Data Quality of Concurrent EEG-TMS in a Faces-Scenes Discrimination Task

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Introduction

By recording the EEG during or immediately after the delivery of TMS pulses, we can quantitatively assess the results of these perturbations on specific event-related potentials (ERPs).

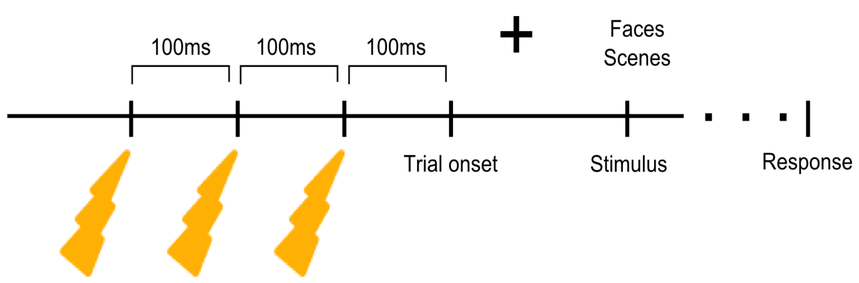
However, TMS induces high amplitude artifacts on the EEG data [1] with spatio-temporal characteristics that are variable within and between subjects and experimental sessions.

We propose a pipeline for analyzing ERPs recorded with TMS, in a Faces-Scenes Discrimination Task. We highlight the limitations of this approach and show how it is nonetheless possible to obtain meaningful ERPs similar to those recorded without TMS.

Methods

TASK & PARTICIPANTS

Five female subjects (mean age 22±7.3y) discriminated scenes superimposed on faces. In different conditions either the scenes (50%) or the faces (50%) were more salient (higher contrast). TMS was applied over the left and right posterior parietal cortex (P3/P4) . Each session included two runs of the task (72 trials each), with and without TMS.

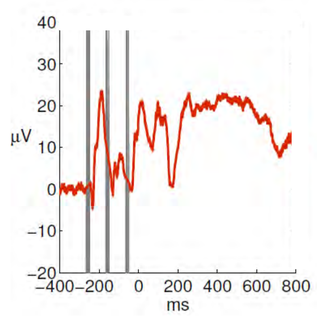


Perceiving a face tends to elicit a negative parietal component at about 170 ms (N170) which is stronger for faces compared to non-face stimuli [2]. Here we assess the effects parietal TMS has on the N170 waveform.

EEG ANALYSIS

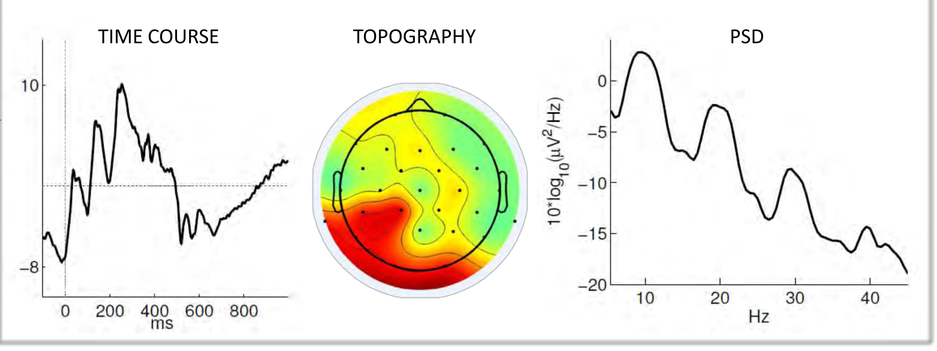
EEG DATA
EEG data were recorded from 29 electrodes (10-20 standard positions, BrainProducts MRPlus amplifier, filter 0.1-1kHz, sampling 5kHz).

1) REMOVE TMS ARTIFACT
Set to zero EEG data (-5ms to 20ms) and spline interpolated (-10 ms to 30ms) around each TMS pulse onset [3], then run ICA

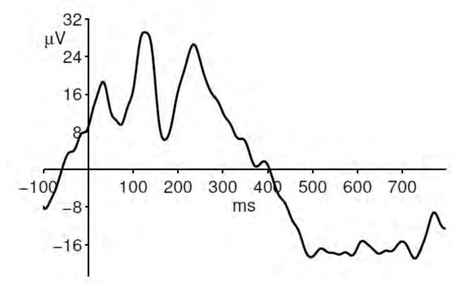


ICA

2) IDENTIFY THE TMS ARTIFACT
Contaminated ICs show high activity in the pre-stimulus window, a characteristic topography (highly subject- and session- dependent), and frequency peaks at 10Hz and its harmonics.



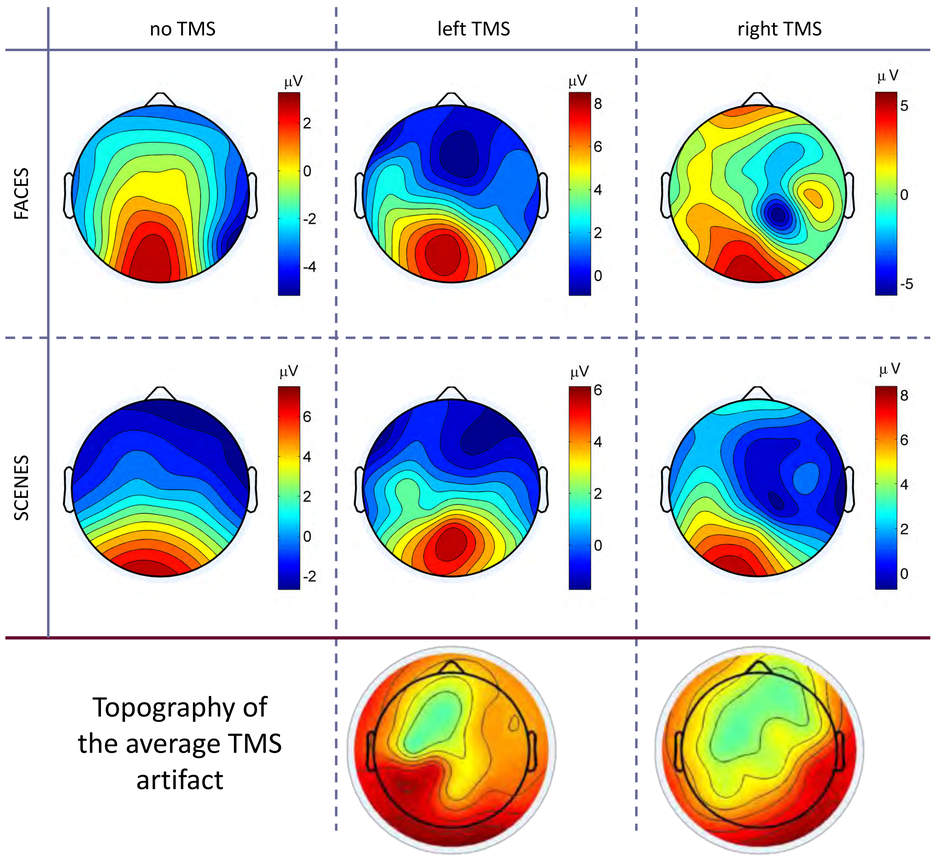
3) EXTRACT ERPs
Reject the ICs marked as artifact and reconstruct the cleaned data. The resulting data were segmented (-100 ms to 800 ms around stimulus onset), baseline corrected (-100 ms to the first TMS pulse onset) and average ERPs were derived in both conditions (FACES salient vs SCENES salient).



Results

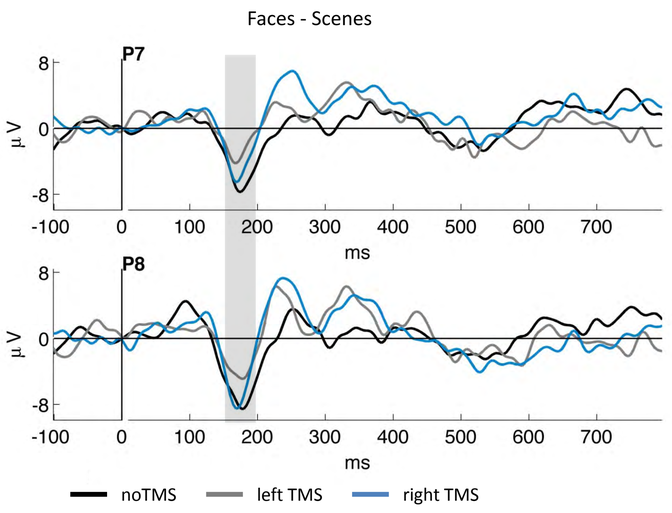
ARTIFACT REMOVAL

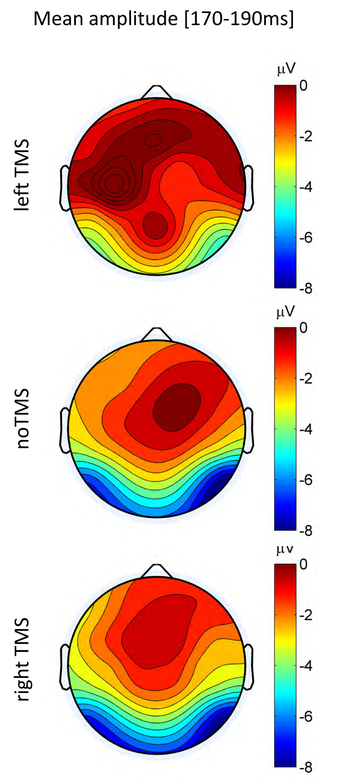
Topography of the N170 after artifact removal (mean amplitude [160-200 ms]). We found ERP topographies similar in both runs (TMS vs noTMS), but different from the topography of the average artifact, indicating minimal residuals of TMS artifacts in the ERP.



Topography of the average TMS artifact

EFFECT OF PARIETAL TMS STIMULATION ON THE N170





ERP difference between the FACES salient and SCENES salient event responses from electrodes P7-P8 for the no-TMS and TMS runs after removal of the TMS artefacts (and corresponding topographies). The difference peaks at the N170 latency and it is clearly modulated by left TMS. Right parietal TMS resulted in a very similar N170 to the no-TMS condition.

Discussion

ARTIFACT REMOVAL

We proposed a simple ICA-based pipeline to remove TMS-related artifacts and explored the quality of the extracted ERPs.

Both the timecourse and the topography of the ERPs recorded with TMS were comparable to those recorded without TMS.

EFFECT OF PARIETAL TMS STIMULATION ON THE N170

The laterality of the TMS stimulation leads to a differential modulation specific to the N170 component. Left parietal TMS resulted in an increased N170 to salient scenes and hence a reduced difference in this time window between the faces-salient and scenes-salient conditions.

The ability to disrupt brain activity in a spatiotemporally-specific manner opens up considerable possibilities as a method of studying brain function.

Further investigation of the artifact induced on the EEG by TMS pulses is necessary to assess the quality of EEG data and the reliability of the differences between conditions.

[1] Veniero, D. et al. (2009), Clinical Neurophysiology, vol. 120, pp. 1392–1399; [2] Bentin, S. et al. (1996), Journal of Cognitive Neuroscience, vol. 8, pp. 551-565; [3] Sadeh, B. et al. (2011), Current Biology, vol. 21, pp. 1894-1899.