Investigating the variability of cardiac pulse artifacts across heartbeats in simultaneous EEG-fMRI recordings: A 7T study

JORGE, João, et al.

Abstract
Electroencephalography (EEG) recordings performed in magnetic resonance imaging (MRI) scanners are affected by complex artifacts caused by heart function, often termed pulse artifacts (PAs). PAs can strongly compromise EEG data quality, and remain an open problem for EEG-fMRI. This study investigated the properties and mechanisms of PA variability across heartbeats, which has remained largely unaddressed to date, and evaluated its impact on PA correction approaches. Simultaneous EEG-fMRI was performed at 7T on healthy participants at rest or under visual stimulation, with concurrent recordings of breathing and cardiac activity. PA variability was found to contribute to EEG variance with more than 500 μV^2 at 7T, which extrapolates to 92 μV^2 at 3T. Clustering analyses revealed that PA variability not only is linked to variations in head position/orientation, as previously hypothesized, but also, and more importantly, to the respiratory cycle and to heart rate fluctuations. The latter mechanisms are associated to short-timescale variability (even across consecutive heartbeats), and their importance varied across EEG [...]

Reference

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Example subject
Resting-state run

0. PA epochs marked and segmented, variables attributed to each epoch (e.g. time of PA occurrence, respiratory amplitude, cardiac period, ...)

1. Cluster the PA epochs from channel Oz with K-means, for a given $K$ (e.g. $K=3$)

2. Group the respiratory amplitude values according to the PA clustering solution from step 1

3. Group all the other variables in the same way (time of PA occurrence, cardiac period, etc.)

4. Repeat steps 1–3 with a different $K$, and/or a different EEG channel