

FSL Workshop

12.09.08

Session 3

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What is MELODIC?

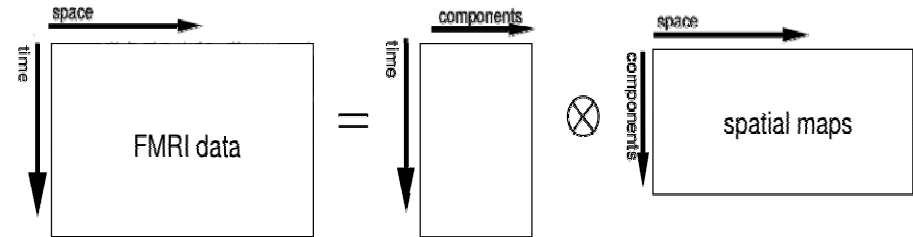
- Probabilistic ICA
- Improves upon standard ICA
 - Allows for inference
 - Avoids over-fitting
- Three stage process
 - 1.) Dimension reduction (pPCA)
 - 2.) Estimate source signals that maximize non-Gaussianity of source estimates
 - 3.) Convert maps into “Z stat maps” and assess significance with Gaussian mixture model

Think of it this way...

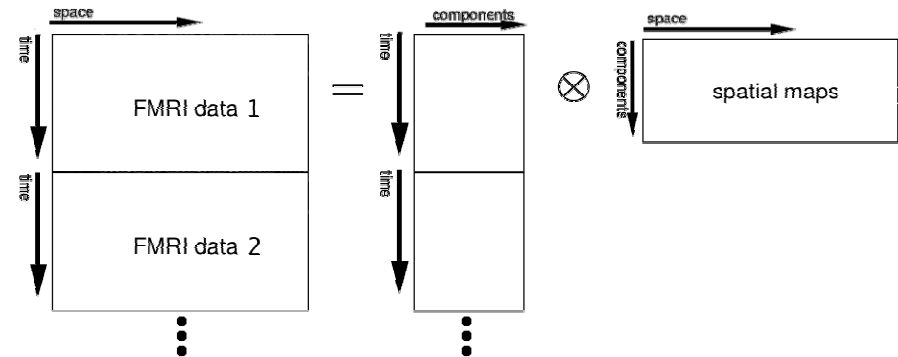
- GLM has a *pre-specified* design matrix
 - Lots of assumptions that do not always hold up
- pICA *estimates* a design matrix (or *mixing matrix*) as part of model fitting

MELODIC options

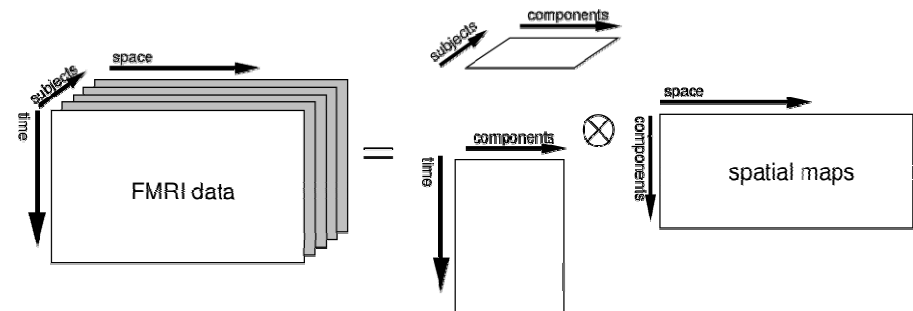
- Single – Session ICA



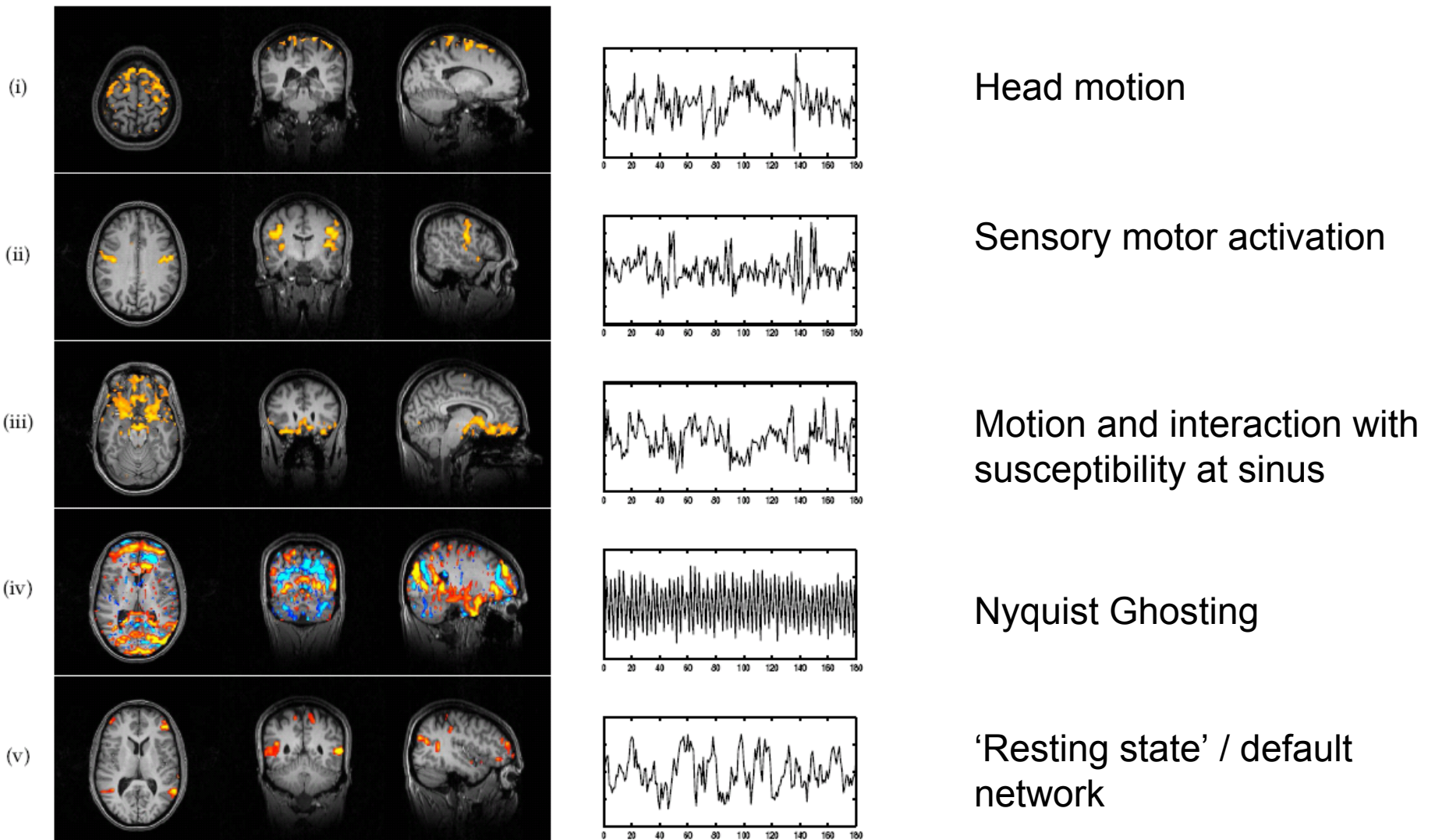
- Multi – Session Temporal Concatenation.



- Multi – Session Tensor ICA



Example components

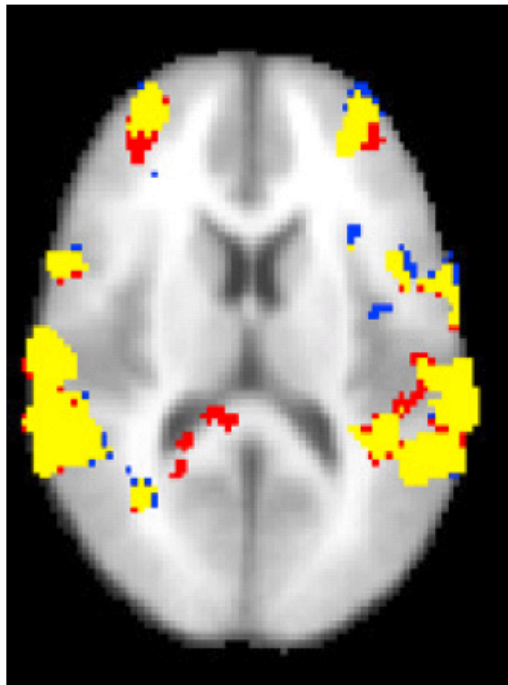


Tohka ... Poldrack (2008) Automation Technique

- Supervised classifier trained to distinguish between noise and signal ICs
 - Global decision tree trained in NP framework
 - NP served a tuning mechanism for conservativeness
- Test against ‘expert raters’
- First automation technique to consider spatial characteristics

<http://www.poldracklab.org/software>

Group-level activations



Red shows original data

Blue shows denoised data

Yellow shows overlap

****Note how activation in white matter posterior to ventricles disappears after denoising***

Dave's Denoiser

- Only examines time courses of ICs
 - Set thresholds
 - Predict motion/air ICs via regression
- 4 basic parts:
 - You do MELODIC
 - Run my MATLAB program (on the wiki)
 - Creates .txt files flagging bad components
 - Run my bash script (also on the wiki)
 - Reads .txt files and cycles through your data removing the bad stuff with FSL's regfilt command
 - Analyze denoised and preprocessed data

WARNING: This program is still being refined and tested!!!

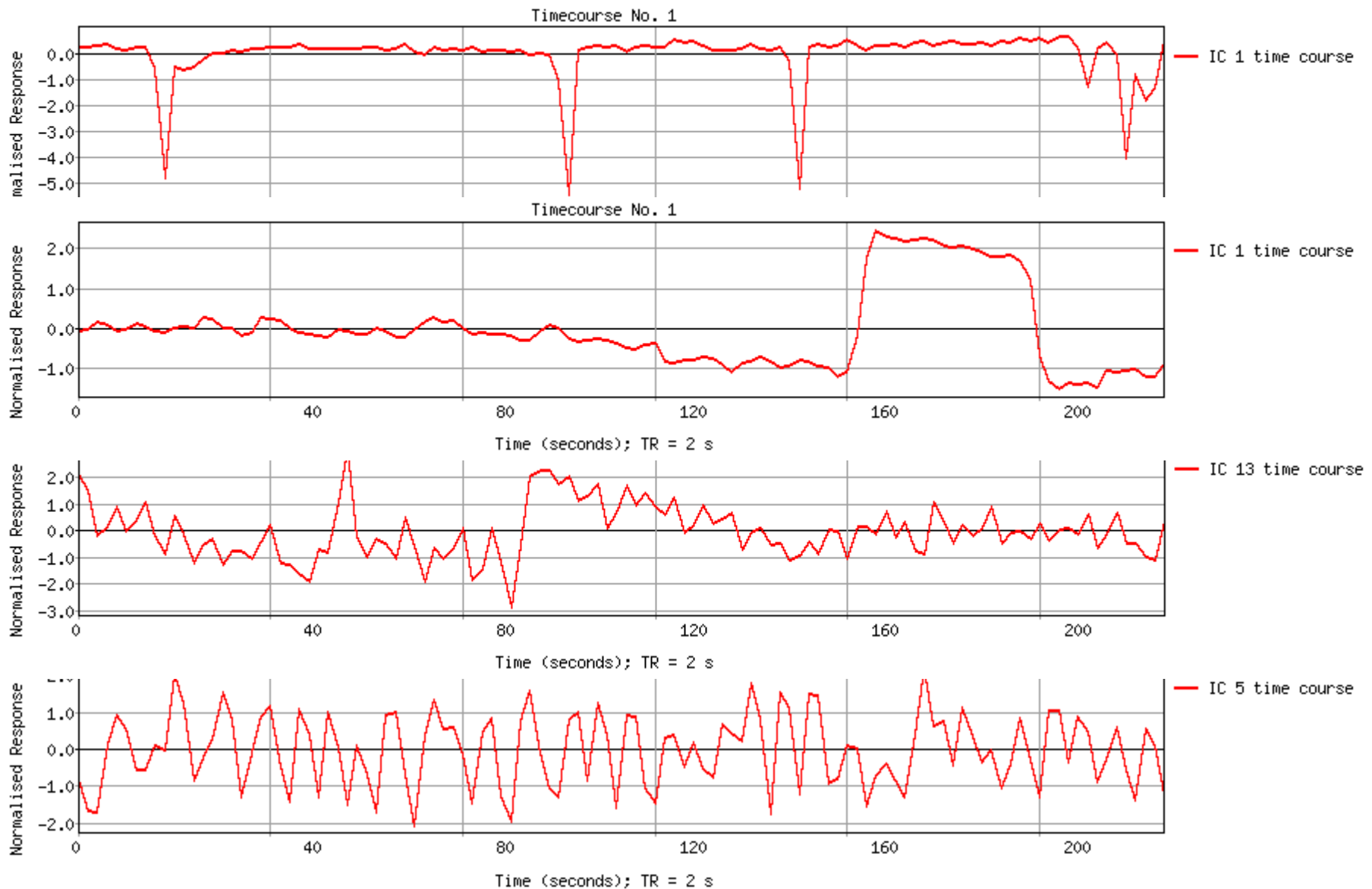
Four features

Flag components that:

- 1.) **have extreme power spectra**
- 2.) **have sudden jumps in intensity**
- 3.) **significantly predict motion**
- 4.) **significantly predict air signal**

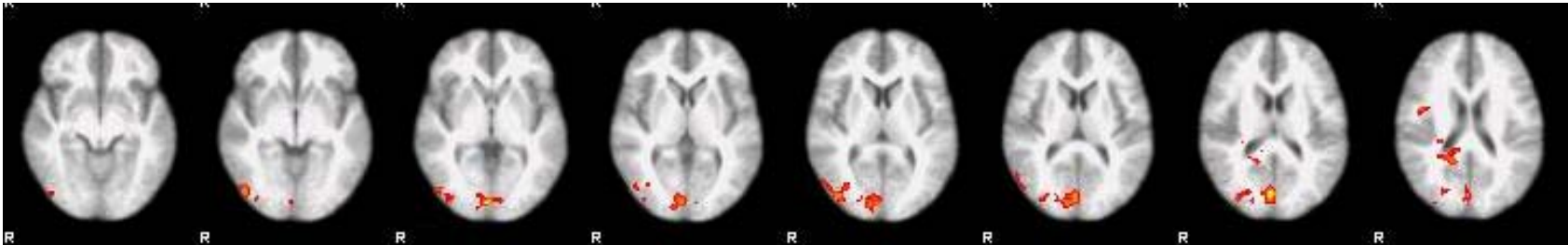
Every threshold is based on a percentile, usually the 90th, of the distribution of ICs across a decomposition (i.e., a run of data). The only exception is the “sudden jumps” feature – explained on the wiki.

Example IC time courses

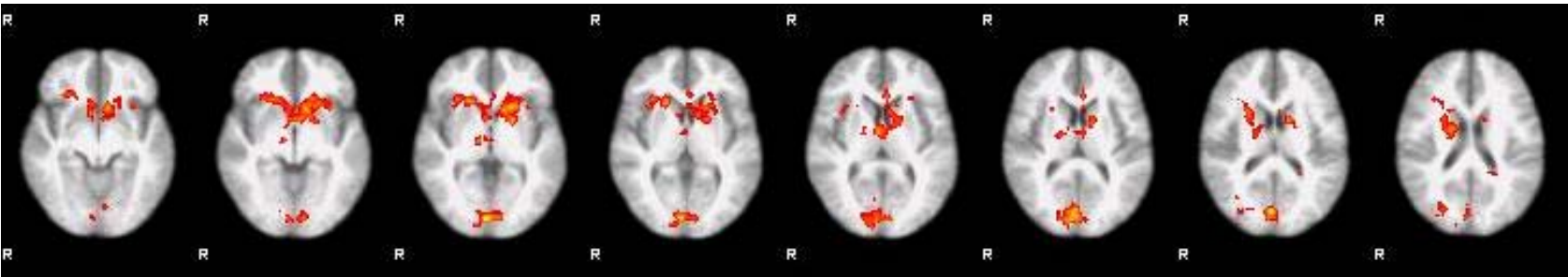


Denoiser results

Normal



Denoised



More on MELODIC...

MELODIC webpage

<http://www.fmrib.ox.ac.uk/fsl/melodic/index.html>

Practical from FSL course

<http://www.fmrib.ox.ac.uk/fslcourse/lectures/practicals/melodic/index.htm>

Featquery: ROI analyses in FSL

- Online sources
 - <http://www.fmrib.ox.ac.uk/fsl/feat5/featquery.html>
 - <http://www.fmrib.ox.ac.uk/fslcourse/lectures/practicals/feat1/index.htm>
 - http://mumford.bol.ucla.edu/perchange_guide.pdf
- Allows you to interrogate FEAT results within a mask or at a given co-ordinate.
- Calculates a number of image and time-series statistics.
- Find ‘featquery’ option under ‘misc’ on FSL GUI.

More on Featquery

- Setting it up
 - FEAT directories (1st or 2nd level)
 - Stats images of interest (e.g. Stats/pe)
 - Mask (either from ROI or an atlas)
 - Probably will want to convert PE/COPE values to % (p)
- Other Options
 - (w) allow weighting of different voxels
 - (i) change post-interpolation, default is 0.5
 - (t) pick a threshold for stats image
 - (a) atlas for output
 - (s) create time-series plots from 4D data.
- Scripting Example
 - `featquery 1 ${COPE_DIR} 1 stats/pe1 ${FQ_DIR} -p -i 0.3 ${MASK}`

Featquery Output

- List of different FEAT stats images that you asked Featquery to report on; each of these is also a link to a raw text file giving the data time-series plot at the position of the maximum image value within the mask.
- Number of non-zero voxels within the mask.
- Statistics derived from each image's values within the Featquery mask, including min, mean, median, max.
- The 10% and 90% columns show the image values at 10% and 90% of the way through the ordered list of values (i.e., at 10%/90% of the cumulative distribution function),
- Co-ordinates of the maximum image voxel within the Featquery mask, both in voxels in native space and in mm in standard space (assuming that FEAT registration was run), as well as overlapping atlas structures, if requested.
- More in output folder if options selected (e.g., time-series).

What about fslutils?

- There are a lot of them:
 - <http://www.fmrib.ox.ac.uk/fsl/avwutils/index.html>
 - Use as command lines on qinteract or in scripts.
- fslmaths
 - Mathematical operations with images.
 - Examples: multiply, add. Use mask to extract values from images very quickly in scripts.
- fslstats
 - report certain summary statistics for an input 3D/4D image.
 - Examples: mean values, coordinates of max/min
- fslnfo - report a basic subset of an Analyze or Nifti header.
- fslmerge
 - concatenate image files into a single output (over time, or in X, Y or Z). Can use to take multiple 3D files and create a single 4D image file.
- fslslice - split a 3D file into lots of 2D files (along z-axis).
- fslsplit - split a 4D file into lots of 3D files.

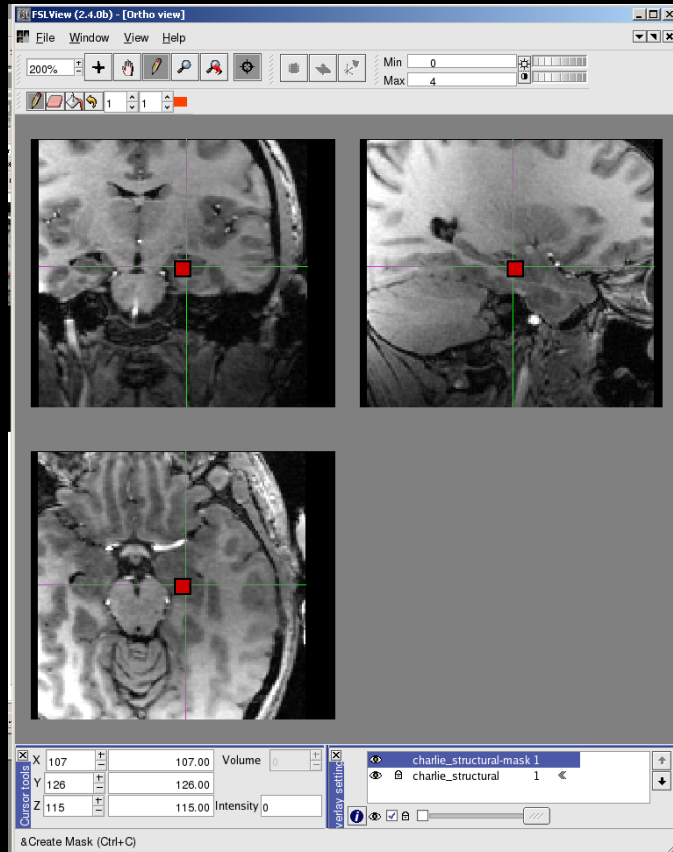
PPI in FSL

- psychophysiological interactions analysis
 - <http://www.fmrib.ox.ac.uk/Members/joreilly/what-is-ppi>
- Method for finding out whether the correlation in activity between two distant brain areas is different in different psychological contexts .
- Is there an interaction between the psychological state and the functional coupling between two brain areas?

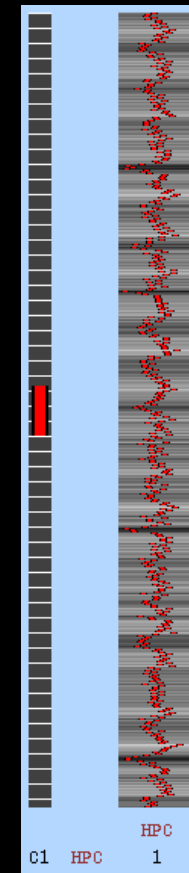
Key concept of PPI:

- If two areas are interacting, their activity will go up and down in synch
- This effect may be task dependent
- It should be more than can be explained by the shared main effect of task

PPI strategy



“Look for all the voxels in which the level of activity is well explained by the level of activity in the hippocampus ROI”



```
>> fslmeants -i filtered_func.data  
-o hippocampus.txt -m hpc_mask.nii.gz
```

Problem:

Some brain areas will have a similar time-course to the seed area *regardless of what task* participants are doing

e.g.

- Shared sub-cortical or neuro-modulatory input
- Shared sensory input
- Anatomical connections

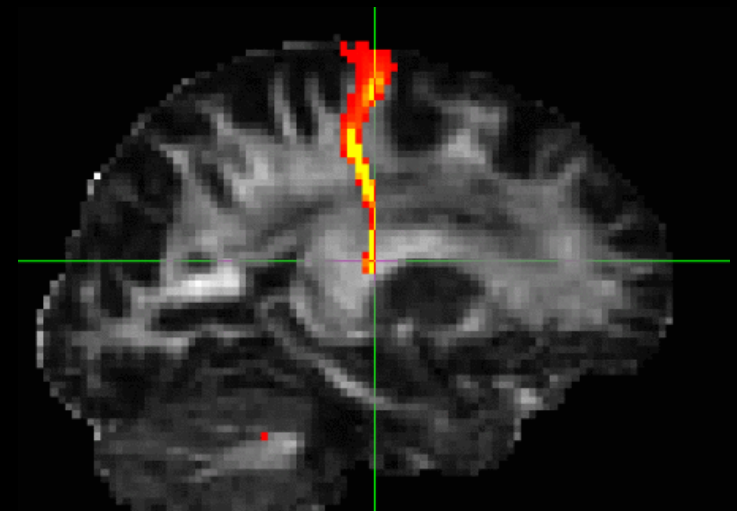
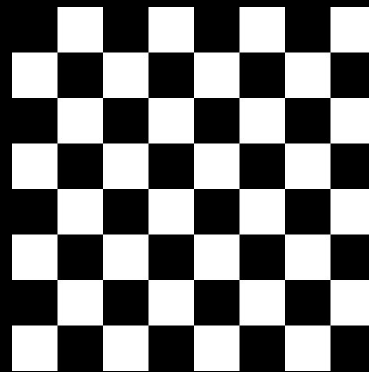
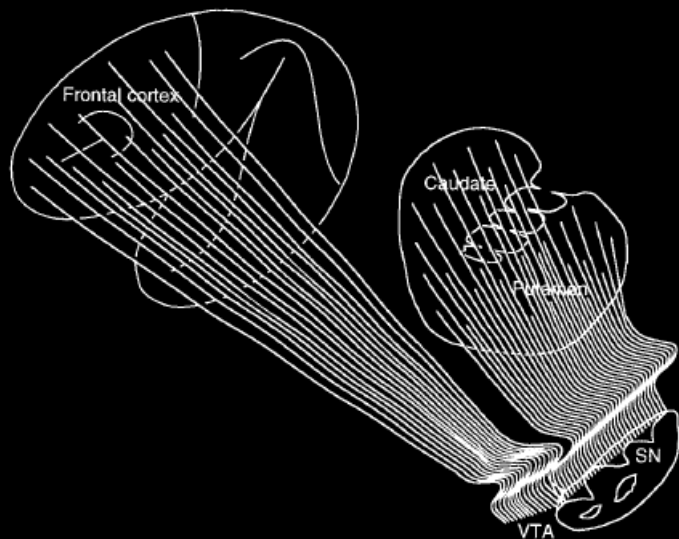
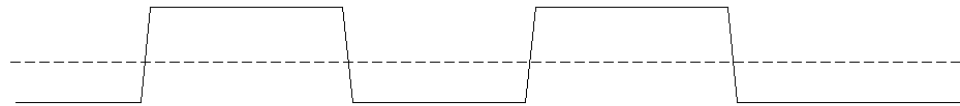


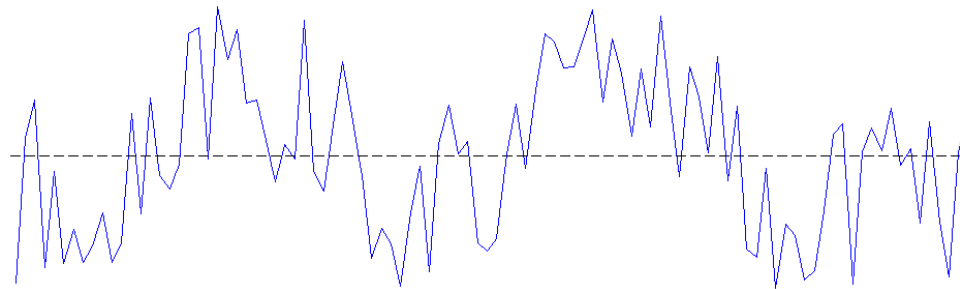
FIG. 7. Global dopamine signal advancing to striatum and cortex.

Solution: use a 'psychophysiological interaction' regressor

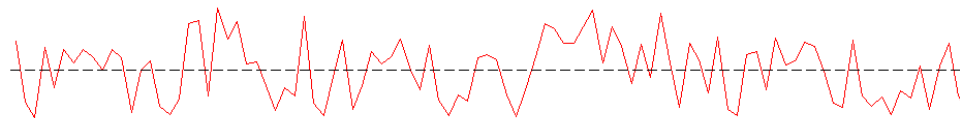
**PSY main effect
(task variable)**



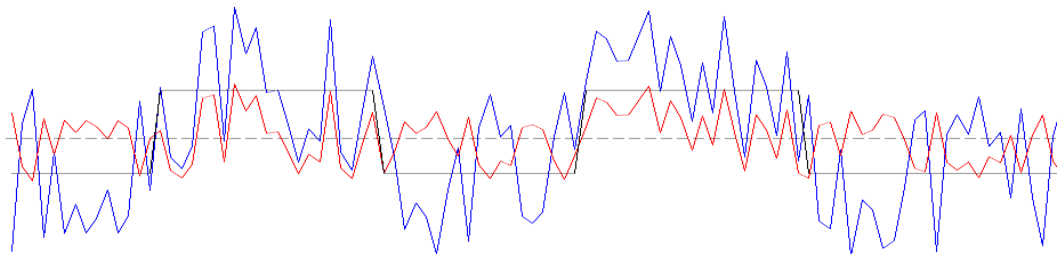
**PHYS main effect
(time-course from
seed region)**



**PPI =
PSY.*PHYS**

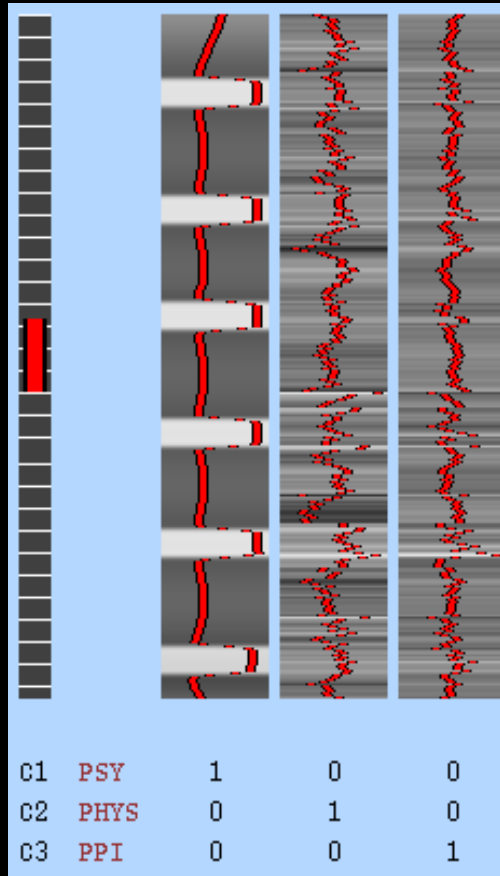


Overlay:



Caveat: covariates of no interest

→ Must include main effects (PSY and PHYS) in model



Design matrix

Setting up your PPI in Feat

In FEAT stats tab...

EV1 = your task regressor
EV2 = your ROI timecourse
EV3 = PPI

EV4 } all your other
EV5 } task regressors
EV6 }

Click on “basic shape” dropdown

→ Interaction

→ Between EVs 1 and 2

Make zero

→ centre for task regressor

→ mean for ROI timecourse

Orthogonalise, temporal derivative, temporal filtering --- OFF

