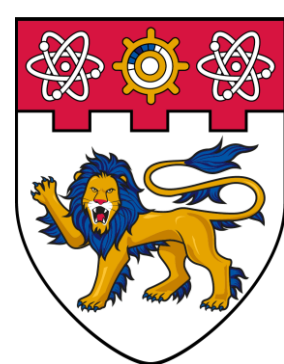
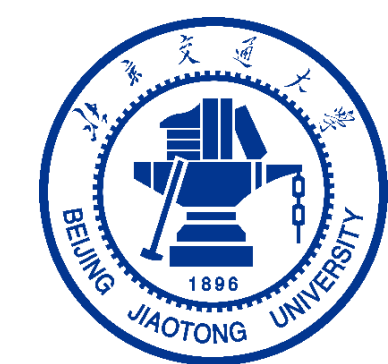


REFED: A Subject Real-time Dynamic Labeled EEG-fNIRS Synchronized Recorded Emotion Dataset

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Project page



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Motivation

◆ **Affective brain-computer interfaces (aBCIs)** play a crucial role in personalized human-computer interaction and neurofeedback modulation.

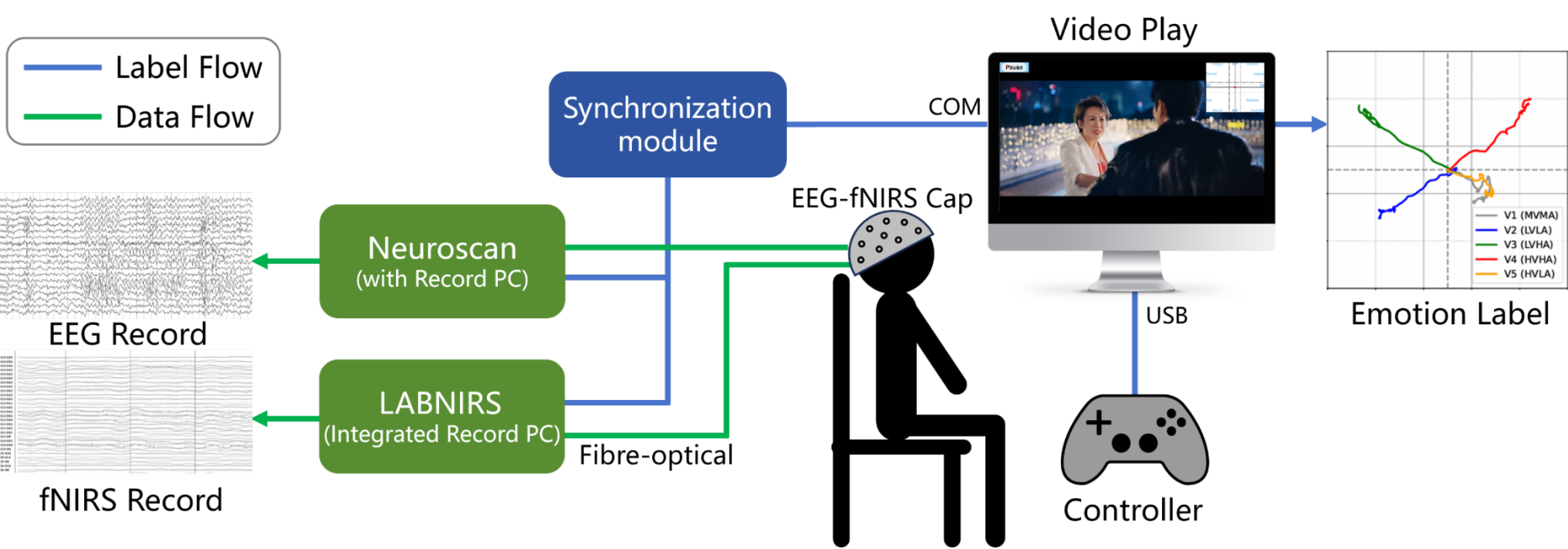
□ Multimodal brain signals:

- **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

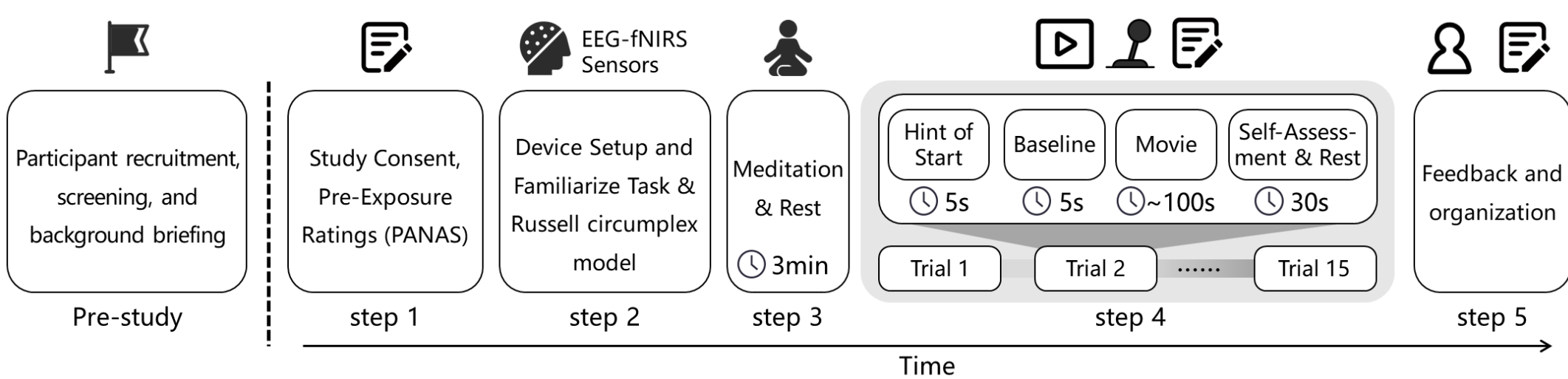
- All processes last about 1.5 hours per subject, in which video watching phase lasts for 40 mins.
- **15 emotional clips** are selected to induce 5 distinct emotions (based on valence-arousal).
- During each video trial, participants are required to provide **real-time feedback for their emotional state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

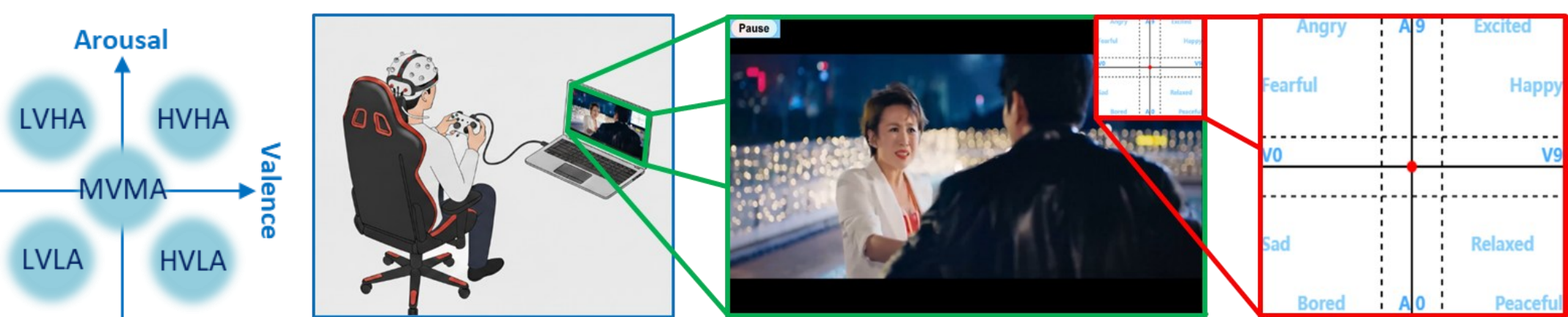
- **480 trials** (32 participants × 15 emotion-inducing video clips, about 820 minutes in total)
- Sampling frequency: **EEG** at 1000 Hz, and **fNIRS** at 47.62 Hz.

□ 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

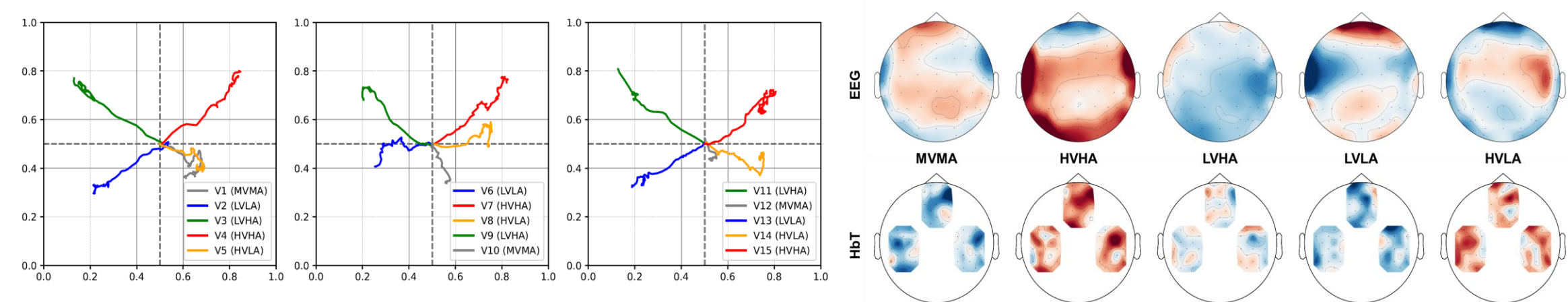
- The average valence-arousal trajectory for 15 video clips indicates that the emotion induction is effective and consistent with expectations.
- Self-reported SAM scores are also consistent with dynamic trajectories.

□ 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.



Modality	Valence - Classification		Arousal - Classification		Valence - Regression		Arousal - Regression	
	Accuracy ↑	F1-score ↑	Accuracy ↑	F1-score ↑	MAE ↓	MSE ↓	MAE ↓	MSE ↓
EEG	0.5961±0.1020	0.3965±0.0848	0.6527±0.1175	0.3720±0.0750	0.1822±0.0432	0.0588±0.0247	0.1542±0.0404	0.0402±0.0181
fNIRS	0.6199±0.1016	0.4485±0.1088	0.6645±0.1217	0.3956±0.0801	0.1716±0.0413	0.0542±0.0248	0.1453±0.0411	0.0376±0.0194
EEG+fNIRS	0.6269±0.1005	0.4611±0.1071	0.6701±0.1171	0.4060±0.0892	0.1705±0.0409	0.0531±0.0236	0.1445±0.0401	0.0369±0.0182

