Original Posting: June 02, 2004
Last Updated: June 02, 2004

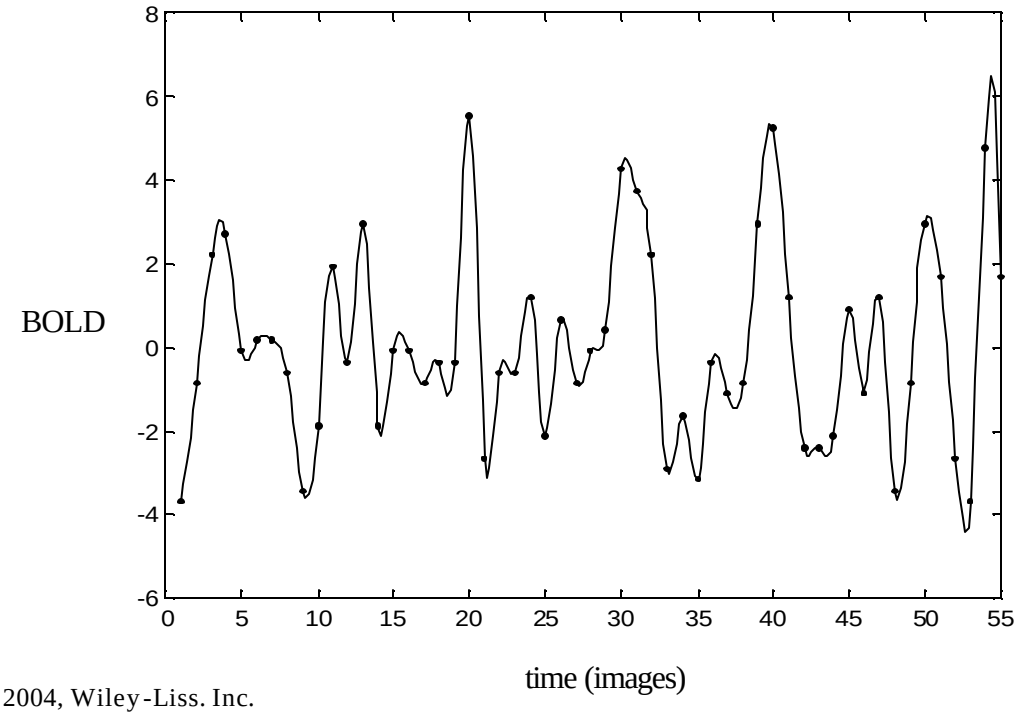
Spatio-temporal Wavelet Resampling for Functional Neuroimaging Data: Supplementary Material

Michael Breakspear, Michael J. Brammer, Ed T. Bullmore, Pritha Das, and Leanne M. Williams

This site hosts supplementary material for the paper, "Spatio-temporal Wavelet Resampling for Functional Neuroimaging Data", published in *Human Brain Mapping*. The aim of this material is to present the results of the spatiotemporal wavestrapping algorithm in a visual format. This is achieved by plotting the data as contour plots. Spatial spectra and cross-sectional data are also visualised.

The slices are taken from the data set described in the Methods section, as examined in Figs 10-17. A surrogate realization of this slice was constructed by wavestrapping in the spatial domain with Daubechies wavelets of order 8, then wavestrapping in the temporal domain with Daubechies wavelets of order 6.

To facilitate visualization, smooth interpolation between consecutively recorded slices was performed. That is, for each pixel, four data points have been interpolated between actual time points using a cubic spline function. An example of a single pixel time series and its smooth interpolation is given below: The data are given as solid points and the interpolation as the solid line. Note that this does *not* smooth the data – but rather smoothly interpolates between data points. There is no manipulation in the spatial domain.

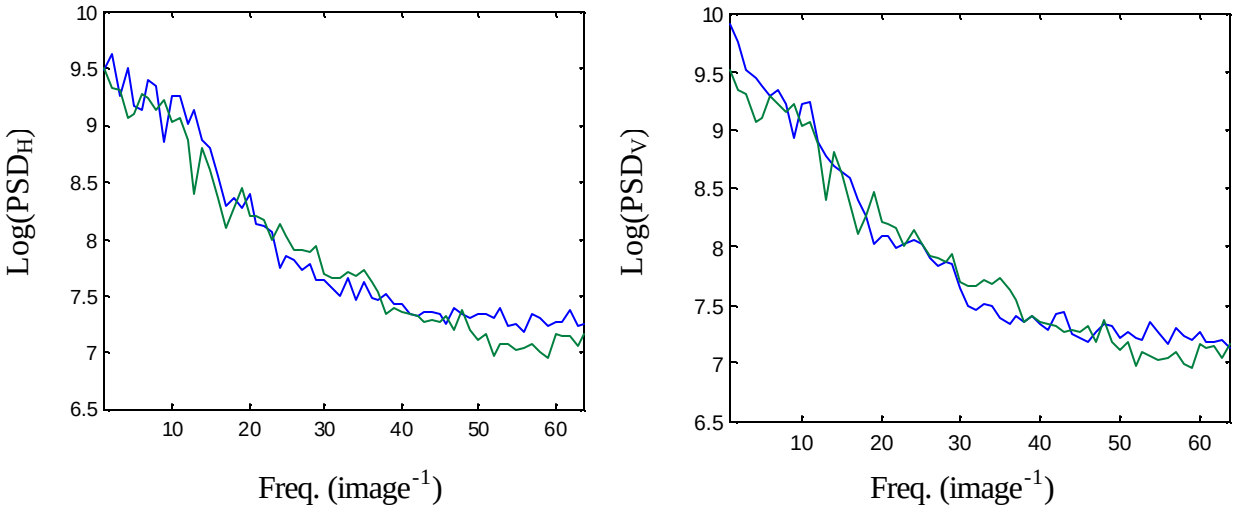


All movies are played at 3.75 times real time (to maximise the visual experience!). WinZipped versions of the movies can be obtained by clicking on the links below: Each zipped file is between 4.1Mb (movie 1) and 11.1Mb (movie 4). The movies unzip to between 120Mb (movie 1) and 330Mb (movies 2-4).

Movie 1 simply presents a visualization of a single fMRI slice, processed from the raw data as above. We recommend it to be displayed at approximately ½ screen size. Subsequent movies are best visualized on full screen mode.

In Movies 2 and 3, the original data is the lower left image and the surrogate algorithm is the upper right image. The blue lines in each plot are derived from the original data: The green lines are derived from the surrogate data.

In **Movie 2** the images are given together with their spatial spectra. The upper left plot shows the horizontal spectra and the lower right plot shows the vertical spectra. Axes are not plotted. The average spectra (across all slices) are plotted on a log-linear graph below (horizontal on the left; vertical on the right, same colour scheme as for the movie).



Average horizontal (left) and vertical (right) spatial spectra of fMRI data (blue) and a surrogate realization (green) as visualized in Movie 1.

In **Movie 3** the images are given together with cross-sections through the middle of the slices (horizontal coordinate=64; vertical coordinate=64). The upper left plot shows the horizontal cross-section and the lower right plot shows the

vertical cross-section. Each of these is directly in line with their cross-sectional coordinates.

Movie 4 illustrates multi-slice surrogate data: The two images on the left hand-side of the movie are derived from two contiguous slices. The images on the right-hand side of the movie are derived from their surrogate realizations.

The purpose of these movies is to display the two-fold properties of the algorithm. Movie 1 shows that, on average, the spectral properties of the data are approximately preserved. Movie 2 shows, that despite this, the particular realizations of the data (the unique "when and where" features) are quite different. The movies also serve to demonstrate some of the rich dynamical properties of these data sets.

Reference:

Breakspear M, Brammer MJ, Bullmore ET, Das P, Williams LM (2004): Spatio-temporal wavelet resampling for functional neuroimaging data. Hum Brain Mapp 23:1–25.