* Input
  + EEG
  + Pupil
  + Empatica (E4)
* Model
  + ML models
  + DL models
  + LLM/Updated Model/APIs
  + Models used from others
* Output (Classification)
  + Attention
  + Insight/Aha! Moment
  + Impasse
  + Relax

A screenshot of a computer

AI-generated content may be incorrect.

Step 0: Why I do this study, meaning of studying correlation between physiological signal (EEG, Pupil, EDA) and mental state (Attention, Impasse, Aha! Moment)

**Scientific Significance**

* **Objective measurement of subjective experience**
  + Traditional methods (e.g., self-reports) are subjective and non-continuous.
  + Physiological signals offer real-time, unbiased, quantifiable insights.
* **Reveal brain-body interactions**
  + Each signal reflects different neural or autonomic mechanisms:
    - **EEG** → cortical activity (e.g., attention, insight).
    - **Pupil dilation** → arousal, effort (via locus coeruleus).
    - **EDA** → sympathetic arousal (stress, excitement, emotion).
* **Differentiate similar behaviors with distinct mental states**
  + Silence or pause can reflect:
    - **Impasse** (↑theta, variable EDA)
    - **Aha! moment** (↑gamma, sudden pupil spike)
    - **Deep attention** (↑beta, steady pupil size)

**Practical Applications**

* **Human-Computer Interaction (HCI)**
  + Systems adapt to user’s mental state in real time.
  + e.g., Lower task difficulty when impasse is detected.
* **Education and Adaptive Learning**
  + Detect moments of engagement, confusion, or breakthrough.
  + Support **just-in-time interventions** (e.g., hints, praise).
* **AI Training for Mental State Classification**
  + Correlation studies provide ground truth for training models.
  + Enable **multimodal classifiers** for attention, insight, etc.

Step 1: Literature Review Categories (To start to write my paper, things that I must to know by doing literature review below)

* Mental state
  + Cognitive
    - What is Attention, Insight/Aha! moment, Impasse
* Physiological signals
  + EEG, Pupil, Empatica
    - What is relationship between these signals and different mental state
    - What is relationship between these signals such as pupil and EEG
* Data processing & Feature extraction
  + Data processing
    - How did other researchers do data processing
    - What features did other researchers extracted from physiological signals
    - Time window selection
* Model selection & result discussion
  + Similar task (mental state classification) by using physiological signals
    - What Models do other researchers used
    - Models that I want to use in our data
    - Model result discussion
    - Correlation between signal and mental state

### Step 2: My methodology (Based on literature review, on the top of other researchers result to do data processing, feature extraction and model selection, I can bring something new, but need to explain it)

* Participants & Experiment introduction

#### Signal Acquisition

* Data processing & Feature extraction
* Model selection

### Step 3: My result discussion

* Singal signal classification
* Muti-modal signal classification
* Feature importance
* Signal mental state vs Relax state binary classification
* Muti-modal mental state classification
* Window size exploration result

### Step 4: Conclusion

* Correlations between signals and mental states
* Challenges
* Future work

Step 5: Put all things that I finished above to the paper and refine it.

* For the literature review should be as much as possible
* Based on my result, appropriate deletion
* Goal: in a result, finalize it, make it is solid and convince.