

REPORT: SOCIAL ENGAGEMENT

by Lena Antonia Philine Regine Hansen, Lisa Søndergaard, Astrid Iversen, Sebastian Engen, Fredrik Sejr | February 2019

Introduction and theory

This study is a replication of the study by Tylén et al. (2012), which was a combined fMRI and eye-tracking study investigating the difference between social observation and social interaction. Literature within the field of cognitive science and neuroscience has often focused on two theories when investigating social engagement: 1. Theory of Mind (also known as *mentalizing*), and 2. The Simulation Theory.

These two theories, however, are mainly explaining the way individuals make sense of others from an observational point of view. It is questionable whether this is comparable to real-life, first person interactions.

Therefore, recent studies have advanced the view of cognitive processes involved in social interaction by introducing theories of an “extended” or “enacted” mind that goes beyond the individual’s mind and brain (e.g. De Jaegher et al., 2010). This theory states that when two people engage in joint activity, their bodies, actions, and cognitive processes become coupled in dynamic ways (De Jaegher et al., 2010; Hasson et al., 2012).

Tylén et al. investigated different brain areas involved in social observation and social interaction while participants were watching short videos of a person holding a cup (2012). Moreover, they investigated pupil dilation and eye movements related to social observation and social interaction. This is the part of the study that we are replicating.

Pupil dilation has been reported as a marker of emotional arousal (Laeng et al., 2012). It is also used to provide a sensitive index of cognitive and affective processes (Partala and Surakka, 2003; Granholm and Steinhauer, 2004). Tylén et al. found that pupil size was significantly bigger for social interaction conditions; especially when the person in the video was oriented towards the participant (first-person perspective). These findings suggest that actors’ ostensive cues and direct body orientation induce participants with increased levels of attentional alertness. In our replication of the

study, we will also investigate pupil size. Furthermore, we will investigate fixation duration of eye gaze as an indicator of emotional engagement.

Hypotheses

We expect to find that stimuli mimicking an interaction with the participant will induce higher emotional engagement and arousal than stimuli that makes the participant third person observer.

This hypothesis will be investigated by looking at 1: Pupil Size, and 2: Fixation duration□.

H1. Pupil size

Pupil size is expected larger for conditions with social interactions (direct rather than divert, and ostensive rather than non-ostensive). This stems from earlier findings that suggest association between increased pupil sizes and emotional arousal.

H2. Fixation duration

Fixations are expected to be longer in conditions with social interactions (direct rather than divert, and ostensive rather than non-ostensive).

Experimental design

A. Participants

Participants in the experiment were 6 Cognitive Science-students during an eye-tracking workshop in 2018.

B. Stimuli

Stimuli consisted of short video clips of 5 seconds. Each video showed an actor with a cup.

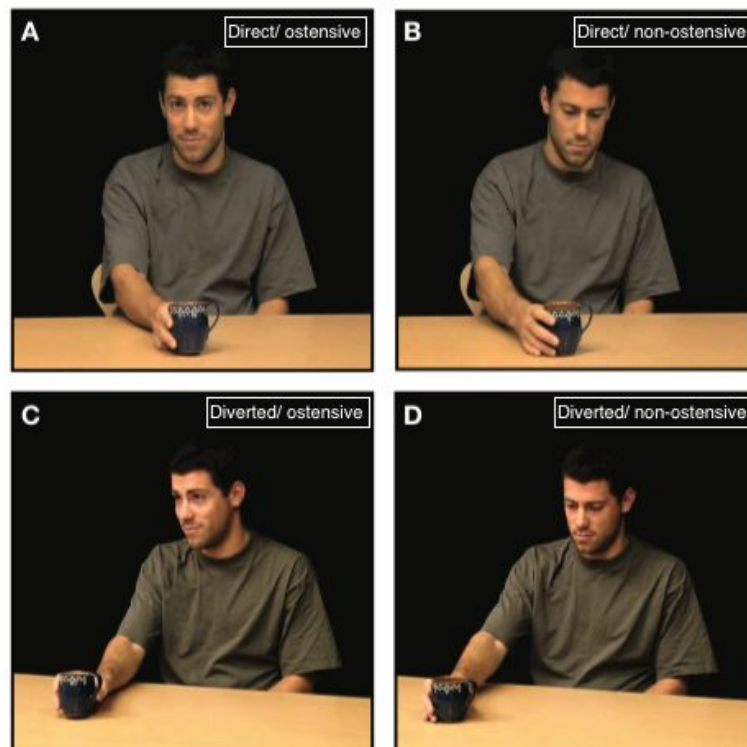
Stimuli varied in terms of two variables:

1. The gender of the actor in the video, and
2. The action performed in the video in a 2x2 design mixed by ostensive/ non-ostensive and direct/ diverted perspective (see *conditions* below)

C. Conditions

Directedness is determining whether the actor is facing the participant (direct perspective) or facing in a different direction than that of the participant (diverted perspective).

Ostensiveness is determining whether the actor's gaze is locked on the cup (non-ostensive) or looking up from the cup and making eye-contact (depending on the directedness, either with the participant or with an imaginary 3rd person)(ostensive).



Example of stimuli from Tylén et al. (2012)

Preprocessing of data

The preprocessing of the data consisted of the following points:

A. Pre-processing in DataViewer

The eye-tracking data (x/y coordinates, velocities and pupil size) were automatically pre-processed using the in-built DataViewer software. Artefacts were removed. Eye-blinks, saccades and fixations were identified.

B. Estimating error

Validation error was used to exclude participants and model measurement error

C. Data exclusion

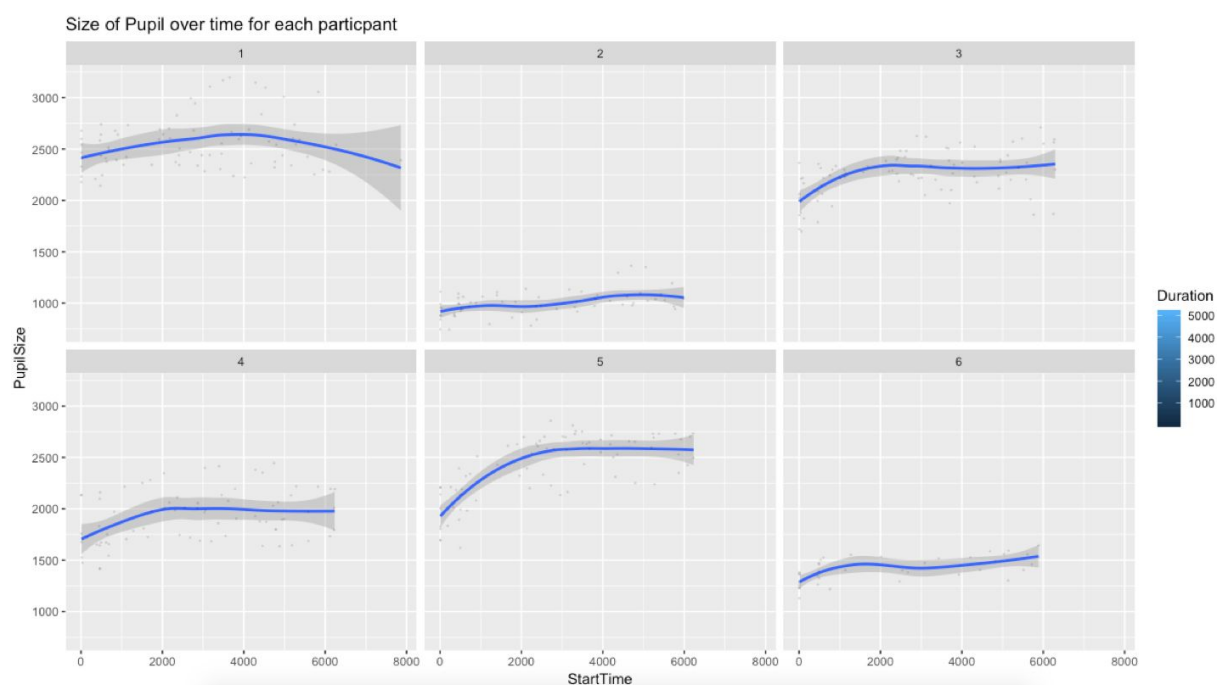
Unfortunately, all the data gathered in 2019 was scrambled up, making it impossible for us to work with. On this basis it was excluded.

D. Investigating the data using plots

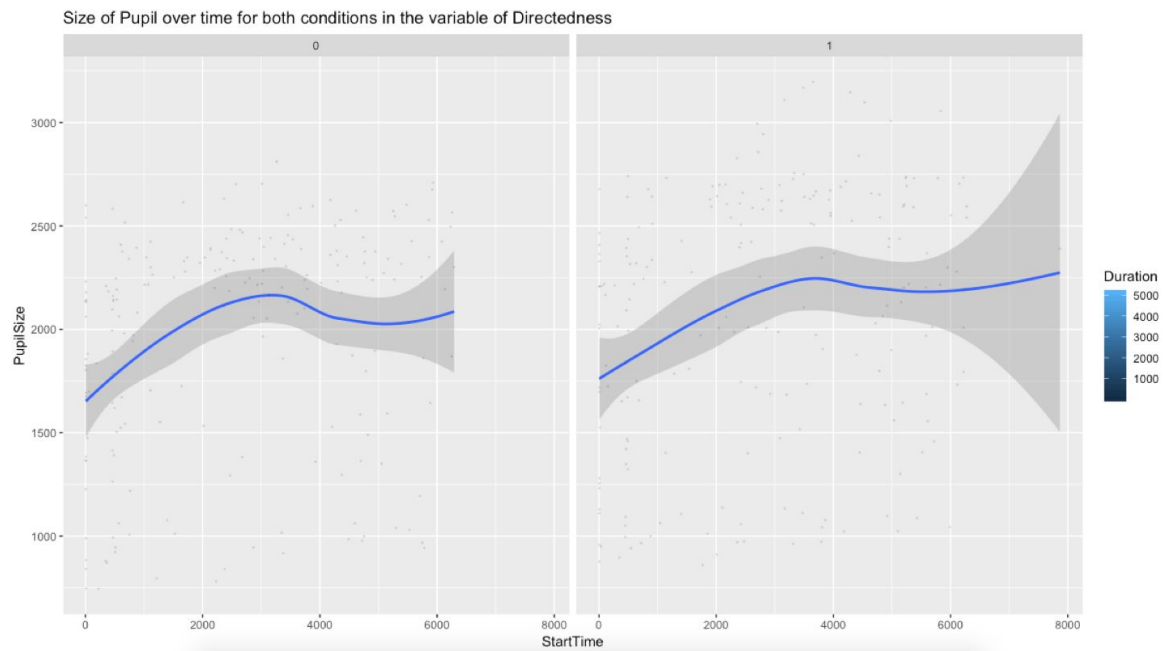
Pupil size and fixation duration were plotted for each participant (**plot 1-6**).

- Eyeballing the data, it seems that pupil size increases more over time for the direct condition than the divert condition and equally more for ostensive condition than the non-ostensive condition. However, the fixation duration seems to only decrease slightly more in the direct and ostensive conditions than in the divert and non-ostensive conditions.

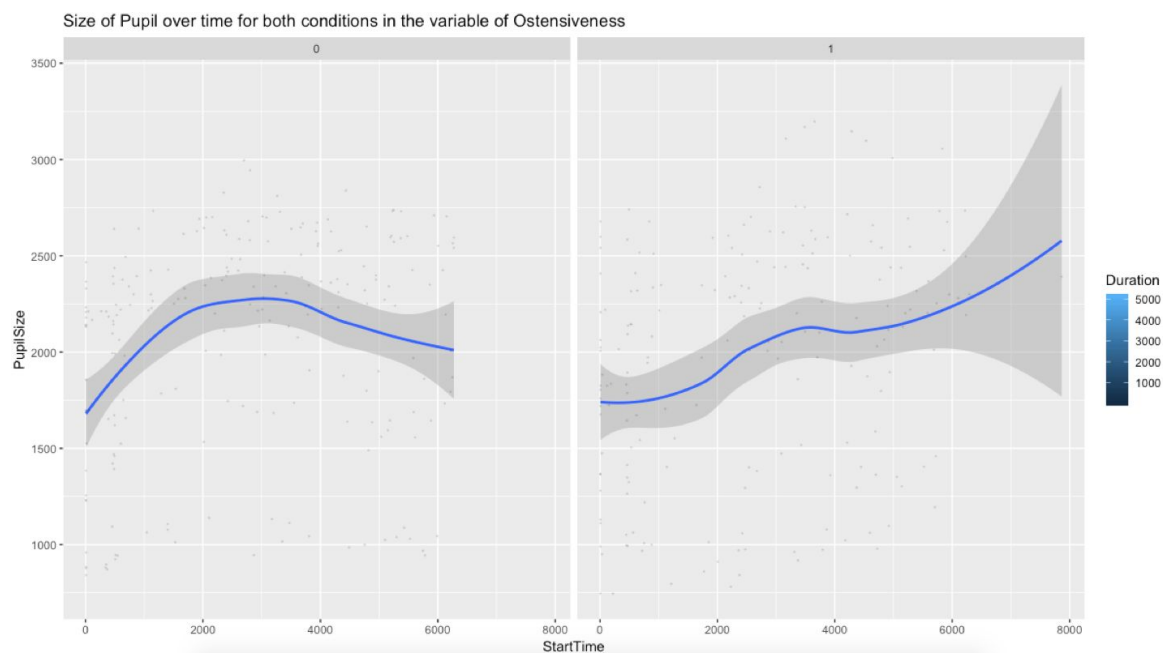
Plot 1: These plots visualize the size of the pupil across time for the different participants.



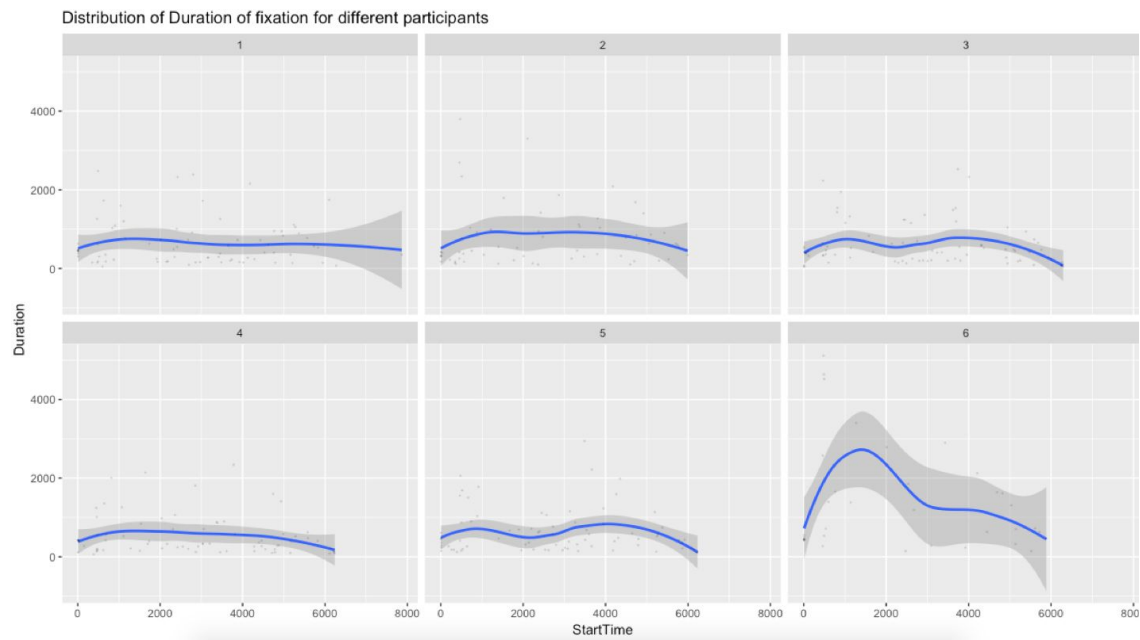
Plot 2: These plots visualize the size of the pupil across time for the two conditions of Directedness of the camera (Looking straight at the person in the video or looking from the side). 1 is looking directly and 0 is the condition looking from the side.



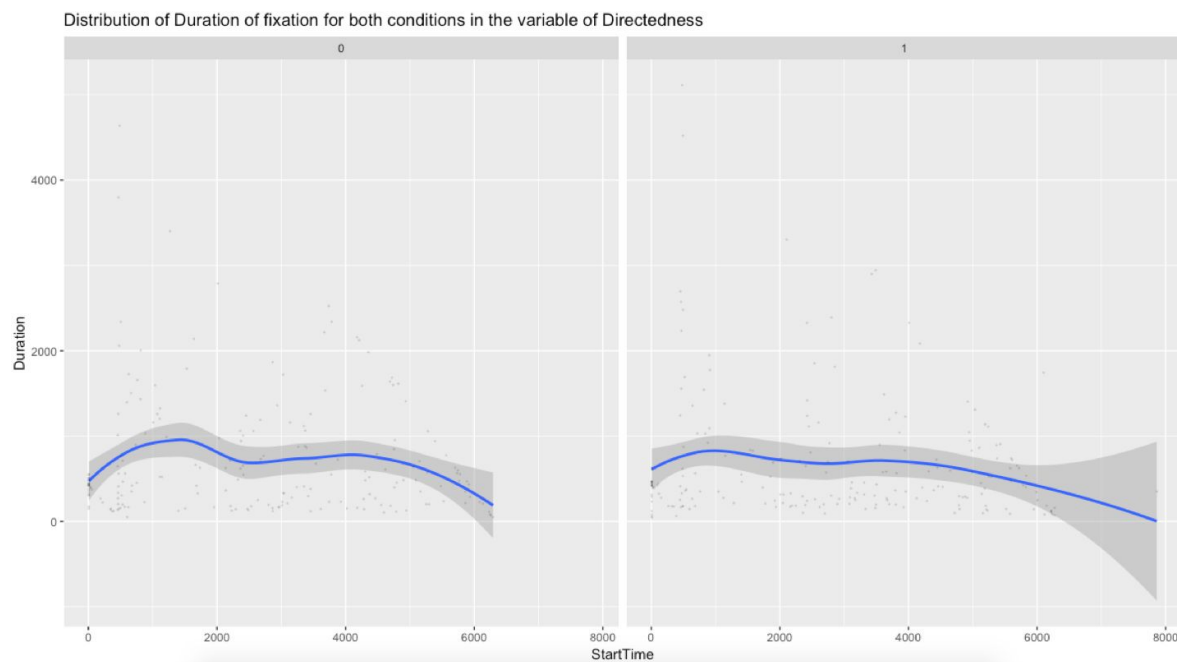
Plot 3: These plots visualize the size of the pupil across time for the two conditions of Ostensiveness (Having eye contact with the person in the video or not). 1 is for eye contact and 0 is for no eye contact.



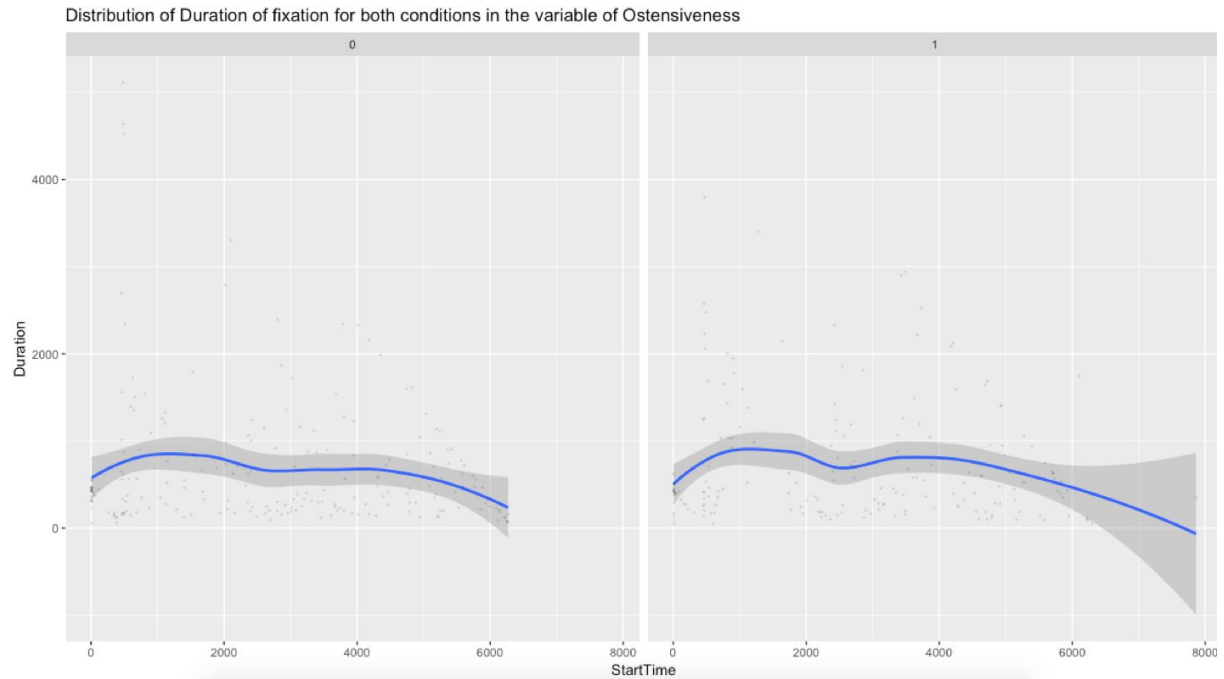
Plot 4: These plots visualize the Duration of fixation across time for the different participants..



Plot 5: These plots visualize the Duration of fixation for the two conditions of Directedness of the camera (Looking straight at the person in the video or looking from the side). 1 is looking directly and 0 is the condition looking from the side.



Plot 6: These plots visualize the Duration of fixation for the two conditions of Ostensiveness (Having eye contact with the person in the video or not). 1 is for eye contact and 0 is for no eye contact.



Results

We built two models to test the hypotheses.

H1. Pupil Size Model

PupilSize ~ Directedness + Ostensiveness + Duration_scaled + (1|ParticipantID)

Predictor	Estimate	Standard Error	p-value
Intercept	7.487477	0.136570	< 2e-16 ***
Direct	0.053665	0.010649	4.67e-07 ***
Ostensive	-0.009644	0.010715	0.3681
Duration_scaled	0.010353	0.006129	0.0912

After doing a five-fold cross validation of the models, even though they mainly came out

insignificant, we found that checking RMSE (Root Mean Square Error) scores across both test and training sets came out similar. Insinuating that our sample might have representability on a larger population level (For this “WIERD” group of people).

RMSETrain				
2141.113	1961.119	2118.828	2000.061	2217.195
RMSETest				
1408.255	2552.390	1930.894	2419.449	1816.261

H2. Duration of Fixations Model

Duration ~ Ostensiveness + Directedness + (1|ParticipantID)

Predictor	Estimate	Standard Error	p-value
Intercept	6.61211	0.14195	<2e-16 ***
Ostensive	-0.07040	0.09947	0.479
Direct	-0.02396	0.09454	0.800

After doing a five-fold cross validation of the models, even though they mainly came out insignificant, we found that checking RMSE (Root Mean Square Error) scores across both test and training sets came out similar. Insinuating that our sample might have representability on a larger population level (For this “WEIRD” group of people).

RMSETrain				
1962.173	2227.305	2142.243	1912.149	2119.962
RMSETest				
2553.371	1000.646	1408.615	2338.472	1932.118

Discussion

Revisiting the hypotheses

In this experiment we wanted to investigate the difference in emotional engagement and arousal in social interaction and social observation.

H1. Pupil size

We expected pupil size to be larger in social interaction-conditions relative to social observation. We found an increased pupil size in the direct perspective-condition (social interaction) compared to diverted perspective-condition (social observation).

We did not, however, find a difference in pupil size between ostensive and non-ostensive conditions.

H2. Fixation duration

We expected duration of fixations to be longer in social interaction-conditions relative to social observation-conditions. We did not find any difference in the fixation-durations between any of the conditions.

Limitations to the experiment

There were a few limitations to the experimental set-up as well as implementation of the experiment.

Amount of participants

The amount of participants in the study was quite small, consisting of only 12 participants. Furthermore, the data collected in 2019 had been scrambled. As a consequence of this, we had to exclude the data from 2019 altogether. Thus, the amount of participants in this analysis consisted of only 6 participants.

Participant-bias

All the participants in the experiment were Cognitive Science students, who had already been introduced to the procedure and the aim of the experiment. This must be assumed to bring in some bias, which might have changed the behavior of the participants.

Relevance of findings

Earlier findings

In spite of the small number of participants, this study contributes to the findings by Tylén et al. that there is a difference between social observation and social interaction.

Future studies

Sexual preference

As dilated pupil size is associated with arousal, we could imagine seeing higher arousal in participants when interacting with someone of their sexual preference relative to someone who is not. In this setup, we did not have access to the sexual preference of our participants. However, this would be an interesting topic of future investigation.

Familiarity

Knowing that all the participants have done a workshop with one of the people in the video - namely Andreas Højlund - one could look into effects of familiarity. This could give a glimpse into whether social observation related to the same extend on familiarity as does social interactions.

References

- De Jaegher, H., Di Paolo, E., and Gallagher, S. (2010). Can social interaction constitute social cognition? Trends Cogn. Sci. 14, 441–447.
- Tylén, K., Allen, M., Hunter, B. K., and Roepstorff, A. (2012). Interaction vs. observation: distinctive modes of social cognition in human brain and behavior? A combined fMRI and eye-tracking study. Frontiers in Human Neuroscience 6

Link to our code:

<https://github.com/sebsebar/Alouishes/blob/master/Port%201%20-%204th%20semester.Rmd>

