Computational Models - Portfolio 1 - Eye-tracking

Social Engagement Experiment

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Link to Github:
https://github.com/Carolinecasey17/ComputationalModels.Portfolio1.SocialEngagement.git

Introduction

In the social engagement task we investigated how participants pupil size would differ dependent on directionality and ostensiveness of stimuli presented, comparing second person and third person social interactions. In all conditions the participant was asked to watch a short video clip of a person handing a coffee cup to either the participant or a third person not presented on the screen. These trials also varied in whether the stimuli would avoid eye contact or make eye contact (a form of social engagement). Directionality in this paradigm refers to the direction the person in the video-stimuli faces, which either faced toward the participant, or faced sideways to the participant. Ostensiveness is whether the person in the video avoids social engagement (such as avoiding eye contact) or demonstrates a form of social interaction initiation (making eye contact) in the trial.

In the experimental literature, it has been found that pupil size is an accurate indication of emotional states. It has been revealed that pupil size increases more with emotional arousal, which in turn is more prevalent in social engagement (Tylén et al, 2012). Therefore, it is hypothesised that pupil size will increase more when watching a trial where the person in the video is handing the cup directly to the participant, accompanied with an interacting gesture. We also hypothesise that pupil size will increase less if the person in the video is handing the cup to a third person. It is further hypothesised that pupil size will increase more if the trial was more ostensive than if they were to not engage in eye contact (non-ostensive trials). This will reveal how participants should be more emotionally engaged when they are involved in a social interaction.

Method

Design

The experiment consisted of 8 videoclips which were shown to the participants in a random order. The video clips either evoked an observational or interactive responsive attitude in the participant toward an actor performing simple object-related gestures. In the interactive condition, the actor made interaction initiation cues (eye-contact, eyebrow flashes and nods) before performing a placing-object-for or showing-object-to-action. In contrast, in the non-interactive 'private' condition, the same actions were performed without ostensive cues. Moreover, the directionality of the action was modulated so that in some conditions the actor would face the participant while in others she/he

was presented from an averted side-on perspective, as if facing a third person outside the perspective of the camera.
The videoclips consisted of following conditions:

Figure 1 - Conditions

2nd person interaction	**3rd person interaction**
Male - Looking down	Male - Looking down
Male - Looking up and interacting	Male - Looking up and interacting
Female - Looking down	Female - Looking down
Female - Looking up and interacting	Female - Looking up and interacting

Participants

In the Social Engagement Experiment there were 6 participants (female = 4).

Apparatus and Material

For the experiment an Eye Link 1000 head mounted eye tracker was used. The eye tracking was recorded at 1000 Hz, tracking monocular eye positions and pupil sizes. The eye tracker was linked and synchronized with a second computer. The second computer ran a PsychoPy (Peirce, 2007) implementation of the paradigm. Furthermore, the second computer continuously recorded time stamps for the initiation of stimuli exposure.

Additionally, the eye tracking data were automatically pre-processed using the in-built DataViewer software. Pre-processing in this software included removal of artefacts and the recording of eye blinks, saccades, and fixations were identified.

Procedure

Screening
Before initiating the experiment, the participants were screened for potential issues. Issues which could affect the sampling rate consisted of eyeglasses, contact lenses and cosmetics. However, if the participants had any of these troublemakers, they were still allowed to continue onto to calibration. If the machine could still calibrate effectively, they were still allowed to participate.

Procedure
The participant entered a room mainly lit by artificial lighting, with minimal natural light. Next, the participant was placed in front of the eye tracker, with their chin placed on a head mount. For optimal eye tracking, the participant was seated comfortably approximately 70 cm away from a 30 inch computer screen.

Before the participant could participate in the Social Engagement Experiment, the eye tracker had to be calibrated. The eye tracker was calibrated using the Eye Link 1000's in-built nine-point automated calibration procedure. Calibration was repeated until the validation procedure reported average errors below 1 and max error below 1.5.

After calibration, the PsychoPy script started, and the experiment commenced. The participants were presented with written instructions for the task on the screen. After having read and understood the instructions, they could continue to the experimental paradigm. The participants were shown different videos and were asked to pay close attention. The participants was told that they would receive a questionnaire in the end of the experiment, however, no questionnaire was shown. This was done to get the participant to pay close attention to the videos. The participant was shown one of every type of video (Figure 1).

Results

To see which model would perform best, we performed a three-fold cross validation on a variety of models. From this we were able to compare RMSE and evaluate the most appropriate model.

Figure 2 - Models & RMSE

RMSE	Model
300	Ostension*Directionality*Trial*Fixation + (1+Directionality*Ostension*Trial*Fixation|ParticipantID) $PupilSize \sim \beta_{0i} + \beta_{1i}Ost + \beta_{2i}Dir + \beta_{3i}Tr + \beta_{4i}Fix + \beta_{5i}Ost * Dir * Tr * Fix + \varepsilon$
321	Ostension*Directionality+Trial + Fixation + (1+Directionality*Ostension*Trial*Fixation|ParticipantID) $PupilSize \sim \beta_{0i} + \beta_{1i}Ost + \beta_{2i}Dir + \beta_{3i}Ost * Dir + \beta_{4i}Tr + \beta_{5i}Fix + \varepsilon$
335	Ostension+Directionality +Trial + Fixation + (1+Directionality*Ostension*Trial*Fixation|ParticipantID) $PupilSize \sim \beta_{0i} + \beta_{1i}Ost + \beta_{2i}Dir + \beta_{3i}Tr + \beta_{4i}Fix + \varepsilon$
316	Ostension*Directionality + Fixation + (1+Directionality*Ostension*Fixation|ParticipantID) $PupilSize \sim \beta_{0i} + \beta_{1i}Ost + \beta_{2i}Dir + \beta_{3i}Ost * Dir + \beta_{4i}Fix + \varepsilon$
321	Ostension+Directionality + Fixation + (1+Directionality*Ostension*Fixation|ParticipantID) $PupilSize \sim \beta_{0i} + \beta_{1i}Ost + \beta_{2i}Dir + \beta_{3i}Fix + \varepsilon$

From the three-fold cross-validation process, the model with the lowest RMSE was Ostension*Directionality*Trial*Fixation+(1+Directionality*Ostension*Trial*Fixation|ParticipantID), RMSE = 300. However, this model showed no significance for any effects of interest ($p > .05$). Two of our models showed a significant effect of fixation time:

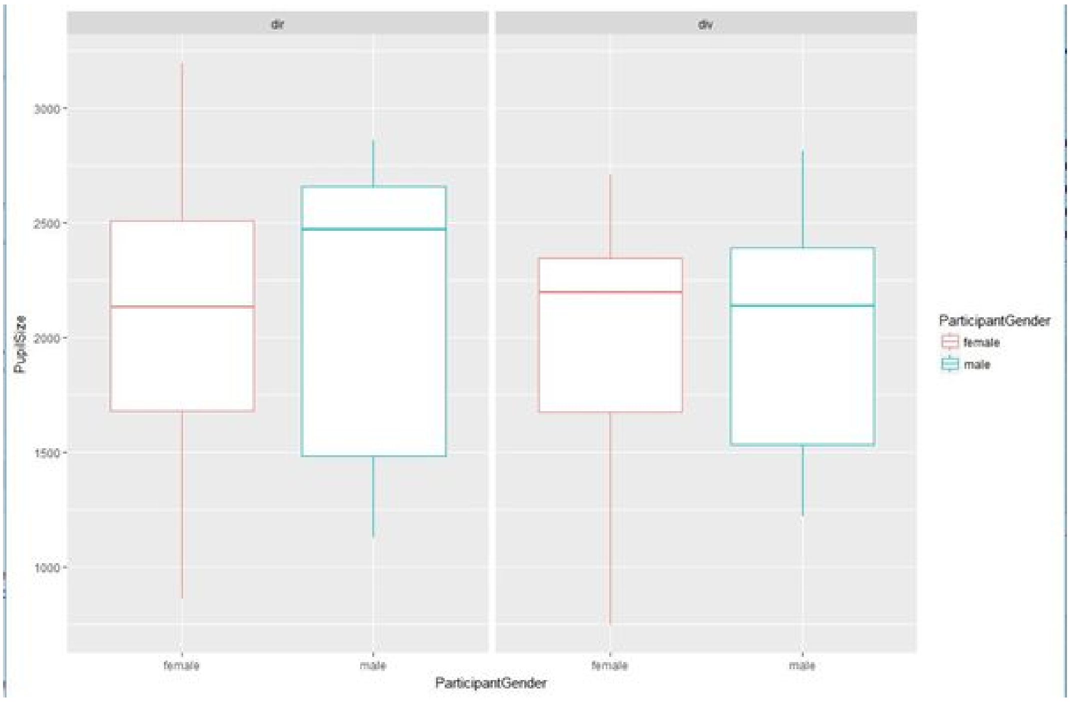
PupilSize~Ostension*Directionality+Fixation+(1+Directionality*Ostension*Fixation|ParticipantID), (= 28.8, se = 6.8, $p < .05$)

PupilSize ~ Ostension+Directionality + Fixation + (1+Directionality*Ostension*Fixation|ParticipantID), (= 30.5, se = 6.2, $p < .05$).

This significance shows that the number of fixations, which is also a function of time (the more fixations, the more time has elapsed in the experiment), affects pupil size in the experiment systematically. Pupil size is positively affected by an increase in fixations. Whilst significant in two models, this is not an effect of interest in our hypotheses. No models showed any significant effect for the presence of ostension or the type of directionality in the trials. In plotting the results, we can see certain tendencies in the data, but we cannot infer anything as none of our results are significant.

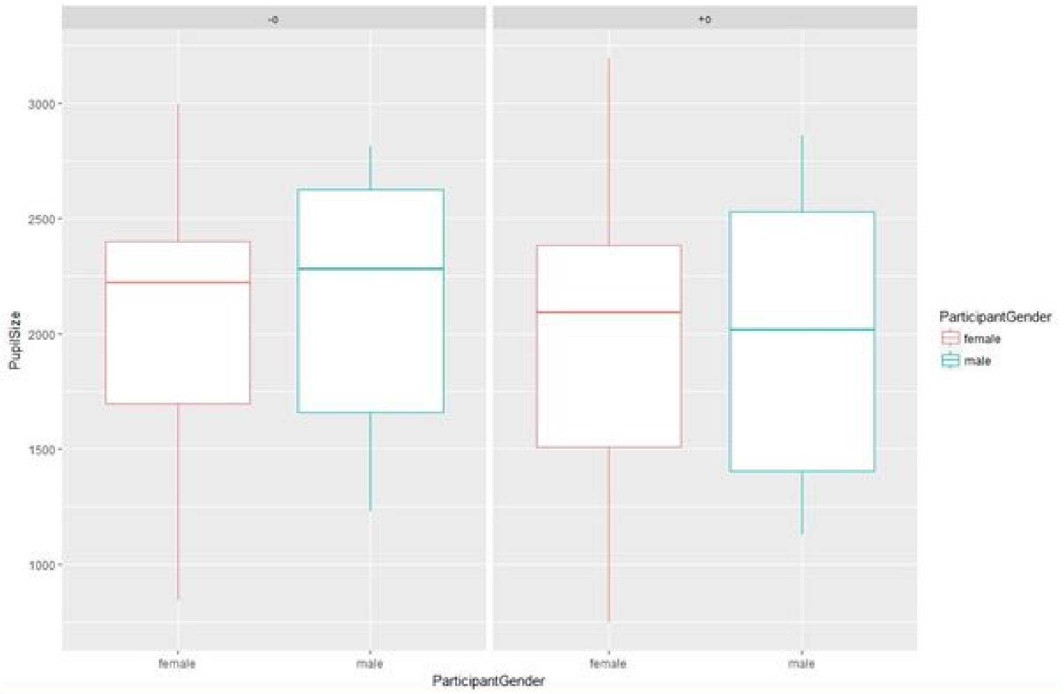
We also plotted our results using a variety of boxplots and density plots.
See below:

Figure 3 - Boxplot of pupil size dependent on directionality across participant gender.



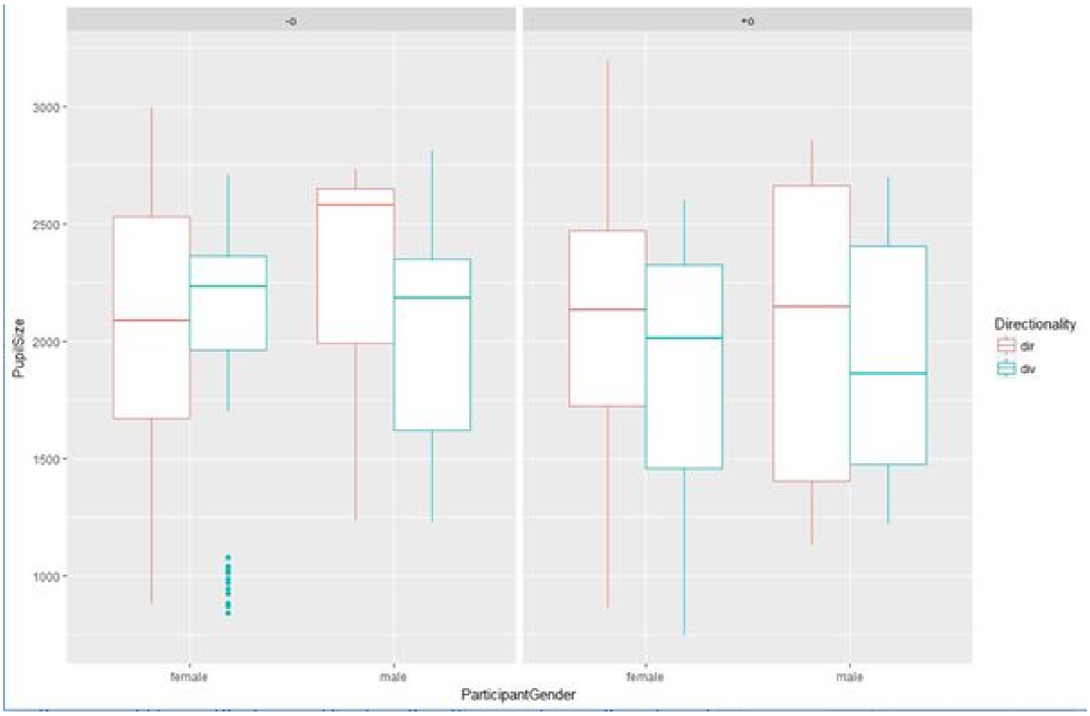
Here we can see that for males the pupil size is more dilated when the stimulus is engaging directly with them, whereas for females pupil size increases more when the stimulus is diverted. However, these are not significant.

__Figure 4 - Plot of pupil size dependent on ostensiveness across participant gender__



In the box plot for ostensiveness, we can see that pupil size is higher in the non-ostensive condition across both genders, although non-significant.

__Figure 5 - Boxplot of pupil size across participants dependent on directionality (colour) and ostensiveness (condition)__



This plot shows how pupil size varies according to ostensiveness and directionality (the colour) across male and female participants. The error bars are far too large to make an inferences, but we can see in general directionality towards the participants (dir) increased pupil size more than diverted social performance (div).

Discussion

The hypothesis that directionality toward the participant compared to side on directionality would increase pupil size more was not supported. Neither was the hypothesis that conditions with ostensiveness would increase pupil size more than non-ostensive conditions. The only effect of significance we found was with fixations (time) in the trials. However, this was not for the model that performed best for RMSE, and so does not bear much weight in our analysis. As all results from cross-validation were quite poor, we had checked all models for results. However, the effect of amount of fixations was not part of our hypotheses regarding emotional arousal from ostensiveness and / or directionality in social engagement. This casts doubt as to whether we can imply emotional arousal from pupil size. However, this effect has much empirical support. A more plausible explanation is that the effects of ostensiveness and directionality in social interactions may not be as emotionally arousing as we have hypothesised. A tendency we saw that was counter to the hypothesis about ostensiveness is that pupil size was larger in non-ostensive conditions. This could be speculated to be due to being more emotionally aroused in a context of “abnormal” social interaction, as it is unusual to have a person not engage in social cues when in the context of an interaction.

However, the experiment only had 6 participants, so it would be better to replicate the experiment with more participants, so more data can be analysed, which may give more robust results. Another confound could be that the participants had a personal relation to one of the persons in the stimulus, and not the other. This could have an impact on the emotional arousal given inconsistent results.

In conclusion, we did not replicate any results in the literature that pupil size should increase significantly across conditions containing social factors such as directionality and ostensiveness. We even saw a tendency to increase pupil size in non-ostensive conditions, although this may be attributed to an abnormal behavioural factor. Neither hypothesis was supported. However, with more participants it may be possible to have more robust findings.

References

Peirce, JW (2007) PsychoPy - Psychophysics software in Python. J Neurosci Methods, 162(1-2):8-13

Tylén, K., Allen, M., Hunter, B., 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*, Vol. 6, 1-11.