TAPAS
Training Adapted Personalised Affective Social Skills with Cultural Virtual Agents

ANR AGENCE NATIONALE DE LA RECHERCHE

JST Japan Science and Technology Agency
CREST Symbiotic Interaction

Paper ID: 81

Emotion Prediction Using Multi-source Biosignals During Cognitive Behavior Therapy with Conversational Virtual Agents

Nara Institute of Science and Technology, Japan

Kana Miyamoto, Hiroki Tanaka, Kazuhiro Shidara, Satoshi Nakamura

2023/12/5

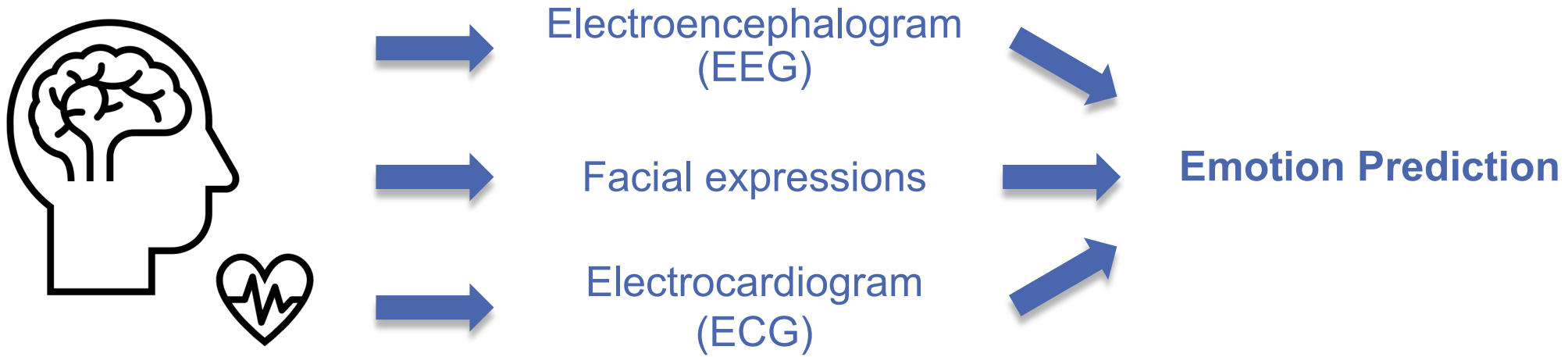
Overview

Purpose

- Emotion prediction using electroencephalogram (EEG) during mental health counseling

Challenge and our approach

- EEG is sensitive to speech noise
- Adopt multi-source biosignals to achieve high accuracy and robustness of emotion prediction

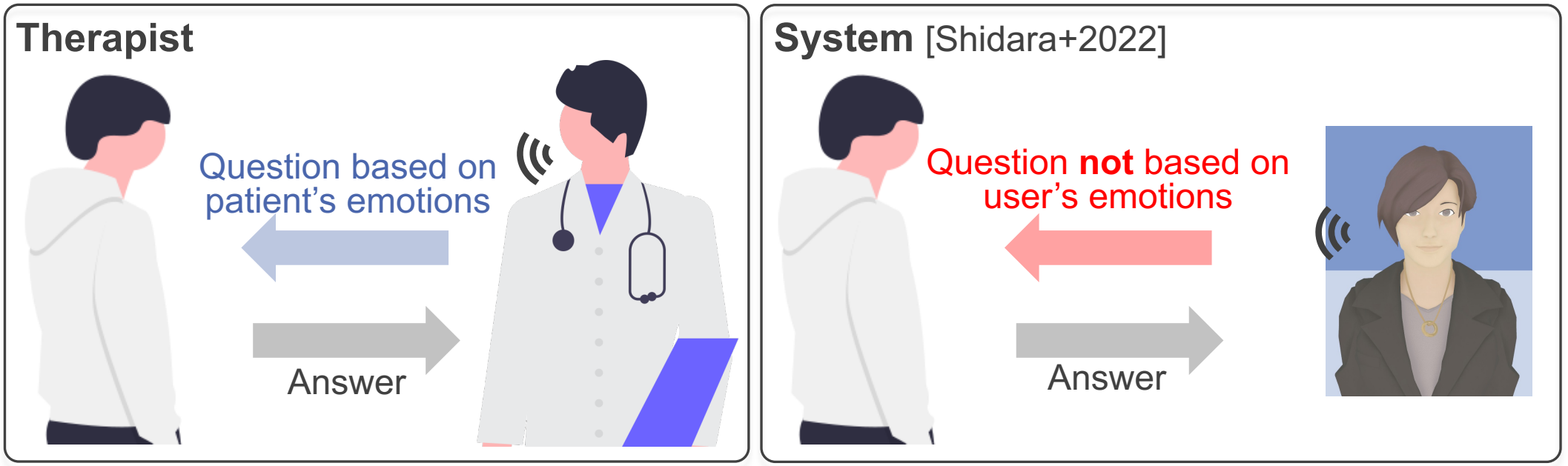


TAPAS SUPPORTED BY ANR-CREST

Background

Emotion Prediction for Mental Health Counseling System

- Systems have been developed to provide daily mental health care [Fitzpatric+ 2017]



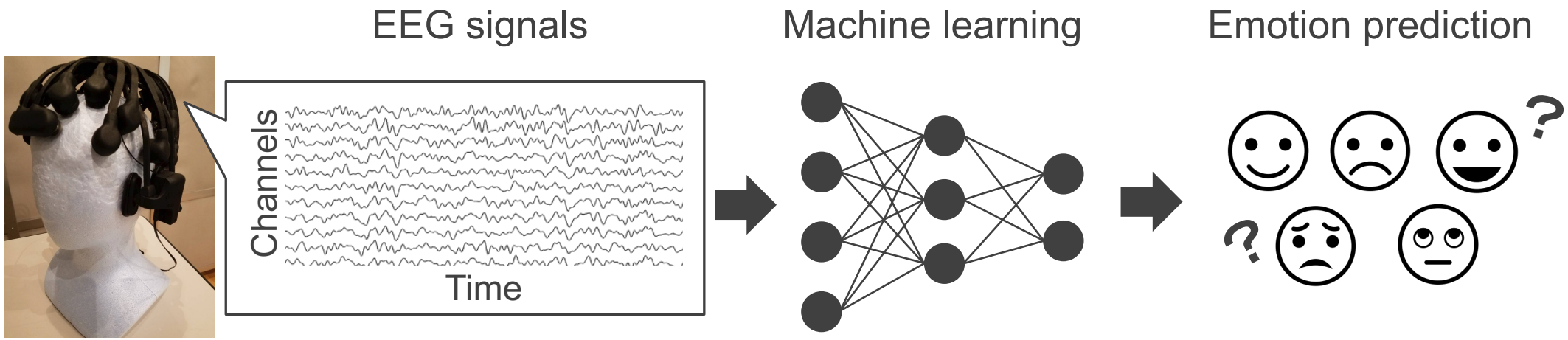
Application of emotion prediction would improve effectiveness of the system

TAPAS SUPPORTED BY ANR-CREST

Emotion Prediction Using Electroencephalogram

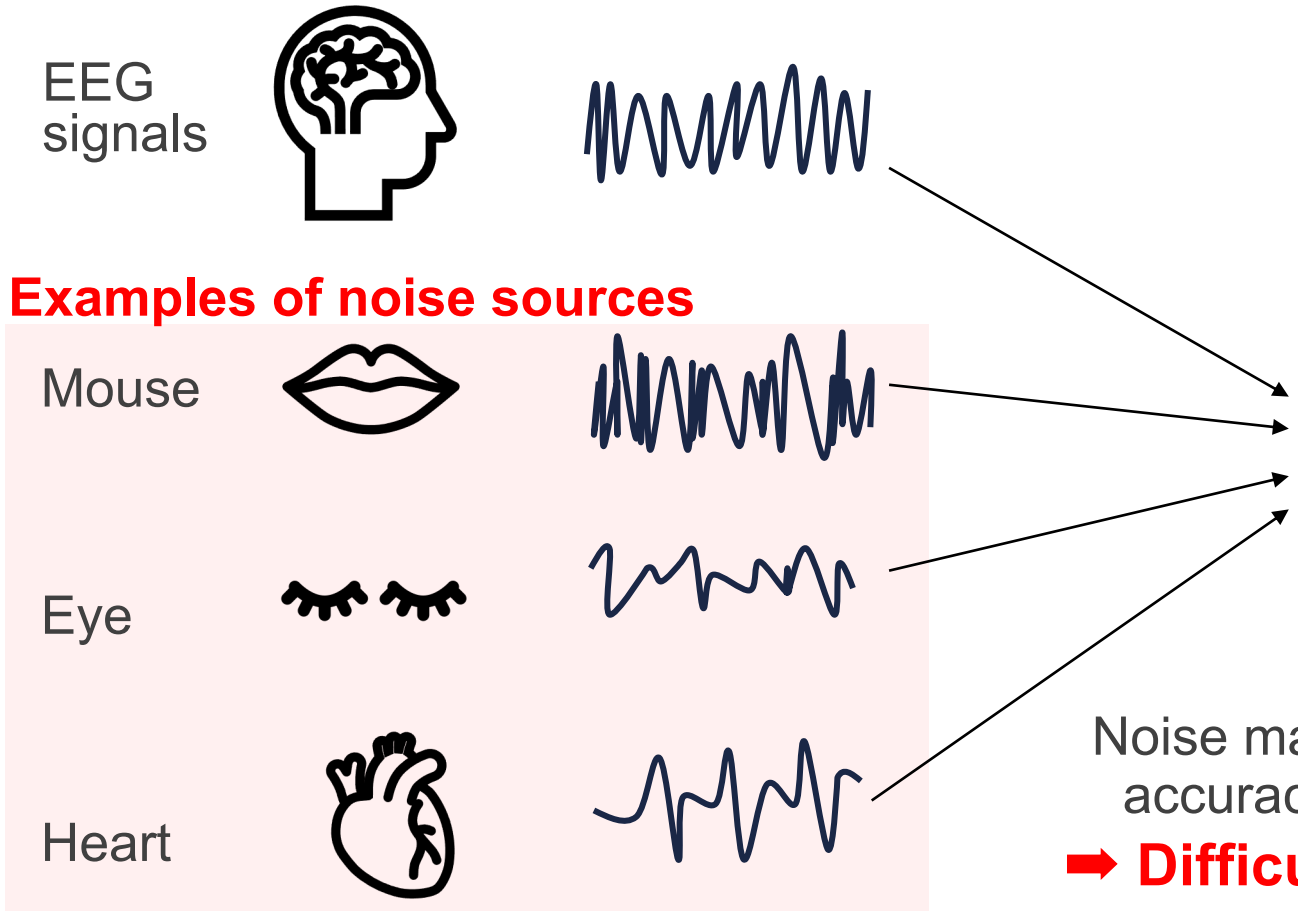
Electroencephalogram (EEG)

- Electrical activity from brain
- EEG signals reflects emotions even when we are not conscious of them
- **Emotion prediction based on machine learning models has been proposed**



TAPAS SUPPORTED BY ANR-CREST

Noise Affects EEG Signals



Noise masks EEG features and negatively affect accuracy of emotion prediction [Kanoga+ 2017]

➡ **Difficult to use EEG during conversation**

TAPAS SUPPORTED BY ANR-CREST

Towards Emotion Prediction Using EEG During Conversation

Emotion prediction using EEG + other biosignals is gaining interest

- Development of K-EmoCon dataset during discussion [Park+ 2020]

- Emotion prediction during talking [Saffaryazdi+ 2022]
  - Applying EEG, photoplethysmography and galvanic skin response

Our study uses EEG and other biosignals during mental health counseling

TAPAS SUPPORTED BY ANR-CREST

Emotion Prediction During Mental Health Counseling

Contributions

- Data collection of biosignals during mental health counseling
- Applying EEG, ECG and facial expressions (FE) for training models
- Comparison of accuracy of four models:

① EEG model

② ECG model

② FE model

④ EEG+ECG+FE model

Data Collection

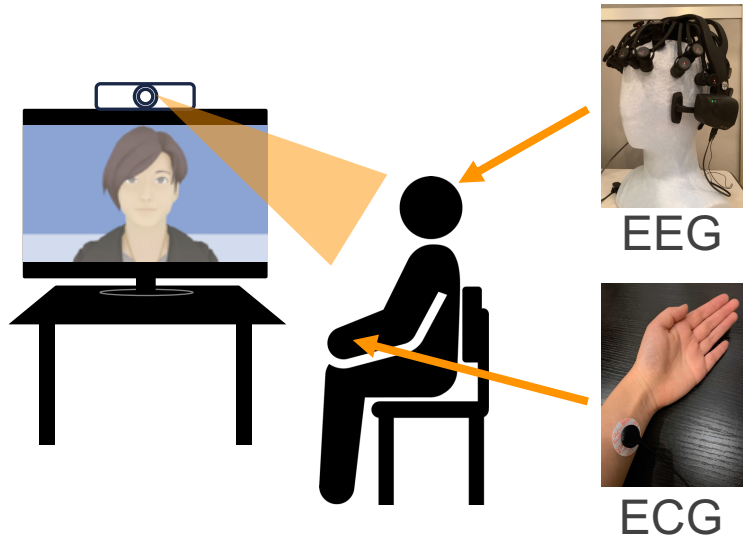
Experimental Setup

Participants

- 22 males and 7 females (age: 24.5±3.24 years old)

Sensors

- EEG : Quick-32r, manufactured by CGX
- ECG : Extension of Quick-32r
- Facial expression : Video camera

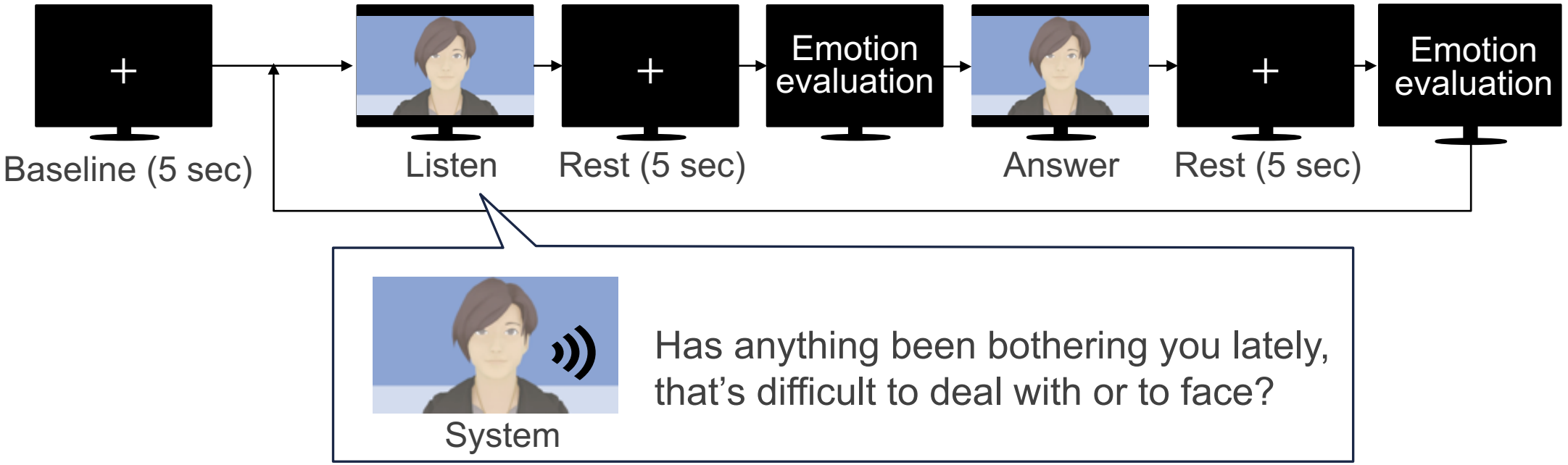


Cognitive behavior therapy (CBT) system [Shidara+ 2022]

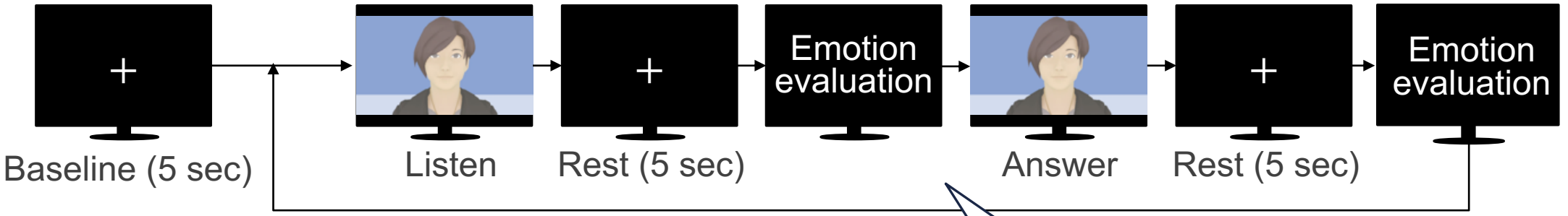
- CBT is a mental health care technique to resolve problems by modifying negative thought
- The system provide predefined questions for changing the negative thought

TAPAS SUPPORTED BY ANR-CREST

Procedure

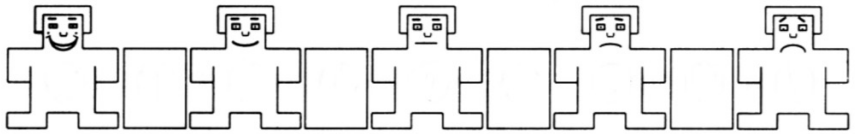

+
Baseline (5 sec)
Listen
+
Rest (5 sec)
Emotion evaluation
Answer
+
Rest (5 sec)
Emotion evaluation
System
Has anything been bothering you lately, that's difficult to deal with or to face?

Procedure

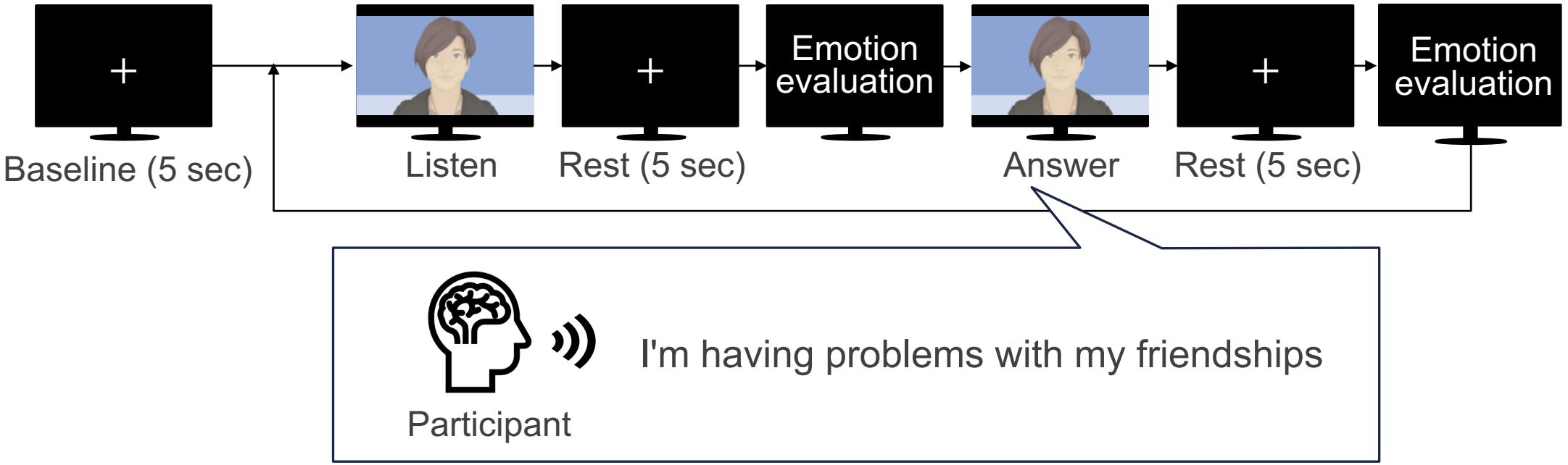


Self-Assessment Manikin [Bradley+ 1994]

- Valence (pleasant-unpleasant) and Arousal (activated-deactivated) assessment using mannequins
- Evaluate values from 0 to 1



Procedure



TAPAS SUPPORTED BY ANR-CREST

Model Training

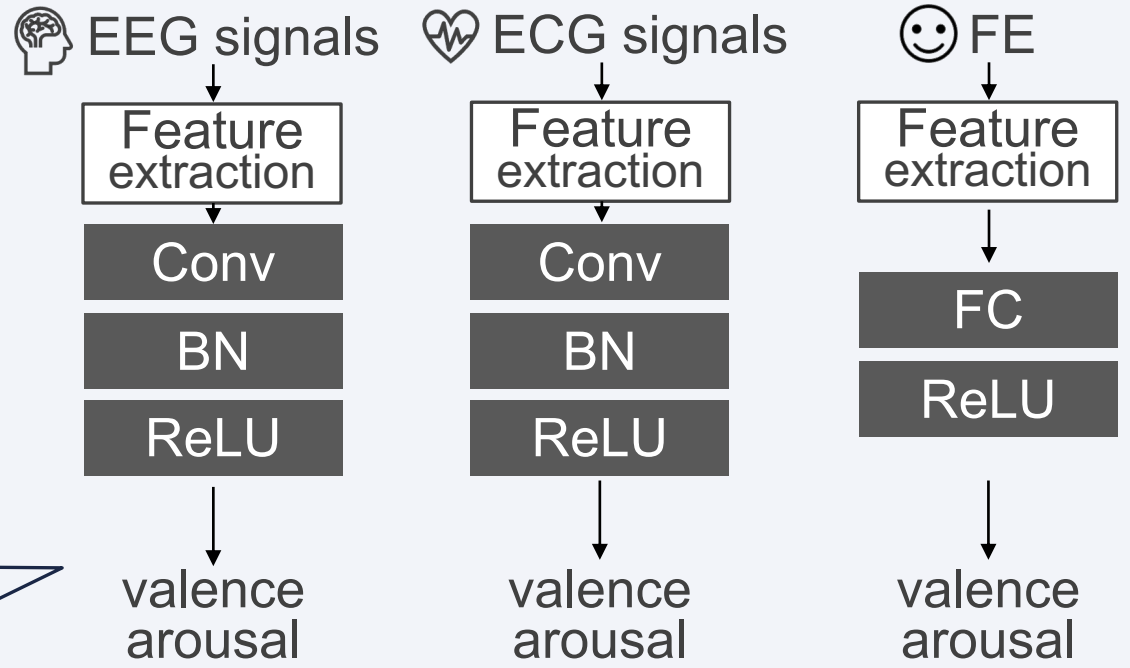
Regression Models for Emotion Prediction

Training models for each biosignal

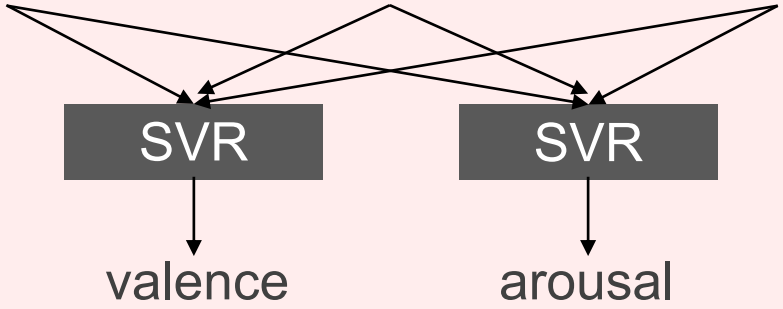
EEG･ECG : CNN

FE : Multi-perceptron

<Example>
valence prediction is 0.2



Predicted emotions from the models were connected to support vector regression (SVR)



TAPAS SUPPORTED BY ANR-CREST

Comparison of Emotion Prediction Models

- Conducting 5-fold cross-validation for each participant
- Evaluation using concordance correlation coefficient (CCC)
  - Agreement between predicted and true values
  - The closer to 1, the higher the degree of agreement

CCC of predicted and true values

	EEG (baseline)	ECG	FE	EEG+ECG+FE
valence	0.355	0.016	0.292	**0.460***
arousal	0.350	0.017	0.294	**0.455***

Wilcoxon signed-rank test * $p<0.05$

EEG+ECG+FE model improves accuracy of emotion prediction during mental health counseling

Conclusion

Purpose

- Emotion prediction using EEG during mental health counseling

Contributions

- Data collection of biosignals during mental health counseling
- EEG+ECG+FE model improves accuracy of emotion prediction

Future work

- Match of ratio of male to female participants of dataset
- Investigation of more effective fusion model structures and features such as speech information

TAPAS SUPPORTED BY ANR-CREST