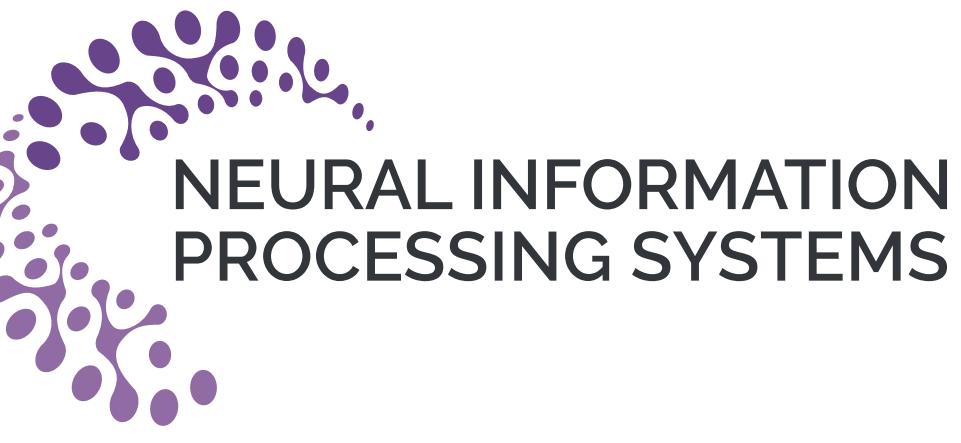
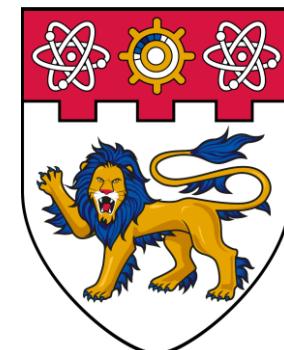


# REFED: A Subject Real-time Dynamic Labeled EEG-fNIRS Synchronized Recorded Emotion Dataset

Xiaojun Ning, Jing Wang, Zhiyang Feng, Tianzuo Xin, Shuo Zhang, Shaoqi Zhang, Zheng Lian, Yi Ding, Youfang Lin, Ziyu Jia

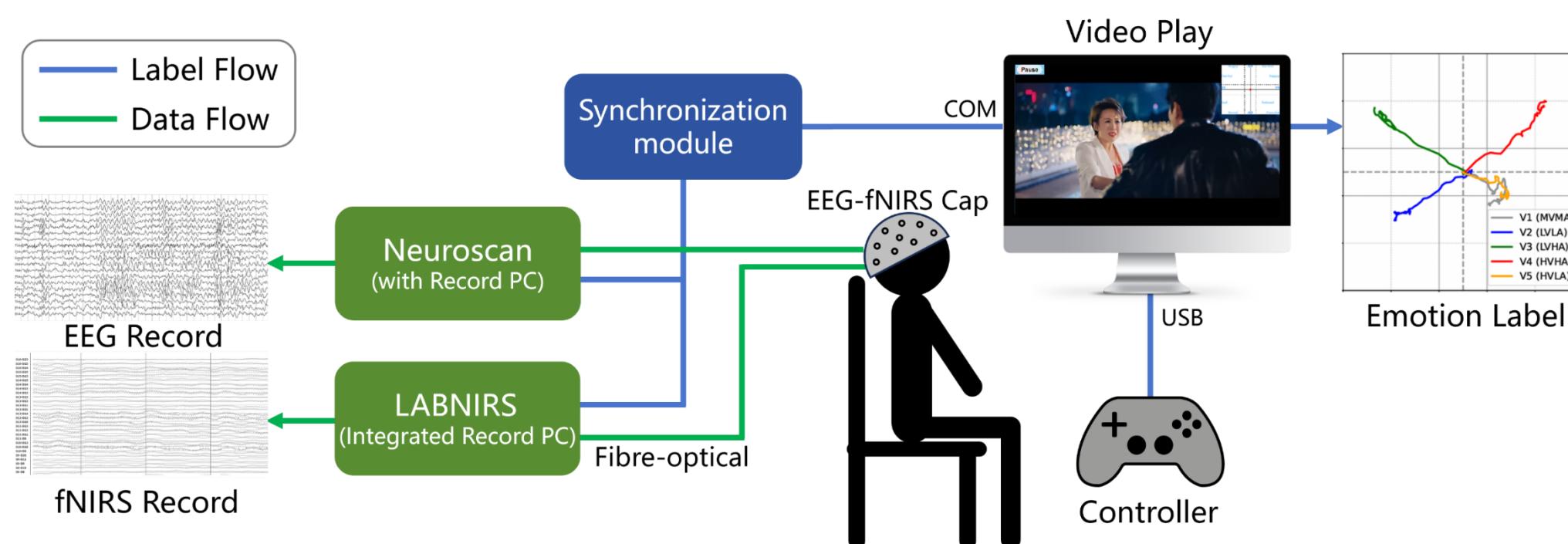


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Project page

## Motivation

- ◆ **Affective brain-computer interfaces (aBCIs)** play a crucial role in personalized human-computer interaction and neurofeedback modulation.
- **Multimodal brain signals:**
  - **EEG** captures neural electrical responses and is most widely used to explore the brain's spatial-temporal patterns of emotions.
  - **fNIRS** measures the cerebral blood flow activity and holds potential for investigating emotional mechanisms.
- **Dynamic emotion annotations:**
  - Emotional experiences are inherently **dynamic** and **subjective**.
  - Traditional static labels are **lack temporal dynamics** and **inaccurate**.
- ◆ To the best of our knowledge, there is no publicly available aBCI dataset simultaneously records **multimodal brain signals** and provides **real-time dynamic emotion annotation**.



## Contributions

- ✓ This study proposes the **REFED dataset**, an affective BCI dataset with **multimodal brain signals** and **real-time dynamic emotion annotations**.
- ✓ By recording EEG and fNIRS signals synchronously, the REFED realizes the joint observation of **neuroelectrical activity** and **hemodynamic response** under emotional inducing.
- ✓ **Experimental validation** shows that the dataset meets standards for both emotion inducing validity and labeling reliability.
- ✓ Further details and access to the dataset can be found at:

<https://refed-dataset.github.io/>

## Recording Details

### Recording Protocol

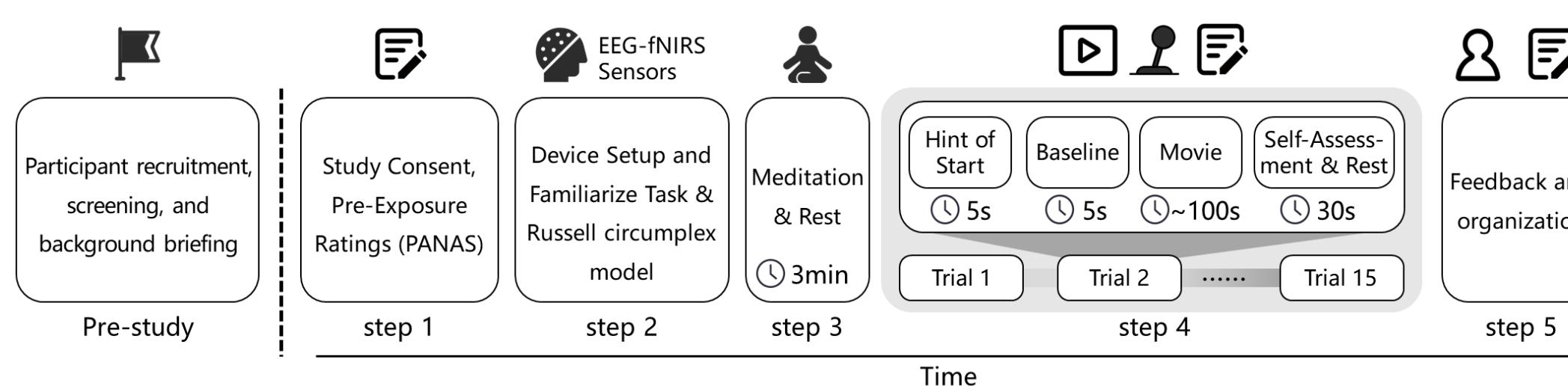
- All processes last about 1.5 hours per subject, in which video watching phase lasts for 40 mins.
- **15 emotional clips** are selected to induce 5 distinct emotions (based on valence-arousal).
- During each video trial, participants are required to provide **real-time feedback for their emotional state (valence-arousal)** using an Xbox controller.
- After each video trial, participants are required to complete the **SAM scale**.

### Participants

- We recruited **32 healthy adults** (22 males, 10 females), aged 18 to 34.

### Video playback and real-time labeling

- A **real-time labeling and control system** is well developed, to control the recording progress, automate video playback, and automatic emotion annotation.
- During video, a **2D valence-arousal coordinate** is displayed in the corner.
- Participants can instantly adjust the position of the red coordinate points using the joystick on the controller to reflect their emotional changes.



## Dataset Details

### EEG-fNIRS data

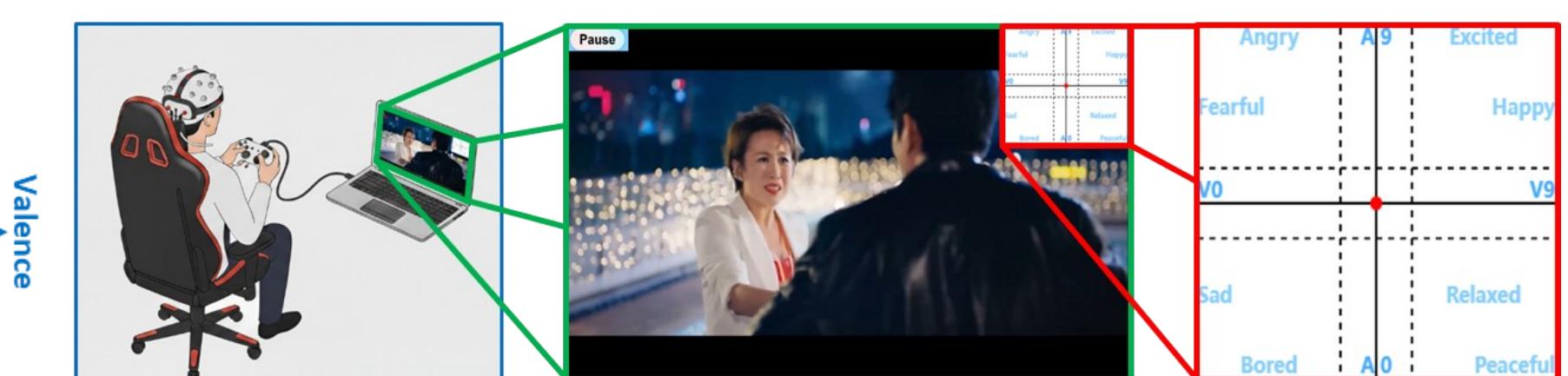
- **480 trials** (32 participants × 15 emotion-inducing video clips, about 820 minutes in total)
- Sampling frequency: **EEG** at 1000 Hz, and **fNIRS** at 47.62 Hz.

### Emotion annotations

- **Dynamic emotion labels** at 1Hz (valence and arousal, synchronously recorded during trials).
- **Self-reported ratings** (including valence, arousal, dominance, and familiarity, after each trial).

### Available usages

- Discrete **Emotion Recognition Tasks**
- Valence / Arousal **Classification Tasks**
- Valence / Arousal **Regression Tasks**
- **Pattern Discovery** in EEG / fNIRS During Emotional Shifts
- **Mechanisms** of Electrophysiological/Hemodynamic Responses to Emotions
- Etc.



## Analysis

### Label Analysis

- The average valence-arousal trajectory for 15 video clips indicates that the emotion induction is effective and consistent with expectations.
- Self-reported SAM scores are also consistent with dynamic trajectories.

### Visualization

- Brain regions show distinct activation patterns under different emotions.
- The EEG and fNIRS views share some consistencies while also complementing each other.
- This is related to the underlying neurovascular coupling mechanism.

### Supervised Learning

- 3-class classification can achieve accuracy > 60%.
- Regression can capture consistent emotional trends.
- EEG+fNIRS outperforms single-modality tests, indicating that EEG and fNIRS features can complement and enhance each other.

