**PROJECT SCOPE & AIM**

The goal of this project is to **analyze eye-tracking data that was collected during an emotion recognition task**. The task involved showing participants **32 stimuli (dance videos depicting varying emotions - sad, angry, happy, neutral)** and asking them to recognize the intended emotion. There are **80 participants** (40 females, 40 males) and **2 groups; self & control**. The difference between the groups is that the self group was shown their own photographs before starting the emotion recognition task.

The eye-tracking data was collected using a **Gazepoint GP3 eye tracker** and is stored in an Excel file. Each row in the file corresponds to a single sample of eye-tracking data, including the time stamp, X and Y coordinates of the point of gaze (POG), and other variables such as the pupil size. The sampling rate of the device is 60Hz.

To analyze the data, we want to:  
**1. count the number of fixations,**

**2. the total duration of those fixations and**

**3. saccades that occurred within a second that the participant made during each trial.**

**A fixation** is defined as a period of time when the participant's eyes remain stationary within a certain radius (in this case, 58 pixels or 1 degree of movement tolerance) for at least 120 ms.

**A saccade** is a rapid movement of the eye between fixation points.

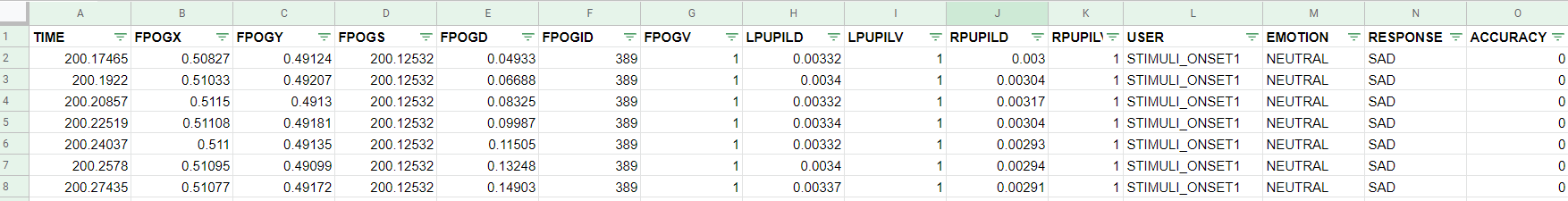
**DATA**:

* **USER**: A unique identifier for each trial.
* **TIME**: The time stamp for each sample of the gaze position.
* **FPOGX**: The horizontal position of the gaze, expressed as a fraction of the screen width.
* **FPOGY**: The vertical position of the gaze, expressed as a fraction of the screen height.
* **FPOGV**: The valid flag with value of 1 if the fixation POG data is valid, and 0 if it is not.
* **FPOGD**: The duration of the fixation POG in seconds.
* **FPOGID**: The fixation POG ID number
* **FPOGS**: The starting time of the fixation POG in seconds since the system initialization or calibration.
* **LPUPILD**: The diameter of the left eye pupil in units of meters.
* **LPUPILV**: The valid flag with value of 1 if the data is valid, and 0 if it is not
* **RPUPILD**: The diameter of the right eye pupil in units of meters
* **RPUPILV**: The valid flag with value of 1 if the data is valid, and 0 if it is not

**DATA PREPROCESSING:**

* Omitting irrelevant data  
  **A**. Data that needs to remain in the Excel file:

TIME, FPOGX, FPOGY, FPOGS, FPOGD, FPOGID, FPOGV, LPUPILD, LPUPILV, RPUPILD, RPUPILV, USER.   
**B**. Any values that do not contain STIMULI\_ONSET string under the USER column should be deleted. Data should look like below:



* Check and clean FPOGV, LPUPILV, and RPUPILV validations. If the value is 1, data is valid and 0 if it is non-valid. FPOGV data should be cleaned first. If the ratio of valid data, flagged as FPOGV=1, is less than 70%, user data cannot be included in the analysis.
* Pass the pupil size data (LPUPILD or RPUPILD- which has the highest validation score) of all users through the Butterworth low-pass filter. All user data (Mean values of pupil size for each trial) should be combined in an excel file before the application. Example video of applying butterworth low pass filter: <https://www.youtube.com/watch?v=N2Z8MEsxRpg&list=LL&index=1&t=1381s>
* Calculate the z-scores of LPUPILD or RPUPILD (which has the higher validation score) data.

**DATA ANALYSIS:**

1. **Participant Data**

**Information about a participant can be extracted from the file name if necessary:**

**emorec\_ctrlm2427\_e**

**emorecF5319\_e**

**Name of the experiment**

**Condition (if the name contains \_ctrl participant is in control group, otherwise it is self)**

**Gender info (m=male, f=female)**

**Participant number**

**Participant age**

**Suffix to indicate eye tracking data**

1. **Fixation count and duration calculation**

**Example MATLAB code to calculate fixation count and duration**

% Load data from Excel file

data = readtable('emorec\_ctrlm2427.xlsx');

% Specify fixation radius and minimum duration

fixation\_radius = 58;

min\_duration = 0.12;

% Get unique trial names

trials = unique(data.USER);

% Loop through trials and calculate fixation count and duration

for i = 1:length(trials)

trial\_data = data(strcmp(data.USER, trials{i}), :);

fixation\_count = 0;

fixation\_duration = 0;

last\_fixation\_end\_time = NaN;

for j = 1:size(trial\_data, 1)

x = trial\_data.FPOGX(j) \* 1920; % Convert fraction of screen to pixels

y = trial\_data.FPOGY(j) \* 1080; % Convert fraction of screen to pixels

if isnan(last\_fixation\_end\_time)

% First sample in trial

fixation\_start\_time = trial\_data.FPOGS(j);

last\_fixation\_end\_time = fixation\_start\_time;

elseif sqrt((x - last\_x)^2 + (y - last\_y)^2) <= fixation\_radius && ...

trial\_data.FPOGS(j) - last\_fixation\_end\_time <= min\_duration

% Continuing fixation

elseif sqrt((x - last\_x)^2 + (y - last\_y)^2) <= fixation\_radius && ...

trial\_data.FPOGS(j) - last\_fixation\_end\_time > min\_duration

% Extended fixation

fixation\_duration = fixation\_duration + (trial\_data.FPOGS(j) - last\_fixation\_end\_time);

last\_fixation\_end\_time = trial\_data.FPOGS(j) + trial\_data.FPOGD(j);

elseif sqrt((x - last\_x)^2 + (y - last\_y)^2) > fixation\_radius

% New fixation

fixation\_count = fixation\_count + 1;

fixation\_duration = fixation\_duration + trial\_data.FPOGD(j);

fixation\_start\_time = trial\_data.FPOGS(j);

last\_fixation\_end\_time = trial\_data.FPOGS(j) + trial\_data.FPOGD(j);

end

last\_x = x;

last\_y = y;

end

% Print results for trial

fprintf('Trial: %s, Fixation Count: %d, Fixation Duration: %.2f seconds\n', trials{i}, fixation\_count, fixation\_duration);

end

**How the code works:**

1. For each trial, the script selects all the rows that correspond to that trial using the strcmp() function. This creates a new variable trial\_data that contains only the data for that trial.
2. The script initializes the following variables to track fixation count and duration:
   1. fixation\_count: The total number of fixations for the trial.
   2. fixation\_duration: The total duration of all fixations for the trial.
   3. fixation\_start\_time: The time stamp for the start of the current fixation. This is initially set to NaN to indicate that no fixation is in progress.
3. The script then loops through each row of the trial data and applies the following logic:
   1. The horizontal and vertical gaze positions are converted from screen fractions to pixels.
   2. If no fixation is in progress (i.e., fixation\_start\_time is NaN), the current sample is considered the start of a new fixation.
   3. If the distance between the current gaze position and the previous gaze position is less than or equal to the fixation radius AND the time elapsed since the start of the current fixation is greater than or equal to the minimum duration, the current sample is considered part of the current fixation.
   4. If the distance between the current gaze position and the previous gaze position is greater than the fixation radius, the current sample is considered the start of a new fixation.
   5. When a new fixation is detected, the fixation count is incremented and the duration of the previous fixation is added to fixation\_duration.
   6. last\_x and last\_y are updated with the current gaze position for use in the next iteration.
4. **Saccades per seconds calculation:**

The velocity-based threshold identification (I-VT) algorithm can be applied to the data to calculate saccade information. Please refer to the article below:

[**https://link.springer.com/article/10.3758/s13428-020-01392-6**](https://link.springer.com/article/10.3758/s13428-020-01392-6)

**Statistical analysis:**

Analyze the data for:

1. Participants with high vs low interoceptive awareness (ANOVA, Post-hoc, T-Tests, Correlation)

* Differences in eye behaviors (fixation counts, fixation duration and saccades/secs) between two groups for all trials, conditions, gender and accuracy scores.
* Differences in eye behaviors (fixation counts, fixation duration and saccades/secs) between two groups for accurate trials.

1. Main effects and interactions in terms of eye behaviors (fixation counts, fixation duration and saccades/secs) between two groups for all trials, conditions, genders and accuracy scores. (ANOVA, Post hoc, T-Tests, Correlation)