



Resting state fMRI and ICA

- Introduction to resting state
- Independent Component Analysis
- Single-subject ICA
- Multi-subject ICA
- Dual regression



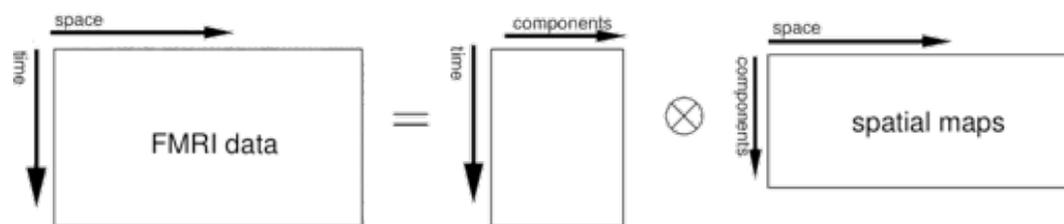
Different ICA models

Single-Session ICA

each ICA component comprises:



spatial map & timecourse



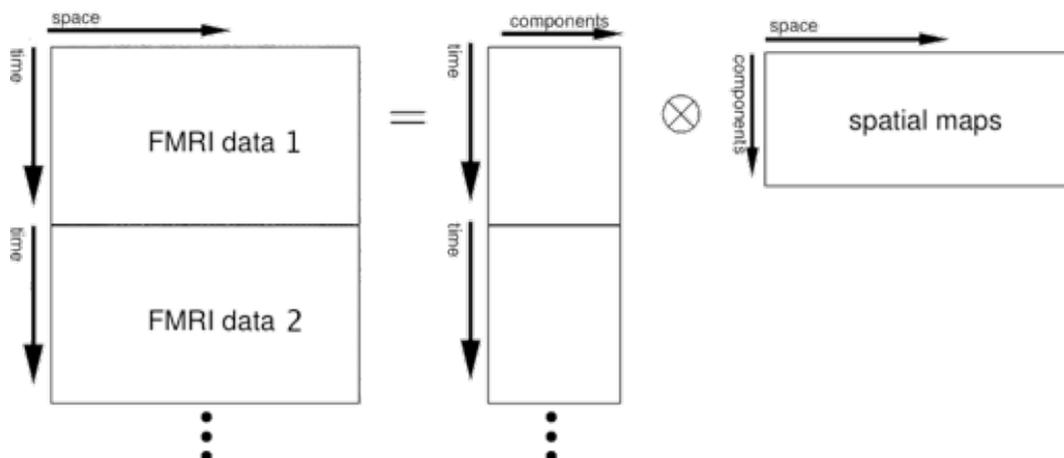
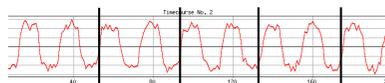
Multi-Session or Multi-Subject ICA: Concatenation approach

each ICA component comprises:



spatial map & timecourse

(that can be split up into subject-specific chunks)

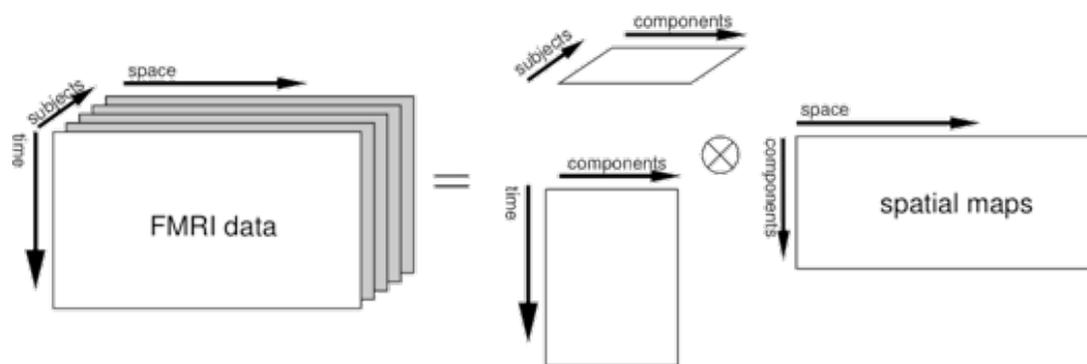


Multi-Session or Multi-Subject ICA: Tensor-ICA approach

each ICA component comprises:



spatial map, session-long-timecourse & subject-strength plot

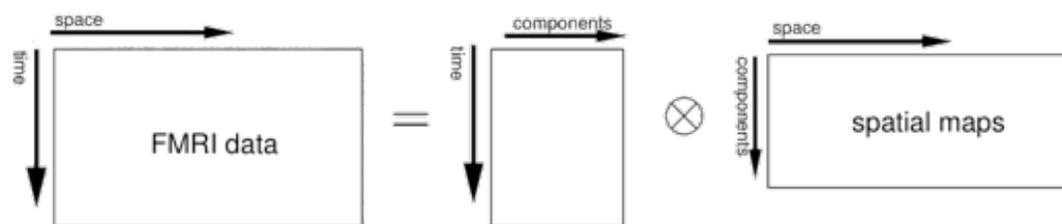




Different ICA models

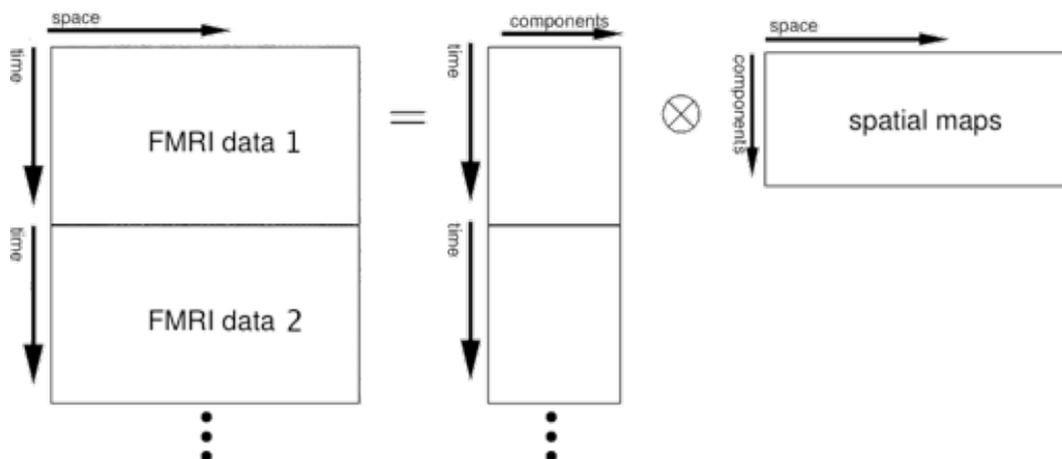
Single-Session ICA

each ICA component comprises:
spatial map & timecourse



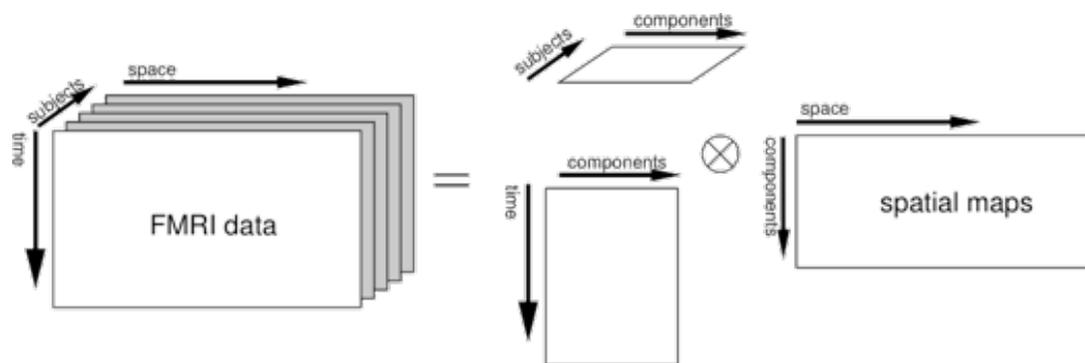
Multi-Session or Multi-Subject ICA: Concatenation approach

good when:
each subject has **DIFFERENT** timeseries
e.g. resting-state FMRI



Multi-Session or Multi-Subject ICA: Tensor-ICA approach

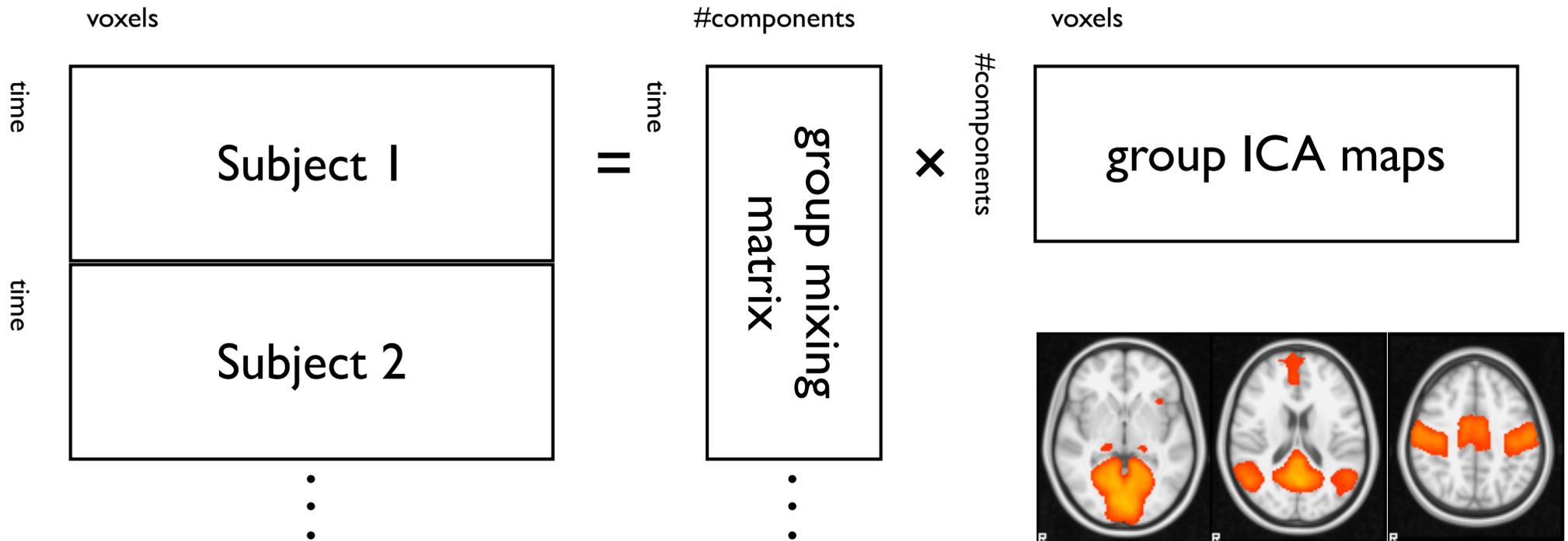
good when:
each subject has **SAME** timeseries
e.g. activation FMRI





Concatenated ICA

- Concatenate all subjects' data temporally
- Then run ICA
- More appropriate than tensor ICA (for RSNs)





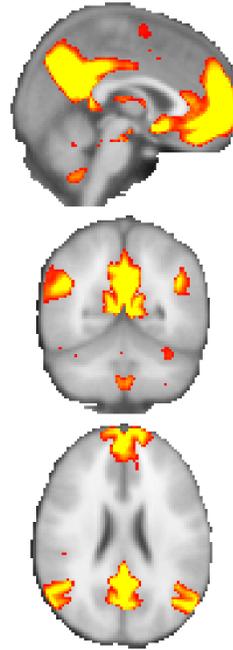
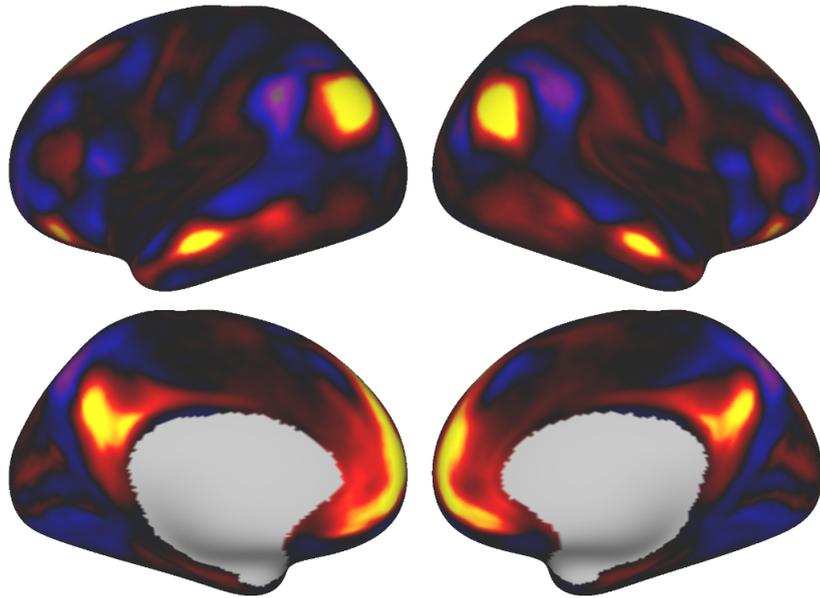
Resting state multi-subject ICA

- Why not just run ICA on each subject separately?
 - Correspondence problem (eg RSNs across subjects)
 - Different splittings sometimes caused by small changes in the data (naughty ICA!)
- Instead - start with a “group-average” ICA
 - But then need to relate group maps back to the individual subjects

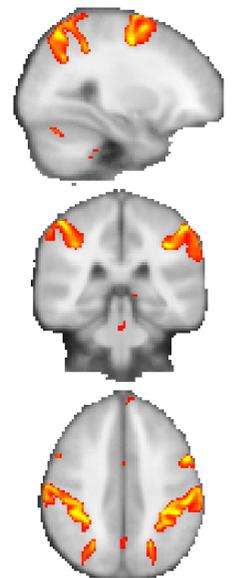
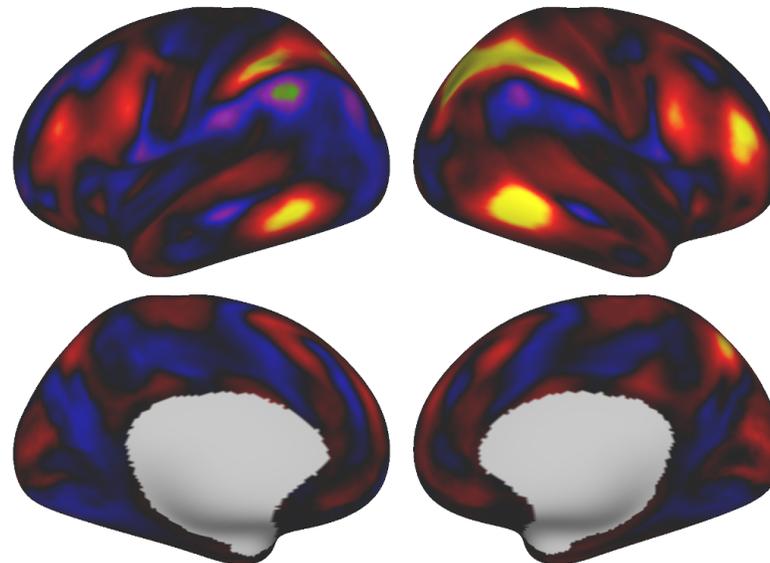


Resting state networks

Default Mode Network



Dorsal Attention Network





Dual regression

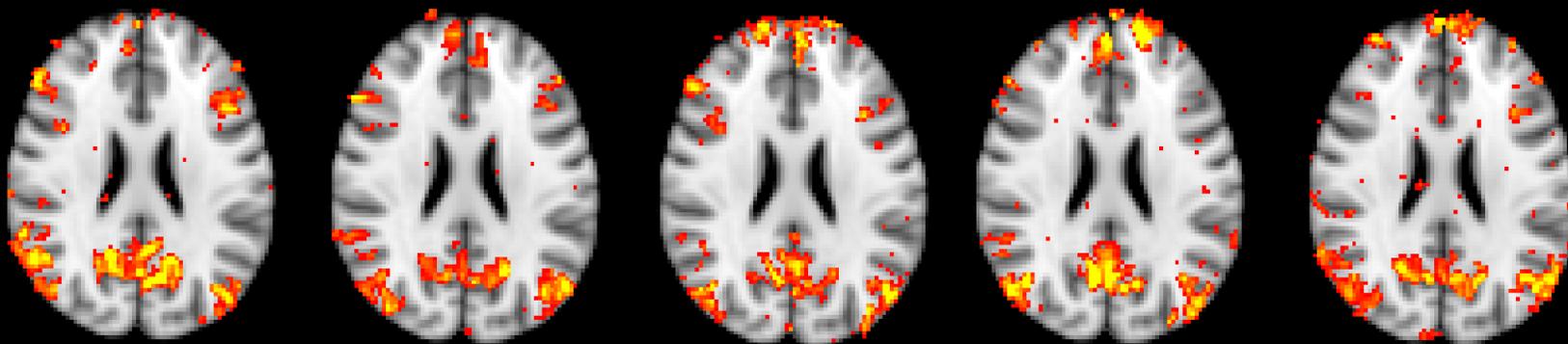


Resting state multi-subject ICA

Group ICA map



Example subject maps derived from dual regression

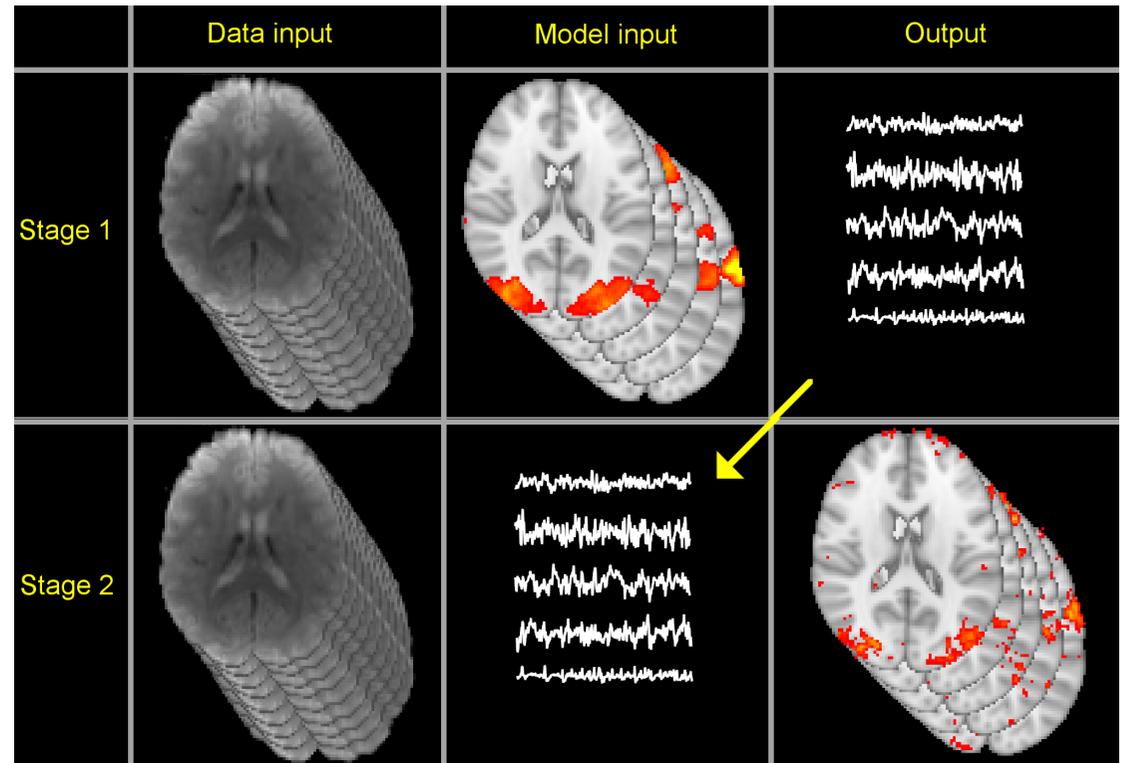




Dual Regression

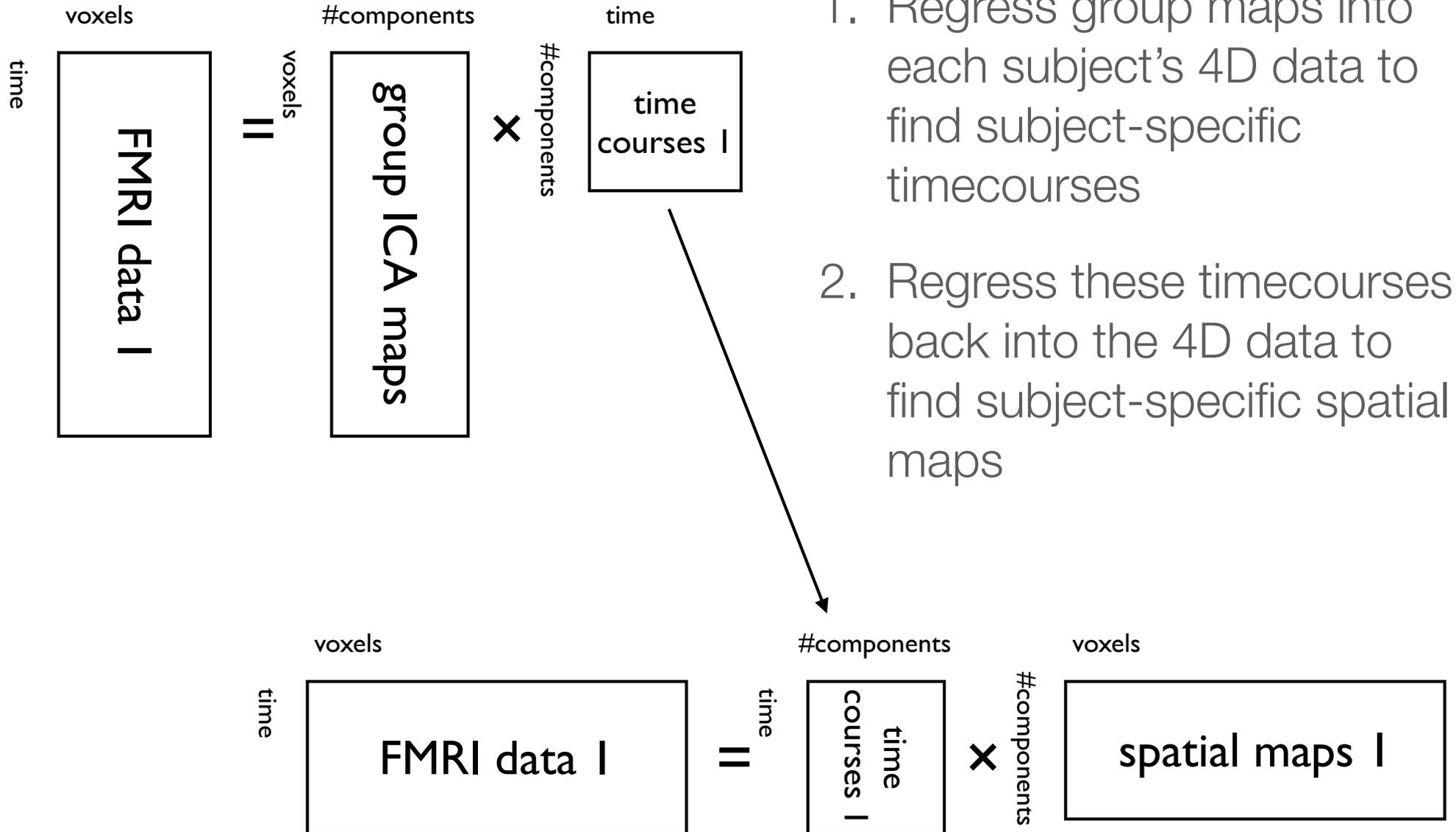
Two steps that both involve multiple regression:

1. Extract subject timeseries
2. Extract subject maps





Dual Regression



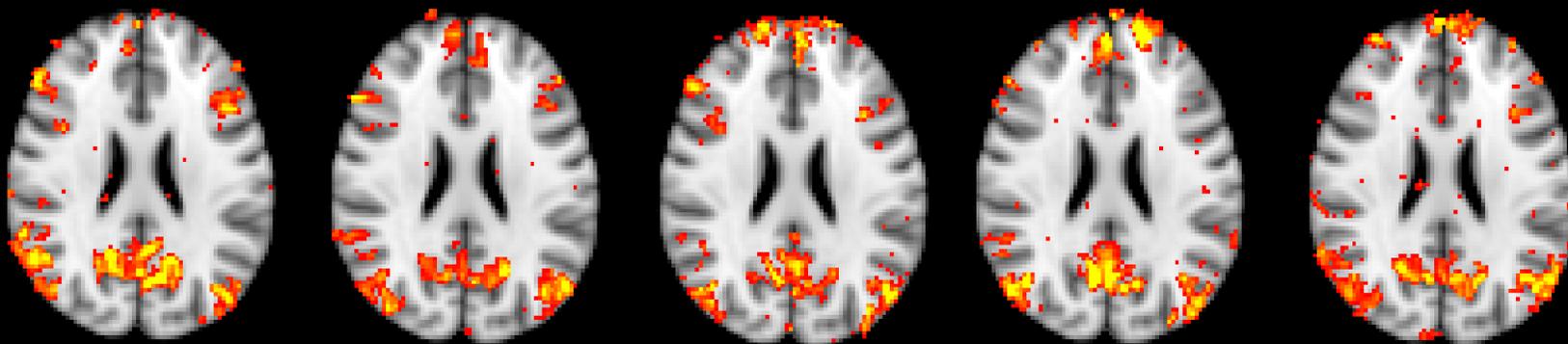


Dual Regression

Group ICA map



Example subject maps derived from dual regression





Running dual_regression

```
beckmann — bash — bash — 142x23
[islay:~] dual_regression.sh

dual_regression v0.5 (beta)

***NOTE*** ORDER OF COMMAND-LINE ARGUMENTS IS DIFFERENT FROM PREVIOUS VERSION

Usage: dual_regression <group_IC_maps> <des_norm> <design.mat> <design.con> <n_perm> <output_directory> <input1> <input2> <input3> .....
e.g.  dual_regression groupICA.gica/groupmelodic.ica/melodic_IC 1 design.mat design.con 500 grot `cat groupICA.gica/.filelist`

<group_IC_maps_4D>      4D image containing spatial IC maps (melodic_IC) from the whole-group ICA analysis
<des_norm>              0 or 1 (1 is recommended). Whether to variance-normalise the timecourses used as the stage-2 regressors
<design.mat>            Design matrix for final cross-subject modelling with randomise
<design.con>            Design contrasts for final cross-subject modelling with randomise
<n_perm>                Number of permutations for randomise; set to 1 for just raw tstat output, set to 0 to not run randomise at all.
<output_directory>    This directory will be created to hold all output and logfiles
<input1> <input2> ...  List all subjects' preprocessed, standard-space 4D datasets

<design.mat> <design.con> can be replaced with just
-1                       for group-mean (one-group t-test) modelling.
If you need to add other randomise option then just edit the line after "EDIT HERE" below

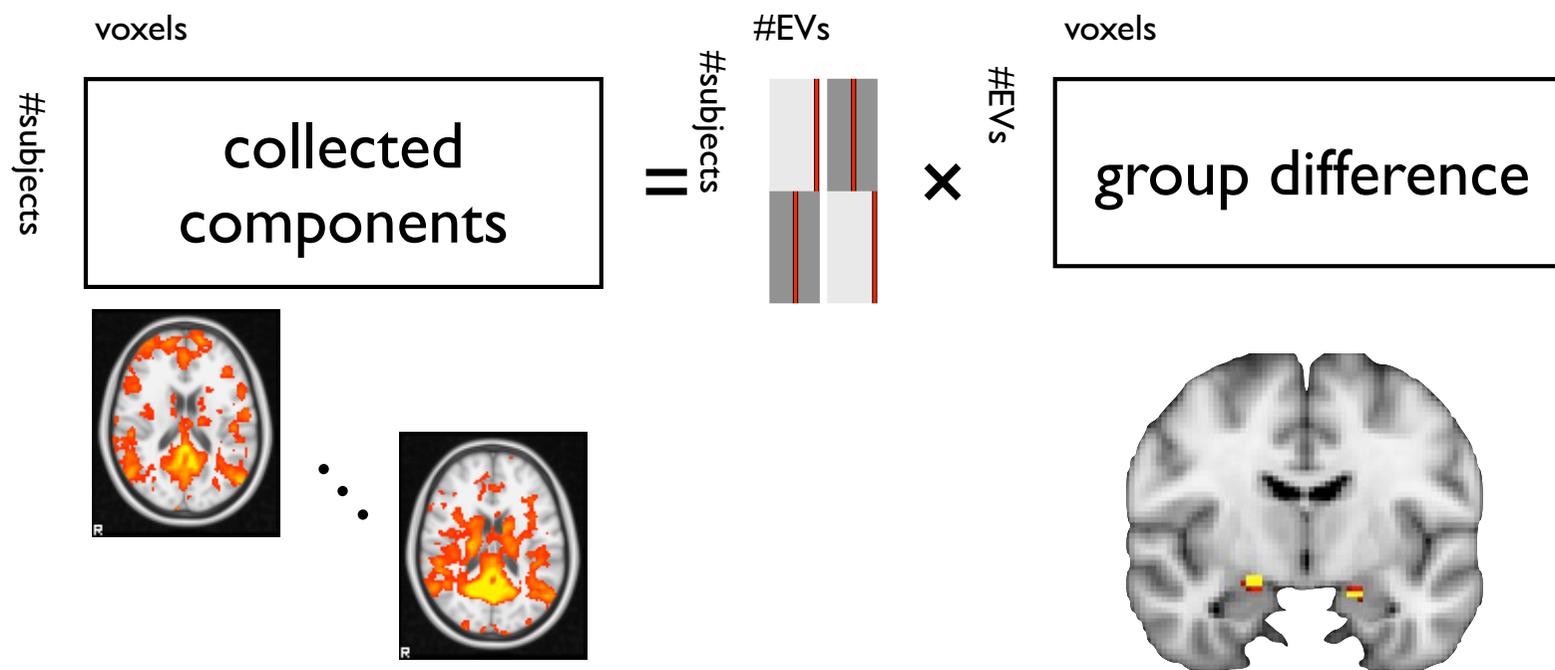
[islay:~] █
```

- FSL command line tool, combining:
 - DR to create subject-wise estimates (stage 1 + stage 2)
 - Group comparison using randomise (stage 3)



Group comparison

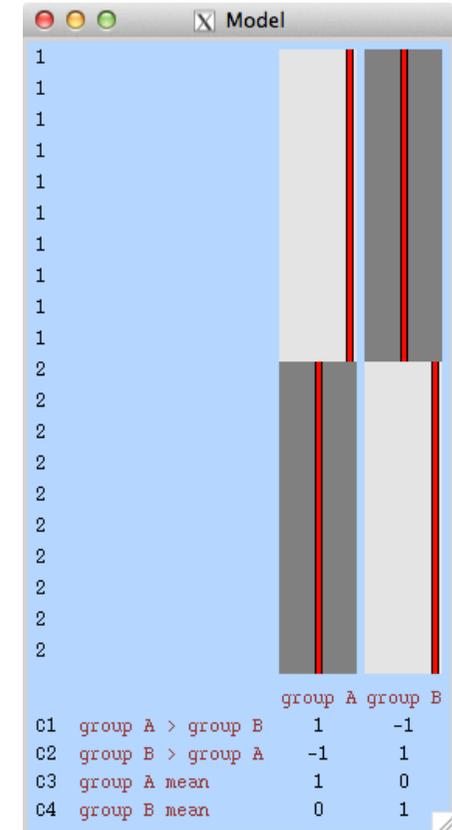
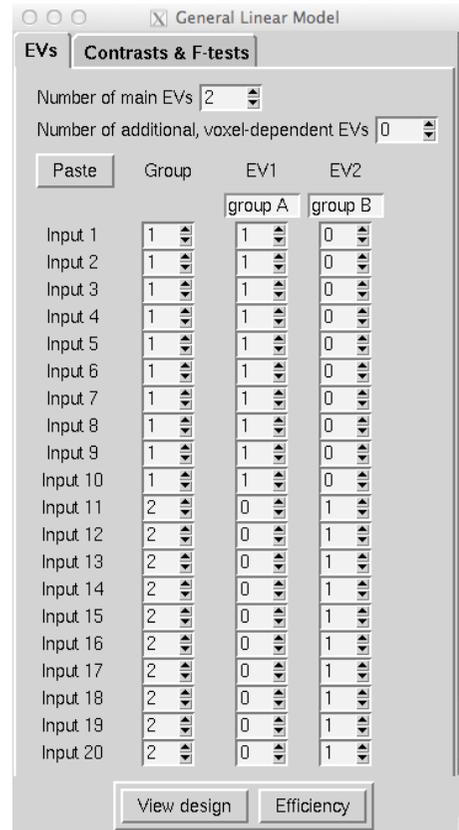
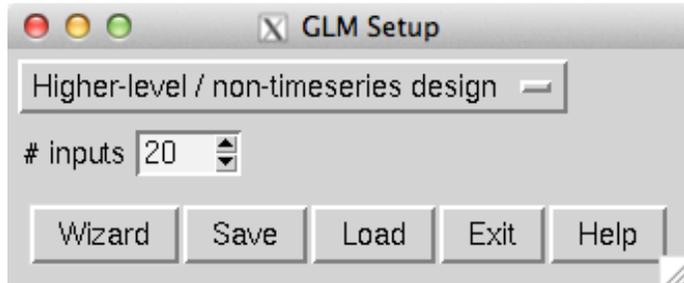
- Collect maps and perform voxel-wise test (e.g. randomisation test on GLM)



- Can now do voxelwise testing across subjects, separately for each original group ICA map
- Can choose to look at strength-and-shape differences



Group analysis on maps

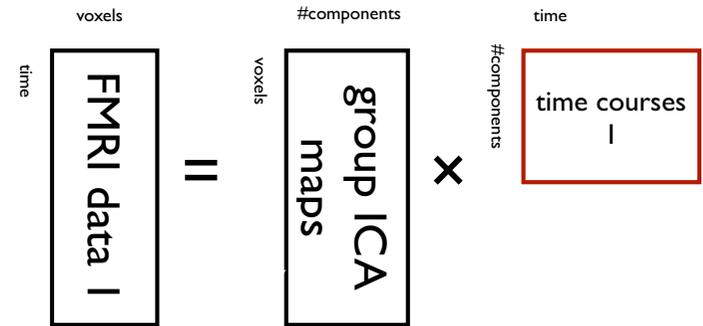


- can use the Glm tool (Glm_gui on mac) to create GLM design and contrast matrices



Dual regression outputs

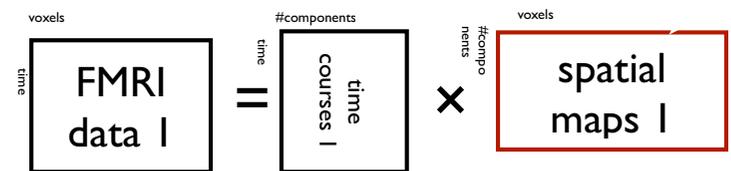
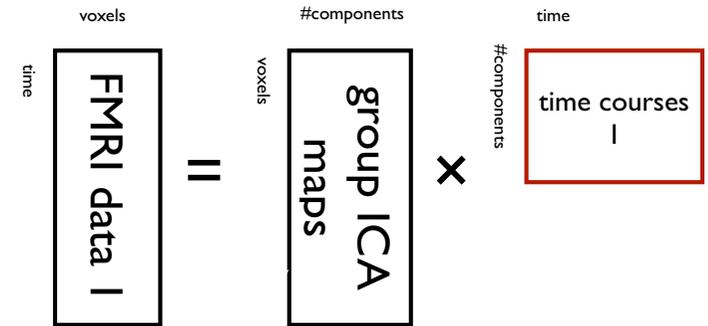
- `dr_stage1_subject[#SUB].txt` - the timeseries outputs of stage 1 of the dual-regression.





Dual regression outputs

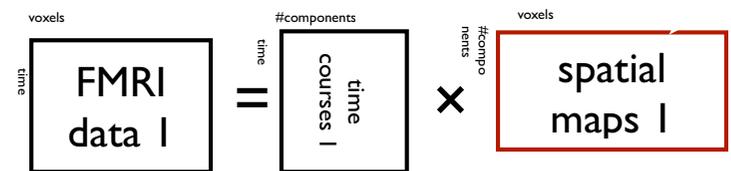
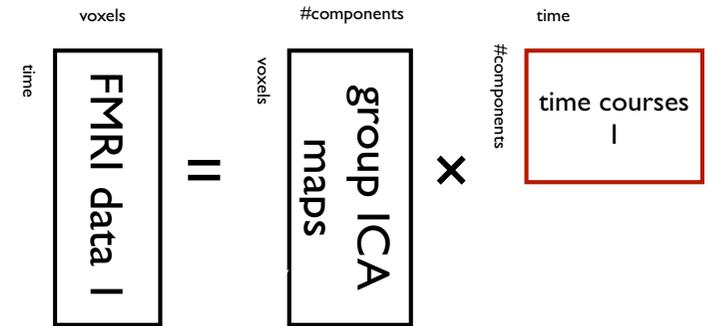
- `dr_stage1_subject[#SUB].txt` - the timeseries outputs of stage 1 of the dual-regression.
- `dr_stage2_subject[#SUB].nii.gz` - the spatial maps outputs of stage 2 of the dual-regression.





Dual regression outputs

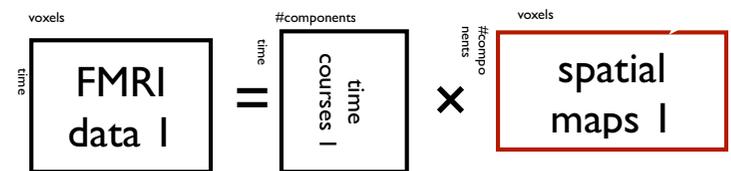
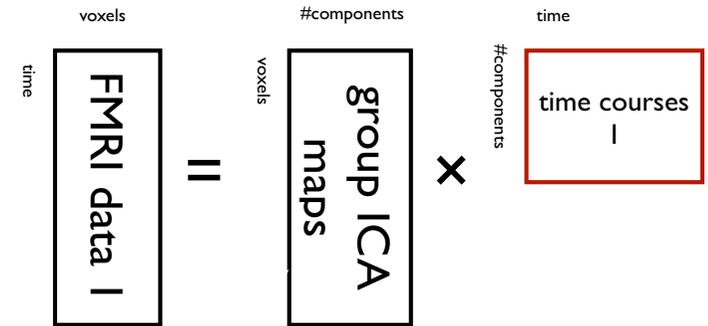
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- `dr_stage2_ic[#ICA].nii.gz` - the re-organised parameter estimate images





Dual regression outputs

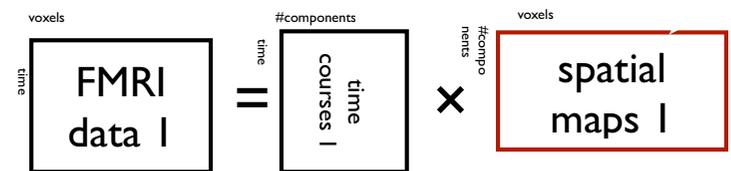
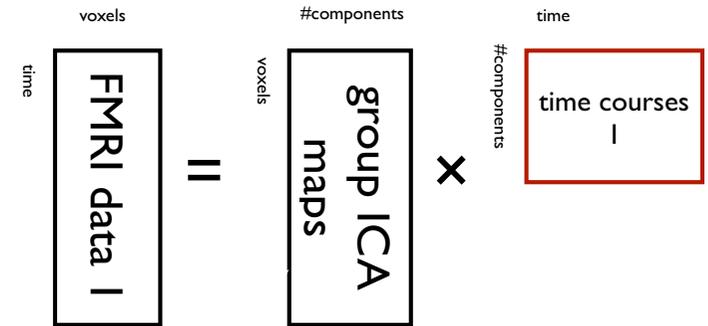
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- `dr_stage3_ic[#ICA]_tstat[#CON].nii.gz` - the output from randomise





Dual regression outputs

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- `dr_stage2_subject[#SUB].nii.gz` - the spatial maps outputs of stage 2 of the dual-regression.
- `dr_stage2_ic[#ICA].nii.gz` - the re-organised parameter estimate images
- `dr_stage3_ic[#ICA]_tstat[#CON].nii.gz` - the output from randomise

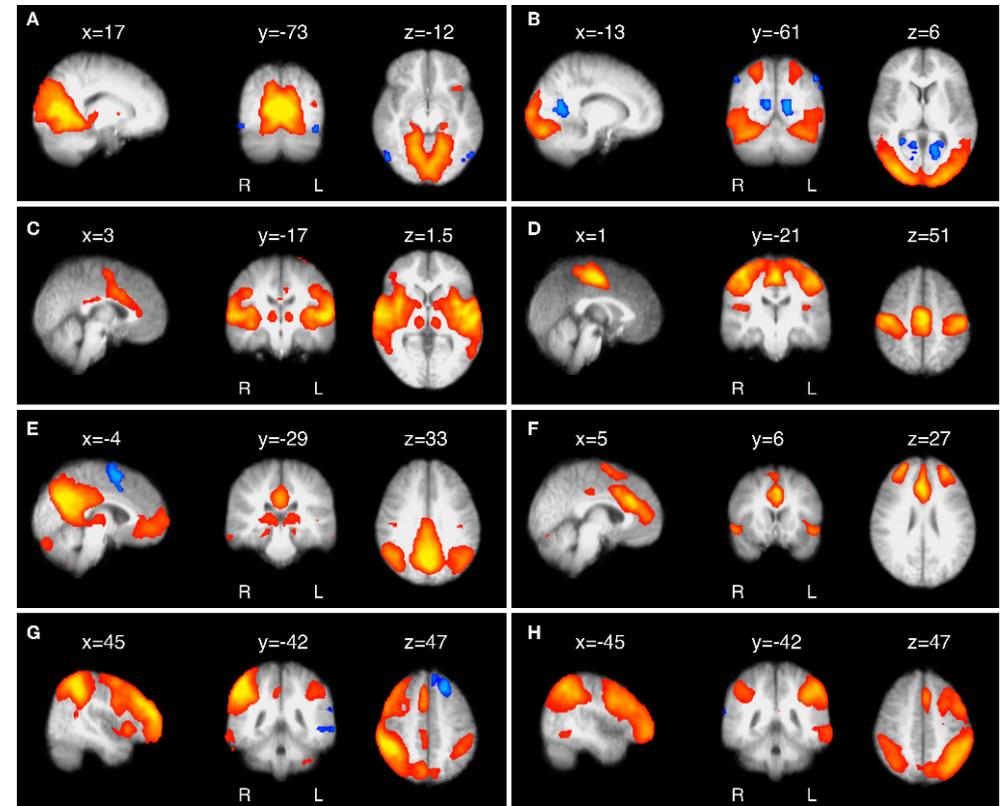


(corrected for multiple comparisons across voxels
but not across #components!!)



Group template maps

- Generate from the data using ICA
- use all data to get unbiased templates



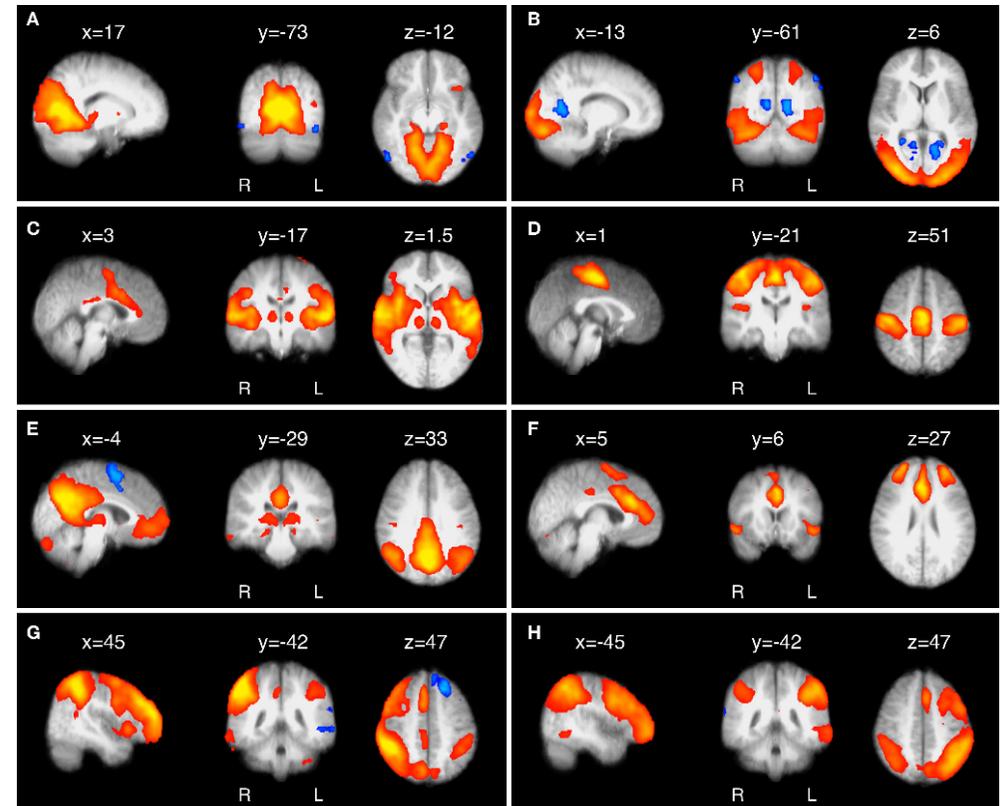
template RSNs

<http://www.fmrib.ox.ac.uk/analysis/research>



Group template maps

- Generate from the data using ICA
 - use all data to get unbiased templates
 - use independent control group
 - will model signals and artefacts



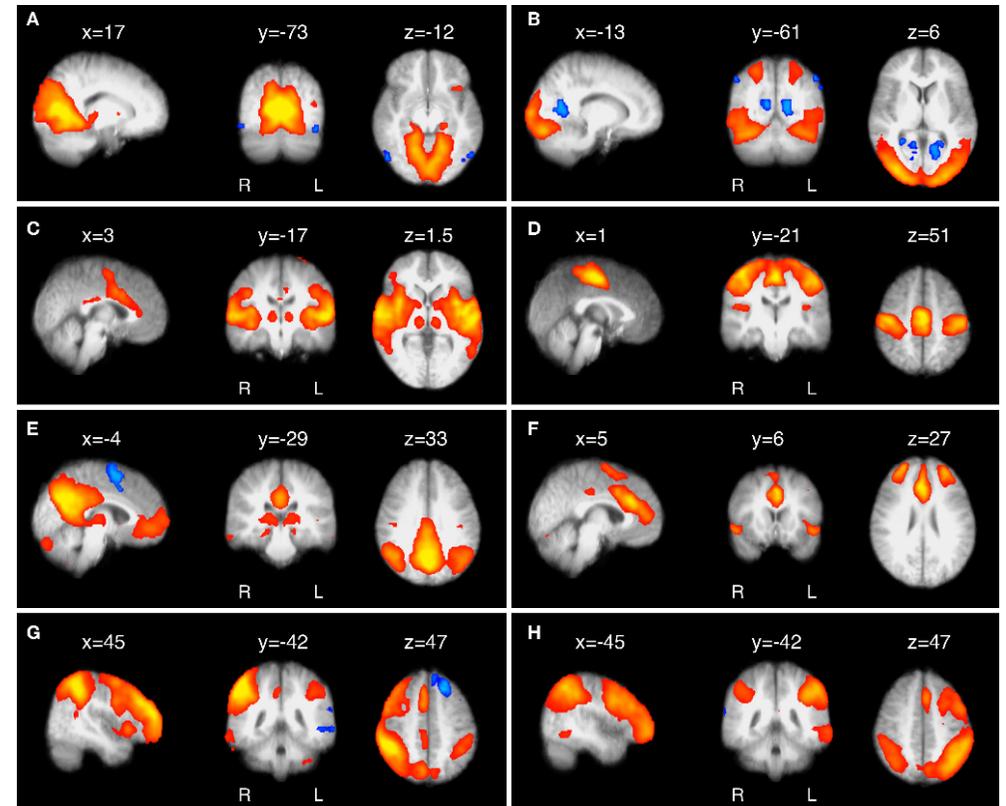
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Group template maps

- Generate from the data using ICA
 - use all data to get unbiased templates
 - use independent control group
 - will model signals and artefacts
- use existing template



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Resting state fMRI and ICA

Available from:

- [Oxford University Press](#)
- [Amazon](#)

