Explorative overview of mutual gaze in social settings

Georgiana Cristina Dobre[1], **Marco Gillies**[1], **Jamie Ward**[1,2], **Antonia Hamilton**[2], **Patrick Falk**[2]

[1]Goldsmiths University of London, London UK, [2]Institute of Cognitive Neuroscience, University College London, London, UK

Introduction

Understanding the gaze behaviour is key to developing virtual characters for immersive virtual environments that implement accurate gaze targets. Researchers investigated gaze in the context of non-verbal cues for social settings using traditional 2D displays, such as flat monitors. The approach of using 2D displays introduces severe limitations for a realistic and immersive communication. Several challenges arise when trying to repurpose the social behaviour from 2D displays to immersive virtual environments. One of the biggest challenges is tracking the user's gaze behaviour and facial expressions while wearing a head mounted display as it blocks half of the person's face. The work presented here attempts to fill in some of the gaps in the area of gaze direction in conversational settings, leading towards automated gaze models for virtual characters partially based on the conversational roles.

Dataset

The dataset contains rich upper body motion capture, eye data video, audio and video recordings from 31 dyads. The participants are engaged in three different tasks: discussion, picture description and meal planning. The activity includes five tasks, the discussion and picture description tasks taking place two times. The tasks order is as follows: discussion 1, picture description 1, meal planning, picture description 2 and discussion 2. The activity takes, on average, 1h to complete.

Discussion Task
It involves watching a short cartoon video followed by a discussion about the watched video.

Meal Planning Task
This is a free discussion in which participants work together to plan a meal using ingredients that both dislike.

Picture Description Task
It includes two parts: a monologue followed by a dialogue. In the first part, one participant is describing a picture while the other one is listening to the first person's description. This is followed by the second part (the dialogue) where the listener can ask questions and the participants can converse together about the picture.
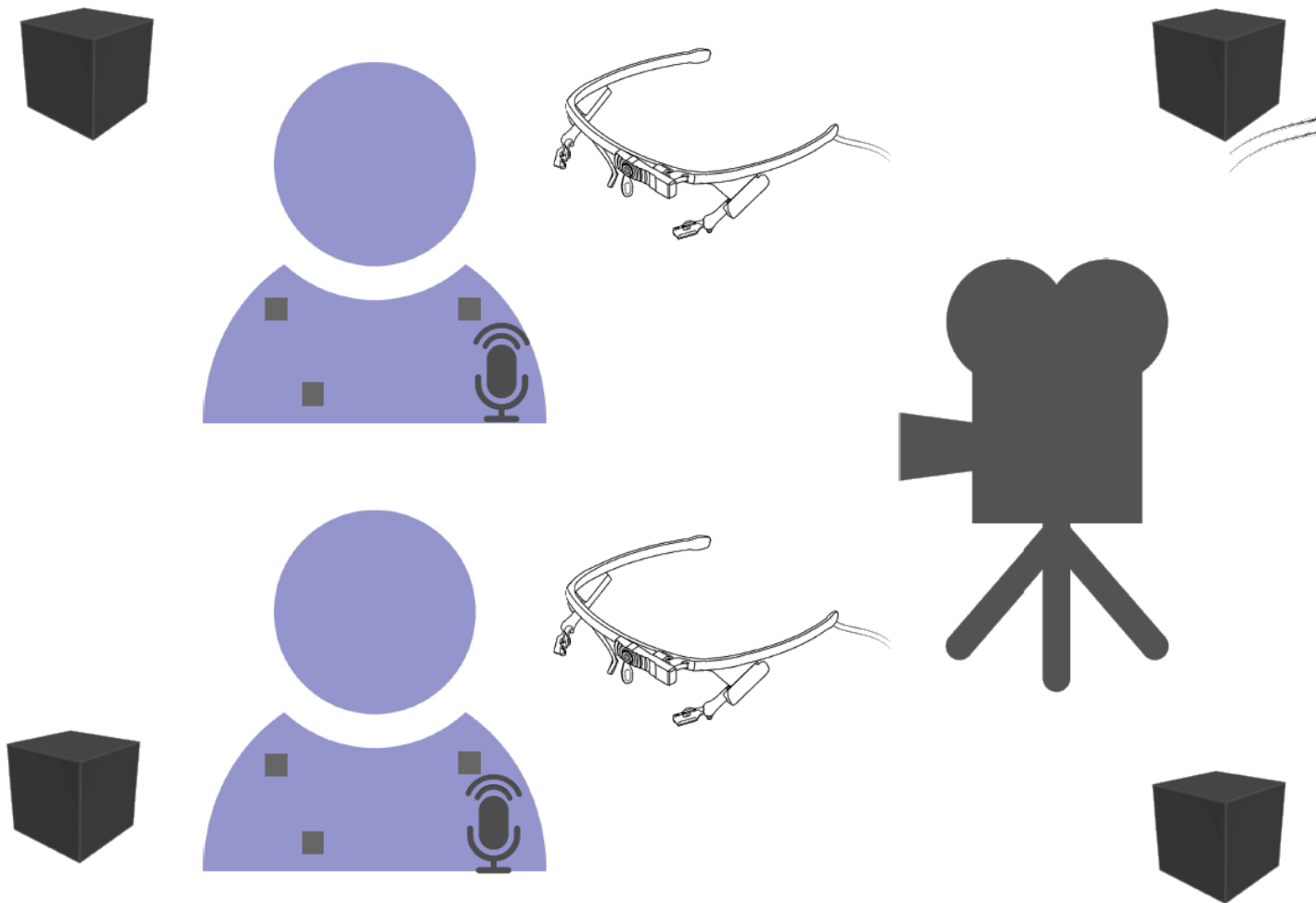
Image 1: Representation of the recording set up: two people are wearing PupilLabs grasses, microphones and mocap suits while performing five tasks

Current Work and Initial Results

Current results indicate a possibility of calculating mutual gaze in a dyad by considering both individuals' amount of directed gaze (one's gaze directed to the other person's face). The predicted proportion of mutual gaze is computed by multiplying the proportion of directed gaze of the individuals in a dyad per each task. Pearson Correlation Coefficient test is performed on the predicted proportion of mutual gaze and the actual mutual gaze proportion, Table 1 showing the results, along with the percentage error of predictive/actual mutual gaze amount.

| Correlation and Error of predictive mutual gaze		
Task	Pearson Correlation R and P	Error
Discussion 1	R = 0.994 P< 0.00001	1.34%
Picture Description 1	R = 0.995 P< 0.00001	1.14%
Meal Planning	R = 0.982 P< 0.00001	1.25&
Picture Description 2	R = 0.996 P< 0.00001	0.50%
Discussion 2	R = 0.9921 P< 0.00001	2.02%

Table 1: Pearson Correlation Coefficient and the error of predictive mutual gaze from individuals' directed gaze for each conversational task

Correlation of directed gaze average duration across tasks		
Task	Person 1	Person 2
Discussion 1 & Discussion 2	R = 0.924 P<0.00001	R = 0.759 P<0.00262
Discussion 1 & Meal Planning	R = 0.700 P<0.00772	R = 0.772 P<0.00198
Discussion 2 & Meal Planning	R = 0.732 P<0.00444	R = 0.538 P<0.06246

Table 2: Pearson Correlation Coefficient on average duration of directed gaze for each person across tasks, shows the consistency of individuals directed gaze duration

For the next analyses, only the discussion and meal planning tasks are considered due to their unstructured conversational nature. The average duration of directed gaze is computed for each person across all tasks. This is used to calculate the correlation between each participant directed gaze duration across each two tasks, showing the consistency of individuals directed gaze. Pearson Correlation Coefficient test results are shown in Table 2.

People tend to have longer directed gaze before mutual gaze. The average duration of directed gaze before mutual gaze being with 15.36% longer than the average duration of directed gaze that doesn't turn into a mutual gaze. (The directed gaze turns into mutual gaze when the other participant looks towards the first participant, and it doesn't when the first participant averts his/her gaze)

The next analysis looked at the relationship between gaze and conversational turn. Results show that speakers tend to avert their gaze a short while before their turn starts and redirect their gaze towards their conversational partner a few seconds after their turn. Listeners, on the other hand, tend to maintain a fairly constant gaze behaviour before the start of the turn and a few second after, with a tendency of averting their gaze as the speaker direct theirs towards them. Image 2 shows the speaker's and listener's gaze behaviour before and after the turn, during the discussion 1&2 (left) and meal planning (right) tasks. The independent two-sample T-test is used to determine statistical significance of the speaker and listener gaze behaviour for a duration of three seconds after the start of the turn. The T-test results are as follow: T=-15.957, P<0.0001 for discussion 1&2 tasks and T=-13.228, P<0.0001 for meal planning tasks.
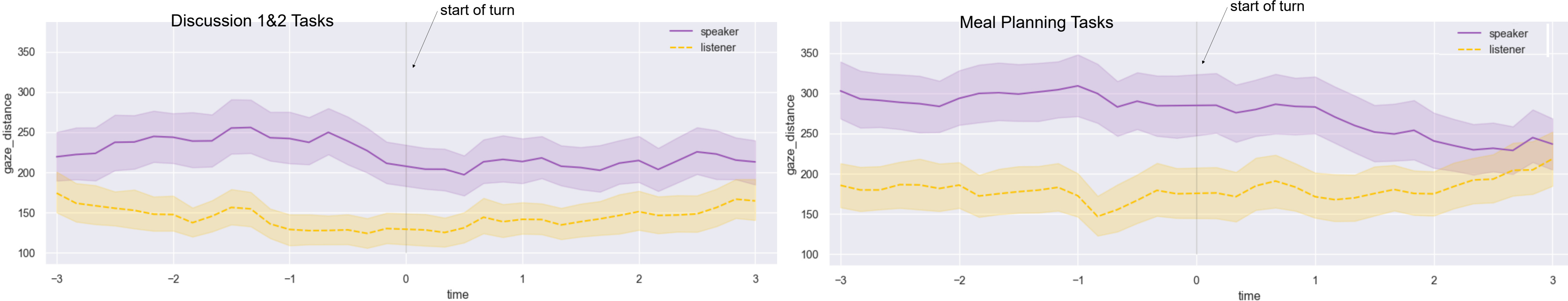
Image 2: The speaker and listener gaze behaviour before and after the start of a turn during discussion 1&2 (on the left) and meal planning (on the right). The Y axis shows the gaze distance in pixels from the other person's middle face, while the X axis shows the time in seconds: 3 seconds before and after the turn starts

Acknowledgements

Contact

Georgiana Cristina Dobre
c.dobre@gold.ac.uk | @shescristina | cristinadobre.github.io

UCL

EPSRC
Engineering and Physical Sciences
Research Council

iGGi

Goldsmiths
UNIVERSITY OF LONDON