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Overview

Get ready to neuroimage!

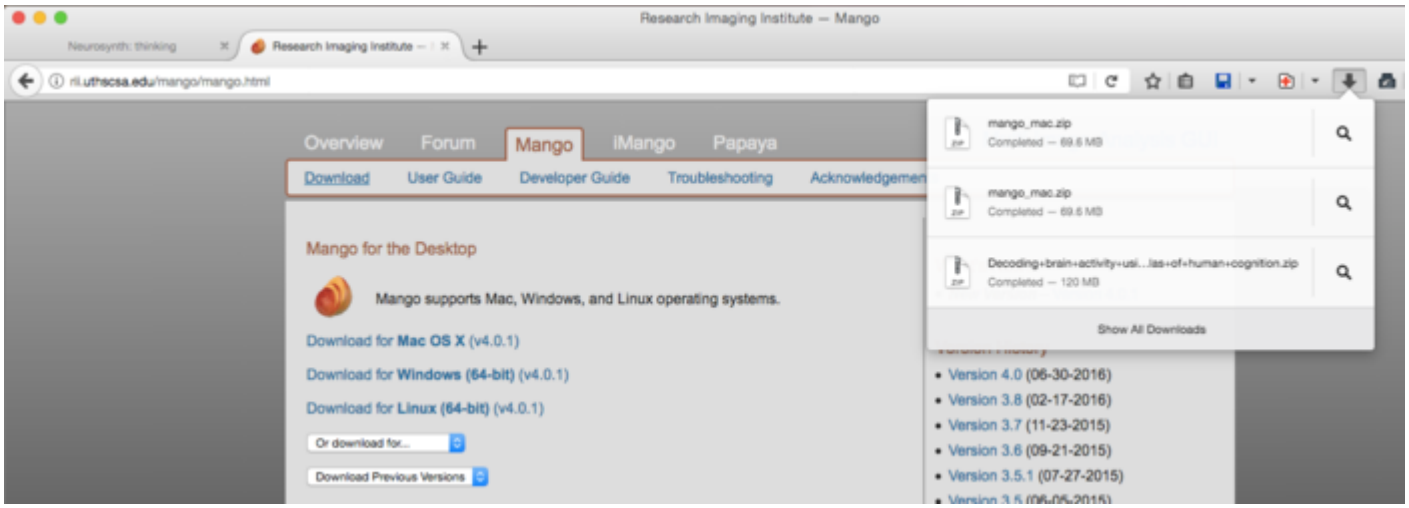
1. Install Mango software

You will need to install the Mango viewer software to do this part of the assignment. In general, I prefer not to ask students to download software, but currently there are no browser-based MRI image viewers available online that provide all the features we need. I have chosen Mango to download because it is non-commercial (so that there are no ads or additional software that come with it), free[1)], and designed to work with all major operating systems.

http://ric.uthscsa.edu/mango/mango.html

- Click on the link for your operating system, and follow the prompts. The website includes some

instructions too.



Mango download page

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2. Download a file to use with Mango

As you know, functional MRI (fMRI) measures differences in blood oxygenation levels. For technical reasons, fMRI images usually need to be relatively low-resolution (they look blurry). Also, the goal of most fMRI studies is to identify small, specific regions of the brain that are associated with a cognitive task. The final results of most fMRI studies (which are usually called “activation maps”) don't look like a picture of a whole brain, or even of a recognizeable part of a brain. They just depict little three-dimensional blobs that mark the location of the brain regions most highly associated with the cognitive task from the study. So, the blobs that are visible in an fMRI activation map are like the Xs that “mark the spot,” but without the underlying treasure map! Looking at activation maps on their own is like looking at a blank piece of paper with an X on it – it tells you that there is, in fact, a treasure/important brain region, but not where to find it.

To understand which locations the activation blobs (the “Xs” in the treasure map analogy) mark in the brain, we need to “put the map under the Xs.” In our case, the “map” is an image of a whole brain (in 3D of course). The image that we will use is a composite image based on averaging together the structural MRI images of 152 individual brains. (Structural MRI images are high-resolution images that look more like a photograph than functional MRI images, and they don't measure blood oxygenation.) This average image is a little too smooth around the edges to look like a real, single person's brain, but that's the point: we want to understand where an activation blob would be located on average, in anyone's brain.

So, please download a file available on our Canvas site:

File name: `mni_icbm152_t1_tal_nlin_asym_09a_acMasked.nii.gz`

(**NOTE:** If your computer asks you to unzip this (or do anything else) with this file, respond “No.” The only

reason this file is zipped (compressed to reduce the size of the file) is to make it easier to download and save. Mango will read this file without you having to unzip it first.)

Make a note of where the downloaded file gets saved, so that you can open it later. You can ask your web browser to show you where the file was saved in a number of ways, including:

- In Firefox: Under the “Tools” menu, select “Downloads.”
- In Chrome: Under the “Window” menu, select “Downloads.”

This file is a version of the standard 152-person average brain created by the Montreal Neurological Institute (MNI) in Canada. You will see this abbreviation a few times during this activity, because the MNI originated a number of widespread neuroimaging techniques. The only difference between this version of the file and the standard version available online from the MNI is that your instructor has removed the face, skull and other non-brain portions of the image, so that it will look more like a brain when we eventually view a 3D rendering of it.

3. View the structural average brain in Mango

Now that we have …

1. The Mango viewing software
2. A copy of the structural average brain file

… we can look at the average brain.

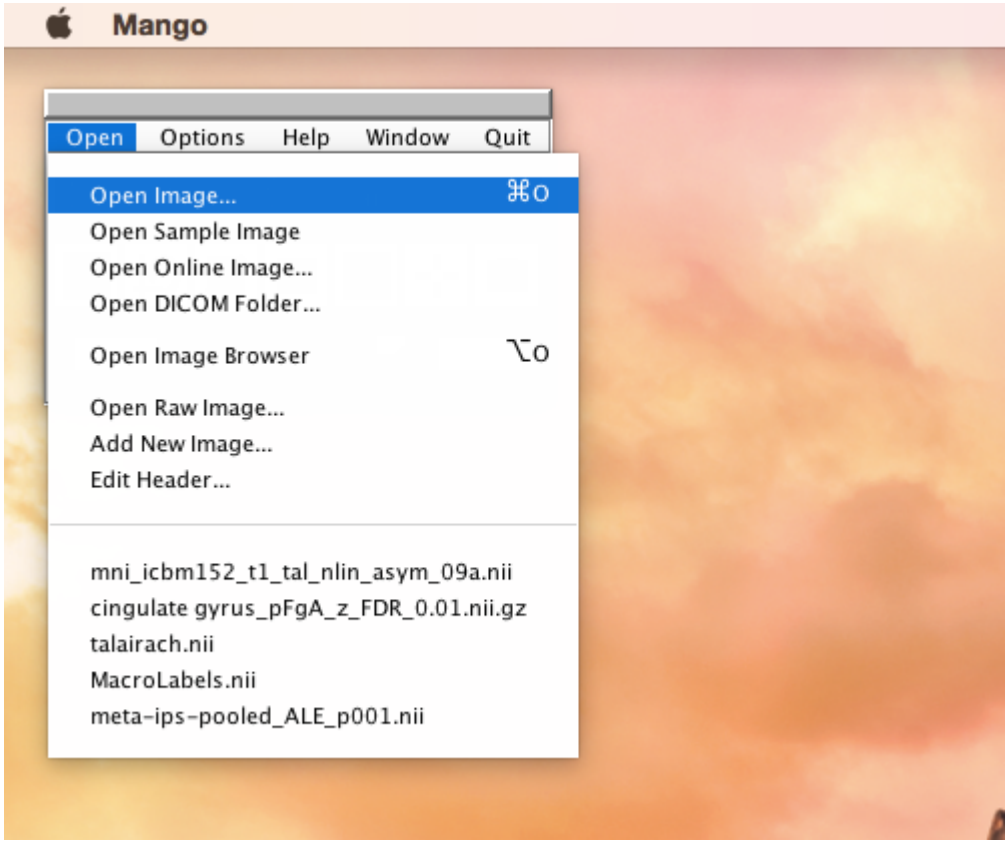
3.1 Start the Mango app

I feel funny writing instructions to you youngsters about how to open apps, because you know, you're more familiar with “apps” than me. However, problems can occur, and please don't hesitate to ask if they do.

3.2 Open the structural average brain file: the "image"

Somewhat confusingly, Mango uses different words when it refers to 1) the structural brain image, and 2) the functional activation map image. To me, these both count as “brain images.” However, Mango calls the structural brain file an “**image**,” and it refers to functional activation maps as “**overlays**.” This is only important because there are different menu commands for the two kids of files.

To load the average structural brain image, use the mouse menus to select “Open image,” as seen here:

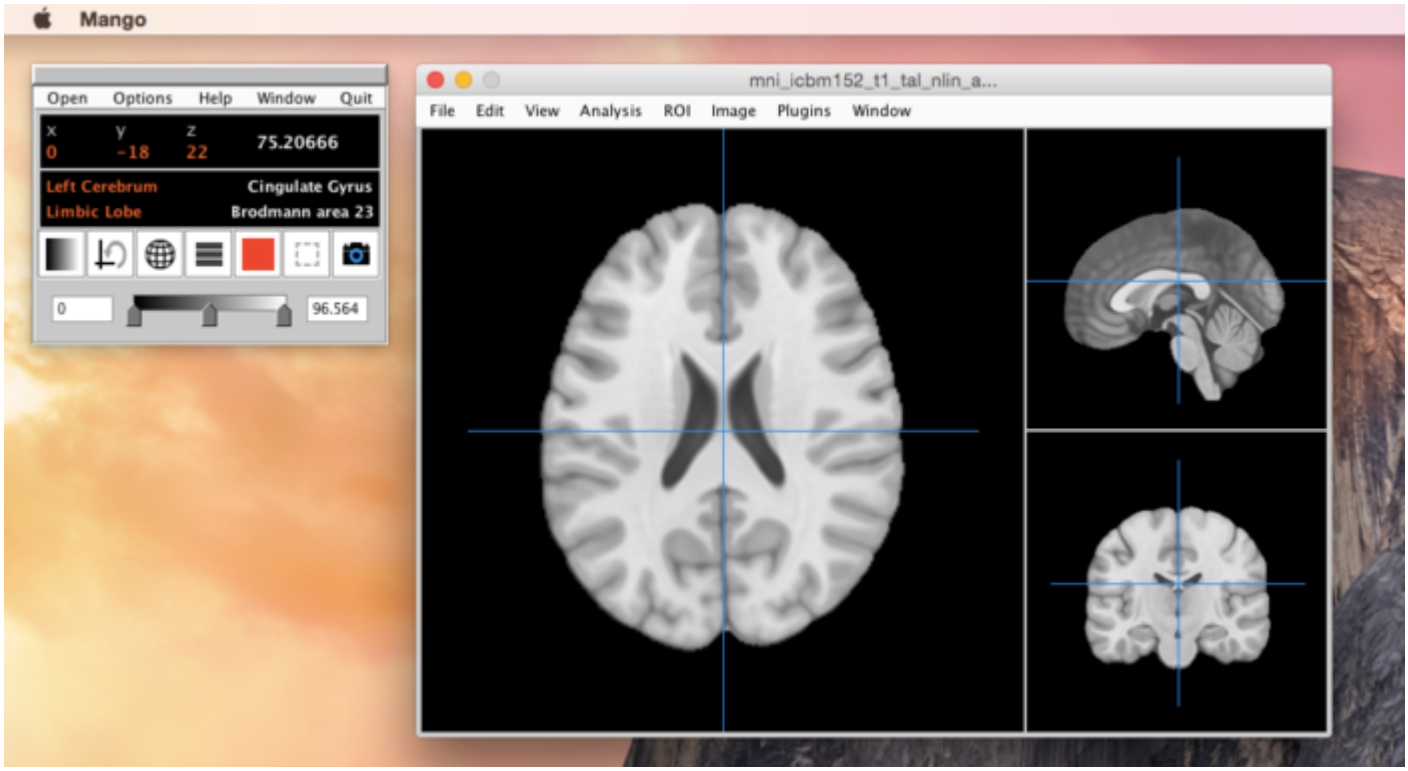


Load the average structural brain image using the “Open image” command

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Select the file that you downloaded from Canvas.

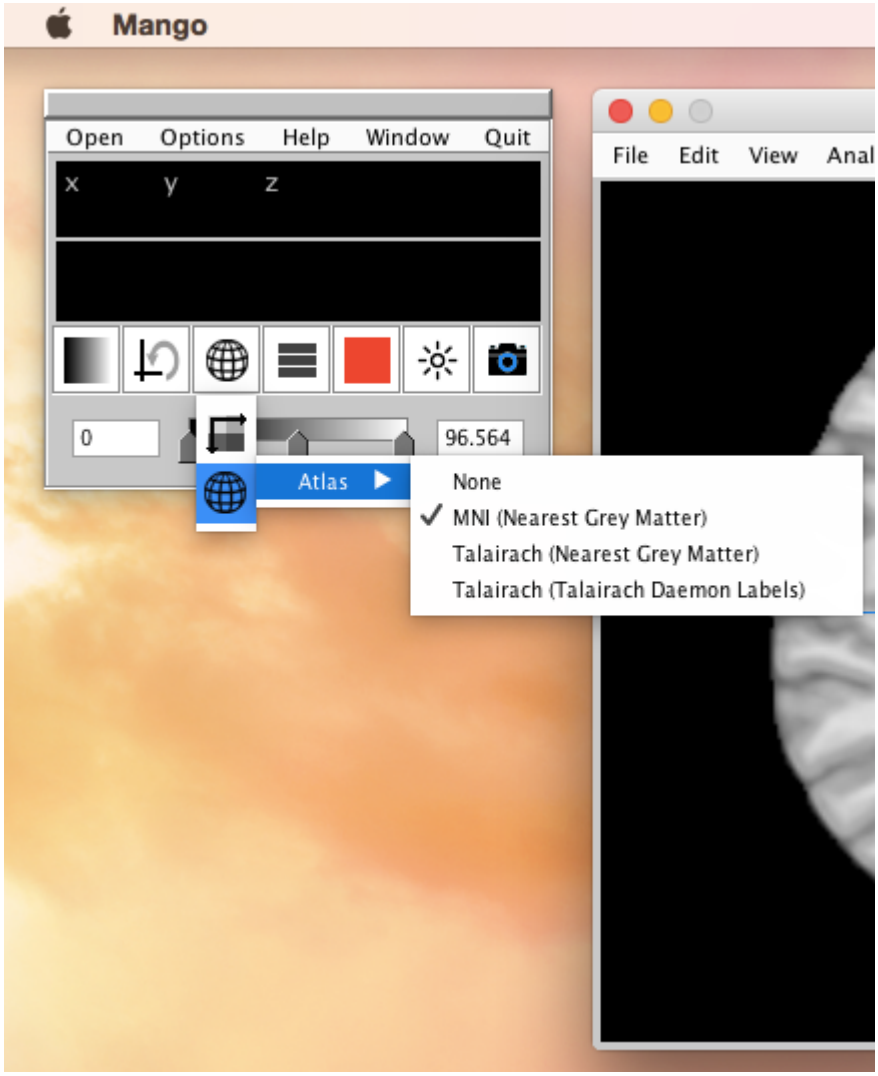
Congratulations! You made a brain appear! It should look like this:



This is what you should see in Mango after loading the average structural brain image.

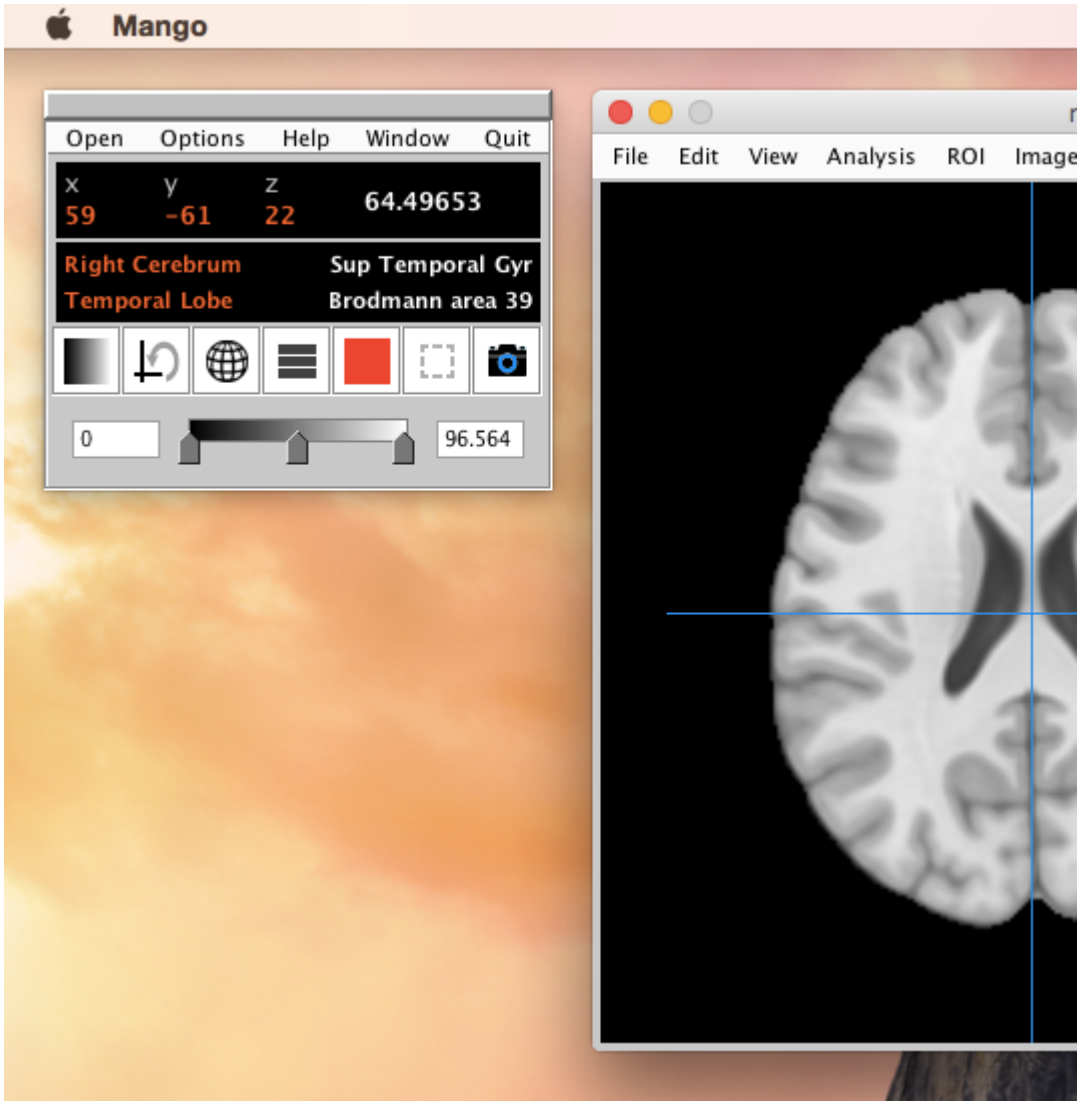
3.3 Enable the atlas feature

Mango can show us the name of the brain region that is under the mouse, but we need to enable this feature first. Mango looks up the most likely name for each brain region using a data set called an “atlas.” Click on the button in the main Mango window (which is actually the smaller window) that looks like a sphere, and then select “Atlas → MNI (Nearest Gray Matter)”.



Enable the atlas feature

Technically, the names of the brain regions (the “atlas labels”) only describe regions of gray matter. However, because our structural brain image is an **average** brain, it is very possible that some individual people's brains will have gray matter in locations that correspond to white matter in the average brain. A consequence of this is that functional activation blobs can sometimes appear to be located in white matter on the average brain. In those cases, we still want to know what to call that part of the brain.



Look in the main Mango window to see the name of the brain region located under the mouse pointer

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Mango will display four different names with different levels of specificity. The one we want is the one at the upper right of the atlas window, e.g. “Sup Temporal Gyr” for superior temporal gyrus.

HINT: if the atlas abbreviations are unclear, try Googling them.

Get brain maps from the Neurosynth website

1. Go to the Neurosynth homepage in your browser

http://neurosynth.org/

2. Get a meta-analysis for your article's topic

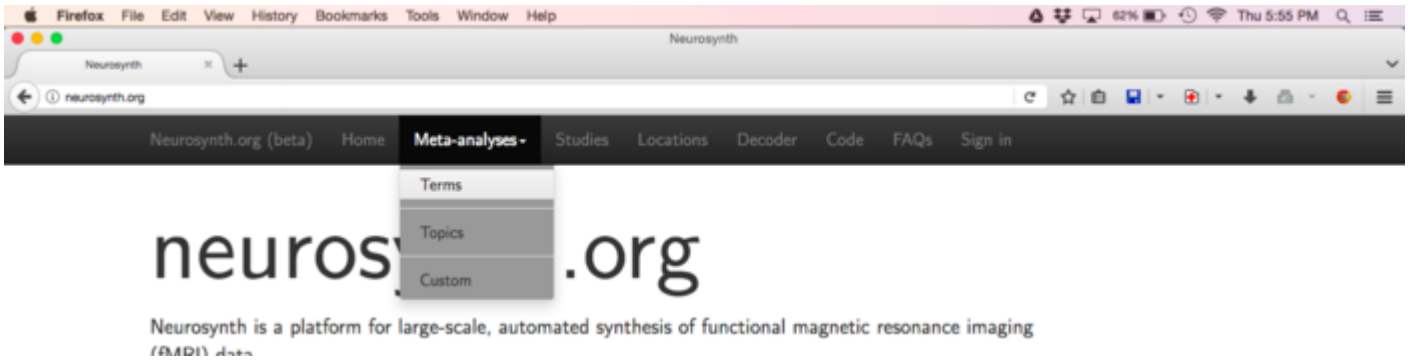
Neurosynth provides a very interesting service: it allows us to view something like the most probable functional activation map that we could expect from an fMRI study if all we knew about the study were its keywords.

Because of this, the terms or keywords that we enter in Neurosynth can make a big difference in the activation maps that we get back. In particular, the level of specificity of the terms can make a big difference. For example, as we know from class, the English word “memory” refers to many different cognitive processes, including many that probably rely on distinctly different brain regions. If we enter the query “memory,” Neurosynth will return a map showing the likely locations of functional activation across all published studies that featured the word “memory.” This will lump together “apples and oranges” – distinctly different patterns of activity produced by qualitatively different cognitive processes that happen to share the term “memory” in their names, like “episodic memory” and “working memory.”

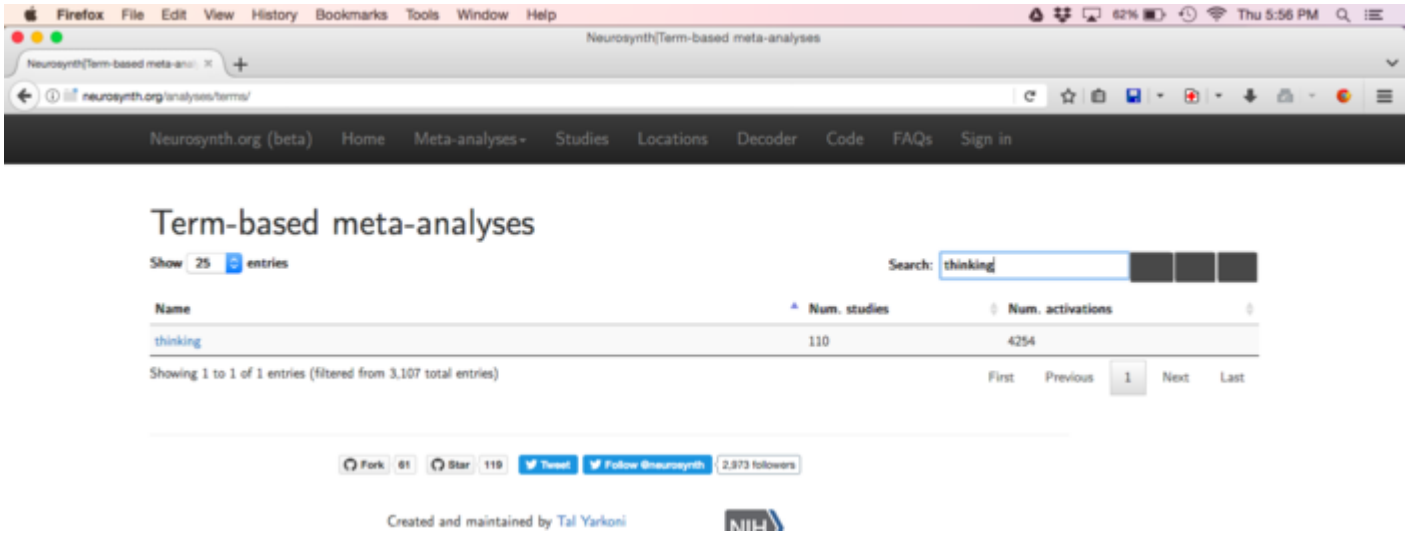
2.1 Select a Neurosynth term to use

Choose a term that captures the meaning of your week's topic, and type it into the “Terms” search box on Neurosynth. Sometimes the term you chose might not be part of the Neurosynth database, in which case you'll have to choose a similar term that is.

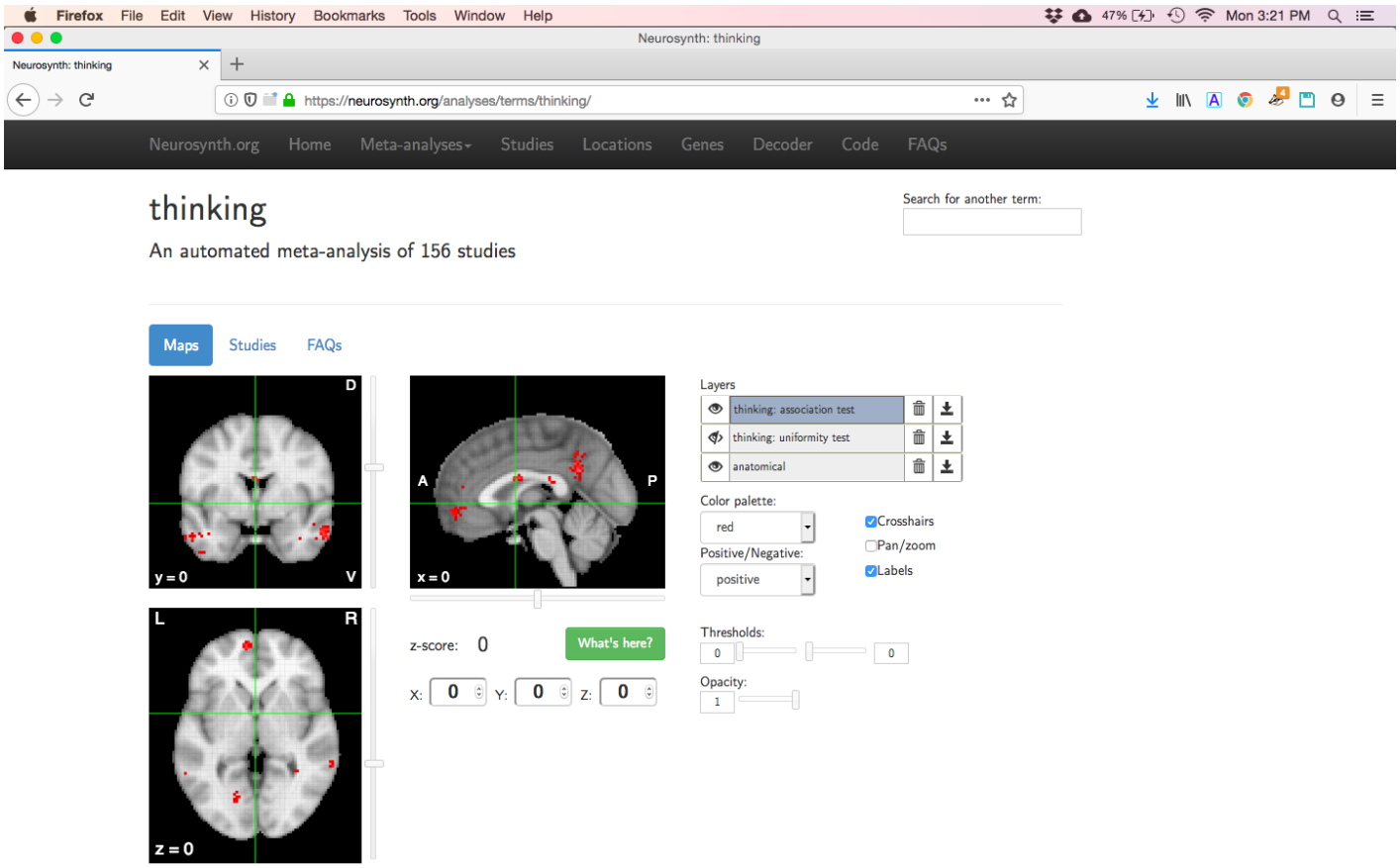
2.2 View the meta-analysis for your term



Select the Meta-analyses → Terms menu

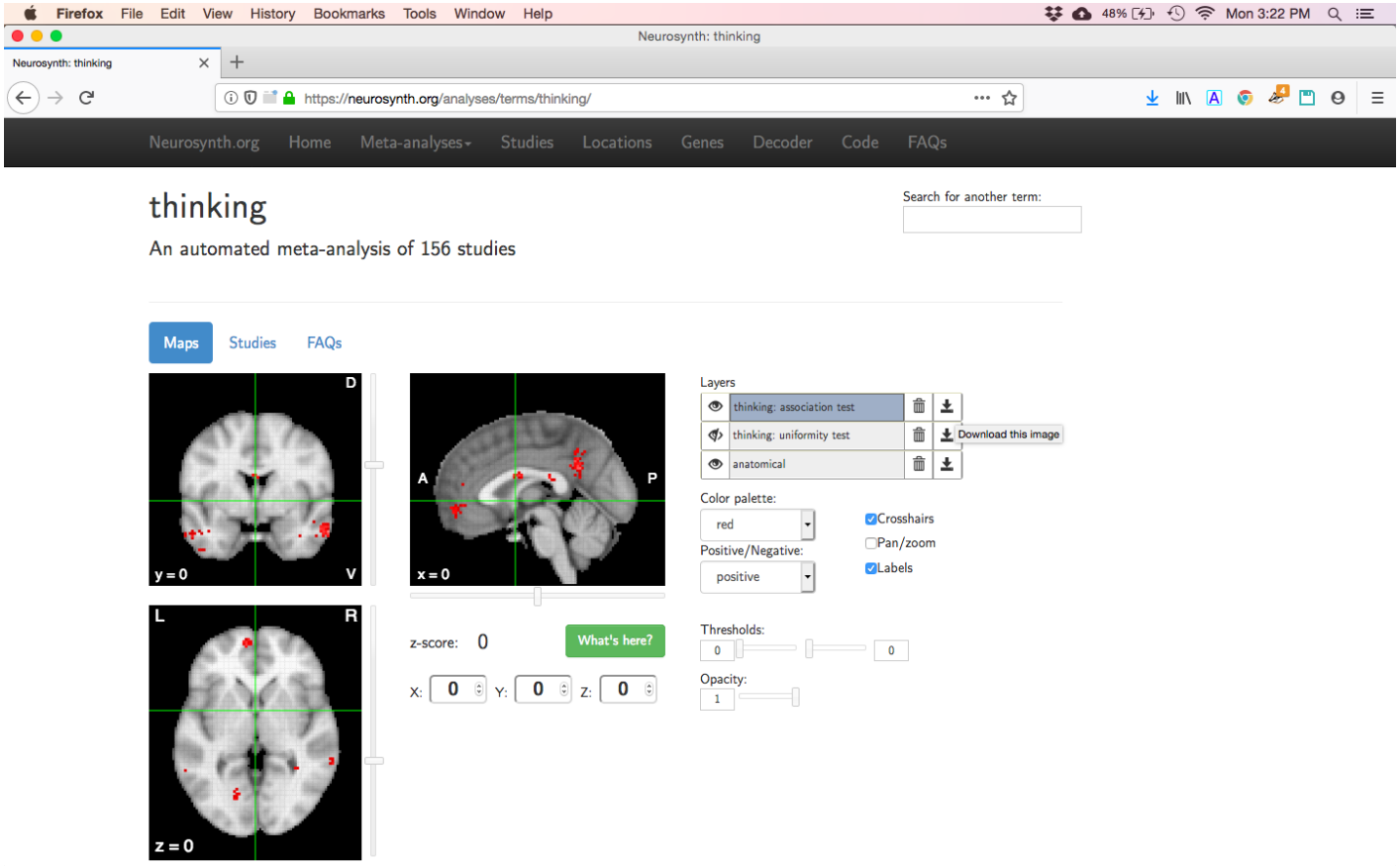


Type in your term and click the link that appears below

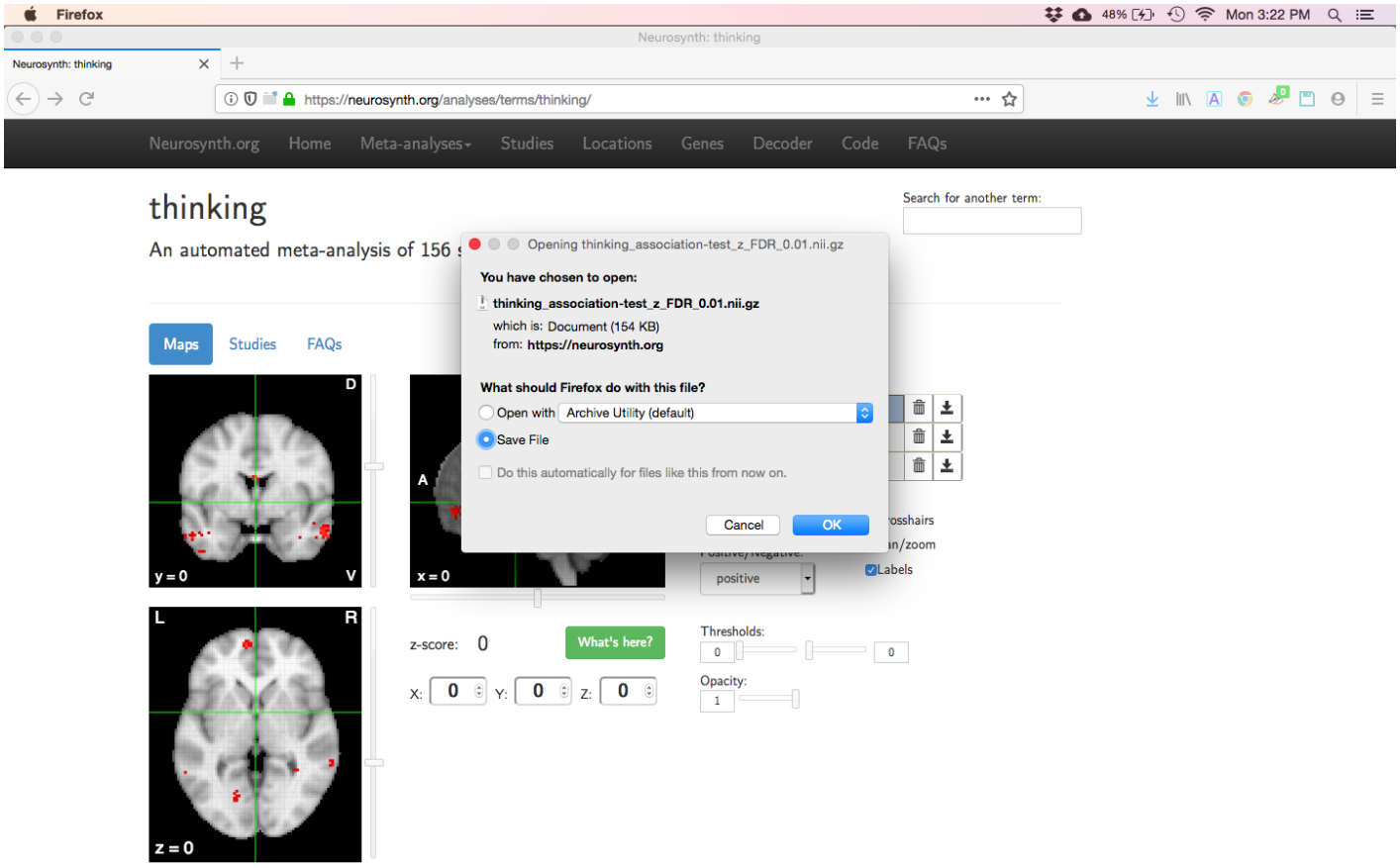


Viola! You see before you the results of a neuroimaging meta-analysis.

2.3 Download the brain map image for your topic



Click on the “download arrow” icon at the end of the “association test” line.



SAVE the file to a location that you can find later.

Explore brain map images using the Mango viewer

Follow the instructions above to open the average structural brain image and enable the atlas feature.

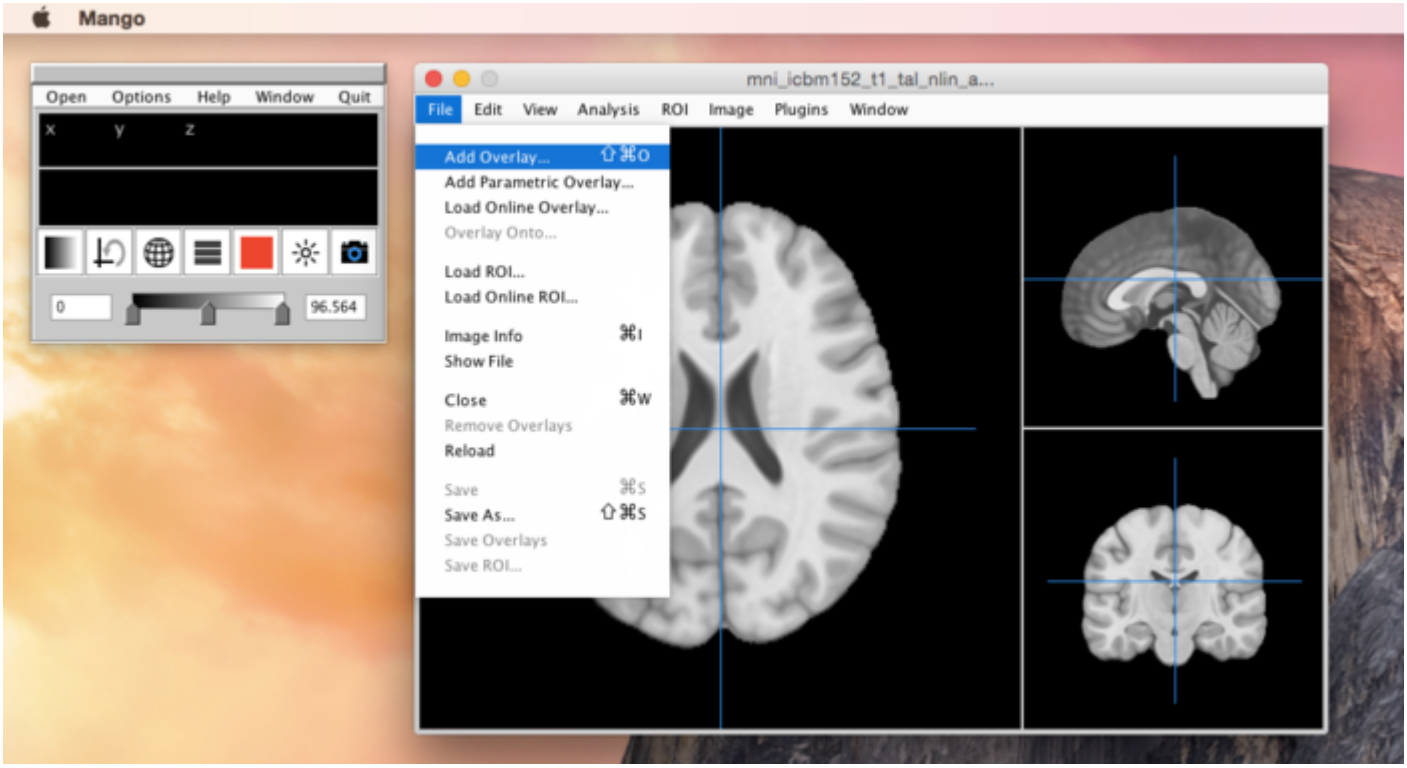
Again, the average structural brain image forms the background over which your functional activation maps will be overlaid.

1. Examine the Neurosynth brain map that you downloaded

Mango refers to functional brain maps as “overlays,” in contrast to the structural brain map, which is the “image.” Mango can only open one “image” at a time, but it can have multiple overlays open simultaneously.

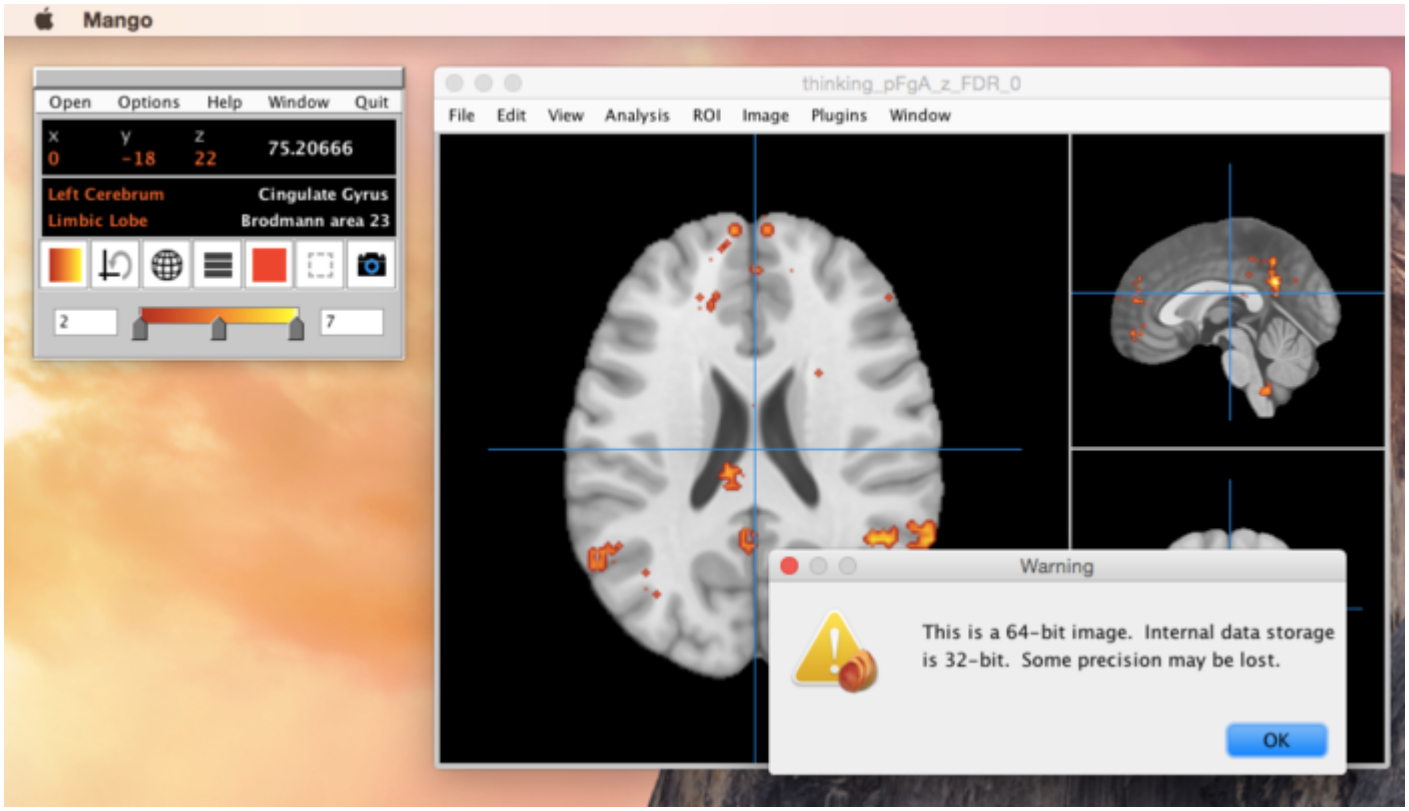
Now we can open the first file that you downloaded from Neurosynth. **DON'T** use the first Mango

window's “Open” menu, even though that sounds like a good choice. Instead, use the “File” menu on the viewing window that is displaying the structural brain image.



Use the File menu in the viewing window to open a functional activation map as an overlay.

If you get the warning shown in the figure below, just click “OK.”



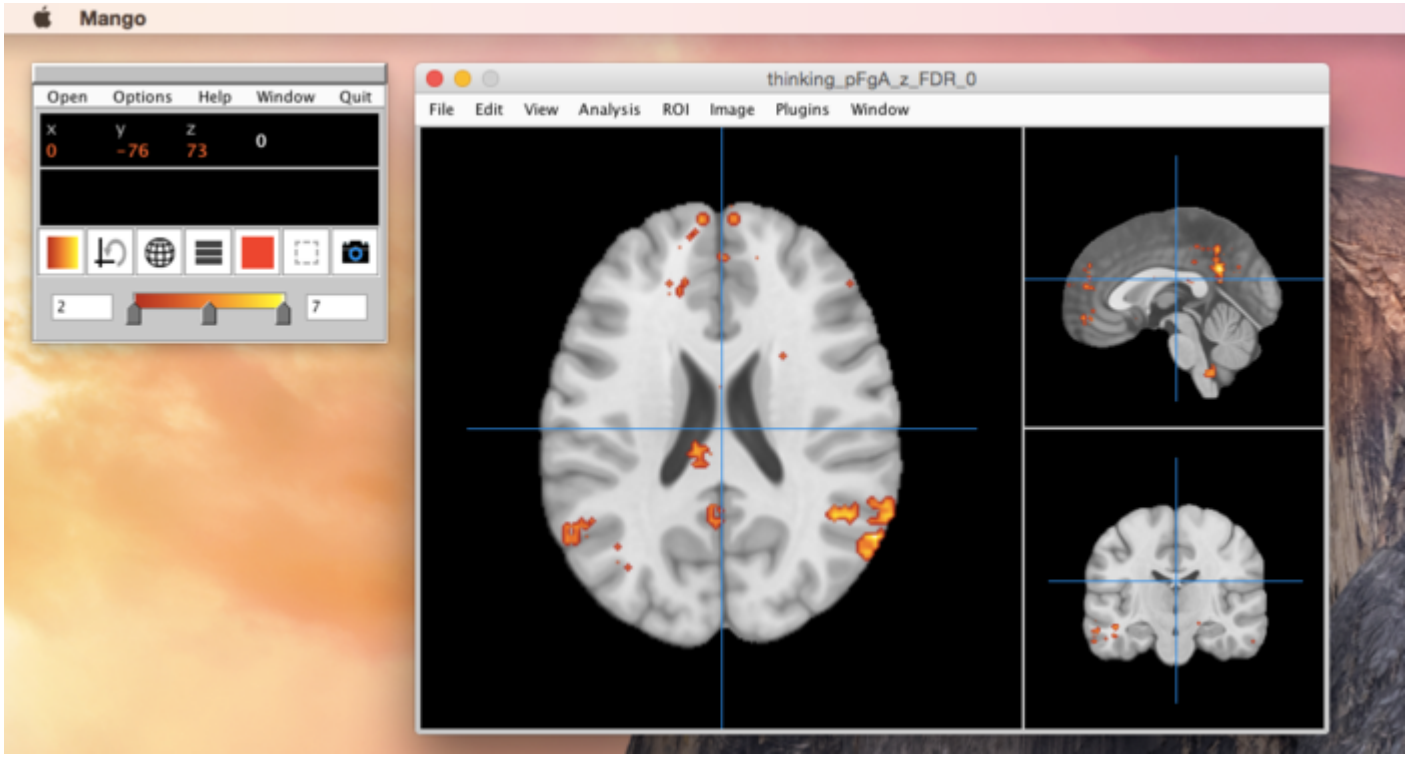
You can ignore this warning and click OK.

With any luck, you will now see bright orange/red blobs superimposed atop the structural brain image.

NOTE: Mango (and most other neuroimaging software) cannot display the entire brain at once. Mango's viewing window shows three different 2D views centered on the same crosshairs, but these three views still can't reveal the entire 3D volume of the brain. This means that there can always be functional activation blobs “hiding” somewhere just out of view.

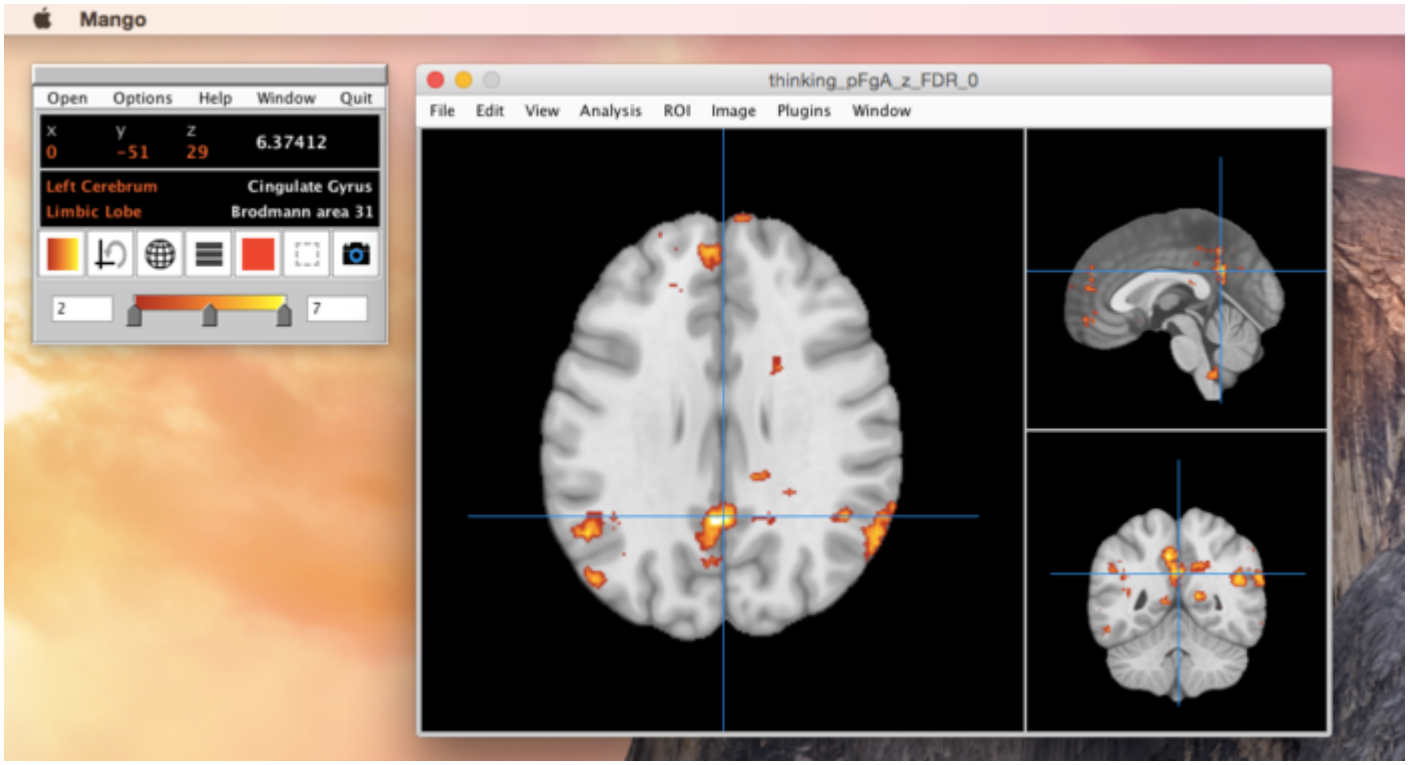
If you don't see any orange/red activation blobs after loading your first overlay, try clicking and dragging the mouse all around the brain, moving the blue crosshairs, until you've looked all over the entire brain. There is almost certainly a blob there somewhere.

it is possible that your particular Neurosynth map might not have any activation blobs that happen to be visible at the current view of the brain.



The display should look like this after adding the first functional activation map overlay.

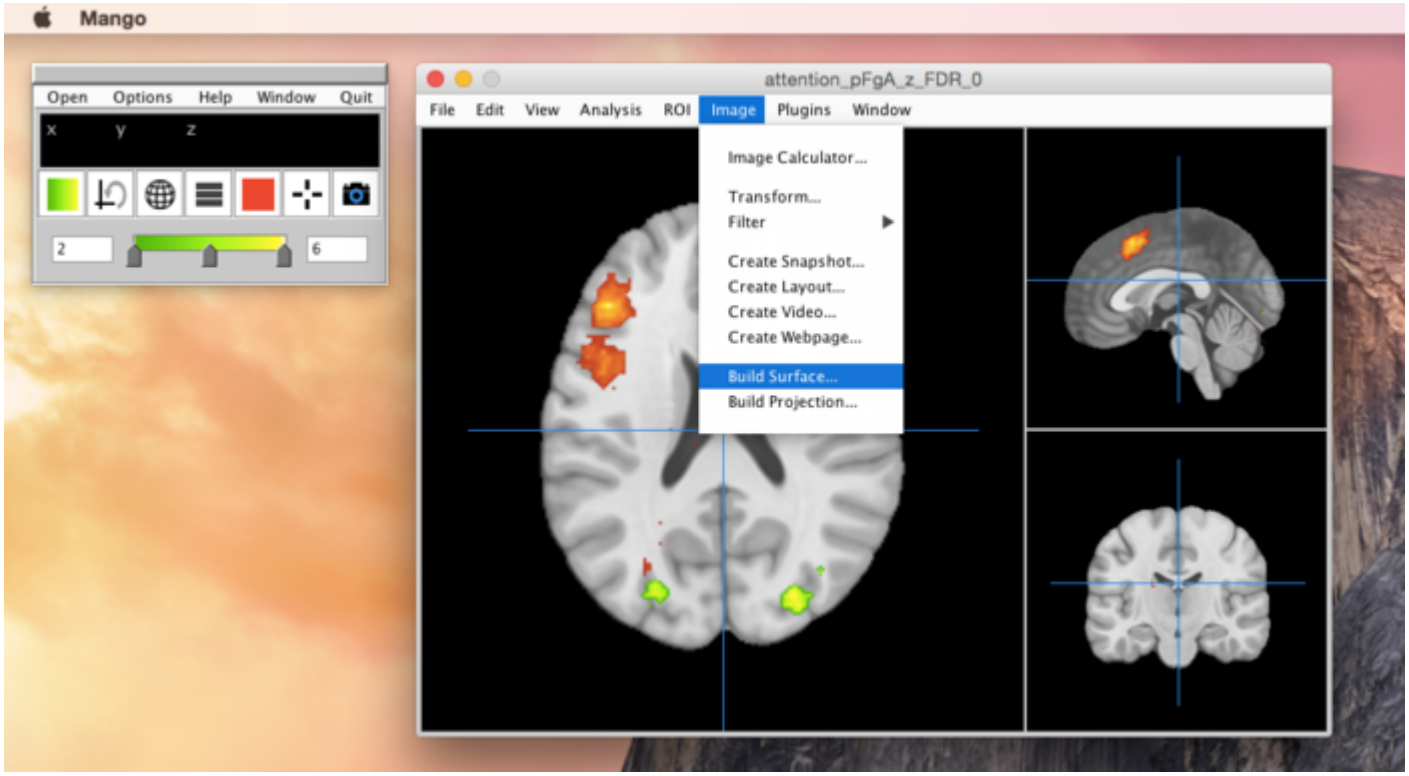
Even if you are rewarded by seeing a brainful of orange/red activation blobs immediately after loading your overlay, you should still click and drag the mouse around to explore the entire brain. You can do this within any of the three different panes of the viewing window. Mango will keep all three panes in sync, i.e. focused on the same point marked by the crosshairs.



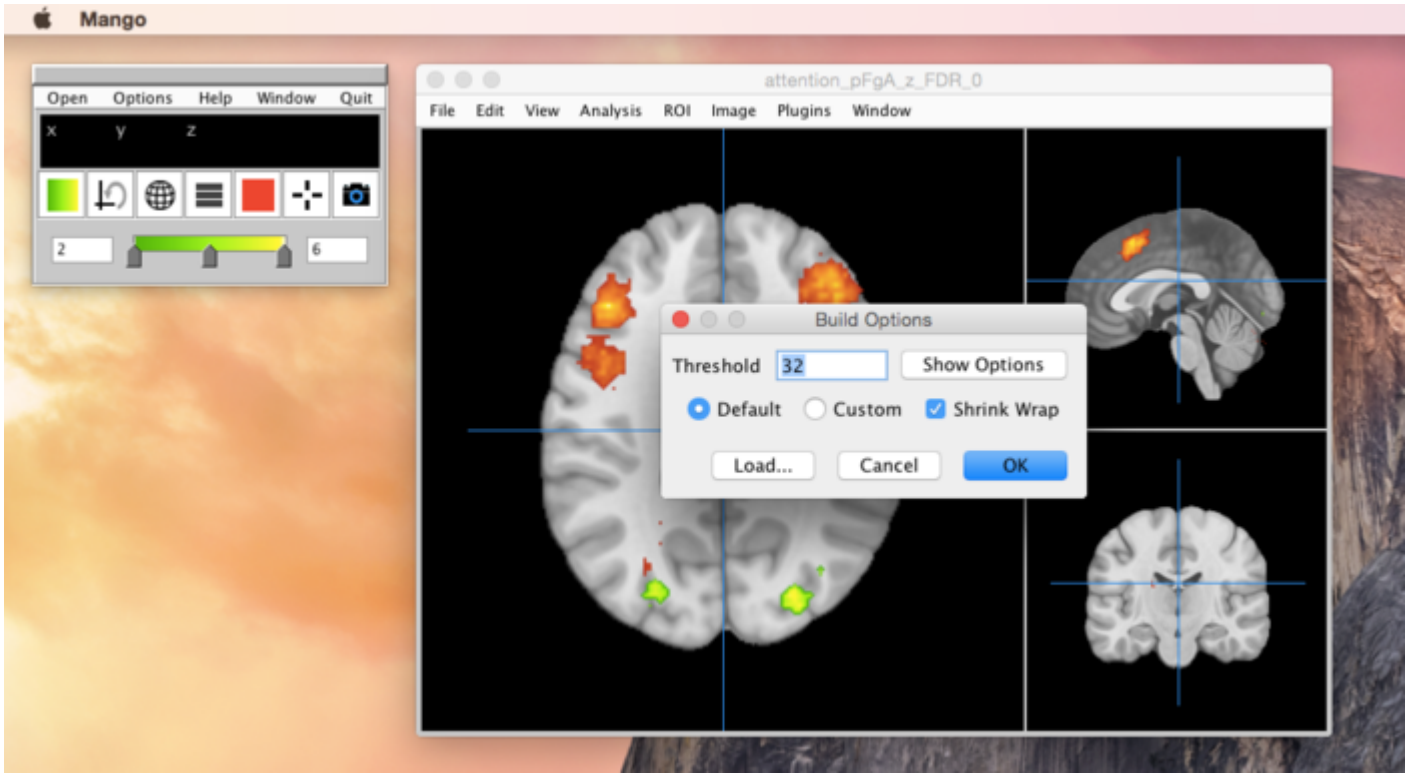
Click on activation blobs to focus all 3 viewing panes.

1.1 Make a 3D surface model

Make a 3D surface model showing the location of the region you chose (above).



Select Image → Build surface to make a 3D surface model



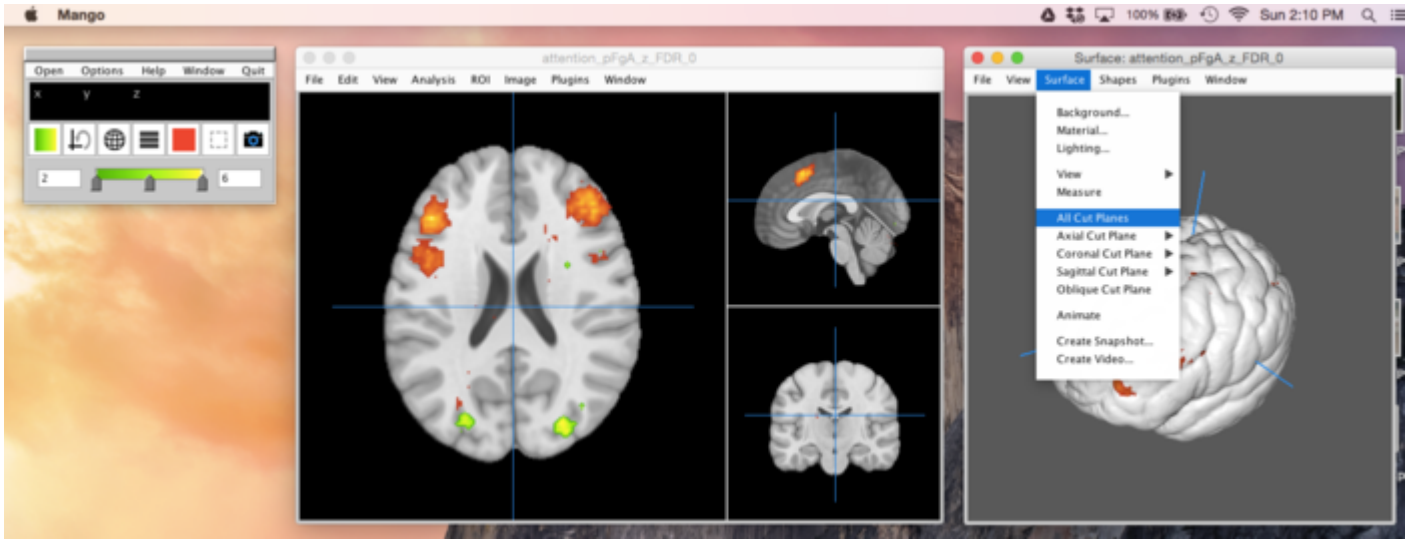
Click “OK” to accept the default options.



Behold! A brain you can spin around by clicking and dragging with the mouse.

The only activation blobs that will be visible on the 3D surface model are those that actually extend all the way to the outside of the average structural brain image. However, we can see any blobs we want by enabling “cut planes” in the 3D surface window. A “cut plane” is a noun, short for “cutTING plane.” It is like an invisible knife that cuts through the brain in one direction and removes all the brain stuff on the side facing us, the viewers seated at our computers.

The “All Cut Planes” option sets up a set of three “cut planes” that intersect at the point marked by the crosshairs.



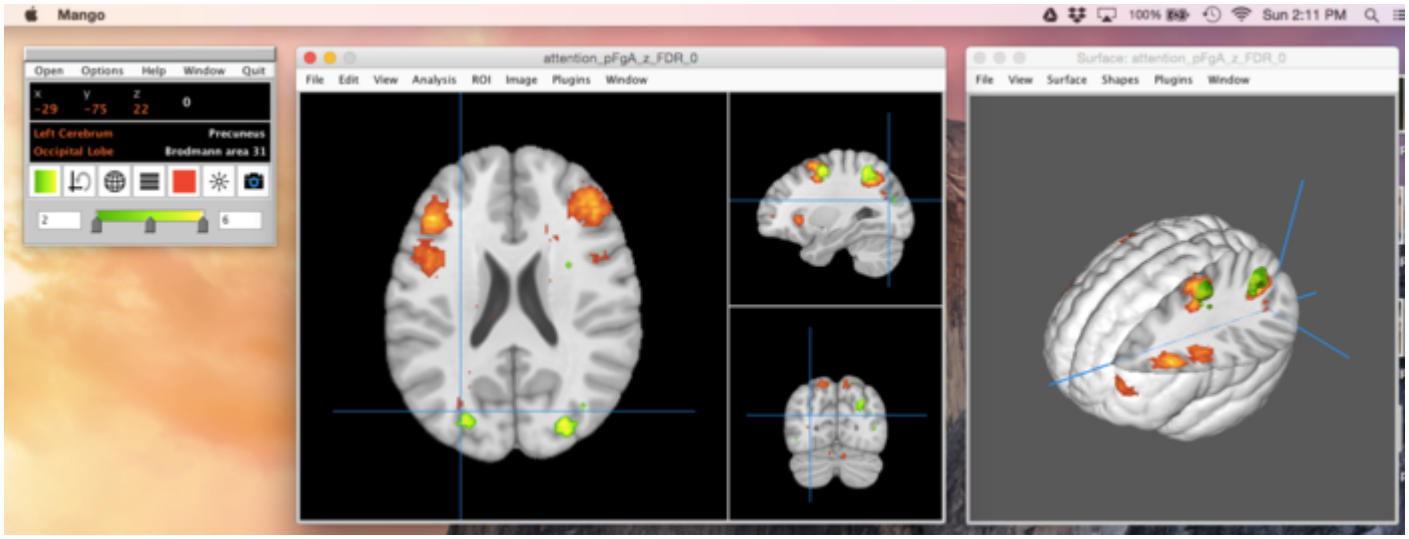
Select “Surface → “All Cut Planes”

This is how the 3D surface model should look after selecting the “All Cut Planes” menu item.



Congratulations! You now have a hole in your head.

The locations of the “cut planes” are linked to the crosshairs in the viewing window. To reveal different parts of the 3D surface model's interior, click and drag the mouse around in the *viewing window* (and not in the surface window).



The 3D surface model cut away to reveal the location marked by the crosshairs in the viewing window.

Take a screenshot of the 3D surface model

Move the “cut planes” around until you have revealed a nice view of the 3D surface model's interior, so

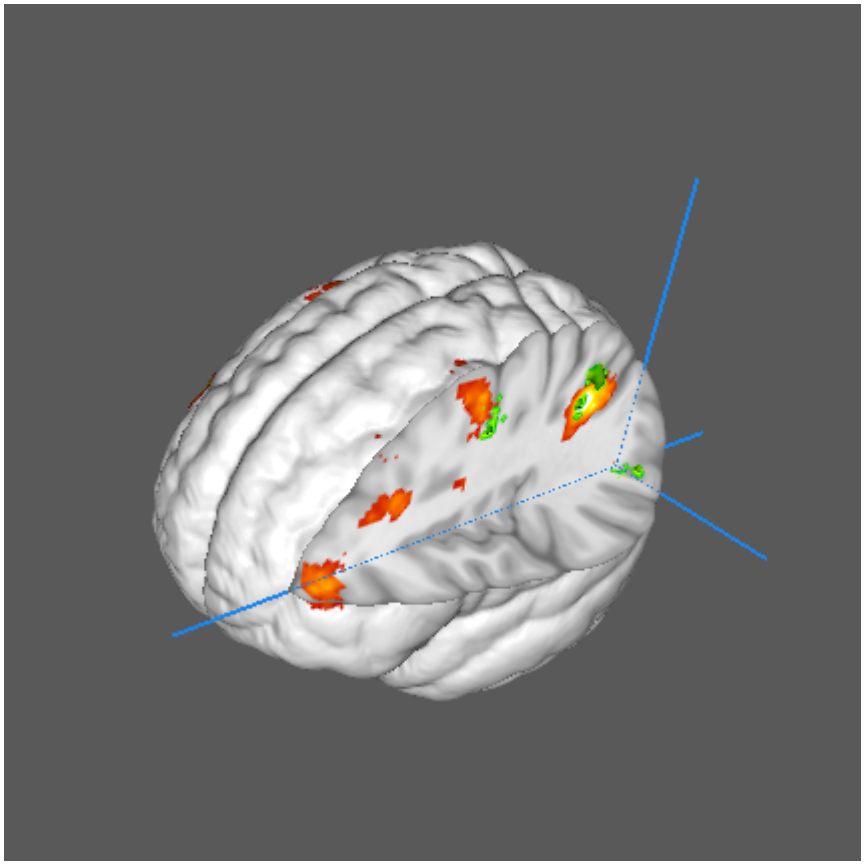
that blobs from the overlay are showing.

Submit a screenshot of your awesome, holey brain by doing this:

- Take a screenshot of the surface window.
- Paste the image into the proper location of the summary document template: the “Neurosynth map for the term” section.

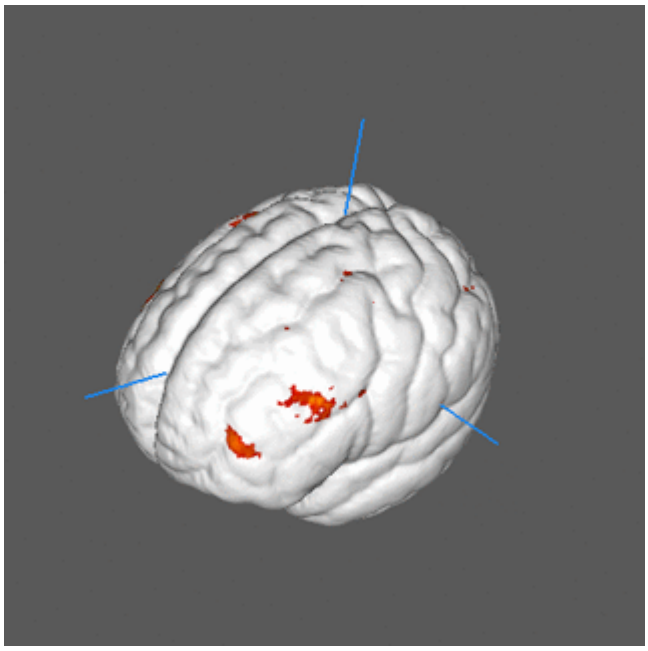
NOTE: You must have the Mango **surface window** “highlighted” or “in focus” (by clicking on it) before you use the main window's “camera” screenshot icon. Only the “highlighted” window's contents will be saved to the screenshot.

It should look similar to this:



An example screenshot of the surface window's contents

COMPLETELY NON-CREDIT OPTIONAL BONUS ACTIVITY:



You can explore the “Surface” menu to create a video of a spinning brain. The world is your oyster now.

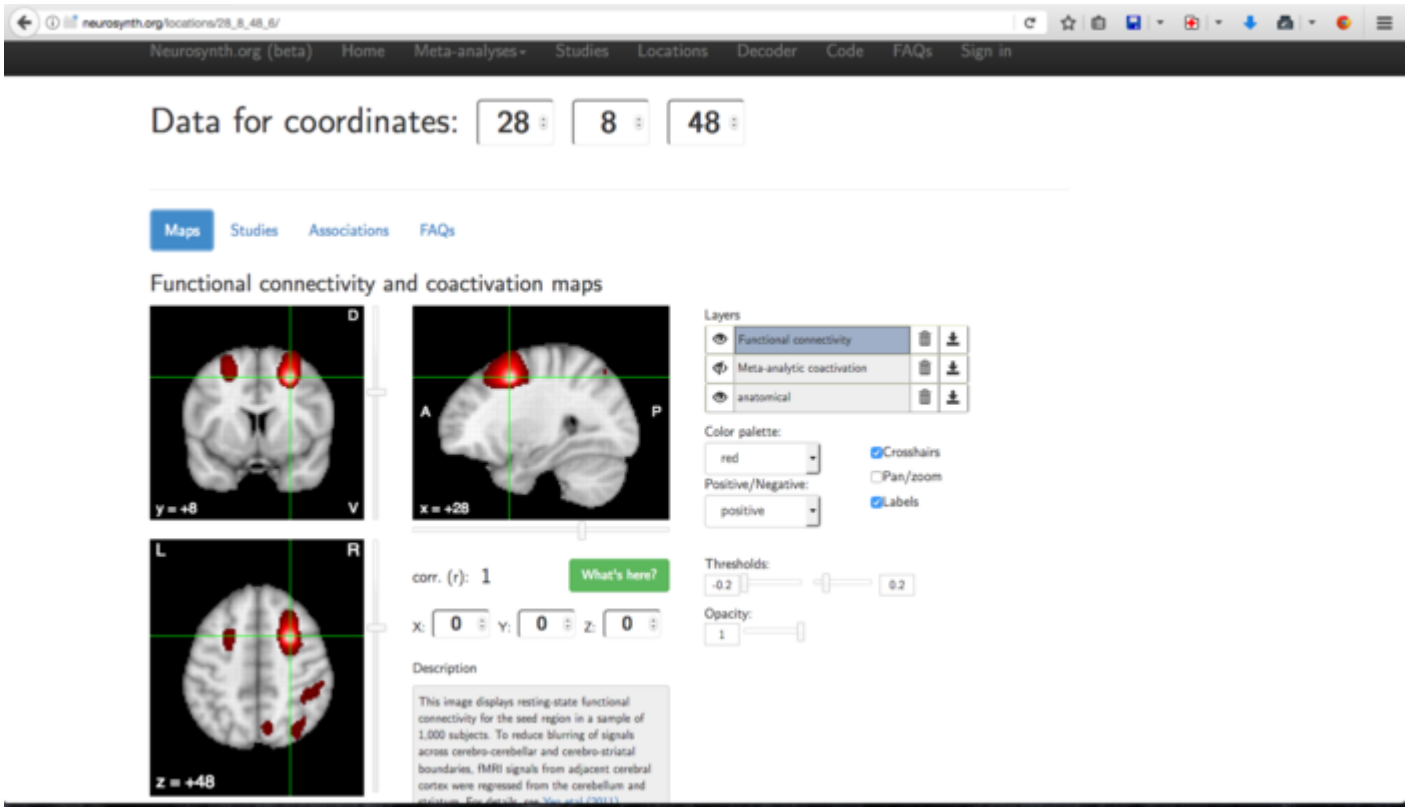
1.2 What other cognitive skills are associated with this region?

After you have picked the most important brain region (Instructions document item II.C.3.a), figure out how to identify that region and look it up on Neurosynth's “Locations” page (click the “Locations” link at the top of the main page.)

You do this in one of two ways:

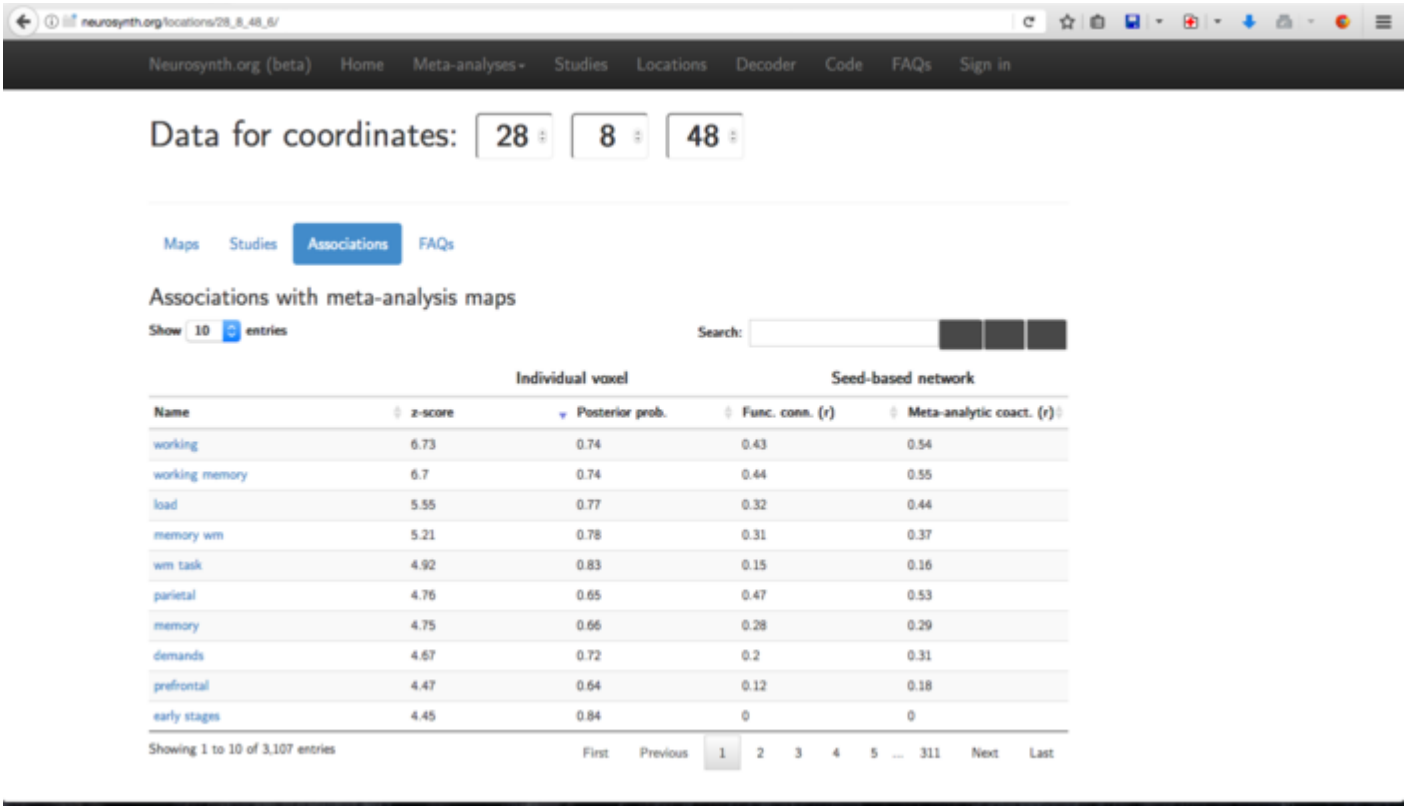
1. If you came across a set of 3D coordinates (x,y,z) in any of your reading or Neurosynth browsing, you can type them in the “Data for coordinates” fields.
2. Find a picture showing where your region is in the brain, and then click on the 3 views of the brain on the Neurosynth Locations page until you think the green crosshairs are at your location. Then click the “What's here?” button.

The web page will reload, showing a brain map with crosshairs and bright colors centered on the coordinates that you entered/clicked on.



We will not use the "Functional connectivity and coactivation maps" that appear, but here is a brief explanation about them for those who might be interested. This color map represents something different from the meta-analysis activation maps that you produced earlier. This time, the color map indicates the probability that the location at these coordinates is "connected" with other locations in the brain. I put "connected" in quotes because the color map is not based on measures of **anatomical** connectivity, even thought those exist (e.g. diffusion tensor imaging maps of white matter pathways). Neurosynths' "Functional connectivity and coactivation maps" display something like the probability that other regions will be active in a functional MRI, given that the region under the crosshairs is active.

We will click on the "Association" link that appears above the brain map. The resulting web page gives a table listing the names of other Neurosynth meta-analysis maps (that already exist, somewhere on the Neurosynth web server) that have especially high values at the coordinates we entered.



Click the “Associations” link to see this list of terms associated with your coordinates.

We can use the names of these meta-analyses as a set of rough guesses about what other cognitive skills might be associated with this brain location. Again, the activation maps from Neurosynth meta-analyses are interesting because they represent pretty good answers to questions like, “If all I know about a neuroimaging study is that the term X appeared in the article, which brain regions were likely to be active?” Right now we are considering something like the reverse question: “If all I know about a neuroimaging study is that coordinate X,Y,Z was active, what terms were likely to appear in the article?” It requires an additional leap of faith to guess that just because an article included the term “language comprehension” (for example), that our brain region is actively involved in producing that cognitive skill, but it's a great start.

Copy the table from the "Associations" page and paste it at the bottom of your answer.

Again, this table should have only 10 rows.

Paste the table into the proper location in the summary document template.

Footnotes

1)

Both “free as in speech” and “free as in beer.” https://en.wikipedia.org/wiki/Gratis_versus_libre

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