

Aztec manual

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The software uses RETROICOR (Glover et al., 2000) and lagged cardiorespiratory regressors (cf. Shmueli et al. 2007, Birn et al. 2006) to attempt to remove confounding effects of cardiac pulsatility, the respiration cycle, heart rate, heart rate variability and respiration volume per unit time. Further, maps of explained variance, correlations and optimal lags are saved. For methodological details, please see van Buuren et al. (2009), Cardiorespiratory effects on default-mode network activity as measured with fMRI. *Hum Brain Mapp* 30 (9): 3031-3042. This document contains further information concerning the software and how to adjust it to use in different labs.

To adjust the software for use in your lab, edit `parseLog_system_specific.m`. This function takes the filename of the file containing physiology data and extracts the raw vectors of detected R peaks (i.e. a vector of zeros and ones) and respiration amplitude. The standard version of `aztec` (in `parseLog.m`) synchronizes the cardiorespiratory and fMRI signals by assuming that both signals end simultaneously, and the rounded product of the number of scans and TR is used to work back from the end of the signal.

There are some known limitations of the current version. First, the "edges" of the signal cannot be corrected, since a region of signal must be available around each sample to assign e.g. a heart rate to it. Ideally, some extra measurement time (around 10 s) would be allowed after the end of the task. Second, no mask is applied, so that some noise will be present outside the brain. Finally, if the raw respiratory signal is noisy, it must be filtered; further, it must be centered roughly around the middle of the inhalation - exhalation extrema for the extraction of respiration amplitude and frequency to work correctly (see `twinpeaks.m`).

To use the software, run the function `aztec` with the following arguments:

1. `logfile`: file with cardiorespiratory data.
2. `funcfiles`: list of image files (`.img` or `.nii`), as returned by `spm_select`.
3. `FS_Phys`: sampling frequency [Hz] of cardiorespiratory data.
4. `TR`: fMRI repetition time [s].
5. `only_retroicor`: set to 1 to only run RETROICOR.
6. `passfreq`: high-pass frequency [Hz] for temporal smoothing.
7. `output_dir`: directory where adjusted images and maps of results will be saved to.

Aztec calls two major subfunctions. First, `parseLog.m` takes raw R-peak and respiration data and creates the heart rate, heart rate variability, respiration amplitude and respiratory volume per time (RVT; Birn et al. 2006) predictors. Second, `physcorr.m` attempts to remove the effects of these cardiorespiratory variables as described in van Buuren et al. (2009). `physcorr.m` saves a number of files:

1. `..._cardiac.nii`: the explained variance of cardiac pulsatility (using RETROICOR).
2. `..._respPhase.nii`: the explained variance of respiration phase.
3. `..._RETRO.nii`: the explained variance of the complete RETROICOR.
4. `..._lagged.nii`: the variance explained by the regression procedure using heart rate, heart rate variability and RVT, relative to the data after RETROICOR correction.
5. `..._r_HR1.nii`: the correlation between the fMRI signal and heart rate.
6. `..._r_HR2.nii`: the correlation between the fMRI signal and heart rate (second sweep).
7. `..._r_HRV.nii`: the correlation between the fMRI signal and heart rate variability.
8. `..._r_RVT.nii`: the correlation between the fMRI signal and RVT.

Of the last four files, the lag at which this strongest correlation was found is saved in files with `_bestLag` instead of `_r`. The corrected scans are saved with a prefixed `aztec_or1` or `aztec_or0`, depending on the `only_retroicor` parameter.

Citation: if the software is used for scientific publications, please reference: van Buuren et al. (2009), Cardiorespiratory effects on default-mode network activity as measured with fMRI. Hum Brain Mapp 30 (9), 3031-3042.

Disclaimer: use of the software is of course at your own risk. Please let us know if you come across any bugs or other problems!