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Exporting spatiotemporal statistics from SPM12

1. From the SPM12 Menu (see Figure 1), click the **Results** button. Select the `SPM.mat` file from the directory where your results from 2nd-level analyses were previously saved. The folder should also contain several `beta` NIfTI-1 (.nii) files, which form the basis for the contrast. Click the **Done** button to continue.

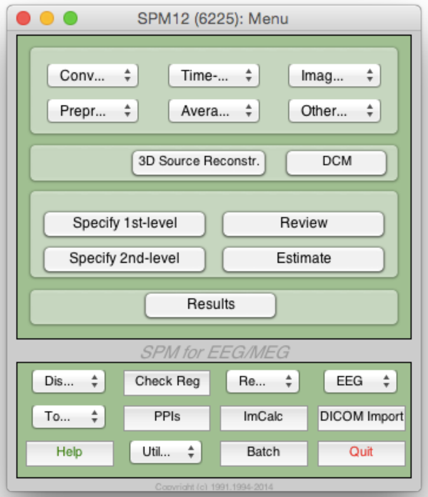

Figure 1. Main SPM12 Menu

2. From the SPM Contrast Manager (Figure 2), either select an existing *t*- or *F*-contrast from the list, or define a new contrast. Click the **Done** button to continue.

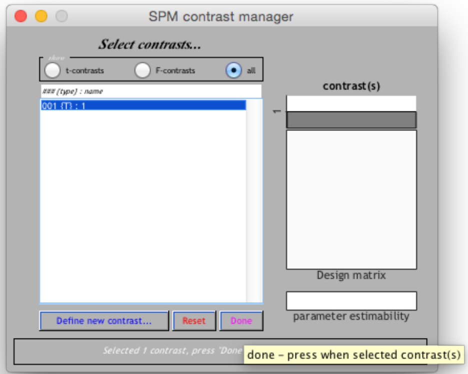

Figure 2. SPM12 Contrast Manager

3. An SPM12 Stats window will open (Figure 3). Specify the following parameters:

    - In the **apply masking** field, select **None**
    - In the **p-value adjustment to control** field, select **FWE** or **uncorrected** and set the value, typically 0.05 for FWE or 0.001 for uncorrected
    - In the **extent threshold** field, set the minimum cluster size, typically 0 or 10
    - From the **Data Type** dropdown menu, select **Scalp-Time** to create a spatiotemporal image

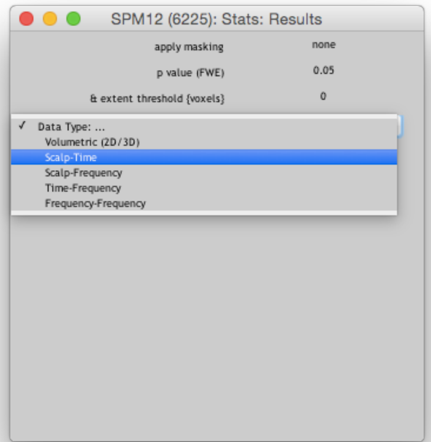

Figure 3. Specifying parameters in the SPM12 Stats window

4. From the **Save** dropdown menu in the Display panel (Figure 4), select **thresholded SPM** and enter an output filename. The image will then be saved as a NIfTI-1 file and the path will be displayed the main MATLAB Command Window.

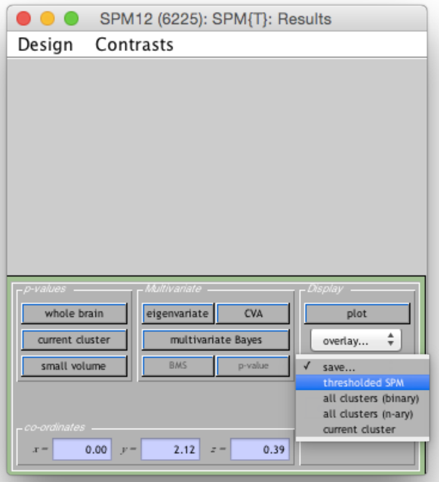

Figure 4. Saving file from Display panel

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Converting NIfTI image to Porthole format

1. Copy the **Porthole** folder (Figure 5) into a local directory, such as the Desktop or your MATLAB folder. You may also wish to copy the spatiotemporal NIfTI-1 file exported from the previous stage into the **Porthole ▸ Datasets** sub-folder. Ensure SPM12 and Porthole have been added to the MATLAB search path, then run the `nii2ph.m` function.

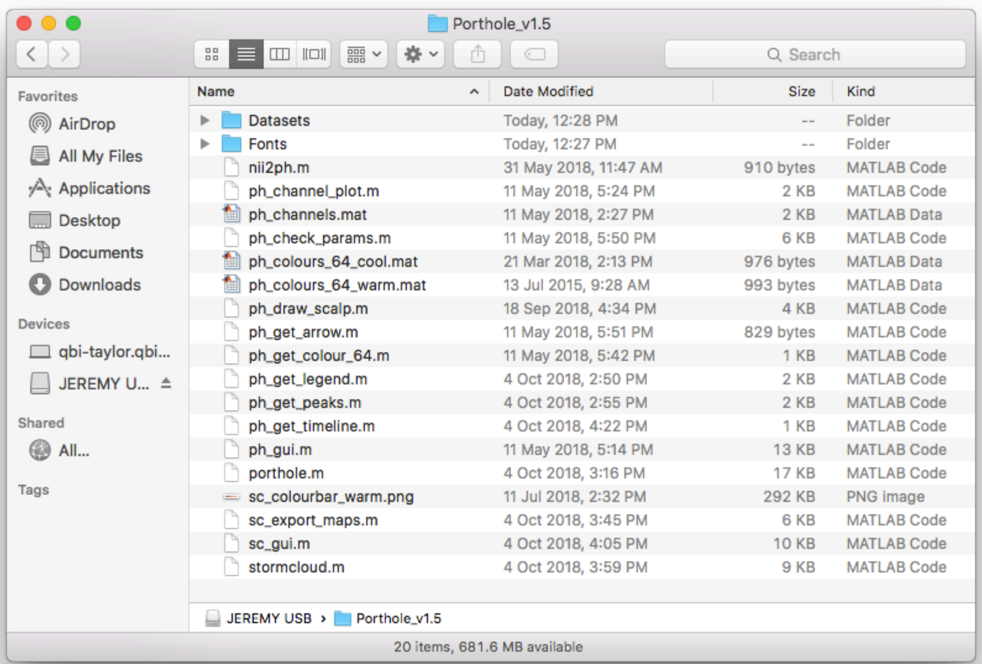

Figure 5. Main folder containing Porthole functions

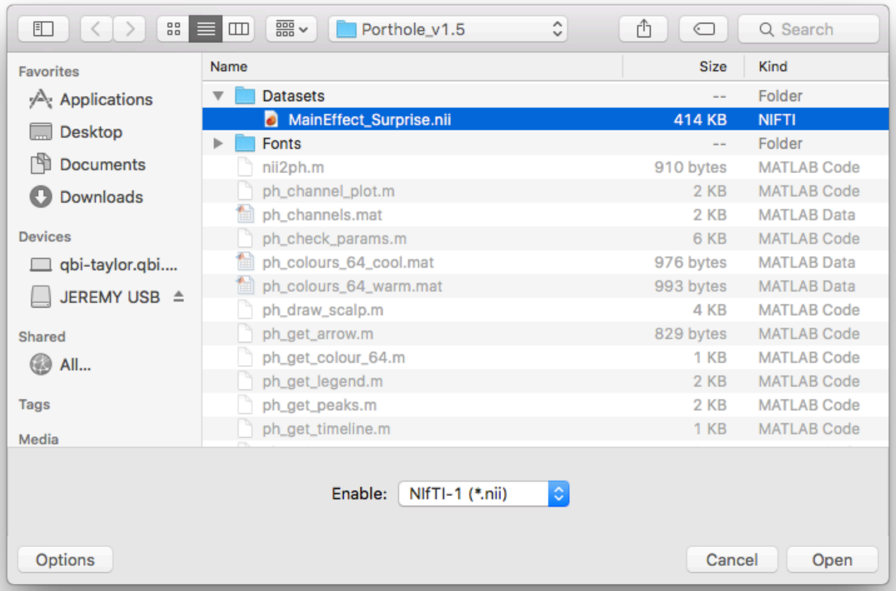

Figure 6. NIfTI-1 selection window

2. A file selection window will open (Figure 6). Choose the NIfTI-1 file to import and click the **Open** button to continue.

3. MATLAB will import the NIfTI-1 file and convert to a 3D array readable by Porthole and Stormcloud, then save the new file in MATLAB Data (.mat) format. A **Save Workspace Variables** window will open (Figure 7). Enter a new filename and click the **Save** button.

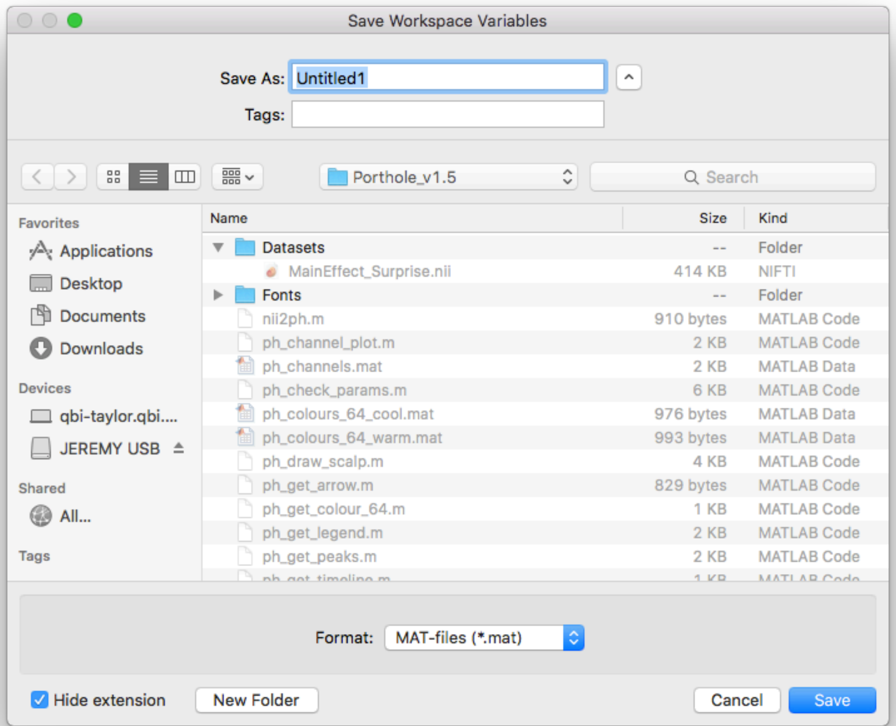

Figure 7. Save Workspace Variables window

Running the Porthole visualisation

1. *(Optional)* If running Porthole for the first time on this machine, open the **Porthole ▸ Fonts** sub-folder and install as follows:
   On Mac, right click on the fonts, select **Open with ▸ Font Book** and click the **Install Font** button.
   On Windows, right click and select **Install.**
   If you do not wish to install the fonts[1], this will not effect how the program runs, but the output will revert to default settings and look slightly different.

2. To open the Porthole Menu GUI (Figure 8), run the `ph_gui.m` function.

3. To visualise a Porthole dataset, first click the **Load** button, select the `.mat` file and click **Open** to continue. The filename will then appear in the text field at the top of the menu.

4. In the Dataset panel, specify the **Contrast** type, **p-value** and **Correction** method as per the original SPM12 contrast. By default, the range of values used in the colorbar will be autofit to the minimum and maximum values within the dataset. To customise, click the **Set Custom Thresholds** checkbox and enter the desired values.

5. In the Timing panel, specify the **Sampling Frequency** (in Hz) and **Pre-Stimulus Time** (in ms), as per the epoch originally defined in SPM. As the effects of interest may only occur later in the epoch, the animation loop can be controlled via the **Animation Start Time** (in ms).

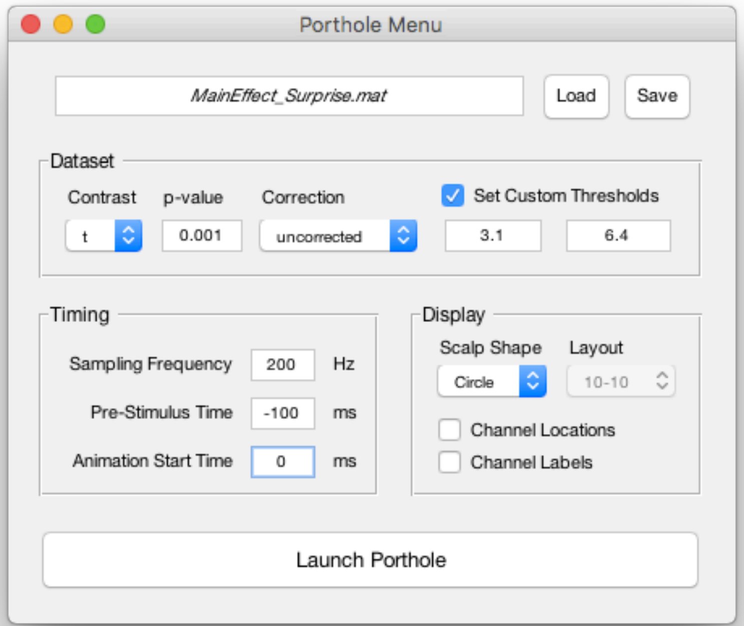

Figure 8. Porthole graphical user interface

[1] Porthole text elements are typeset using the Fira Mono family of fonts in regular and bold weights, designed by Erik Spiekermann and made freely available by the Mozilla Foundation under the SIL Open Font Licence.

6. In the Display panel, specify the desired **Scalp Shape.** To enable an EEG template overlay, click the **Channel Locations** checkbox to show the electrode positions as dots and/or the **Channel Labels** checkbox to show names of each electrode, then select a standard **Layout.**

7. *(Optional)* To write the selected parameters to your Porthole file, click the **Save** button in the top right corner of the menu. Next time the dataset is loaded, all the options will be pre-filled. These can be further customised and rewritten at any time.

8. To start the visualisation, click the **Launch Porthole** button at the bottom of the menu. The Porthole display window (Figure 9) will take a few seconds to load.

9. The Porthole visualisation has both an animation mode and an interactive mode. By default, the animation will play. To pause and enter the interactive mode, press and hold the **space** bar. The scalp maps at each timepoint can then be iterated through by pressing the up and down **arrow keys.** To resume the animation, press the **space** bar. To quit the program and return to MATLAB, press the **Esc** key.

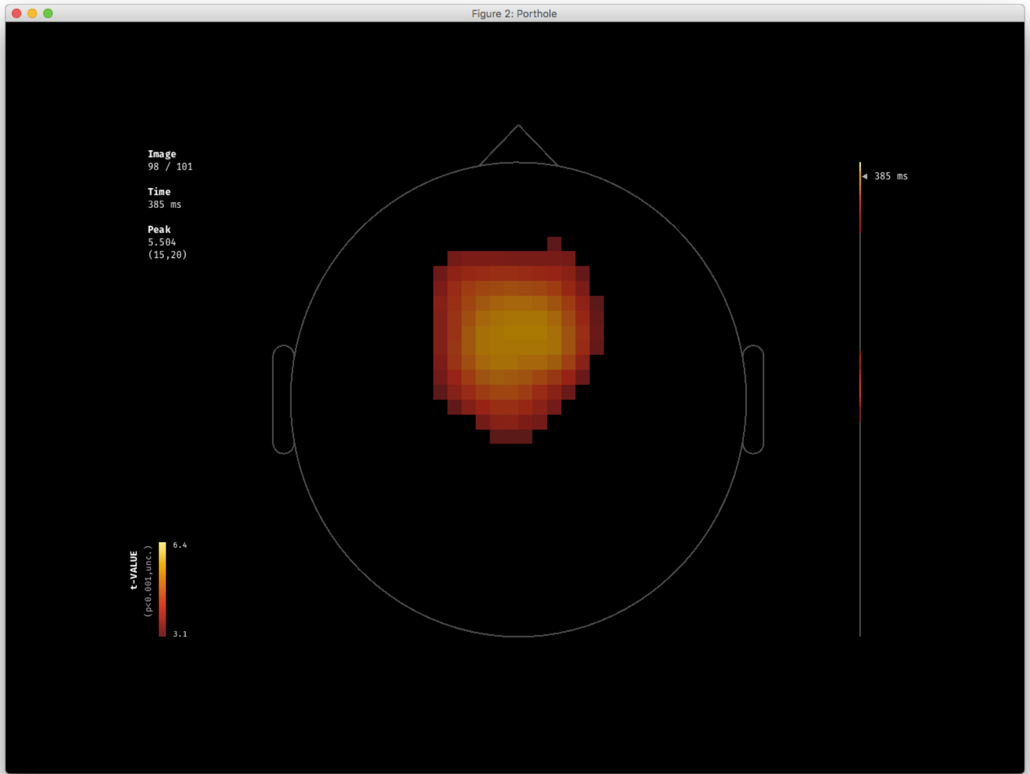

Figure 9. Porthole display window

Generating the Stormcloud visualisation

1. To open the Stormcloud Menu GUI (Figure 10), run the `sc_gui.m` function.

2. Stormcloud uses the same data structure as Porthole. To import the data, click the **Load** button, select the `.mat` file and click **Open** to continue. The filename will then appear in the text field at the top of the menu.

3. In the Peak Selection panel, the discrete clusters within the volume will be listed as the number of voxels and peak value within each. By default, the **Enable peak annotations** checkbox will be ticked. To select which cluster to annotate, click an item on the list to highlight it. To select multiple clusters, hold the **Command** (⌘) key on Mac or **Ctrl** key on PC and click each item.

4. In the Display panel, first specify the **Viewing Angle**. The isometric viewing angle describes the orientation of the volume in terms of the quadrant closest to the viewer (see Figure 11). Then, specify the **Scalp Shape** and the **Axis Side**, i.e. which side of the volume the time axis appears in the rendering. By default, the range of values used in the scalp map colorbar will be autofit to the minimum and maximum values within the dataset. To customise, click the **Set Custom Thresholds** checkbox and enter the desired values.

5. To render the 3D volume, click the **Launch Stormcloud** button in the bottom left corner of the menu. The Stormcloud display window may take a few minutes to load. A copy of the rendering will automatically be saved in the current folder, named according to the viewpoint index (e.g. `stormcloud_view2.png` for right anterior).

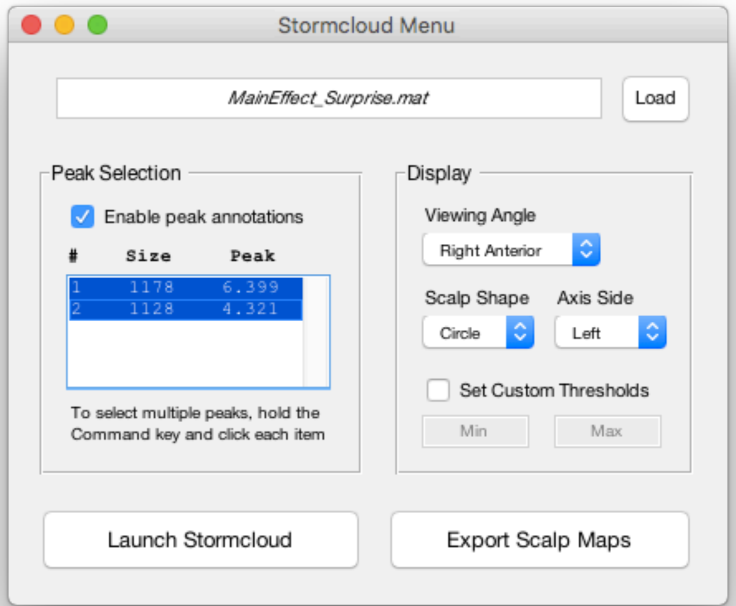

Figure 10. Stormcloud graphical user interface

6. To explore the data, try rendering the volume from all four viewing angles and choose the two which best explain the effects of interest. Views which typically complement well are orthogonal to each other (e.g. left posterior and right posterior). Placing the time axis on different sides for each viewpoint allows dual views to be merged into a single figure with a shared axis, as shown in Figure 11.

7. To render 2D scalp maps corresponding to the selected cluster peaks, click the **Export Scalp Maps** button in the bottom right corner of the menu. The display window will iterate through the clusters and automatically save copies in the current folder, named in order of peak size (e.g. `peak1_t101.png` for to the larger peak, occurring at time index 101, `peak2_t53.png` for to the smaller peak at time index 53).

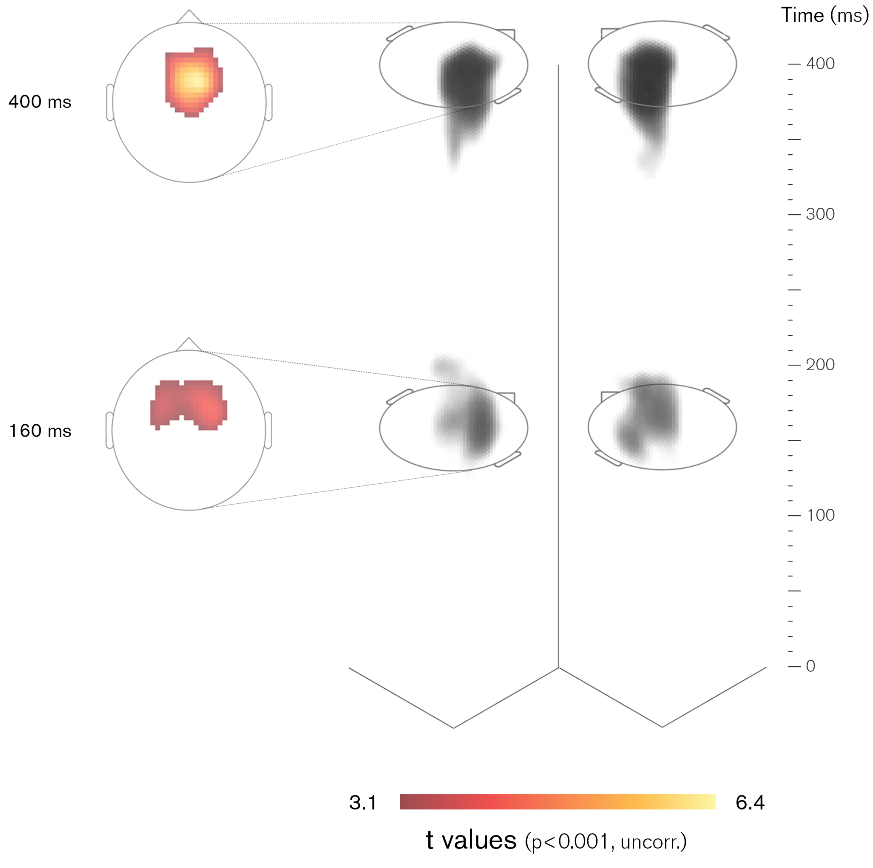

Figure 11. Exemplar Stormcloud visualisation — 3D spatiotemporal clusters rendered from dual isometric perspectives with voxel transparency mapped to statistical significance and 2D scalp maps referring to cluster peaks