THE IMPACT OF ARTIFACT REMOVAL METHODS ON TMS–EEG SIGNAL

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INTRODUCTION

- TMS–EEG can inform us about causal, effective connectivity.
- TMS pulses can cause severe artifacts in EEG.
- To extract TMS-evoked potentials (TEPs), artifacts need to be removed offline.
- Different methods of artifact removal give rise to variability in the results.

" Are data cleaned with different methods comparable? "

METHODS

- 16 healthy young participants.
- 120 TMS single-pulses on the left Inferior Parietal Lobule (IPL) and left Dorsolateral Prefrontal cortex (DLPFC – data not shown) at 100% of the Motor threshold.
- An identical retest session was conducted after 72.3 ± 35.8 days.
- Artifact were removed with four methods: ARTIST [1], TMSEEG [2], TESA [3] and SOUND-SSP–SIR [4-5], keeping the common parameters constant.
- The outputs of these methods (TEPs) were compared.

RESULTS - Differences in TEPs' amplitude

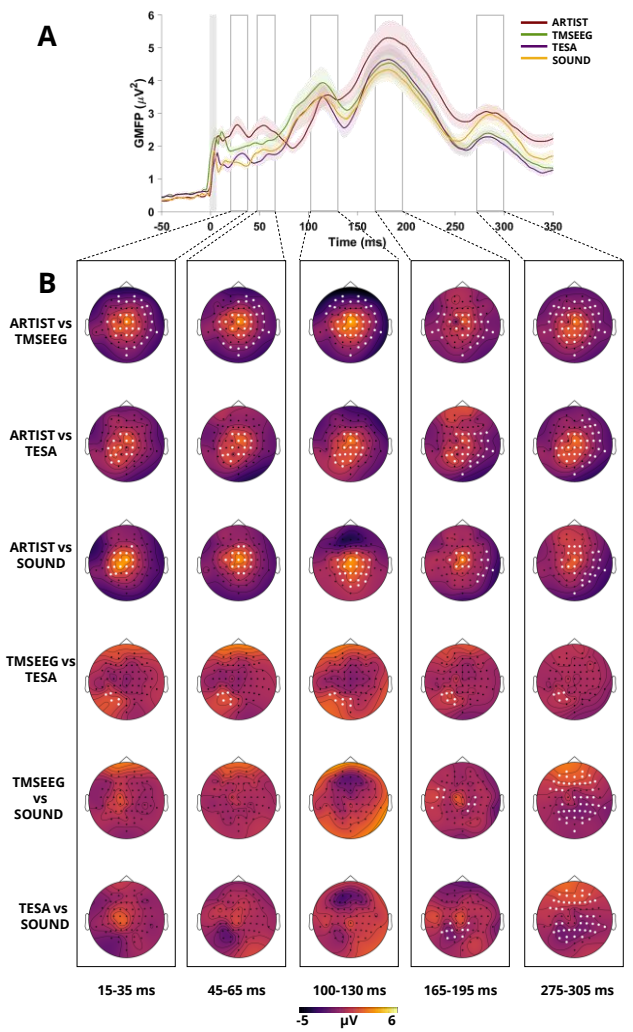
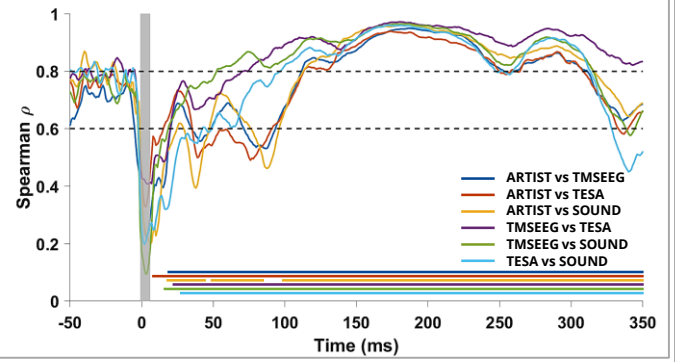


Fig.1: A: Global Mean Field Power (GMFP, y axes) over time (ms, x axis) of TEPs resulting from IPL stimulation, cleaned with the four preprocessing methods (color-coded). Shaded area around each colored line represents SEM. The shaded grey column around zero represents the TMS-pulse interpolation interval.

B: scalp topographies of the voltage differences (color-coded) for each preprocessing method contrast (rows) in five selected time windows (columns). White dots represent significant channels (p<0.0042, cluster-based correction).

RESULTS - TEPs Correlations

Fig. 2: IPL, TEPs spatial correlation (ρ, color-coded) over time (ms) of contrasts between methods. The shaded grey column around zero represents the TMS-pulse interpolation interval. Horizontal colored lines represent instants in time in which the correlation is significantly different from zero (p<0.0042, FDR corrected).



RESULTS - Test–rest reliability of TEPs

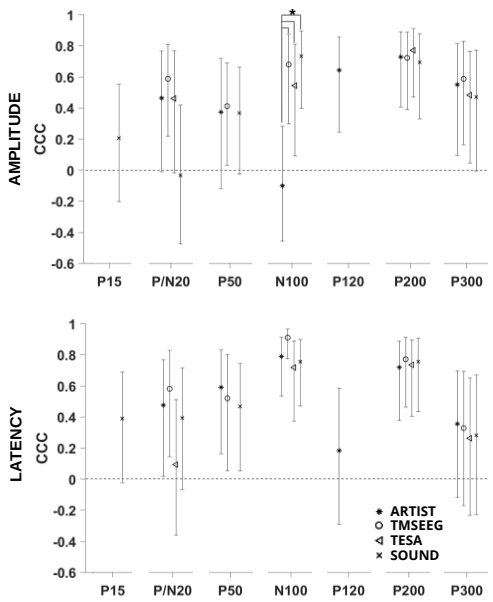


Fig. 3: Test-retest reliability estimation of peaks' amplitude and latency in IPL, computed on TEPs obtained from the four preprocessing methods. Vertical error bars represents bootstrapped CIs. Note that peaks P15, P50 and P120 were not present in TEPs after preprocessing. CCCs were considered significantly different from zero when the CIs did not include zero (p<0.05). Stars represent significantly different CCCs within the same peak.

CONCLUSIONS

- The choice of the preprocessing method strongly affects the signal, even when the common preprocessing parameters are kept constant.
- This might add ambiguity when comparing results from different TMS–EEG experiments.
- The lack of a ground truth limits the possibility to evaluate the benefits of each preprocessing pipeline.
- Further research is needed to identify more effective approaches to reduce TMS-induced artefacts.

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