Instructions:

Your task is to analyze and make inferences from a dataset that compares pupil diameter during spatial emotion detection tasks. Below are step-by-step instructions for understanding the experimental design and conducting the analysis.

Experiment Overview:

- Data was recorded in 6 blocks, two blocks targeting each specific emotion (Happy, Angry, Neutral). So, two blocks are for happy, two blocks are for angry, and two blocks are for neutral.
- 240 trials per block. As for each emotion, we have two blocks, so for each emotion, the total number of trials is 480.
- Each trial starts (Figure 1) with a fixation (700 ms), followed by a cue presented for 150 ms. The cue can be presented randomly based on any of the three eccentricities on either side of the fixation point (refer to the figure 1, cue frame). After the cue presentation, the display will be blank for 500 ms, followed by a face stimulus presented for 200 ms at the cued location (80% of the time) or uncued location(20% of the time). As soon as the stimuli disappeared, the participants were asked to register their responses as soon as possible.
- The task is a modified version of the Posner cueing paradigm.
- The task is a 2-alternative forced choice (2AFC), where participants report whether the target emotion (e.g., Happy) was presented or not.

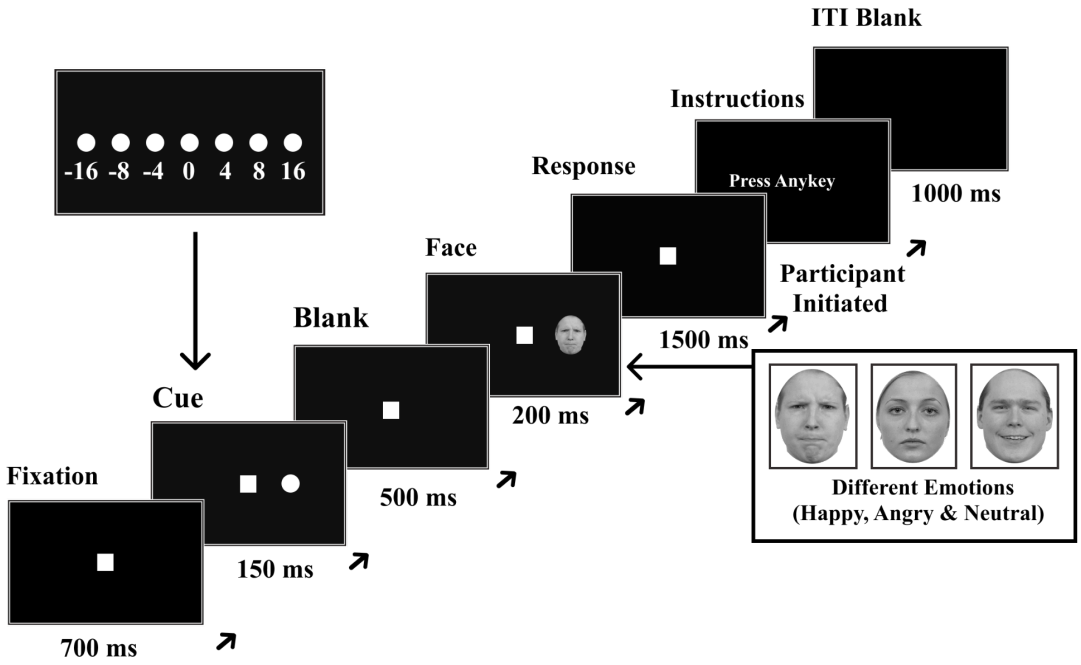

Figure 1: The study flow for the experiment.

Dataset Overview:

The dataset provided to you contains data from an emotion recognition experiment, where participants were asked to identify specific emotions (Happy, Angry, or Neutral) across multiple trials. The data has been preprocessed and only includes trials where **participants correctly identified the target emotion**. Each experiment block focuses on a different target emotion, and the data is organized accordingly. Below is a detailed breakdown of the dataset structure (as you can see in the data files → excel sheets) and instructions on how to use it.

Dataset Columns:

- **Column 1: Stimulus Name**
    - This column contains the name of the face (happy/angry/neutral) stimulus presented during the trial.
- **Column 2: Reaction Time**
    - This column represents how long (in milliseconds) the participant took to respond after the presentation of the stimulus. This measures the participant's reaction time.
- **Column 3: Reaction Key**
    - This column indicates the key the participant pressed to register their response. For example, 'Left' or 'Right' keypresses could represent their decision.
- **Column 4: Stimulus Location**
    - This column represents the eccentricity where the face stimulus was presented.
- **Column 5: Cue Location**
    - This column represents the eccentricity where the cue (white circle) was presented.
- **Columns 6 onwards: Pupil Diameter (Time Series)**
    - Each subsequent column contains pupil diameter measurements samples at intervals of **8 ms by** the eye tracker. These measurements track the participant's pupil response during each trial, starting from the presentation of the fixation cross and continuing through the stimulus and response phases.
    - The number of columns may vary across trials due to the task's nature and the trials' length. This means some trials have more data points than others. This is

because as soon as the response is given the trial is completed. The response times are different for different trials, it leads to difference in the length of data.

⚠️Important Note on Pupil Data:

The first 87 columns of the pupil data correspond to the 700 ms fixation period before the stimulus was shown. For your analysis and plots, focus on the data from **column 87 onward**, representing the pupil responses after the stimulus was presented. Slice the dataset from column 87 to the end to analyze the relevant stimulus-response period.

Explanation of the Experimental Blocks:

The dataset is divided into three experimental blocks, each representing trials where a specific emotion was the target. For each emotion block the data was recorded into two subblocks to increase the trial numbers and reduce the fatigue of the participants.

1. **Block E1 (Happy Target)**
    - In this block, the task was identifying and reporting "Happy" faces. The dataset contains only trials where participants correctly recognized Happy faces as Happy.
2. **Block E2 (Angry Target)**
    - In this block, participants were asked to identify Angry faces. The dataset contains only the trials where Angry faces were correctly identified as Angry.
3. **Block E3 (Neutral Target)**
    - In this block, participants were tasked with identifying Neutral faces. The dataset includes only trials where Neutral faces were correctly recognized as Neutral.

Folder Structure and Dataset Organization for Your Analysis

Each of you has been assigned a unique dataset for analysis. The dataset folders are labeled with codes like D2-1, D3-11, etc. Here's a detailed breakdown of how the folder structure is organized and how you should navigate it for your analysis.

D2-1, D3-11, etc., are the codes for the dataset folders. The first part (D2, D3, etc.) refers to the main folder that you can access from the link provided

https://drive.google.com/drive/folders/1s8tXW5YzmsqcbslrMBNngfIO9SZgAisx?usp=sharing

The second part (e.g., 1 in D2-1) refers to a subfolder inside the main folder. This subfolder contains the dataset specifically assigned to you.

❌ ***Important: You are assigned a unique dataset. DO NOT use someone else's dataset for your analysis. Stick to the folder assigned to you.***

Let's say your assigned folder is D2-1. Inside D2-1, you will find ten subfolders. Each subfolder contains the data for a single participant in the study. The participants' names are anonymized and encoded using three-letter codes (e.g., SAN, JKT, etc.).

For each participant (e.g., SAN), you will find the following structure:

Experiment Folder: This contains the data from the Experiment where participants were tasked with recognizing emotional expressions (Happy, Angry, or Neutral) presented at different eccentricities.

Inside the Experiment Folders: contains three subfolders named:

- **E1**: Corresponds to the block where the participant's task was to identify Happy faces (as described in the Dataset Overview).
- **E2:** Corresponds to the block where the participant's task was to identify Angry faces.
- **E3:** Corresponds to the block where the participant's task was identifying Neutral faces.

You have three main experiment folders: E1, E2, and E3, each corresponding to different emotional conditions (Happy, Angry, Neutral). Inside each of these folders, there are two subfolders, "1" and "2", which contain trials conducted in two different sets for the same emotion block.

To process your data properly:

1. Merge the data from subfolders "1" and "2" within each experiment (E1, E2, E3) into a single data frame per experiment.

2. Ensure that all trials for a given emotion (e.g., Happy in E1) are combined before further analysis.

Inside Each of the subfolders ("1" and "2") inside E1, E2, and E3 Folders. You will find two CSV files (one for cued trials: target_cued.csv and another is for uncued trials : target_uncued.csv) containing the data for that specific task block. This CSV file includes the pupil diameter measurements, reaction times, and other data for each trial in that block.

Schematic folder structure for reference:

D2-1/
└── SAN/ # Participant folder
  ├── **E1/** # Block 1 (Happy Target)
  │ ├── 1/
  │ │ └── target_cued.csv & target_uncued.csv
  │ ├── 2/
  │ │ └── target_cued.csv & target_uncued.csv
  ├── **E2/** # Block 2 (Angry Target)
  │ ├── 1/
  │ │ └── target_cued.csv & target_uncued.csv
  │ ├── 2/
  │ │ └── target_cued.csv & target_uncued.csv
  ├── **E3/** # Block 3 (Neutral Target)
  │ ├── 1/
  │ │ └── target_cued.csv & target_uncued.csv
  │ ├── 2/
  │ │ └── target_cued.csv & target_uncued.csv

What do you all have to do?

Data Understanding and Preprocessing:

- Make sure you understand the structure of the data.
- Slice the data to focus on the pupil diameter columns from the 87th column onwards.

Pupil Analysis:

- Analyze the pupil diameter data across trials (take column-wise averages across all the trials from a participant and then across participants) to observe how pupil size changes in response to different emotional faces (Happy, Angry, Neutral) and different eccentricities.
- Compare the reaction times across the three blocks.

Visualization:

- Create plots showing pupil trends over time for each emotion (Happy, Angry, Neutral) and compare the control blocks.
- Compare RT between valid and invalid cues, for the three emotion categories.

Inferences:

- Make inferences about how different task blocks and emotions affect pupil diameter and reaction time.
- Are there any patterns present?

Below are some points that may be used while interpreting the results. The students are encouraged to come up with their points and explanations.

    - Does pupil diameter change significantly in response to increasing eccentricities? And different emotional faces on different eccentricities (Happy, Angry, Neutral)?
    - How does reaction time differ across the emotional blocks (E1, E2, E3) and eccentricities (0, 4, 8 and 16)?
    - How does reaction time differ across the emotional blocks (E1, E2, E3) and the validity of the cue?

⭐Writing a Report

As part of this assignment, you are required to produce two main components:

1. **A Written Report (Maximum 1000 Words)**: This will involve presenting your results, findings, and conclusions based on the analysis of the provided dataset.

Rubrics:

1. Plotting the Average Pupil Diameter for cued(valid) and uncued(invalid) trials (2.5 + 2.5 Marks)

Task:

- You must create two plots.A **single plot** showing the average pupil diameter across all participants for the cued(valid) trials and another is for the uncued(invalid) trials .
- The plot should include data for all the eccentricities and emotions in a single plot.
- Plot pupil data for each of the eccentricities and their corresponding emotions as a time series in a single plot but with individual visualization of each of the conditions.

Key Points:

- Ensure that each block's average pupil diameter (E1, E2, E3) is distinguishable. You can use different colours or markers for the three blocks.
- Clearly label the plot with axes titles (e.g., Time in milliseconds, Average Pupil Diameter), legends, and an appropriate title. Plots won't be considered for review if your data is wrong.

2. Plotting the Reaction Time (2.5 + 2.5 Marks)

Task:

- Create two plot showing the **Reaction Time** for the experiments. One plot is for cued(valid) trials and another is for uncued (invalid) trials.

Key Points:

- The plot should allow for an easy comparison of Reaction Time across the different eccentricities and emotions.
- Use appropriate visual distinctions (e.g., different colours or line styles) to differentiate between the eccentricities and emotions.
- Label your axes (e.g., Reaction Time in milliseconds, Number of Participants) and include a legend. Plot won't be considered for evaluation if your data is wrong.

3. Supporting Plot (3 Marks)

Task:

- You must create **any additional plot** that reasonably supports your inferences about the data.

Key Points:

- This plot could showcase trends, comparisons, or other insights supporting your analysis. For example, you could create a plot comparing the variation in pupil dilation across different emotions or reaction times across different stimulus types.
- The plot should add value to your report and provide further evidence to support your findings.
- It should be straightforward, well-labelled, and easy to interpret.

4. Inferring Results from the Data (5 Marks)

Task:

- You will need to **infer meaningful results** from your data analysis. This involves drawing conclusions based on the trends in pupil diameter, reaction time, or other plots.

Key Points:

- Your inferences should clearly explain the significance of the data.
- You should also relate your inferences to the aim of the task, which involves understanding how emotion and attention to a task modulate pupil diameter.
- The clarity of your inferences is essential—avoid vague or unsupported claims.

5. Report Writing and Formatting (5 Marks)

Task:

- Your report should be **well-organized and formatted**, adhering to the word limit of **1000 words (excluding references)**.

Key Points:

- Structure your report with results and conclusion.
- Ensure that the language is clear and concise and that your explanations are easy to follow.
- Include all necessary elements (figures, tables, and references) in the proper format.

Submission Requirements:

1. Project Report: The document should be a PDF and should be named with the data folder you are allotted. E.g. if you are allotted data "D2-1", then your report should be submitted as "D2-1.pdf". The project won't be evaluated if you don't format the report name as mentioned.
2. Submit codes also by the same name (.py/ jupyter notebook file).
3. Submit a CSV file of the time series pupil diameter averaged across all the trials (divided by their eccentricities and emotions). Failing to submit one will attract negative marks.