

Flex-printed electrodes for mobile EEG applications

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Abstract

EEG is one of the most widely deployed brain monitoring techniques for both research and clinical purposes, but the relatively bulky sensors, which require expert training to apply, still hinder deployment and limit the technique's wider uptake. We developed a printed electrode system that is lightweight, nearly imperceptible to the wearer, and provides high signal quality.

Our electrode system consists of printed Ag/AgCl sensors on a carrier of thermoplastic polyurethane, compatible with different contact materials between sensor and skin. The tests reported here used electrolyte gel. The printed design results in a *patch* less than .25 mm thick that is laid across the skin, and remains in place due to an additional adhesive layer. One patch has 4 periauricular sensors, 1 near the eye, and 5 on the forehead. Separate left and right patches allow uni- and bilateral use for different use cases. The right preauricular sensor served as ground.

We recorded bilateral data from 19 participants using the ERP CORE paradigms, and compared the brain responses to data recorded using state-of-the-art research-grade electrodes. We also surveyed participant comfort.

Differences in coverage precluded a direct comparison to the scalp electrodes. Instead, we projected the channel-time data for each participant and task onto a virtual channel using the first PCA component, which was calculated from the grand average ERP difference wave for each task, after data cleaning using independent component pruning. To investigate class separability, a Wilcoxon rank-sum test was performed across participants on mean amplitudes within the ROI.

Patch data accurately showed all seven brain responses elicited by the ERP CORE. All ERPs showed statistically significant separation between classes within the respective ROI (all $p < 0.005$), even for the most distant cases, i.e. the parieto-occipital N170 and N2pc. Participants reported the patch to be nearly imperceptible once applied.

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Results indicate the feasibility of printed electrode systems to provide comfortable, mobile EEG of high quality.

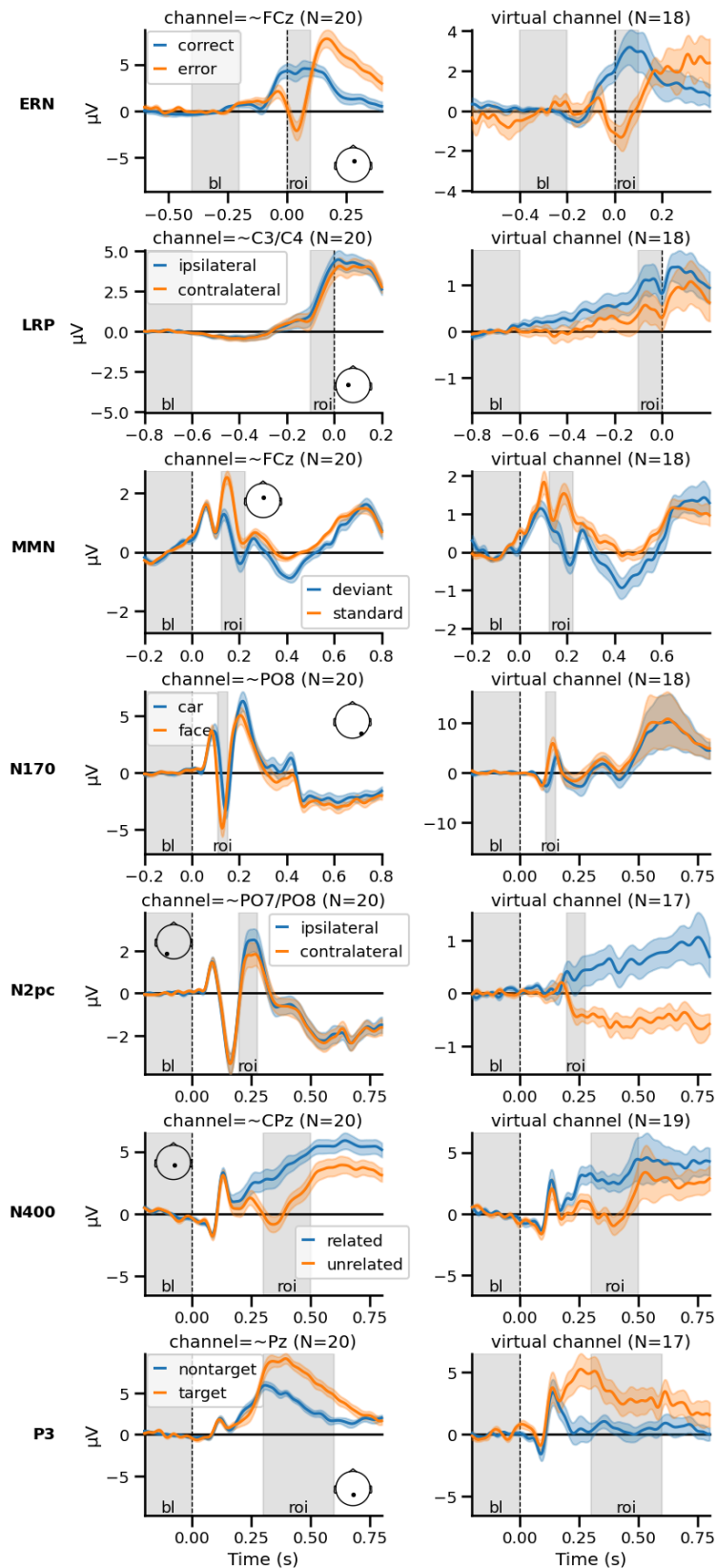
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Fig. 1: ERP comparison between research-grade system (left) and our patch electrodes (right).



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