Results from IntoxEye analysis

As a first step, the analyses conducted for now concerned only the eye tracking data, since the principal goal of the project was to test the feasibility of a model for the detection of alcohol intoxication, to be included some day in a driver monitoring system relying on an eye tracker.

The eye tracking parameters can be divided into three main categories:

- The pupil diameter
- The gaze parameters: saccades and fixations
- The parameters related to the eye openness: mean eye openness, time percentage open/closed, blink duration etc.

We investigated all these features, in a subject-by-subject analysis. In each case, we compared the metrics between sober and intoxicated conditions. Here we present some interesting results.

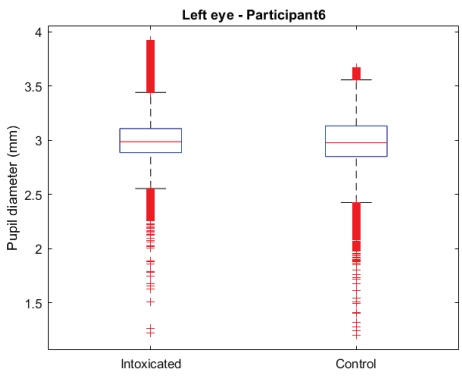
Data preparation

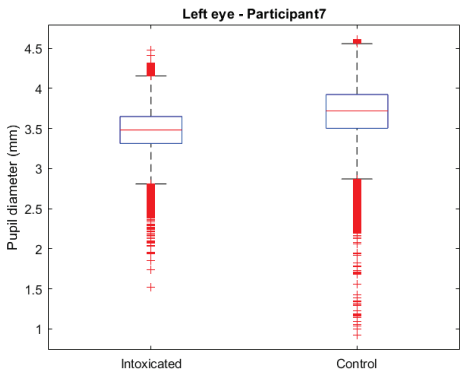
The eye tracking data was collected with a Tobii Pro Fusion device. We extracted the relevant metrics with the Tobii Pro Lab program, to obtain pupil diameter, eye openness, saccades and fixations information. An additional step was conducted on the eye openness data, with our in-house algorithm PhysioCore which enables the extraction of more than 140 features related to eyelids behaviour and blinks.

We did the analysis on 5 subjects in total, keeping only the ones with an acceptable eye tracking signals quality. Among those 5 subjects, one was lacking eye openness data for one of the conditions, thus we could not run the analysis for the eye openness parameters. The pupil and gaze information were available.

Pupil diameter

Regarding pupil diameter, the literature investigating intoxication to alcohol does not provide significant increase or decrease of the measure. In our study, we did not observe a tendency, as some of the subjects showed a very small increase in the intoxicated condition, while others a very small decrease.



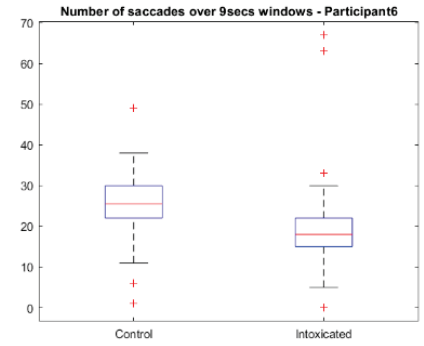


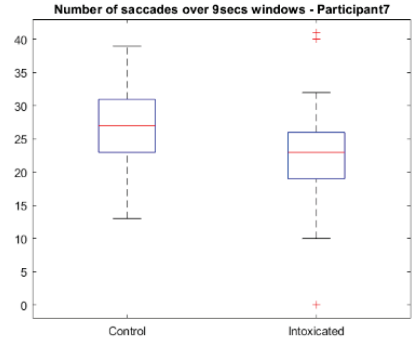
Saccades and fixations

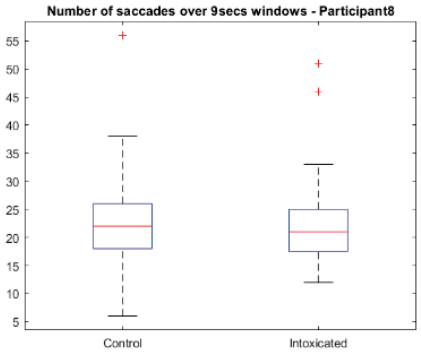
Saccades and fixations were computed on 9-seconds windows. Each frame outputted by the eye tracker (at 120 Hz) is associated with a label for which group it belongs to: “Saccade”, “Fixation” or “EyeNotFound” when the data is not valid. Therefore, in each 9-seconds window we can compute the number of saccades/fixations, the total duration of saccades/fixations and the mean duration of saccades/fixations.

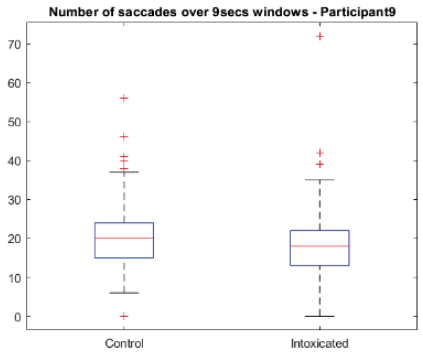
Based on literature results, we would expect to see an increased number of saccades, as well as an increase in fixation mean duration in the intoxicated condition compared to the sober one. However, mixed results were found for the number of fixations.

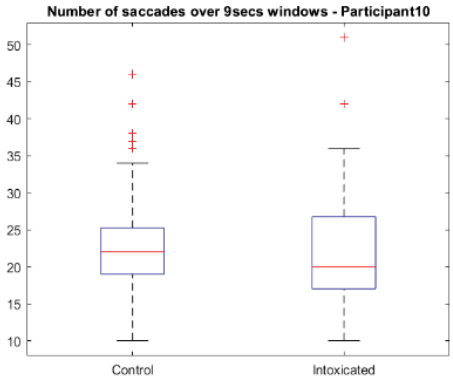
Unfortunately, in our analyses we did not observe a similar behaviour in the number of saccades, the number did not really differ from one condition to the other, and when it did it seemed to decrease instead of increasing.



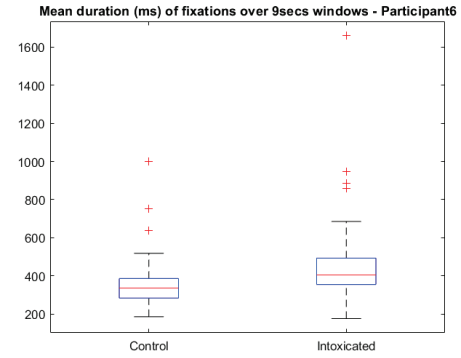


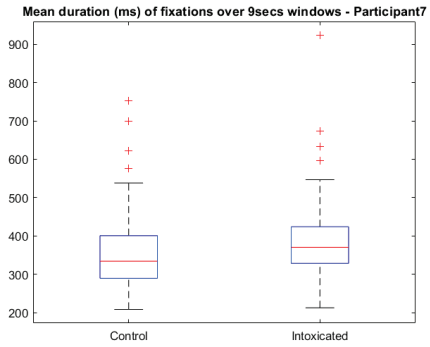


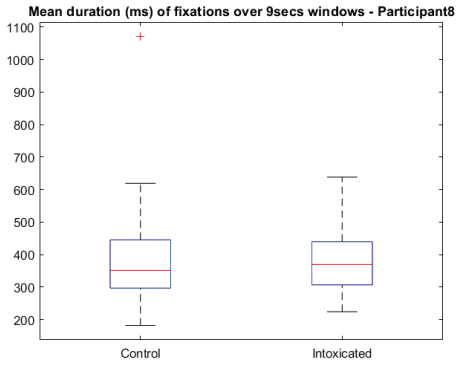


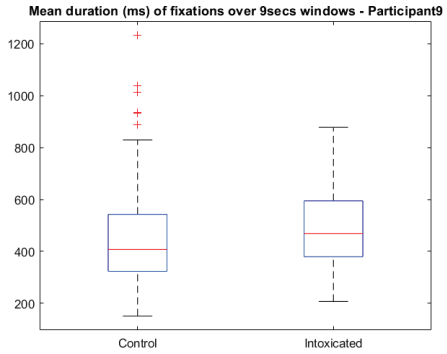


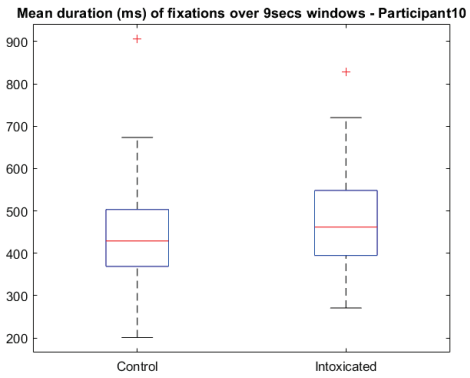
Regarding the mean duration of fixations, we did see a slight increasing tendency in the intoxicated condition compared to the control condition, but we would need more data from more subjects to confirm this trend.











Eye openness features

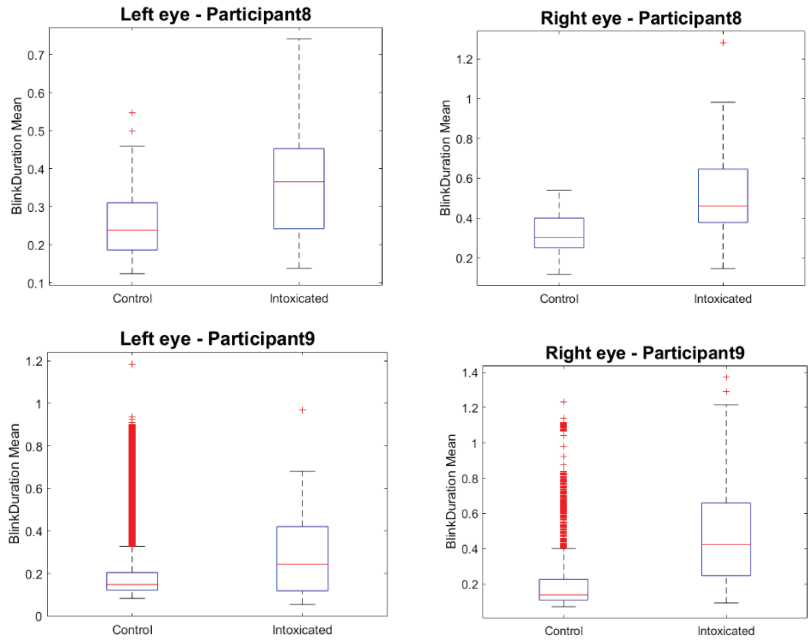
Regarding the eye openness features computed with PhysioCore, several parameters seemed to be impacted by intoxication to alcohol in at least 3 subjects out of the 5. Those are mostly related to blinks, for example the mean and median of the total blink duration increased during intoxication. We also observed an increase in the percentage of blinks with a duration of at least 350ms, as well as the ones with a duration of at least 2000ms (= long blinks). Such results seem to indicate that when intoxicated, participants tend to blink more and for a longer time, and they are more subjected to long blinks (2 seconds blinks). It agrees with literature results, where it is stated that intoxicated participants tend to have a higher blink number and rate. However, 2

seconds blinks are quite rare if the participant is not drowsy, so it could come from an error from the eye tracker (e.g. if the participant looks down for several seconds).

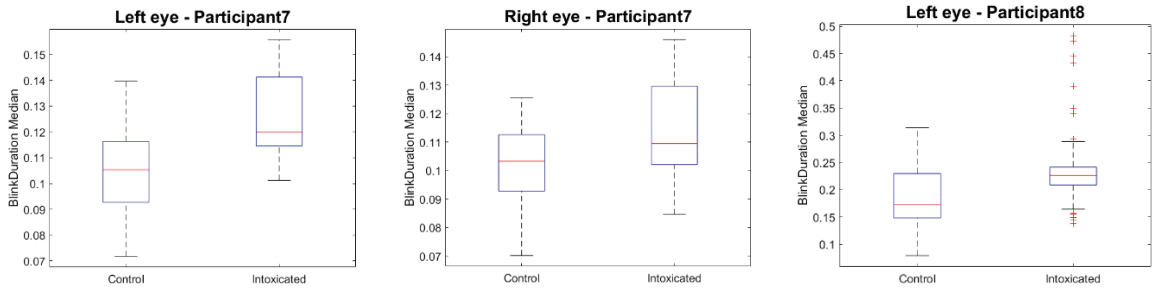
We also observed an increased perclos80, corresponding to the percentage of time where the eyelid gap is below 0.2. It seems to be related to the previous results, as well as to the literature.

In addition to those results, we also observed an increased percentage of blinks with an average closing speed above an arbitrary threshold (i.e. 30%). This combined with the previous results seems to indicate that intoxicated participants blink more often and more rapidly than when sober.

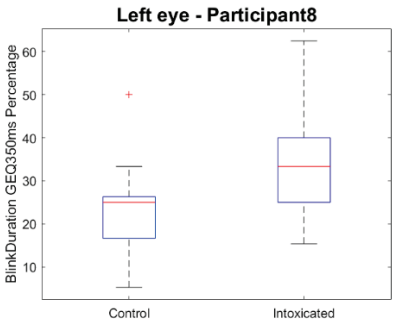
Mean blink duration

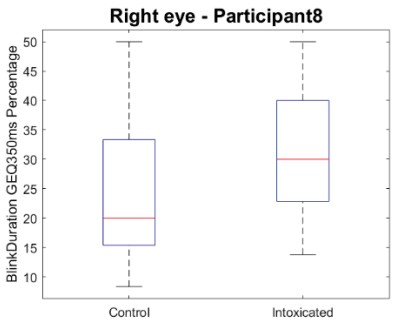


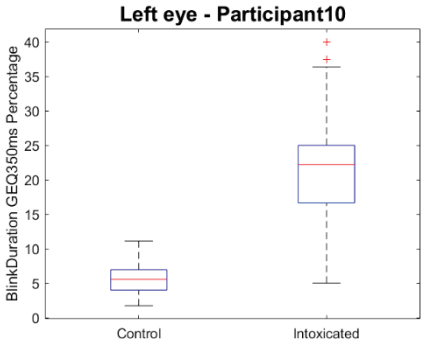
Median blink duration

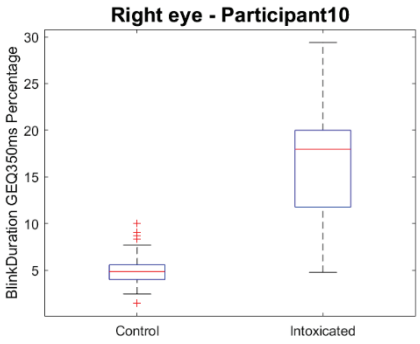


Percentage of blinks with duration greater than or equal to 350ms

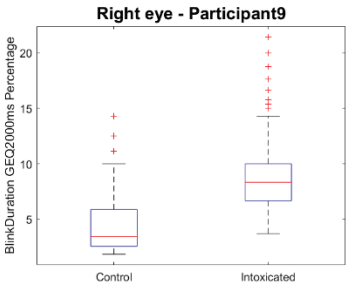


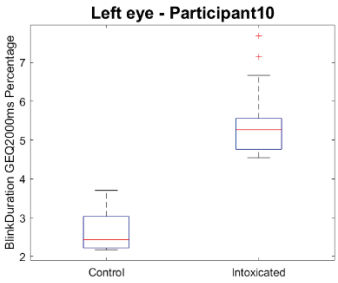


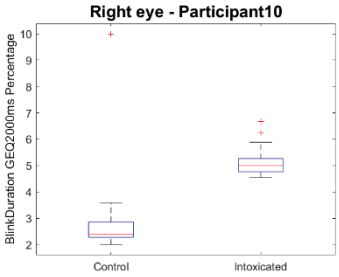




Percentage of blinks with duration greater than or equal to 2000ms







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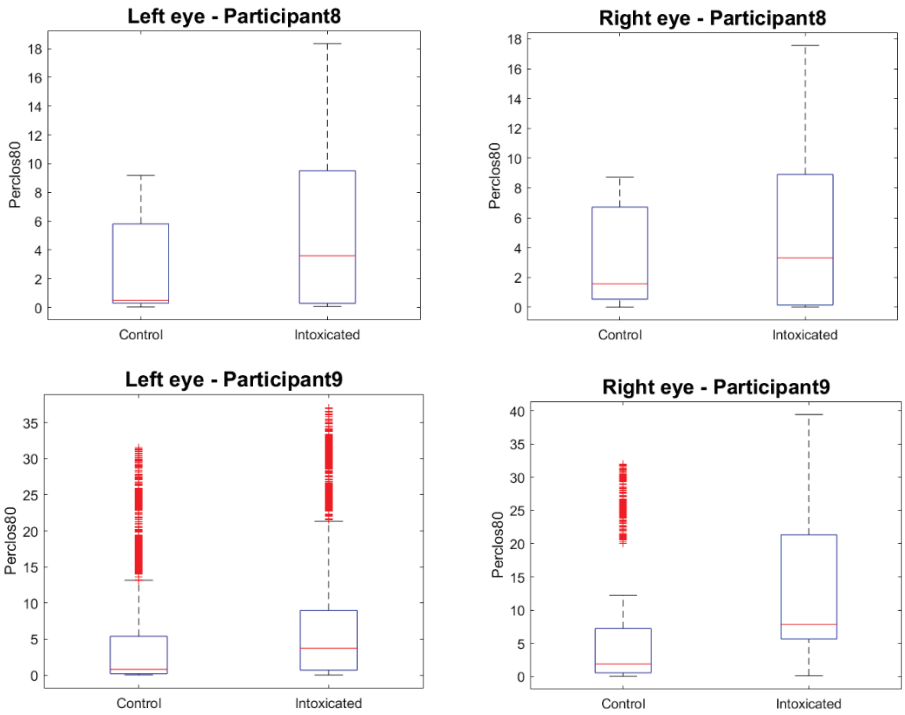
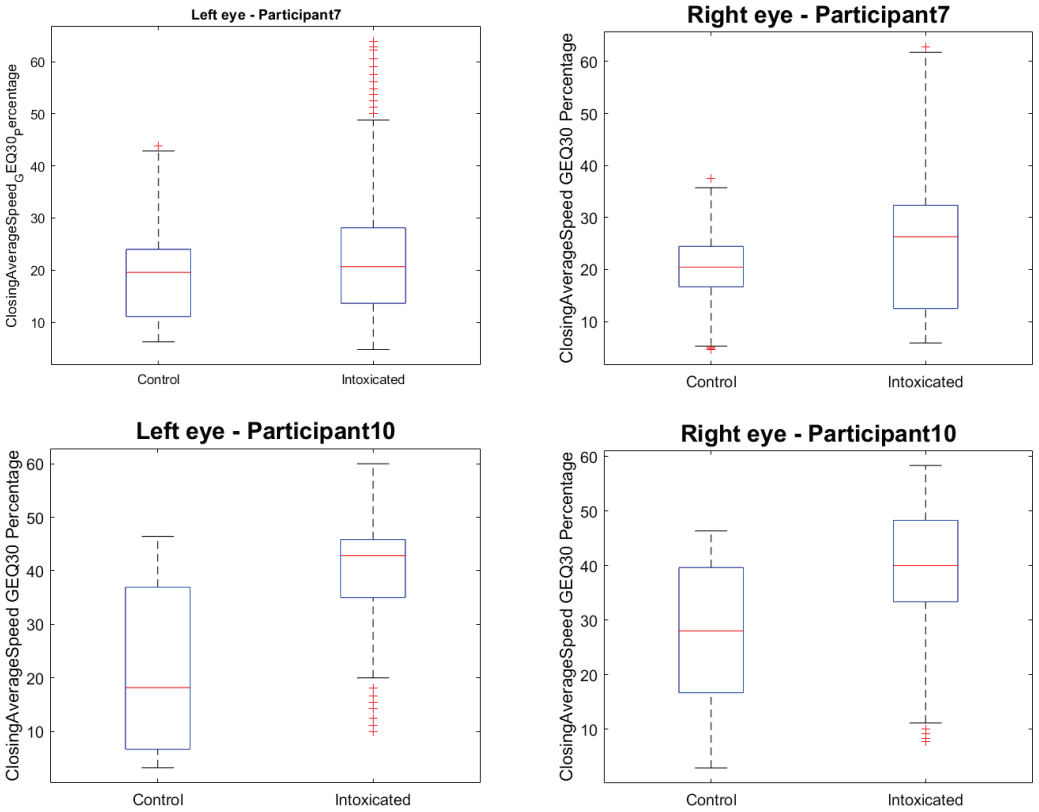


Percentage of blinks with an average closing speed greater than or equal to 30%



Conclusions

The pre study, although it contained only a small number of participants, showed promising results in the feasibility of a system able to detect intoxication to alcohol based on eye tracking data. The parameters related to pupil dilation and saccades/fixations did not seem to lead to consistent observations across subjects, but the ones associated with eye openness showed interesting tendencies. Such parameters could be promising to develop a model for intoxication detection. In addition, in a driver monitoring system as the one currently developed at Tobii, the temporal and spatial precisions of the hardware do not allow to compute parameters from pupil and saccades/fixations, thus it is good news that the features related to eyelids behaviour seem to work better for that purpose.

However, the results must be taken with caution, due to the very small size of the dataset. In order to develop our model, we will need to make similar observations when all the subjects are considered together, and not with a subject-by-subject analysis. Therefore, a large study with a greater number of subjects is needed to confirm such results.