INTRODUCTION

Physiological noise from respiration during naturalistic viewing may induce artifacts in inter-subject correlation analyses (SC). If participants are watching the same movie and their breathing and heart rate are synchronized in events with the movie, this will create synchronized global artifacts. Multi-echo fMRI helps to remove head motion artifacts and rapid pulsatile respiratory and cardiac artifacts, but current denoising methods, such as tedana\(^1,2\), may be less effective at removing changes in blood oxygenation due to slow T2* weighted changes in respiratory rates and depths.

We collected data to induce these artifacts and test the effectiveness of current multi-echo denoising methods at removing these noise sources. We additionally examined a method to directly measure and remove slow breathing artifacts as part of multi-echo denoising methods.

METHODS

Experimental Paradigm

24 participants completed runs where they watched a movie while doing a cue breathing task or just did the cue breathing task.

The breathing cue was task-locked and varied according to phase and frequency. The participants alternated between movie viewing sessions with phase-A and phase-B respiration patterns, and phase-A-only resting-state sessions.

The movie and breathing sessions lasted for the same duration (~8 minutes), with 3-3 runs per subject, and with the same movie being shown on subsequent runs.

Acquisition

T2* Siemens Prisma, Multi-echo fMRI (CMR sequence, EPI, SMS=[2, iPAT=2], TE=13.44, 31.7, 49.96ms, 3.0mm isotropic voxels). Magnitude and phase scans were retained and 5 RF-off “noise” volumes were collected at the end of each sequence. (Phase and noise information were not used in these analyses)

Processing

Data was pre-processed with AFNI. The respiration and cardiac traces for the design matrix were calculated using NIPhIlm\(^3\). The within- and between-subject correlations were calculated using AFNIs's 3DZ/Model, within-subject correlations were assessed at the group level with 3Dtds, and inter-subject BOLD synchronization was calculated with 3DSC. Runs were compared across 3 conditions: 1) movie x movie with different respiration patterns, 2) movie x rest with same respiration patterns, and 3) rest x rest with same respiration patterns.

Our denoising method involved 1) tedana’s denoising pipeline or 2) a combined regressors model that combined tedana with fitting regressors based on respiratory and cardiac signals, head motion, and CSF and white matter regressors to the component time series.

PROCESSING CODE

[GitHub link to ComplexMultiEcho]

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REFERENCES