The dialogs were scripted and include greetings, offers, persuasive utterances, humorous utterances, a request to take water, a toasting utterance *(skål)* and closings. Two wizards (one for navigation and one for the dialog) controlled the robot from a deck one floor above the experiment site, having a good overview of the experiments the entire time while not being noticed by the participants.

Results on Toasting

Our analysis shows that many people drink, lift their glasses and reply *"skål"* when the robot utters *"skål," but that compliance with the robot's suggestion depends on whether or not the robot has previously established mutual gaze*:



A chi-square test of independence shows that the difference in water consumption is not significant ($\chi^2(1,34)= 1.108$; $p=.292$), but that people lift their glasses ($\chi^2(1,34)= 11.806$; $p=.001$) and say "skål" ($\chi^2(1,34)= 9.722$; $p=.002$) significantly more often in the mutual gaze condition.

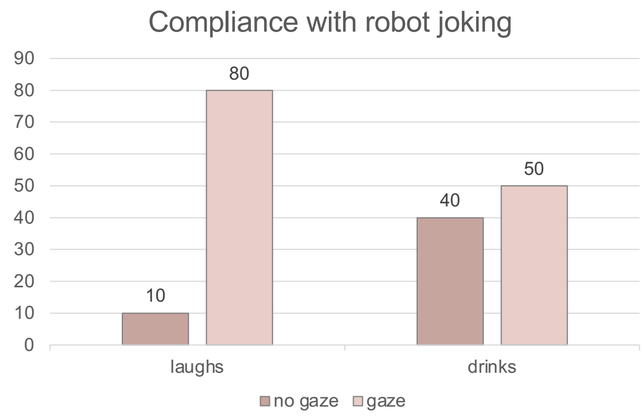
Results on Joking

We study the effects of two jokes that have a similar two-part structure together in the analysis:

1) I have something to make you laugh: tickle water! (= carbonated water in Danish)

2) Do you know how to make a fish laugh? You put it into tickle water.

The analysis shows that many people laugh and drink water after the robot tells the jokes, but significantly more so if there is mutual eye gaze between human and robot.



The results of a chi-square test show significant differences between people's laughing behavior depending on whether or not there is mutual gaze between the participant and the robot ($\chi^2(1,35)= 13.895$; $p=.001$), while regarding drinking and mutual gaze the difference does not reach significance ($\chi^2(1,35)= 0.0005$; $p=.982$).

Conclusion

Our results show that

- toasting and joke telling are effective means to get people to drink in human-robot interaction
- in spite of the contingencies of in-the-wild situations, robots can be persuasive social agents
- the persuasiveness of these utterances depends however crucially on their coordination with the robots' gaze behavior
- Robot behavior should thus be designed in a holistic fashion, paying attention to the tight coupling between different robot behaviors, such as gaze and dialog behavior.