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Towards a decision-making BCI for dynamic detection of uninformed decisions

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Introduction: Making fast and accurate decisions utilizing the available information is essential for animal survival and human success. However, especially in the time of enhanced communication and information systems, additional information seeking behavior can enhance decision making quality in a time-efficient way. Previous studies have identified a decision variable signal decodable from animal single cell recordings and human electroencephalographic recordings that reflects a variety of decision parameters and cognitive processes. Passive BCIs are proposed to decode these decision parameters in real time. A BCI automatically differentiating between more or less informed decisions could assist a user by detecting uninformed decision-making and recommending the initiation of additional information search. This could be especially relevant in situations where important decisions need to be made under factors that have been reported to affect decision quality such as time pressure or stress. Additionally, patients suffering from disorders associated with decision making impairments could benefit from such an application.

Methods: Cortical and subcortical electrophysiological signals are acquired using stereoelectroencephalography (sEEG) implanted in 6 epilepsy patients for localization of the epileptogenic zone. The participants perform a computerized decision-making task where they are asked to decide which group each stimulus belongs to. While this decision is random in the first iteration, the participants are expected to learn from their previous decisions and to make an informed decision in the second and third iteration of seeing the same stimulus.

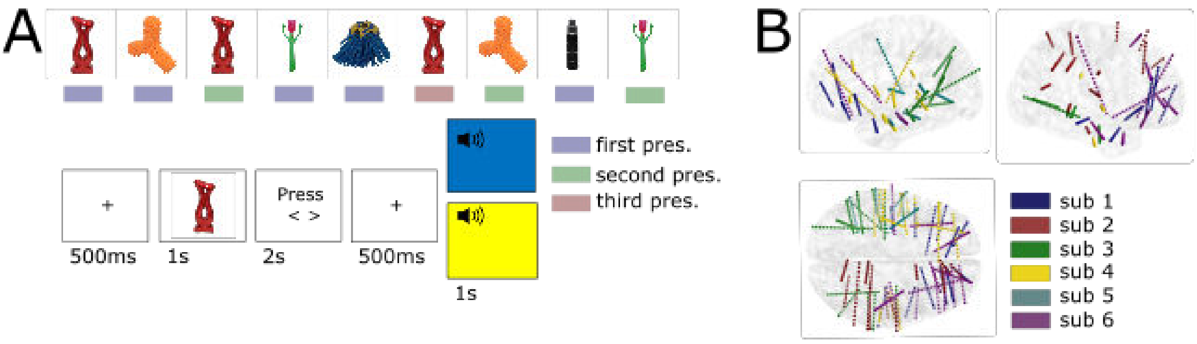

Figure 1. *(A)Task setup: 60 different stimuli are presented 3 times in random order (first, second and third presentation). For each stimulus participants are prompted to respond with a button press. Feedback is provided using a colored screen and an audio signal. (B) Electrode locations of the 6 participants included in this study are depicted in the left hemisphere, right hemisphere and in a top-down view in both hemispheres.*

Results and Discussion: From the electrophysiological signal we extract time-domain and oscillatory features during different time-intervals time-locked to stimulus presentation and response. We evaluate these features for their predictability for differentiating between random and informed decision-making using machine learning. We show the general feasibility of a passive BCI for detecting random versus informed decision-making above chance level.

Significance: This work contributes to gaining insights into the neural dynamics of decision-making and the differences between informed and uninformed decision-making. Additionally, it highlights relevant time-windows, electrode locations and neurophysiological features for decoding in invasive and non-invasive BCIs that aim to improve decision-making quality.

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