

Region of interest analysis using the MarsBar toolbox for SPM 99

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The MarsBar SPM toolbox

Most functional imaging software packages, including SPM 99, are designed to detect activation anywhere within the volume of brain analyzed; in other words to ask the question: where has activation occurred? In many cases this is not the question that the experimenter wishes to ask; we often want to know if there is evidence of activation within a particular brain area. This is a Region of Interest (ROI) approach rather than a whole brain approach. The MarsBar toolbox is designed to help ROI analysis by providing tools for defining and manipulating regions of interest, calculating a summary time course from the region data (such as the mean), and using the statistical machinery within SPM to analyze the summary data for the ROI.

MarsBar is named after the town in which it was written: the MARSeille Boite A Regions d'interet (the Marseille region of interest toolbox).

The software is free to download and use, and is released under the GNU public licence: the beta version is currently available at: <http://www.mrc-cbu.cam.ac.uk/Imaging/marsbar.html>

Why region of interest analysis?

Region of interest analysis is important and useful for a number of conceptual and methodological reasons:

- 1) Specificity: if the researcher wishes to ask if the average activity in a particular brain region has changed as a result of the manipulation, then ROI analysis gives the direct answer to this question
- 2) Interpretability: the use of ROIs requires specific regional hypotheses, which in turn can make functional imaging experiments easier to interpret and replicate
- 3) Power: ROI analysis restricts analysis to a small number of regions, so that the multiple comparison problem inherent in analysis of many brain voxels is greatly reduced, and power is increased
- 4) Smoothing: ROI analysis involves pooling data over voxels; if the region has been correctly specified, this increases power by stabilising the estimate of the time course, its variance and optimal whitening filter. This is the basis for smoothing in whole brain analysis; ROI analysis can be seen as specifying the correct shape of smoothing to use for a region, instead of choosing some arbitrary shape and size, such as an 8mm 3D Gaussian kernel.
- 5) Communication: summarising data from an ROI makes data simple to visualize, and makes it easier to compare the results of statistical analysis with other standard packages.

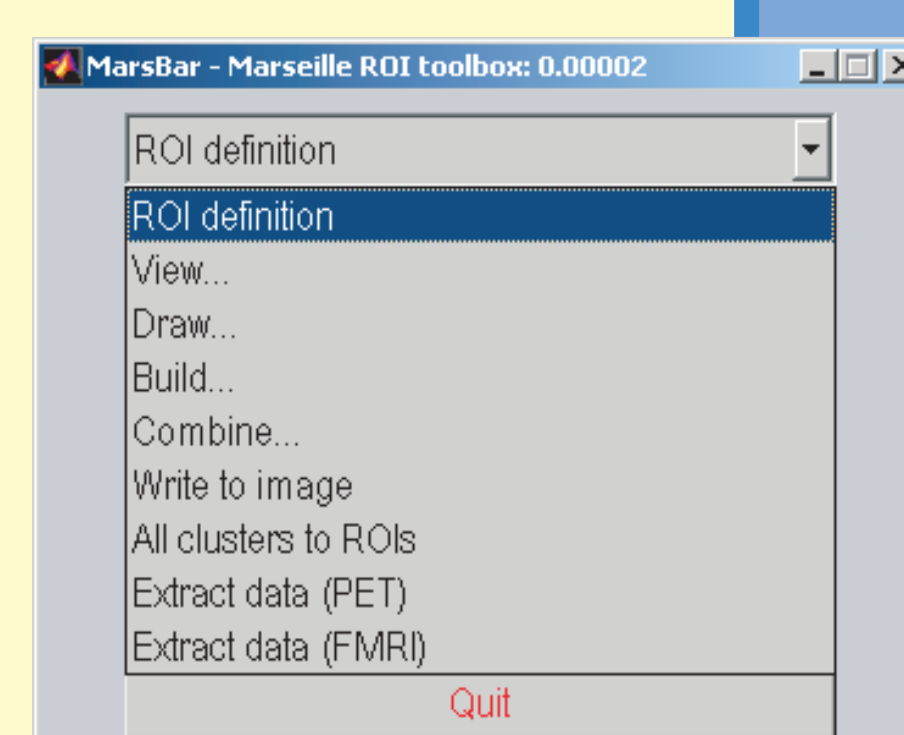
Marsbar features

Marsbar provides facilities for:

ROI design, import and manipulation and display
Specifying statistical models
Estimation of models on ROI and other input data
Display of results

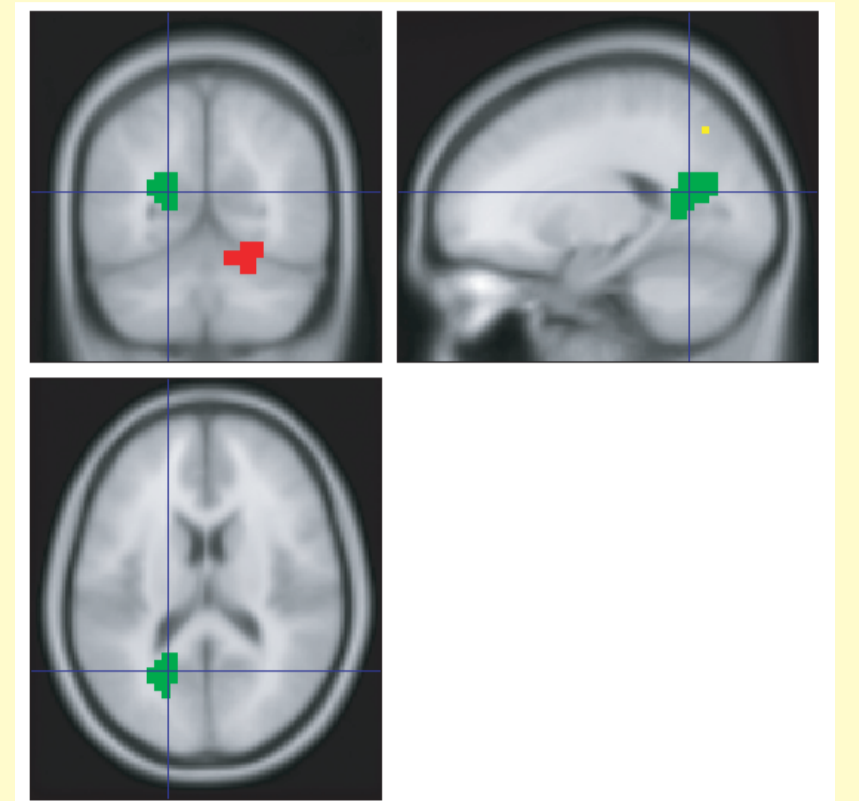
ROI design, import, manipulation and display

- ROIs can be created from
- Activation clusters from SPM analyses
 - Binary or non-binary images
 - Geometric shapes - boxes or spheres
 - Arbitrary shapes via a GUI ROI design tool
 - Algebraic combinations of other ROIs



Marsbar features (continued...)

- Defined ROIs can be
- written to images
 - displayed on any image

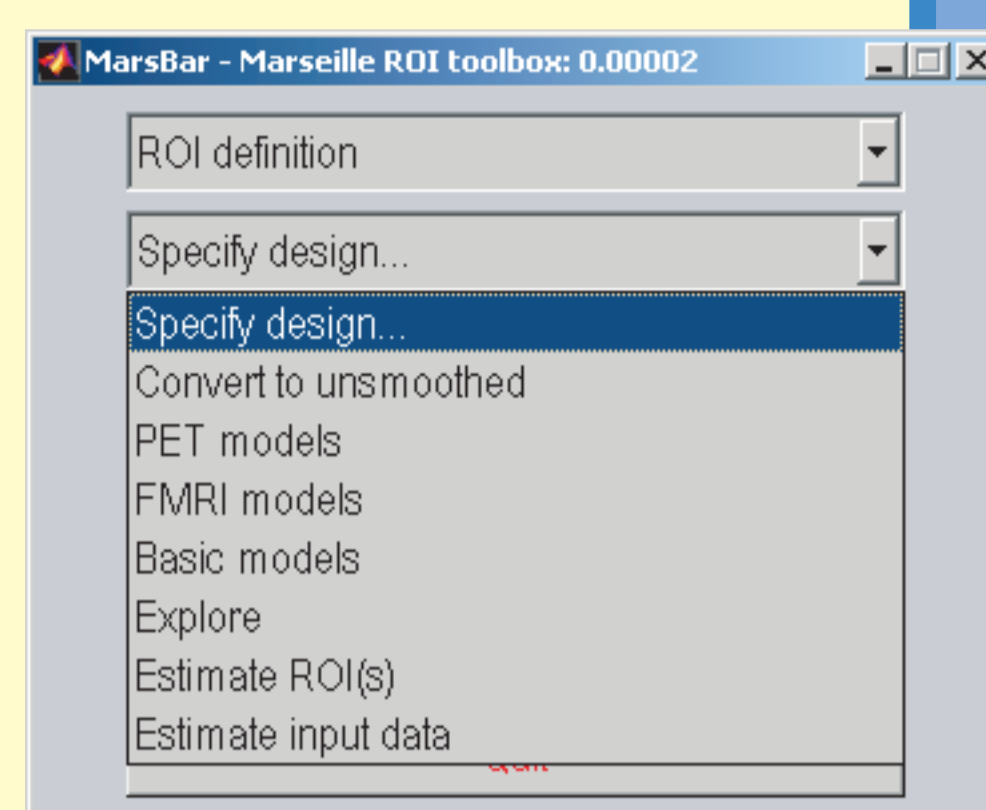


Data for further analysis outside MarsBar can be extracted from ROIs with options for standard SPM filtering and preprocessing

Statistical estimation / modelling

Statistical models can be used from previous SPM analyses, new models can be specified using the standard SPM interface

Data may be extracted from ROIs during estimation, or provided directly via Matlab

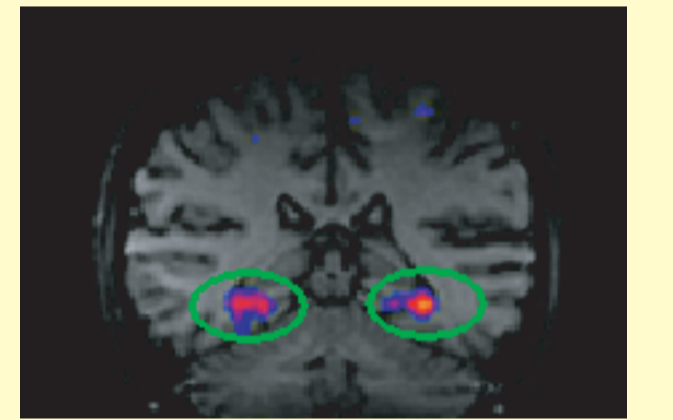


Results display

Results for specified contrasts are output to the matlab window
Data / results plotted using SPM interface

Example: PPA

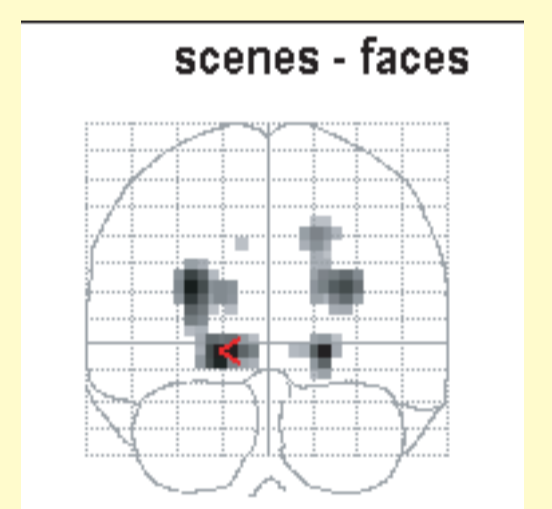
Bilateral activation of a Parahippocampal Place Area (PPA) when subjects view scenes compared to faces (Epstein, Kanwisher 1998)



What does this area do: localizer experiment viewing scenes to define PPA ROI, followed by investigation of signal in this area with other stimuli (Epstein et al 1999)

MarsBar analysis:

- Analyze localizer with SPM
- Write activation cluster as ROI
- Analyze further experiments within PPA ROI



Work in progress

Currently working on:

Estimation of percentage signal change (compared to baseline) for any event type

Calculation of optimal whitening filter with diagnostic output

Integration of Bayesian HRF estimation (Phillipe Ciuciu / Jean-Baptiste Poline)

Conclusions

Region of interest analysis is likely to play an increasing role in functional imaging. Previous data and increasing understanding of anatomical and functional variability allow us to define functional regions on individual anatomy with greater accuracy. ROI analysis is a powerful method for using information from other data, such as anatomy and other functional imaging experiments, to increase statistical power and interpretability. Reducing the analyzed data to that from the ROI allows use of standard statistical techniques and improves communication with other fields. The MarsBar toolbox is designed to provide the tools to integrate ROI analysis with standard functional imaging tools such as SPM99, and therefore expand the range of analyses easily available to the functional imaging community