The effects of preprocessing options on (f)ALFF maps
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Background: Every resting-state based data analysis makes use of low frequency oscillations in the brain. Different methods have been developed to utilise the information contained in the frequency band between approximately 0.01 and 0.1 Hz. One simple method, which tries to get an estimate of the power in this range is called ALFF (Amplitude of Low Frequency Fluctuations) and its normalized version fALFF (fractional ALFF). This index depends directly on the processing steps used before its estimation. Here we want to show the importance of artefact correction steps during preprocessing on the final estimates.

Methods: Six-minute resting-state scans from twenty-five subjects (23 of which were included in the analysis) were acquired at 7T using a 32-channel head coil and a multiband EPI sequence (TR/TE/FA 1.4 s/23 ms/62°, 128x128 px², 78 slices, 1.5x1.5x1.25 mm³ voxel size, 25% slice gap, multiband factor 3). Additionally a three-echo fieldmap was acquired for distortion correction. The scans were despiked, corrected for slice-timing, distortion and motion and normalised to the MNI-152 space. Additionally, all combinations of bias field correction, nuisance regression (demontaging, realignment parameters and PCA based CSF and WM signals) and Hanning windowing were used prior to estimating the (f)ALFF maps using Matlab’s Discrete Fourier Transform for estimating the square root of the power between 0.01 and 0.1 Hz as well as the total power. All (f)ALFF maps were normalised to the mean of the respective map in the brain. Paired t-tests between different processing steps as well as relative changes in the t-statistics of group-level tests were calculated.

Results: Bias-field correction resulted in elevated ALFF values in the centre of the brain (Fig.1a). Increased numbers of nuisance regressors led to a relative increase of group t-values, especially in inferior regi ons for both ALFF and fALFF (Fig.1b). Using all nuisance regressors led to increased ALFF values in the white matter and reduced values at the borders of the brain. fALFF values were especially reduced in the CSF due to nuisance regression. Using the Hanning window prior to estimating the (f)ALFF maps to reduce spectral leakage had similar, but less pronounced, effects like nuisance regression, when no nuisance regression was used and no effect when it was used.

Conclusions: Here we have shown that nuisance regression can increase group t-statistics in (f)ALFF maps. In addition, the use of bias-field correction must be taken with caution and that Hanning windowing will have in parts similar effects as nuisance regression. We therefore recommend the use of nuisance regression as part of the (f)ALFF preprocessing.

Figure 1. a) Parameters (mean across subjects with and without all nuisance regressors, student’s t-test depicting significant changes when all nuisance regressors are used and student’s t-test showing the differences when a Hanning window was used without nuisance regression) for (f)ALFF maps with and without bias field correction. b) Relative changes in t-values across subjects with different combinations of nuisance regressors across slices.