Decoding Neurophysiological Correlates of Cognitive and Affective States

Katharina Lingelbach
Katharina.Lingelbach@iao.fraunhofer.de

Background

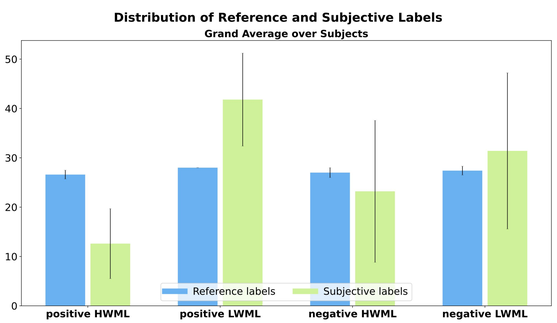
- Decoding of interwoven affective and cognitive states is crucial for adaptive/collaborative human-machine systems [1,2]

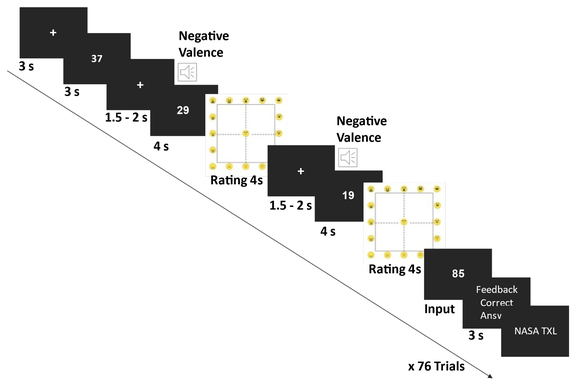
Aim

- Investigate decoding performance of simultaneously induced cognitive and affective mental states
- Investigate effects of ground truth (GT) choice for training on decoding performance

Methods

- EEG data from five participants (2 female, 1 diverse; *M* = 23 ±1.02 years)
- Arithmetic tasks adding either a series of 1-digit (low working memory load, LWML) or 2-digit numbers (high working memory load, HWML) with simultaneous auditory emotional distractions [3]
- Temporal-spatial discriminative features (FBCSP) and Linear Discriminant Analysis





Conclusion

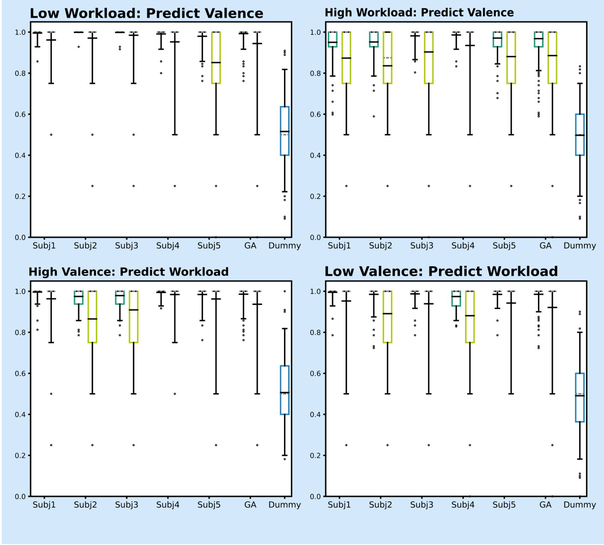
Further research is needed to:

- Investigate reasons for observed discrepancy, e.g., effects of cognitive biases or social desirability
- Obtain suitable GT and calibration tasks for Brain-Computer Interface training models

What I **Feel**

Reference ratings as GT

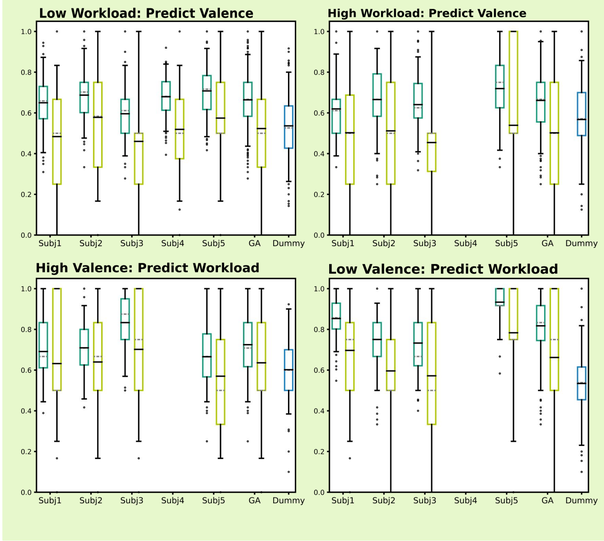
High decoding performance (balanced accuracy) of interacting mental states for **reference ratings**



What I **Say**

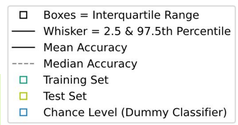
Individual subjective ratings as GT

Chance-level decoding performance for **subjective labels** as GT



Grand Average Test Classification Performance

	Reference Labels	Subjective Labels
Low Working Memory Load: Predict Valence	0.944* [0.500; 1.000]	0.523 [0.000; 1.000]
High Working Memory Load: Predict Valence	0.886* [0.500; 1.000]	0.502 [0.000; 1.000]
High Valence: Predict Working Memory Load	0.937* [0.500; 1.000]	0.636 [0.167; 1.000]
Low Valence: Predict Working Memory Load	0.921* [0.500; 1.000]	0.662 [0.000; 1.000]
Four Class Prediction	0.656 [0.250; 1.000]	0.357 [0.083; 0.750]
Dummy Classifier	0.453 [0.136; 0.800]	0.507 [0.158; 0.800]



References

[1] Appriou, A., Cichocki, A., and Lotte, F. (2020). Modern Machine-Learning Algorithms: For Classifying Cognitive and Affective States From Electroencephalography Signals. IEEE Syst. Man Cybern. Mag. 6, 29–38. doi: 10.1109/MSMC.2020.2968638

[2] Vukelić, M., Lingelbach, K., Pollmann, K., and Peissner, M. (2020). Oscillatory EEG Signatures of Affective Processes during Interaction with Adaptive Computer Systems. Brain Sci 11. doi: 10.3390/brainsci11010035

[3] Gado, S., Lingelbach, K., Bui, M., Rieger, J. W., and Vukelić, M. (2021). "Real-time feedback of subjective affect and working memory load based on neurophysiological activity," in The International Conference, HCI International 2021, Washington DC, USA, July 24-29, 2021, Proceedings. Springer.

Get access to our Abstract.

Katharina Lingelbach
Fraunhofer IAO, UOL ANCP

Sabrina Gado
Fraunhofer IAO

Jochen W. Rieger
UOL ANCP

Mathias Vukelić
Fraunhofer IAO

Fraunhofer IAO · Carl von Ossietzky Universität Oldenburg · ANCP Applied Neurocognitive Psychology