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

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

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***.

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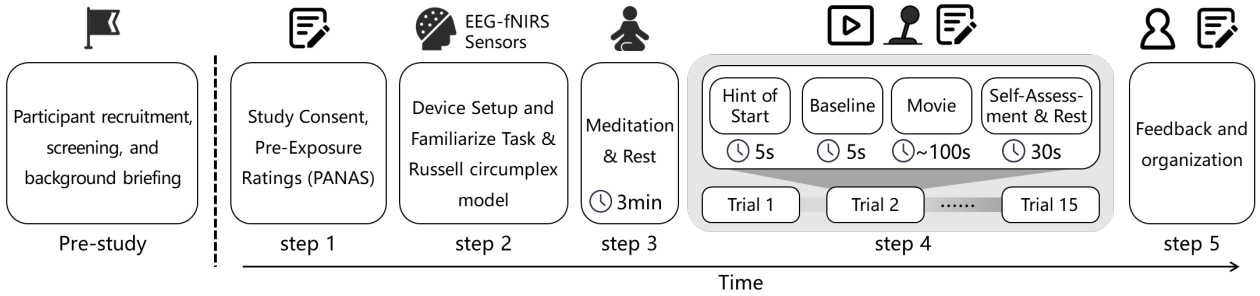
Recording Details

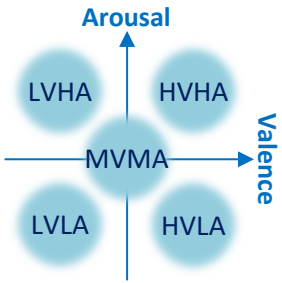
Recording Protocol

- 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 watching trial, participants are required to provide **real-time feedback for their emotional state (valence-arousal)** using an Xbox controller.
- After each video watching trial, participants are required to complete the **SAM questionnaire**.

Participants

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

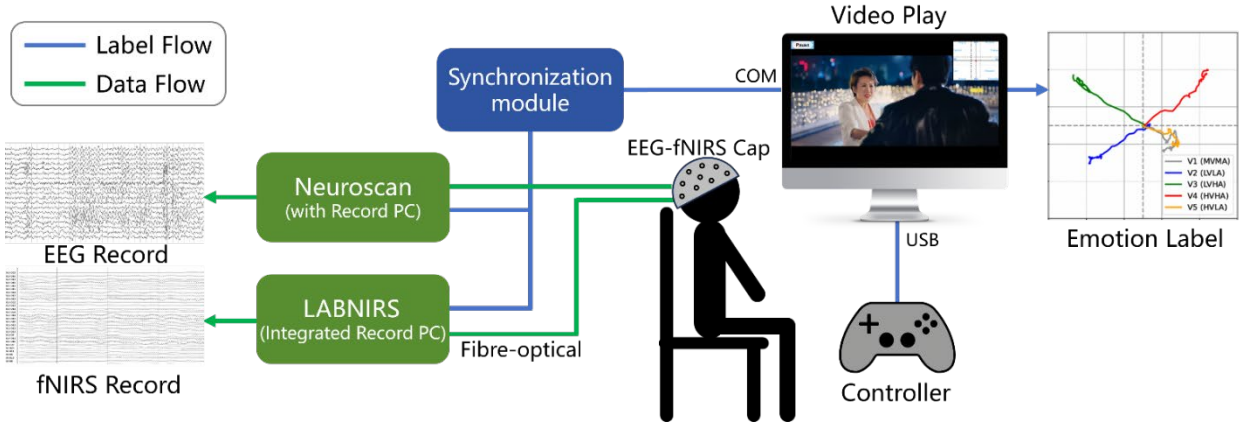




Recording Details

Devices

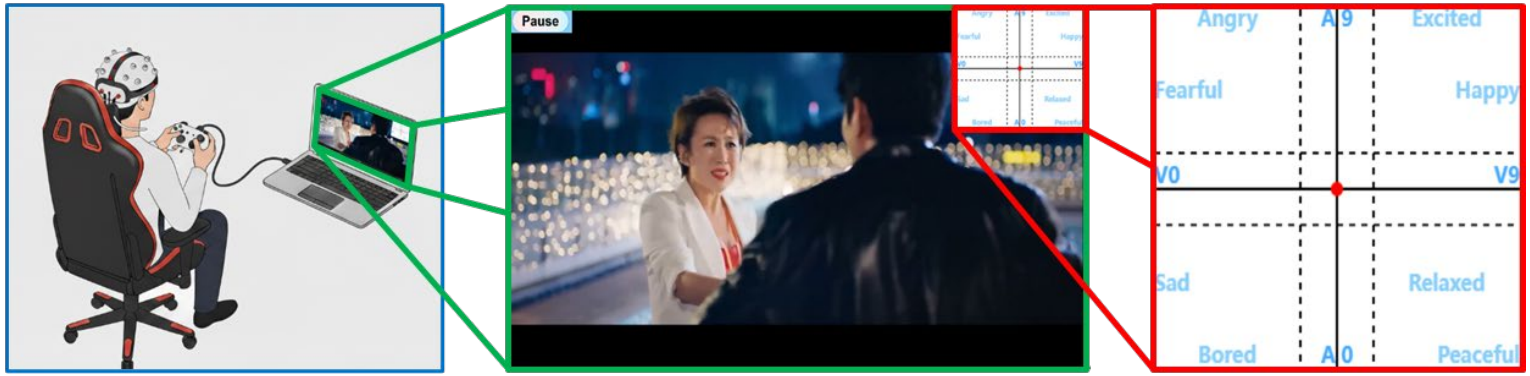
- **EEG**: ESI Neuroscan 64-channel EEG system
- **fNIRS**: Shimadzu LABNIRS fNIRS system (51 channels)
- EEG-fNIRS joint cap
- Synchronization module *(for synchronizing EEG, fNIRS, and annotation time frames)*
- Xbox controller *(for moving the valence-arousal coordinate points)*



Recording Details

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 system** is displayed in the top-right corner.
- Participants can instantly adjust the position of the red coordinate points using the joystick on the controller to reflect their emotional changes.



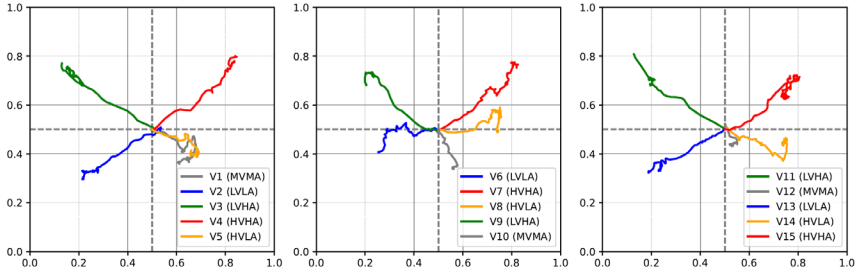
Dataset Details

- **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** (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
  - Mechanistic Study of Emotion-Induced Electrophysiological / Hemodynamic Responses
  - ……

Analysis

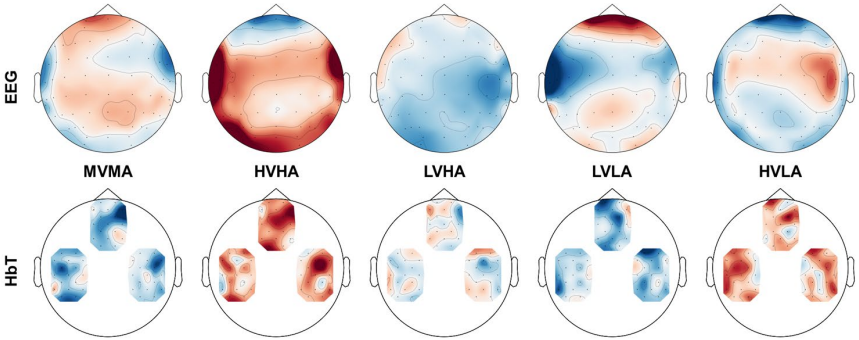
Label Analysis

- 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

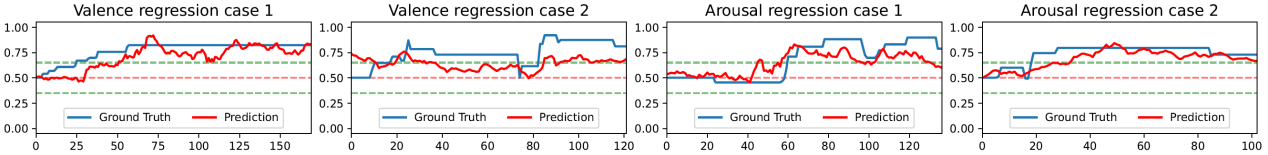
- Brain regions show distinct activation patterns under different emotions.
- The EEG and fNIRS views share some consistencies while also complementing each other.
- This is related to the underlying neurovascular coupling mechanism.



Supervised Learning

- Supervised learning models are employed to validate the performance for valence/arousal classification/regression tasks.
- 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



Conclusion

- ✓ 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/.

REFED Dataset Summary

Motivation	
Summary: An affective BCI dataset integrating multimodal brain signals (EEG-fNIRS) and real-time emotion annotation (valence-arousal).	
Example Use Case: Emotion recognition, Valence/Arousal classification, Valence/Arousal regression	
Original Authors: X. Ning, J. Wang, Z. Feng, T. Xin, S. Zhang, S. Zhang, Z. Lian, Y. Ding, Y. Lin, Z. Jia	
Metadata	
Hosting Platform	Hugging Face (https://huggingface.co/)
Keywords	Affective BCI, EEG, fNIRS, Real-time label, EEG-fNIRS
Format	.mat, .csv
Ethical Review Approval	IRB-CASIA
License	CC BY-NC-SA
Sensors	
EEG	ESI Neuroscan, 64 channels, 200Hz
fNIRS	Shimadzu LABNIRS, 51 channels, 47.6Hz
Annotations	
Dynamic Emotion	Valence and arousal
Self-Assessments	Valence, arousal, dominance, and familiarity
Other Data	PANAS scales
Participants	
Count	32
Gender	22 male, 10 female
Age	18~34 (M=21.3, SD=2.7)
Criteria	Healthy adults
Dataset Size	
Record Duration	about 820 minutes (Emotion Inducing) 40 minutes (Baselines Total)
Total Size	about 30 GB (Raw Data)


Thank you!

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