Instructions for using fMRIpower

1 Overview

FMRIpower was introduced in a 2007 OHBM Poster and is based on the power analysis technique described by Mumford and Nichols (2008). The software is intended for use in study design, such as in the preparation of a grant application. It is not statistically appropriate to use a power analysis to assess the power of a study that has already taken place, but they can be used as a guide for planning future studies. See Hoenig and Heisey (2001) for some interesting examples why posthoc power doesn't make sense.

FMRIpower uses a region of interest approach to power analysis where, by default, the power analysis will be carried out for each of the regions of the automated anatomical labeling (aal) roi mask, (Tzourio-Mazoyer et al., 2002). Since these regions may tend to be too large, it is recommended to use more specific anatomical regions. Circularity has shown to greatly bias activation analyses (Kriegeskorte et al., 2009), thus it will greatly bias a power analysis so do not use the activation clusters from the analysis of the pilot data as ROIs for the power analysis.

2 Steps in analysis

This power calculation operates in Matlab and now functions with analysis output from FSL or SPM. Note, even if you're inputting a previous FSL analysis, SPM must be installed as SPM functions are used to read, write and display images. Both FSL and SPM versions of fMRIpower work in similar fashions and require the following steps:

1. Add both SPM and the fMRIpower directory (which you downloaded from the web) to the Matlab path using the `addpath` command. Even if you're an FSL user you must add the SPM path.

2. Type `fmripower` at the Matlab prompt and a window will open asking if you're a SPM or FSL user. Click the appropriate button and then the main fMRIpower GUI will open.

3. Load in the previous group analysis that the power calculation will be based on. For SPM this is a SPM.mat file and for FSL it is the group .gfeat directory.

4. Select the contrast of interest from the analysis

   - FSL: You must select the cope.feat directory (corresponding to the lower level cope) as well as the cope.nii.gz corresponding to the group level cope of interest. If you find it confusing, look in your group .gfeat directory and you'll see that

there are cope.feat directories for each lower level contrast analyzed and within the stats directory is a cope.nii.gz for each contrast you specified.

- SPM: You will see a list of contrast names in the dropdown menu, select the one you'd like to use.

5. Set up design information. You must enter the design matrix that corresponds to the design matrix for the *future* study, not the study that you already ran. The software will try to automatically detect what your previous design was and should be able to detect 1-sample, 2-sample, and paired t-test analyses. In these cases you will only need to specify how many subjects will be in the future analysis, otherwise you will need to enter the entire design matrix for the power analysis (eg., ANOVA models).

   - Automated design matrix generator. If the design is automatically detected, a window (Figure 1) will ask whether you'd like to carry out the power analysis for a single sample size or for a range. For an individual sample size, the output display will show the power, mean in standard deviation (sd) units, mean and sd (Figure 1, left). For a range of sample sizes the mean in standard deviation units is displayed as well as a power curve showing the power as a function of sample size (Figure 1, right). Note, for a 2 sample t-test, it is the number of subjects *per group*.

   - Manual design specification. If your design cannot be detected by fMRIpower you'll need to use the manual design specification option, which has 3 options: select a design stored in a text file, use an editor to specify the design (set up like a spreadsheet), copy and paste a matrix into a window. Note, if your covariate of interest was a continuous covariate fMRIpower cannot handle this case.

6. Select the ROI mask. You can either use the default AAL atlas, or create your own ROI mask and enter that. Please be sure that the resulting calculation does not appear to have had a R/L swap. If you're a FSL user and have used an approach that is typically FSL friendly for creating your ROI, you'll be fine. Likewise, SPM users should use an approach they would typically use in other SPM applications. Note that the ROI may display properly, but the swap may have occurred during the calculation. To check this, make sure the magnitude of the mean seems reasonable for your ROI.

7. Select type I error rate. Set however you'd like, but if you are looking at multiple ROIs use a Bonferroni correction to adjust for multiple comparisons.

8. Hit calculate and wait for output (bottom of Figure 1). Note that power is displayed as a percentage, so you will be hoping for a number greater than 80, not 0.8.

9. Matlab will display a message indicating where output images are stored. This includes a .mat file that contains the power analysis output. This could be used if you wanted to make a separate figure of the power curve for your grant application.
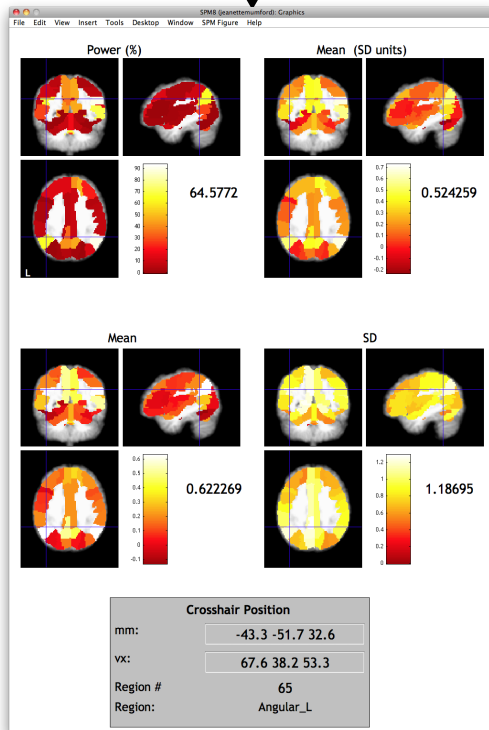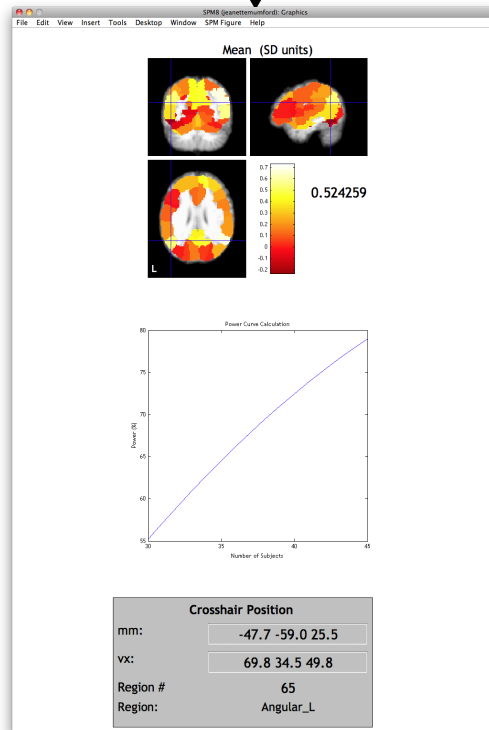
Figure 1: Two options for sample size specification. If an individual sample size is selected you'll obtain power estimates for that sample size only (left), whereas a range of sample sizes supplies a power curve (right).

3 Reporting power results

Now that you have succeeded in obtaining a sample size that has a reasonable amount of power associated with it, you need to communicate this in your grant. I often prefer converting my effect sizes to percent signal change units, but this is not easy to automate and so fMRIpower will not do it for you. It is acceptable to report the mean in sd units, which is called the Cohen's D in the case of a 1-sample t-test. Here is an example of text that could be adapted to describe your power analysis.

The fMRI-based power analysis employed novel methods developed Mumford and Nichols (2008) that are implemented in the fMRIpower software package (fmripower.org). This method estimates power for detecting significant activation within specific regions of interest, with the assumption that the planned studies will have the same number of runs per subject, runs of the same length, similar scanner noise characteristics, and data analysis with a comparable model. The effect sizes have been expressed in standard deviation (sd) units, which is analogous to the Cohens D measure. All power calculations are based on a region of interest (ROI) using the [can you describe the region of interest and how it was determined] with a p-value threshold of 0.005 for a 1-sided hypothesis test. With X subjects we will have at least 80% power to detect an effect of size [state effect size in sd units or % signal change] in the [give region name].

References

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