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Prediction of unconsciousness using clinically available markers

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***Abstract*— Propofol is an anesthetic with known behavioral, hemodynamic, and electrophysiological effects. We investigate the ability of several simple clinically available markers to predict unconsciousness using a logistic regression framework. Our results show that even a single EEG-based marker is able to predict consciousness of propofol-sedated subjects.**

***Clinical Relevance*— This supports the usage of EEG markers during anesthesia care to inform a patient's level of consciousness.**

I. Introduction

It has been shown that various types of information extracted from the electroencephalogram (EEG) can be used to predict propofol-induced unconsciousness with high accuracy [1]. In practice, we want to decrease complexity and simplify the information required for clinical decision making. A number of simple physiological measures are already commonly tracked in clinical settings. In this study, we test two such single indices that can be measured easily in clinical settings as markers of unconsciousness: heart rate and power in the alpha frequency band (8-13 Hz) of the EEG (alpha power). We hypothesized that even a single EEG-based marker alone is an accurate predictor of unconsciousness.

II. Methods

In this study, six subjects of age 18-36 years were subject to computer-controlled propofol infusion [2]. Continuous ECG and EEG were collected. LOC and ROC times were recorded based on response to an auditory stimulus. A multitaper spectrogram was computed using MATLAB R2020a from the EEG for each subject, from which the total power in the alpha frequency band (8-13 Hz) [3] across time was computed. The instantaneous mean heart rate was computed using a point process model [4]. We used logistic regression with leave-one-subject-out cross-validation to predict consciousness or unconsciousness using either alpha power or mean heart rate markers as predictors. The areas under the receiver operating characteristic curve (AUROC) were used to measure predictive performance.

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III. Results

TABLE I. Summary of AUROC Results

AUROC	Subjects					
	1	*2*	*3*	*4*	*5*	*6*
EEG	0.989	**0.953**	**0.979**	**0.998**	0.862	**0.980**
Mean HR	**0.993**	0.819	0.831	0.950	**0.886**	0.373

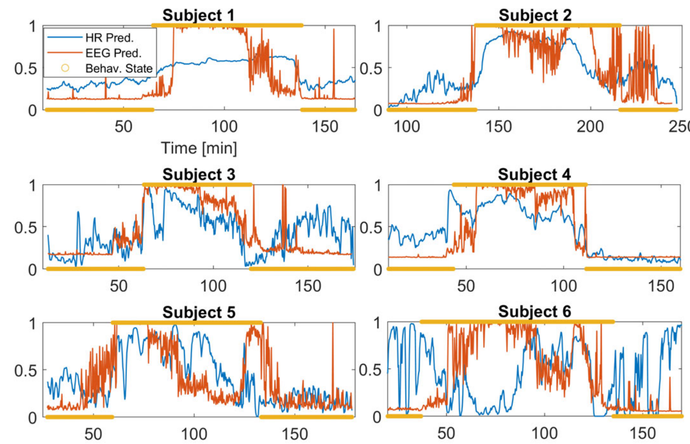

Figure 1. Prediction (pred.) values of using meanHR or EEG indices against the true behavioral state (Behav. State) of each subject. In this figure, unconsciousness is labelled 1 while consciousness is labelled 0.

Results are summarized in Table 1 and Fig. 1. For 4 out of 6 subjects, the best prediction performance was using alpha power from the EEG. For subjects where the mean heart rate was slightly better, EEG still maintained almost comparable predictive power.

IV. Discussion & Conclusion

Our analysis highlights that even a single EEG-based marker can accurately predict consciousness and unconsciousness, which can be used in clinical settings. In our future work, we will develop and test multimodal models.

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