

Learning Without Feedback: Does the P300 ERP Component Encode an Implicit Prediction Error

Stephen J.C. Luehr, Francisco L. Colino, and Olav E. Krigolson
Centre for Biomedical Research, University of Victoria

INTRODUCTION

Anterior cingulate cortex used within reinforcement learning systems for optimizing behaviour (Holroyd & Coles, 2002).

However, we also learn without reinforcement.

Less clear what neural structures are recruited in these instances.

The P300 component of the human event-related brain potential (ERP) shown to be used for the processing of novel stimuli (Spencer, Dien, & Donchin, 2001).



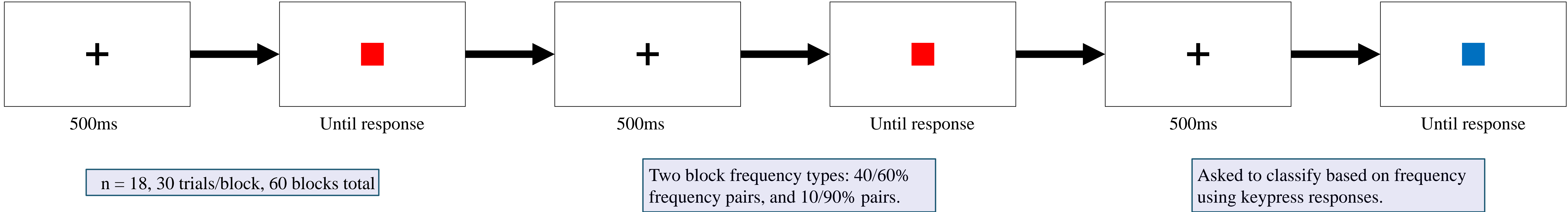
RESEARCH AIM

Elaborate on the role of the P300 ERP component in implicit learning of stimulus frequencies – learning driven by the stimulus itself and not reward feedback.

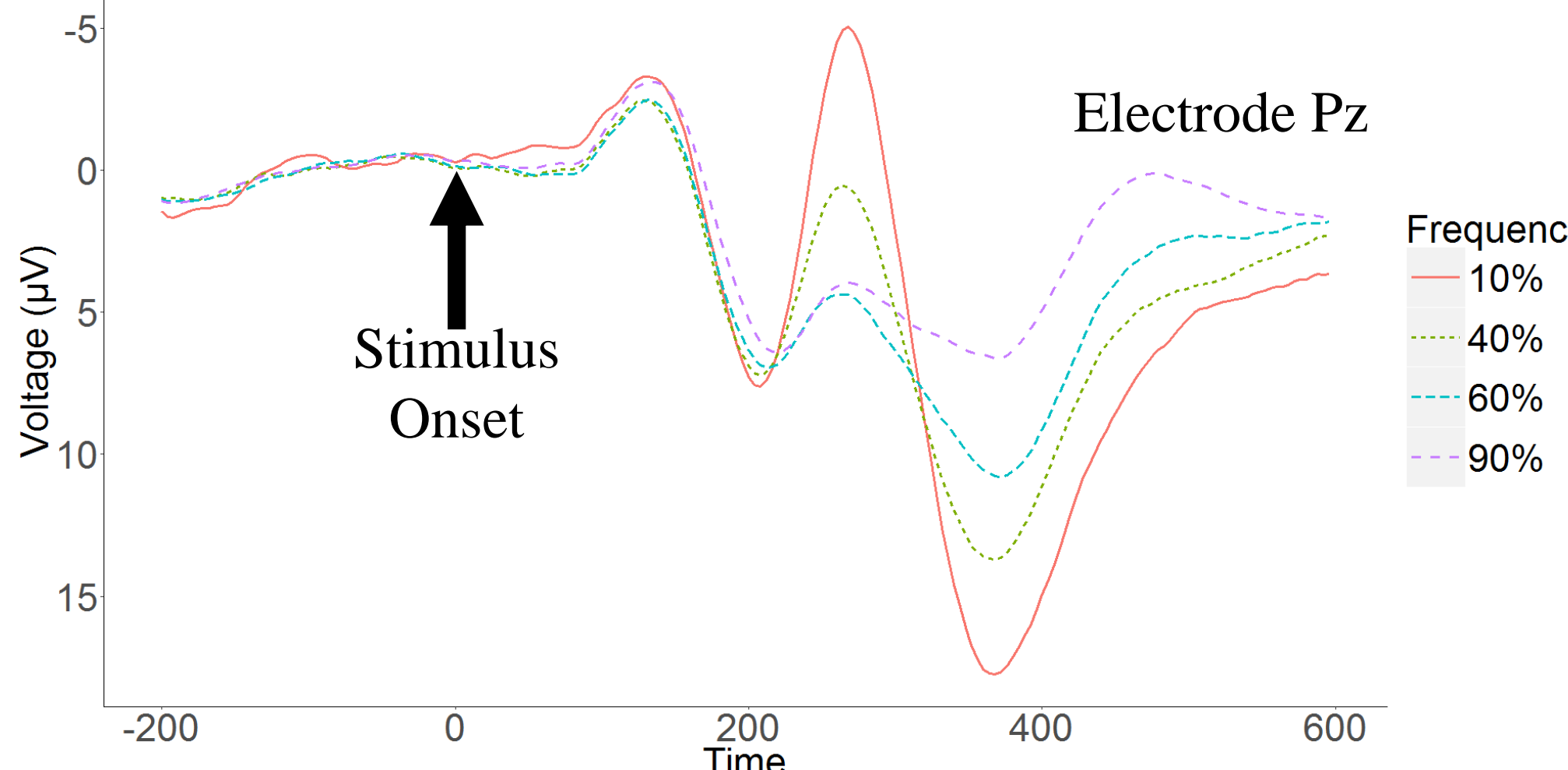
HYPOTHESIS

We hypothesised that the amplitude of the P300 ERP component reflected an implicit prediction error – the difference between the expected frequency of a given stimulus and its actual frequency.

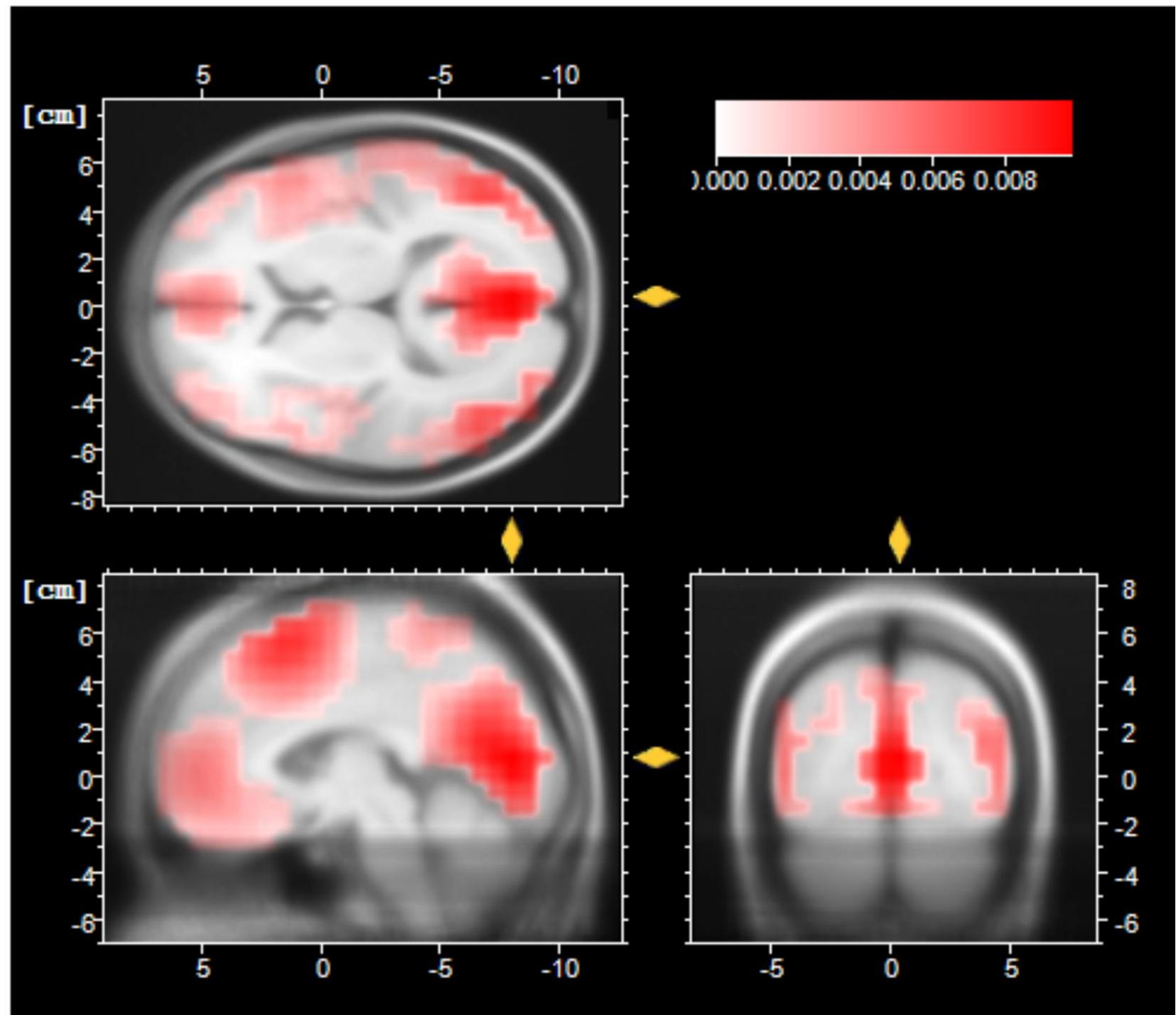
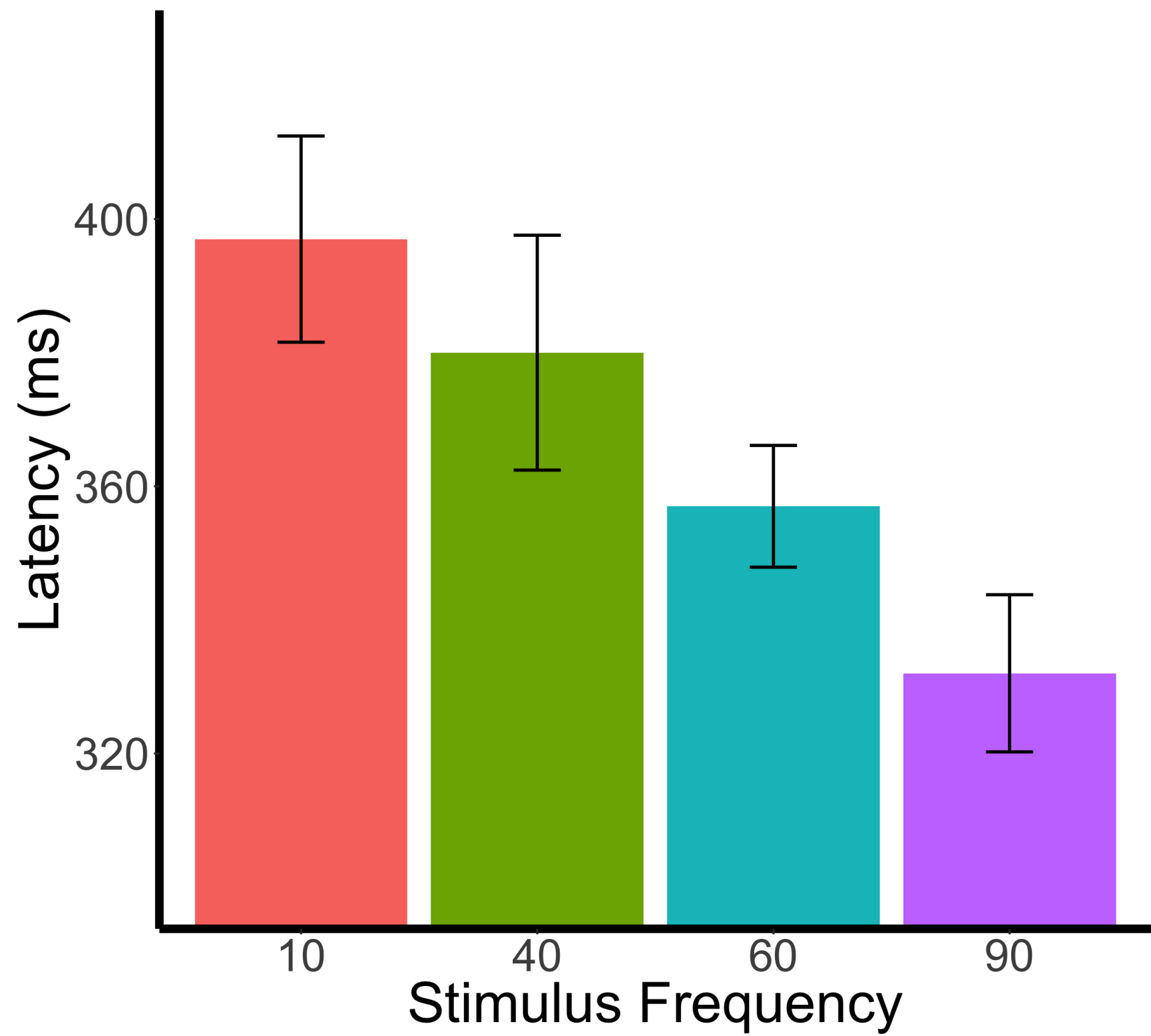
METHOD



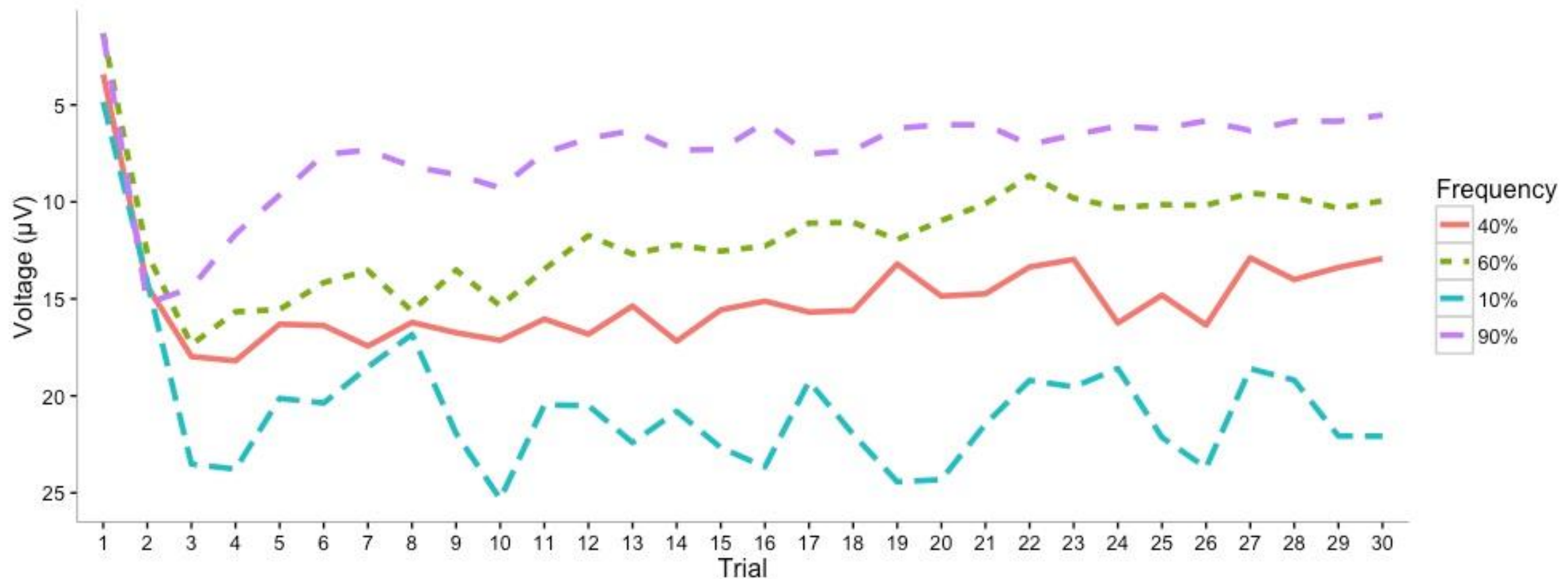
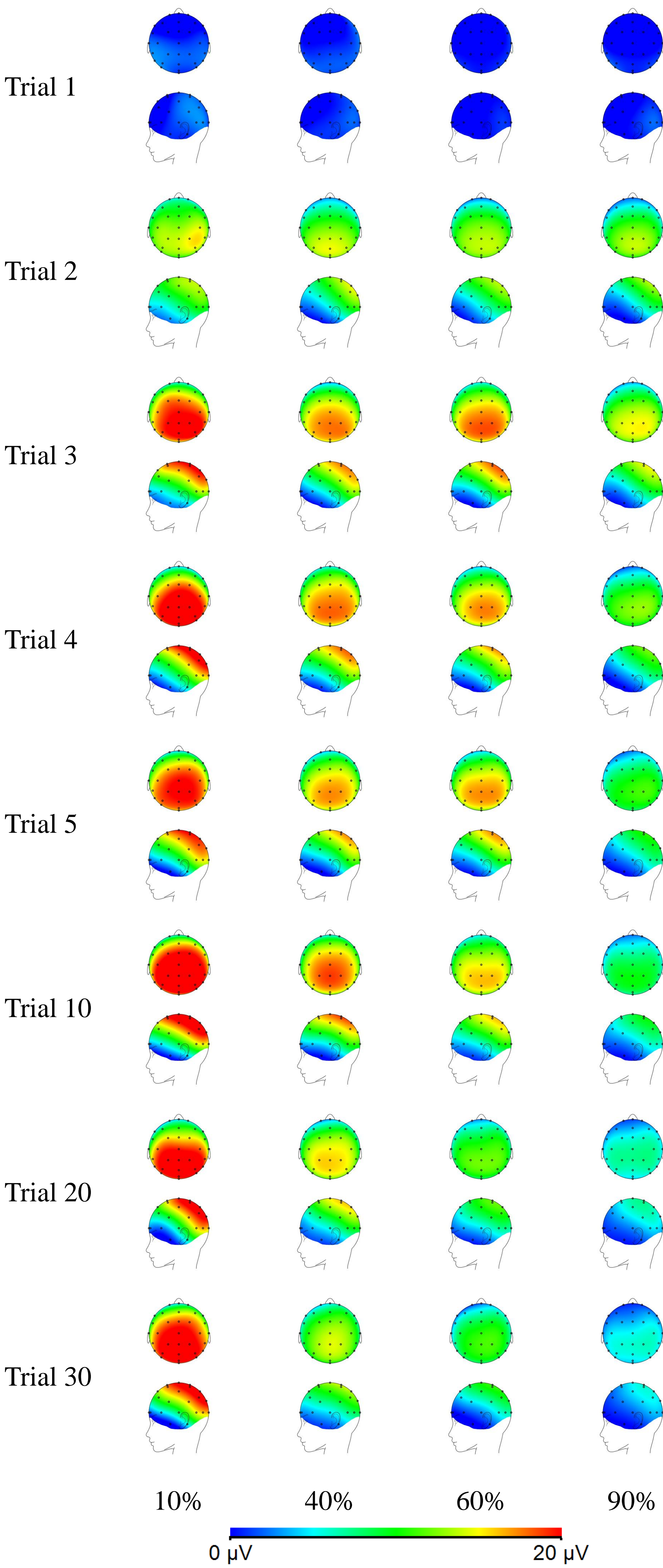
RESULTS



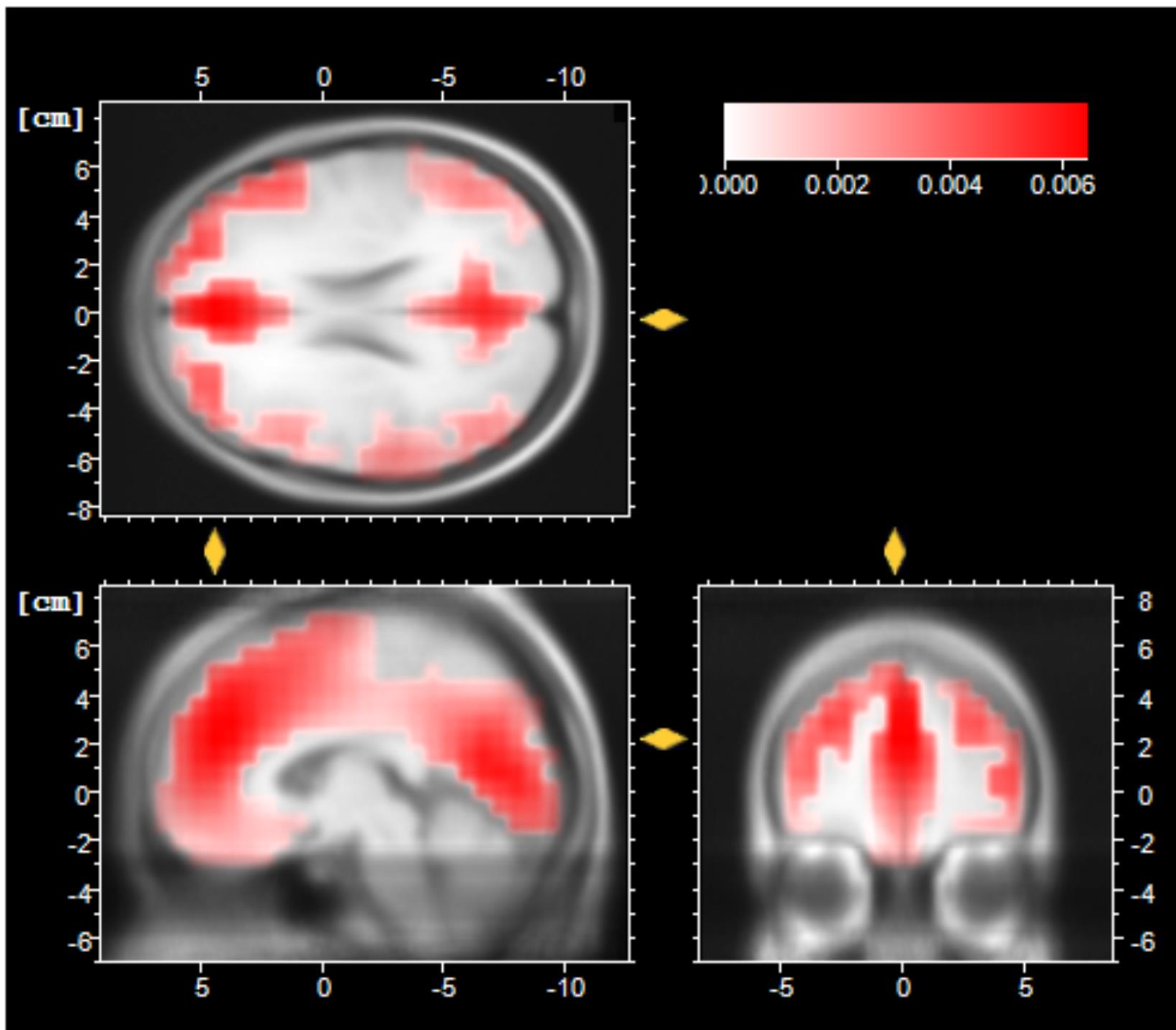
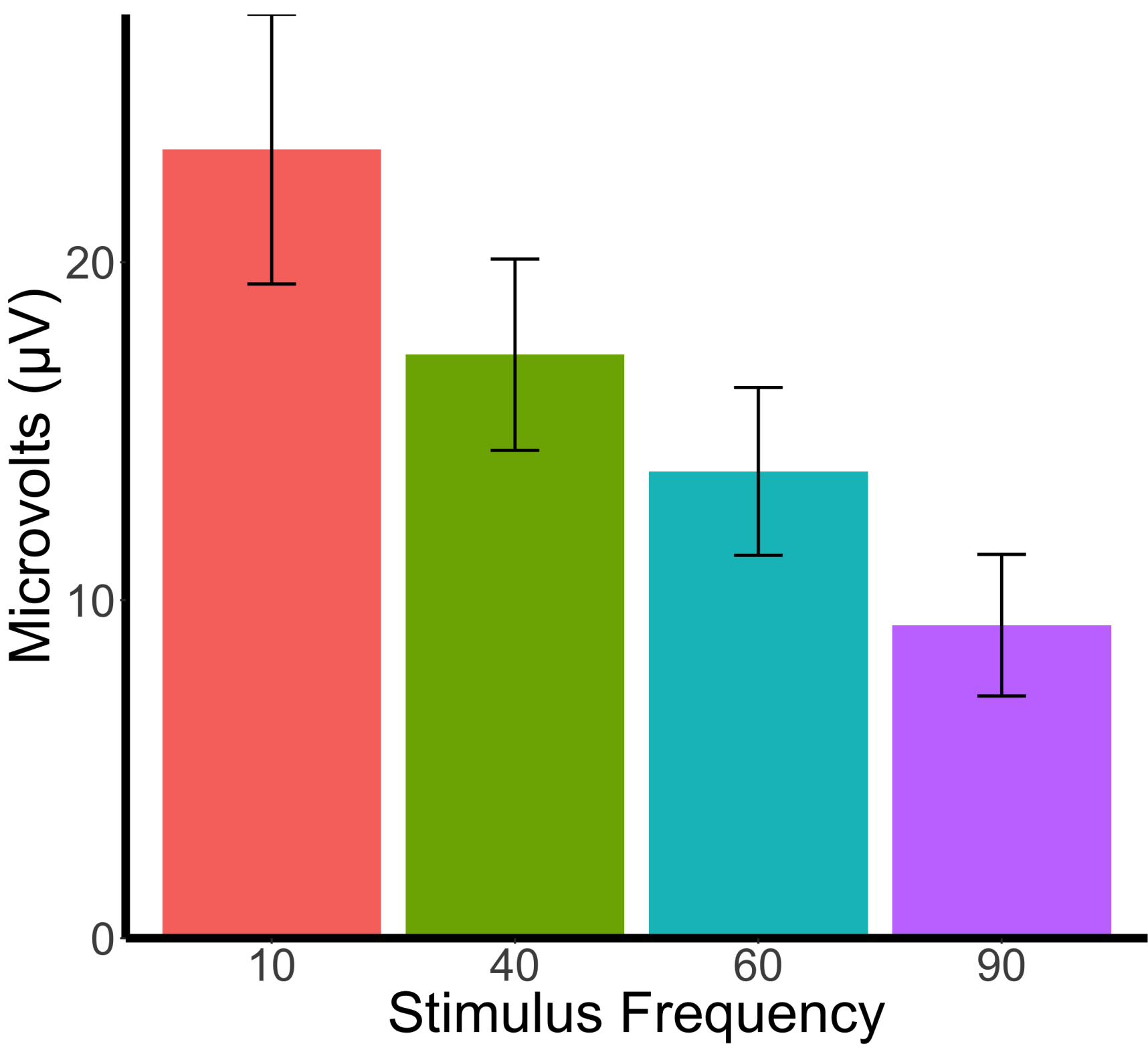
Grand Average waveforms time locked to stimulus presentation.



Trial 2 LORETA localization to the Cuneus



Peak amplitude by trial



Trial 30 LORETA localization to the Frontal Lobe

CONCLUSIONS

- P300 amplitude and latency was dependent on stimulus probability, as found in previous studies (Nieuwenhuis, Aston-Jones, & Cohen, 2005).
- Trial-by-trial analysis reveals a learning process taking place over the course of each block. Amplitudes scale to frequency over time, the fastest adaptation observed for the 10% frequency condition.
- Source localization of the P300 supports the posterior parietal cortex may play a role in prediction error driven implicit learning mechanisms (Wolpert, & Ghahramani, 2000).
- Our results suggest that the amplitude of the P300 reflects an expectancy driven prediction error. Specifically, a reinforcement learning process is taking place based on implicit violations of frequency rather than feedback.
- The cuneus, which has previously been shown to reflect a modulation based on potential reward (Doñamayor, Schoenfeld, & Münte, 2012), could be the specific structure responsible for adjusting expectations without feedback.

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