Brain Atlas

The BRAPH 2 Developers

June 30, 2023

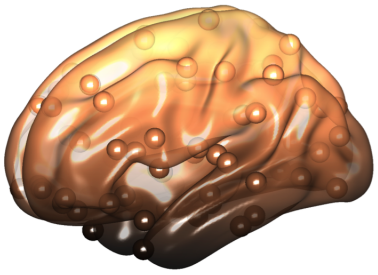


Figure 1: **Brain atlas figure created with BRAPH 2.0.** Example of a brain surface image with some nodes representing brain regions.

This Tutorial explains how to work with the Graphical User Interface (GUI) to manage brain atlases. This is typically the first step required to perform a graph analysis in BRAPH 2.0. In this Tutorial, we will explain you how to upload a brain atlas, how to visualize it, and how to export publication-ready brain figures.

Contents

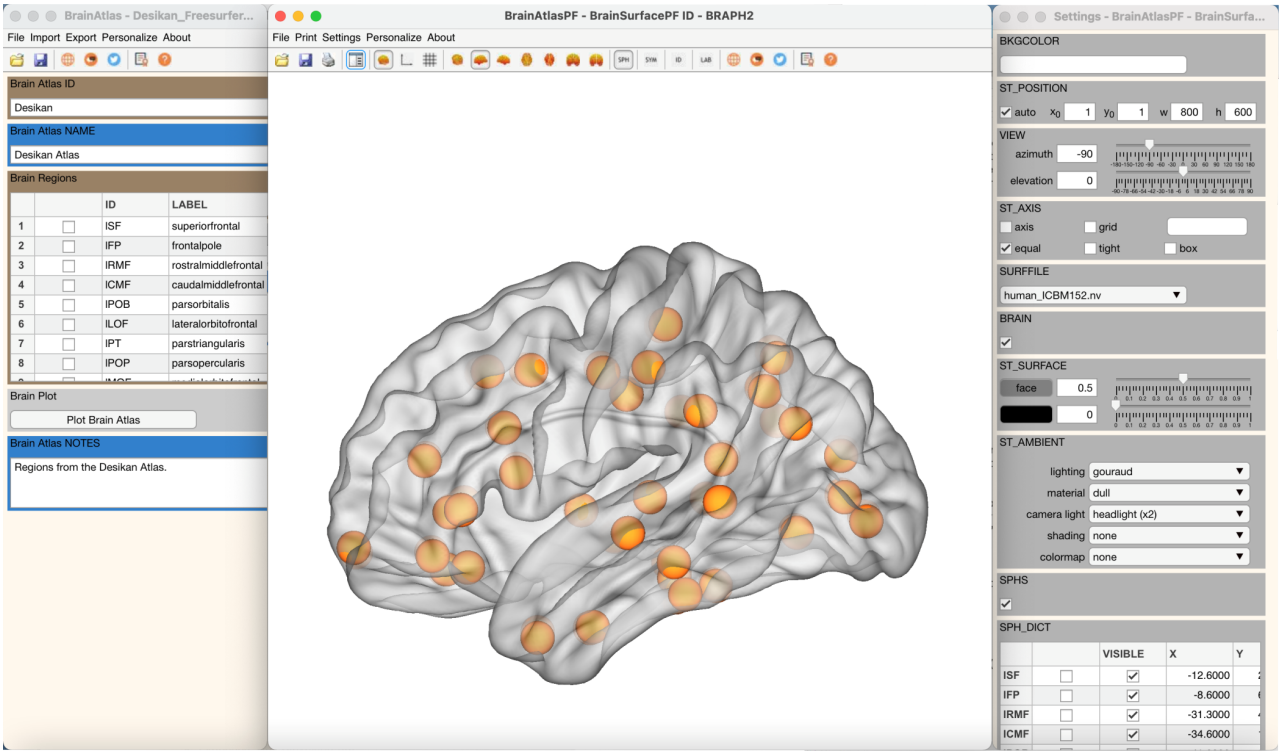


Figure 2: **Brain Atlas GUI.** Full graphical user interface to work with a brain atlas in BRAPH 2.0.

Open the GUI

The brain atlas GUI is the first step in most BRAPH 2.0 pipelines. You can open it by typing `braph2` in the MatLab's terminal, which allows you to select a pipeline containing the steps required to preform your analysis. The initial step is typically to upload the brain atlas, as shown in Figure 3a.

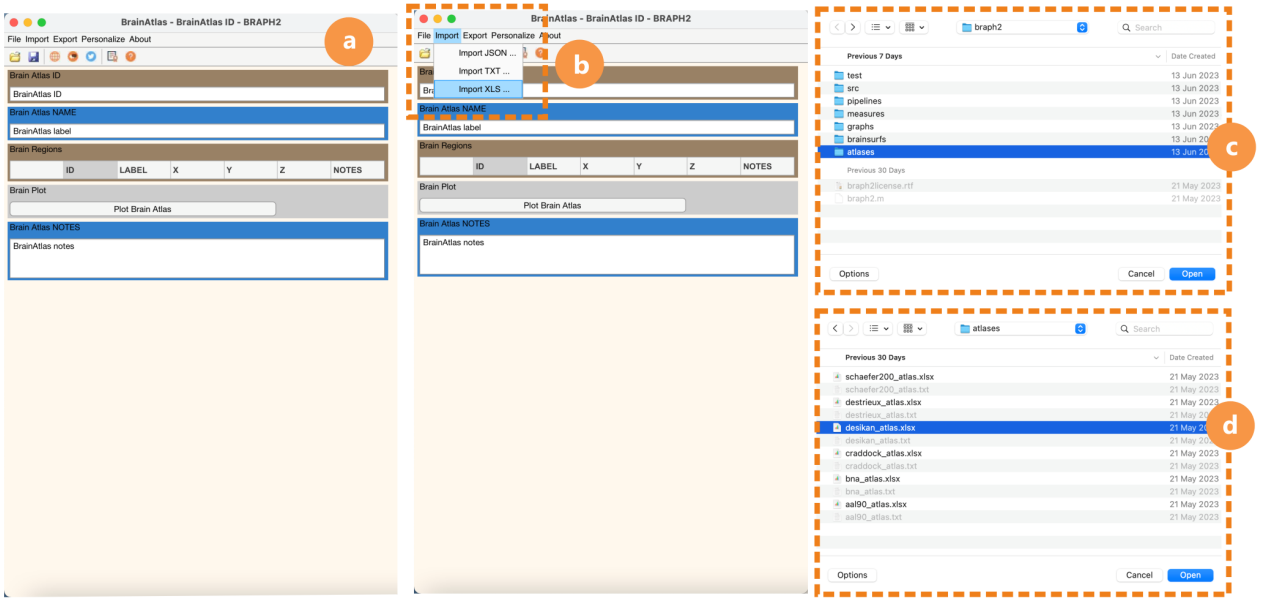


Figure 3: **Upload a brain atlas.** The different steps you need to follow to open a brain atlas using the GUI: **a** Open the brain atlas GUI. **b** Import a brain atlas from an XLS or TXT file. **c** Navigate to the BRAPH 2.0 folder `atlases`. **d** Select the desidered atlas.

To open the GUI and upload the brain atlas, you can also do it from the command line (i.e., without opening an analysis pipeline) by typing the commands in Code 1.

Code 1: **Code to launch the Brain Atlas GUI.** This code can be used in the MatLab command line to launch the Brain Atlas GUI without having to open a pipeline.

```
1 ba = BrainAtlas(); (1)
2
3 gui = GUIElement('PE', ba); (2)
4 gui.get('DRAW') (3)
5 gui.get('SHOW') (4)
```

(1) creates a new object `BrainAtlas`.

(2) creates a GUI to upload the brain atlas.

(3) draws the GUI.

(4) shows the GUI.

Upload the Brain Atlas

In the GUI launched in the previous step, you have a menu that can be used to import a brain atlas (Figure 3b) either by loading one of the already-available atlases in the BRAPH 2.0 folder `atlases` (Figure 3c) or by loading a file you have created. In this example, we are uploading the Desikan atlas (Figure 3d).

You can change the ID, name, and notes of the brain atlas (as shown in Figure 4a) as well as the IDs, labels, coordinates, and notes of the brain regions (Figure 4b).

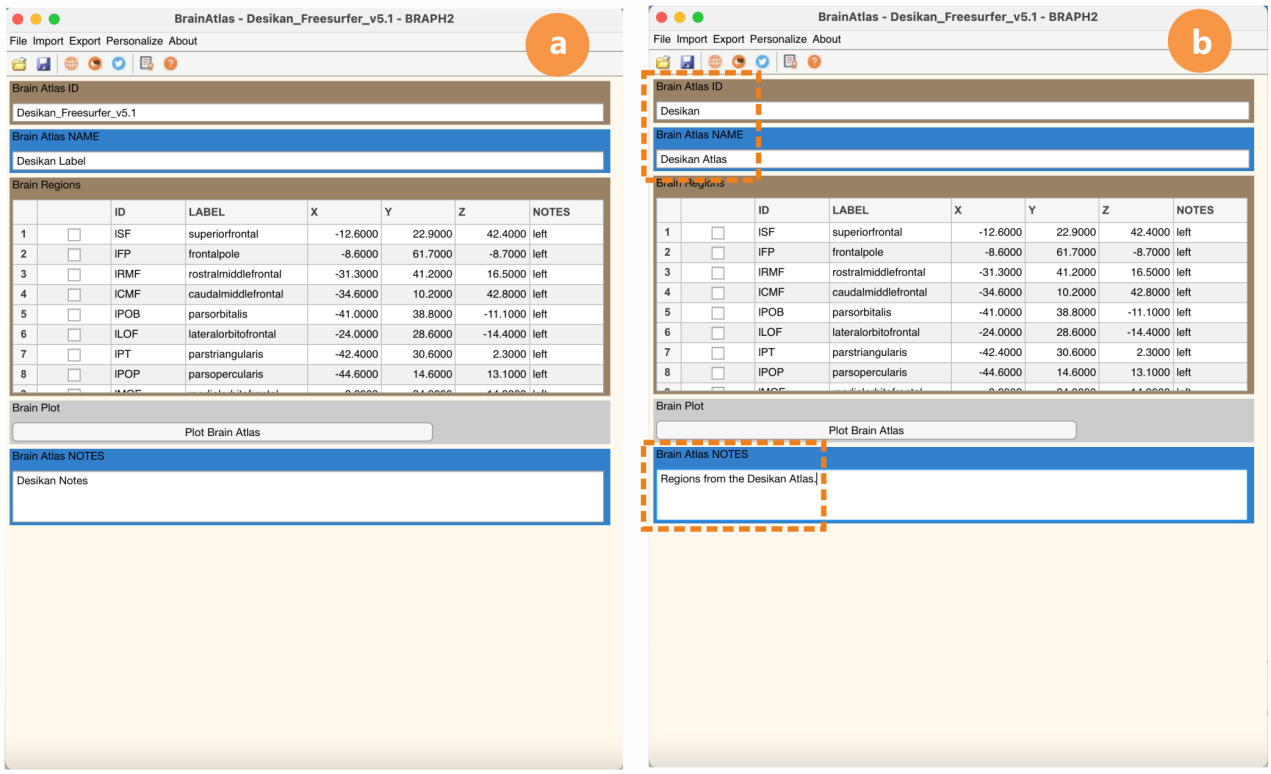


Figure 4: **Edit the brain atlas information.** Information that can be changed in the brain atlas GUI: **a** The ID, name, and notes of the brain atlas. **b** The IDs, labels, coordinates, and notes of the brain regions.

Ready Brain Atlases

Currently, we provide several brain atlases that are commonly used in the field of brain connectomics, some of which are shown in Figure 5). They are available in the BRAPH 2.0 folder `atlases` in XLS and TXT formats, and they can also can be downloaded from our website (`http://braph.org/software/brain-atlases/`).

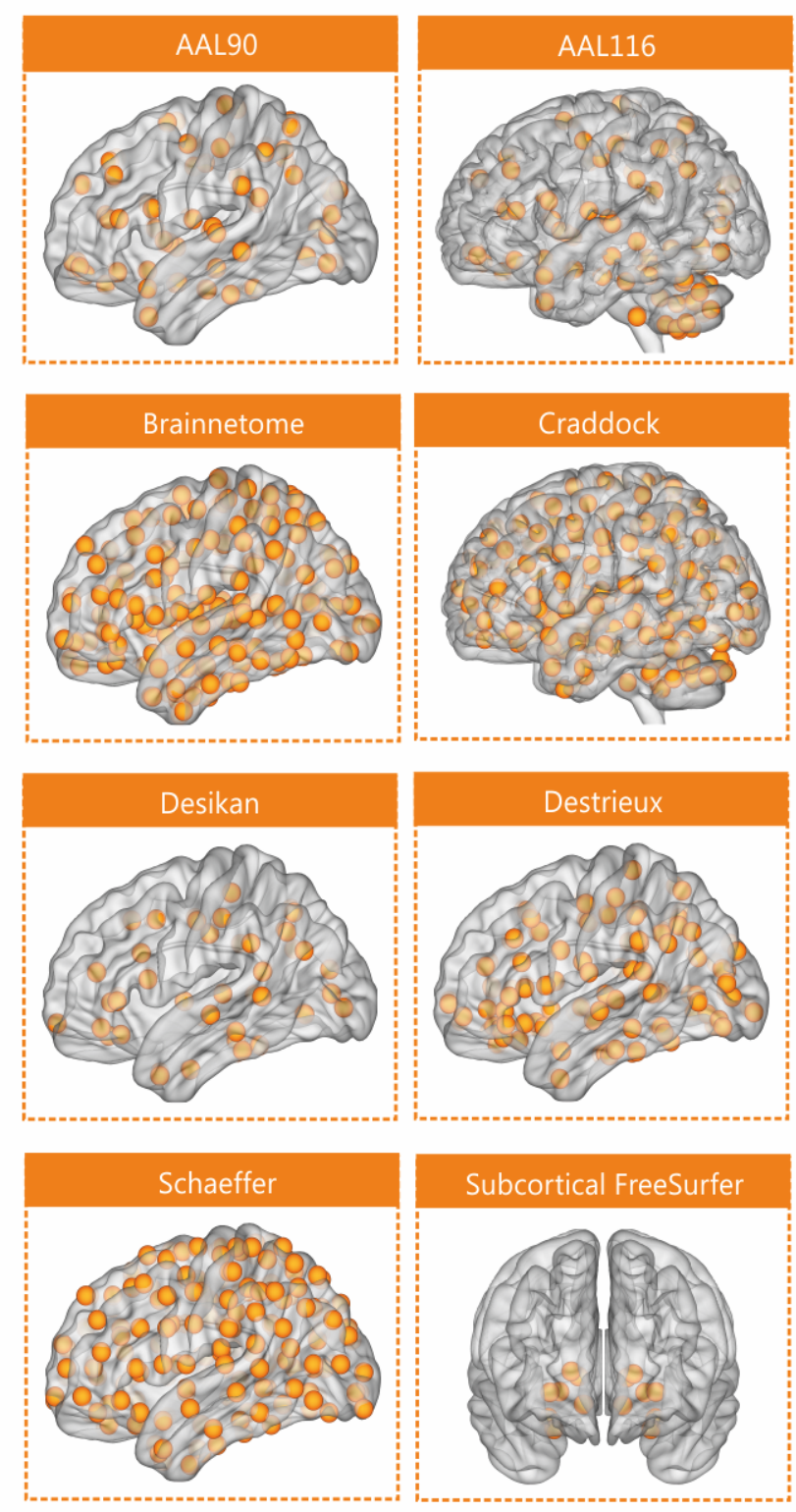
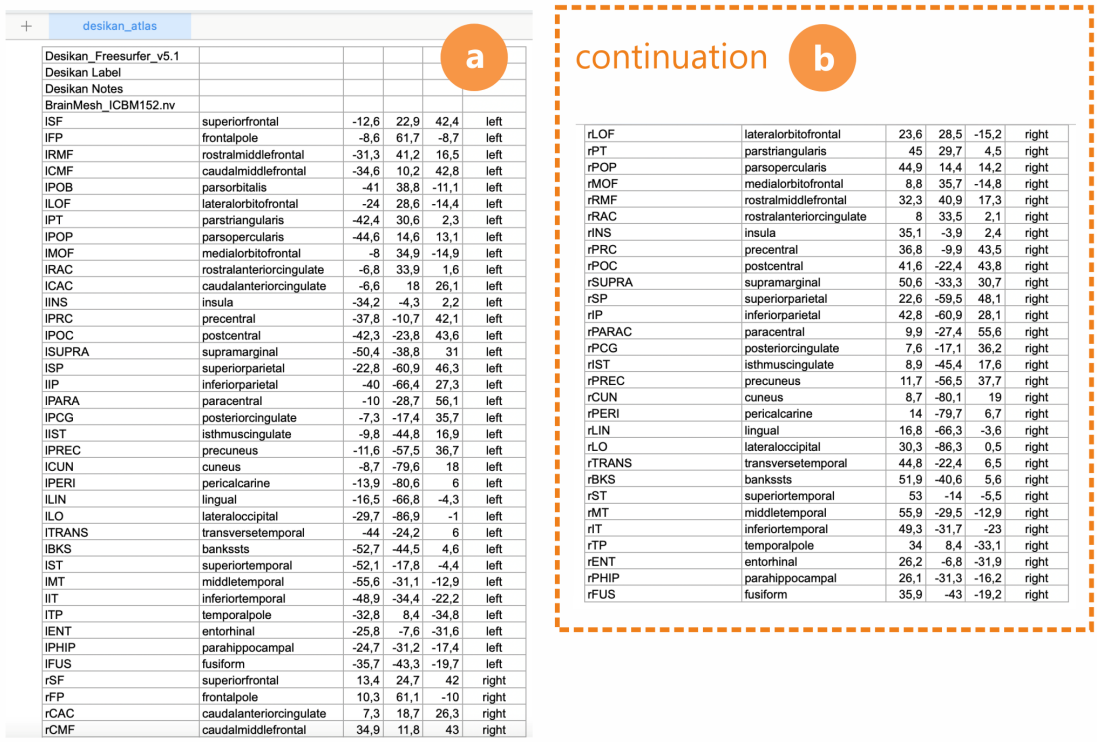


Figure 5: **Brain Atlases.** Some brain atlases provided by BRAPH 2.0:
AAL90 Automated Anatomical Labelling atlas with 90 cortical and subcortical regions.
AAL116 Automated Anatomical Labelling atlas with 116 cortical and subcortical regions, including cerebellar areas.
BNA Brainnetome atlas with 246 cortical and subcortical regions.
Craddock Functional atlas with 200 cortical and subcortical regions, including cerebellar areas.
Desikan Anatomical atlas with 68 cortical from the FreeSurfer software.
Destrieux Anatomical atlas with 148 cortical from the FreeSurfer software.
Schaefer Functional brain atlas with 200 cortical regions that belong to 7 different resting-state fMRI networks.
Subcortical FreeSurfer Anatomical atlas with 14 subcortical gray matter regions from the FreeSurfer software.

Create a New Brain Atlas

To create a new brain Atlas in BRAPH 2.0 format, you should create a new XLS file (`*.xls` or `*.xlsx`), as shown in Figure 6. (It is also possible to create it in TXT format (`*.txt`), for which we refer to the examples available in the BRAPH 2.0 folder `atlases`.)



Desikan_Freesurfer_v5.1					
Desikan Label					
Desikan Notes					
BrainMesh_ICBM152.nv					
lSF	superiorfrontal	-12,6	22,9	42,4	left
lFP	frontalpole	-8,6	61,7	-8,7	left
lRMF	rostralmiddlefrontal	-31,3	41,2	16,5	left
lCMF	caudalmiddlefrontal	-34,6	10,2	42,8	left
lPOB	parsorbitalis	-41	38,8	-11,1	left
lLOF	lateralorbitofrontal	-24	28,6	-14,4	left
lPT	parstriangularis	-42,4	30,6	2,3	left
lPOP	parsopercularis	-44,6	14,6	13,1	left
lMOF	medialorbitofrontal	-8	34,9	-14,9	left
lRAC	rostralanteriorcingulate	-6,8	33,9	1,6	left
lCAC	caudalanteriorcingulate	-6,6	18	26,1	left
lINS	insula	-34,2	-4,3	2,2	left
lPRC	precentral	-37,8	-10,7	42,1	left
lPOC	postcentral	-42,3	-23,8	43,6	left
lSUPRA	supramarginal	-50,4	-38,8	31	left
lSP	superiorparietal	-22,8	-60,9	46,3	left
lIP	inferiorparietal	-40	-66,4	27,3	left
lPARA	paracentral	-10	-28,7	56,1	left
lPCG	posteriorcingulate	-7,3	-17,4	35,7	left
lIST	isthmuscingulate	-9,8	-44,8	16,9	left
lPREC	precuneus	-11,6	-57,5	36,7	left
lCUN	cuneus	-8,7	-79,6	18	left
lPERI	pericalcarine	-13,9	-80,6	6	left
lLIN	lingual	-16,5	-66,8	-4,3	left
lLO	lateraloccipital	-29,7	-86,9	-1	left
lTRANS	transversetemporal	-44	-24,2	6	left
lBKS	bankssts	-52,7	-44,5	4,6	left
lST	superiortemporal	-52,1	-17,8	-4,4	left
lMT	middletemporal	-55,6	-31,1	-12,9	left
lIT	inferiortemporal	-48,9	-34,4	-22,2	left
lTP	temporalpole	-32,8	8,4	-34,8	left
lENT	entorhinal	-25,8	-7,6	-31,6	left
lPHIP	parahippocampal	-24,7	-31,2	-17,4	left
lFUS	fusiform	-35,7	-43,3	-19,7	left
rSF	superiorfrontal	13,4	24,7	42	right
rFP	frontalpole	10,3	61,1	-10	right
rCAC	caudalanteriorcingulate	7,3	18,7	26,3	right
rCMF	caudalmiddlefrontal	34,9	11,8	43	right
rLOF	lateralorbitofrontal	23,6	28,5	-15,2	right
rPT	parstriangularis	45	29,7	4,5	right
rPOP	parsopercularis	44,9	14,4	14,2	right
rMOF	medialorbitofrontal	8,8	35,7	-14,8	right
rRMF	rostralmiddlefrontal	32,3	40,9	17,3	right
rRAC	rostralanteriorcingulate	8	33,5	2,1	right
rINS	insula	35,1	-3,9	2,4	right
rPRC	precentral	36,8	-9,9	43,5	right
rPOC	postcentral	41,6	-22,4	43,8	right
rSUPRA	supramarginal	50,6	-33,3	30,7	right
rSP	superiorparietal	22,6	-59,5	48,1	right
rIP	inferiorparietal	42,8	-60,9	28,1	right
rPARAC	paracentral	9,9	-27,4	55,6	right
rPCG	posteriorcingulate	7,6	-17,1	36,2	right
rIST	isthmuscingulate	8,9	-45,4	17,6	right
rPREC	precuneus	11,7	-56,5	37,7	right
rCUN	cuneus	8,7	-80,1	19	right
rPERI	pericalcarine	14	-79,7	6,7	right
rLIN	lingual	16,8	-66,3	-3,6	right
rLO	lateraloccipital	30,3	-86,3	0,5	right
rTRANS	transversetemporal	44,8	-22,4	6,5	right
rBKS	bankssts	51,9	-40,6	5,6	right
rST	superiortemporal	53	-14	-5,5	right
rMT	middletemporal	55,9	-29,5	-12,9	right
rIT	inferiortemporal	49,3	-31,7	-23	right
rTP	temporalpole	34	8,4	-33,1	right
rENT	entorhinal	26,2	-6,8	-31,9	right
rPHIP	parahippocampal	26,1	-31,3	-16,2	right
rFUS	fusiform	35,9	-43	-19,2	right

Figure 6: **Create your own brain atlas.** Overview of how the XLS file containing your atlas information should look like.

Start by writing the following information in the first 4 rows:

- Brain Atlas ID (row 1, column 1). For example: Desikan FreeSurfer
- Brain Atlas LABEL (row 2, column 1). For example: Desikan Labels
- Brain Atlas NOTES (row 3, column 1). For example: Desikan Nodes
- Brain Surface Name (row 4, column 1). For example: BrainMeshICBM152.nv

Then, from row 5, you should include the IDs of the regions of your atlas (1st column), the labels of the regions of your atlas (2nd column), the X, Y and Z coordinates (3rd, 4th, and 5th columns), and any relevant notes (in this case, the brain hemisphere, 6th column).

Plot the Brain Atlas

Once you are satisfied with the brain atlas, you can plot it by pushing the button "Plot Brain Atlas" (Figure 7a). This will open an image with a brain surface and nodes corresponding to the brain regions (Figure 7b).

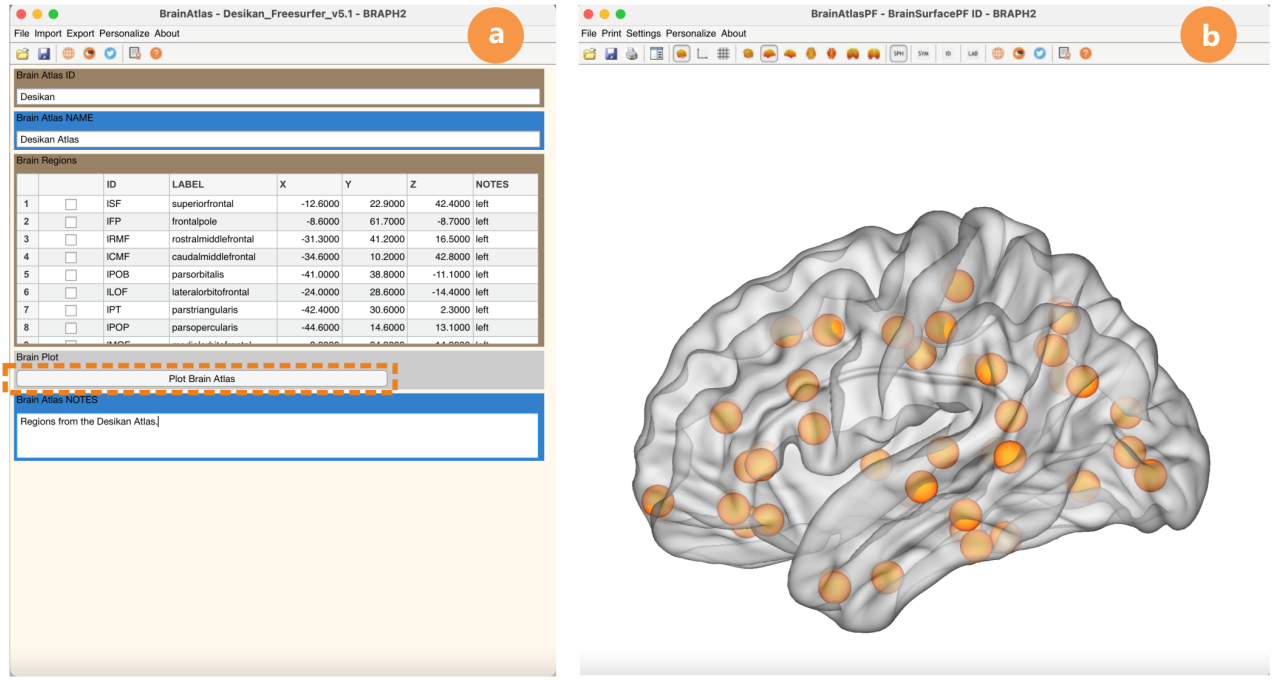


Figure 7: **Brain atlas visualization.** Plotting the nodes of a brain atlas on a 3D brain surface.

This new window has a large toolbar that allows you to change the visualization of the atlas. We suggest you try the different options to understand how they change the figure. Importantly, within this menu, there is one option called "Settings Brain Surface" (highlights in Figure 8a), which opens the settings window shown in Figures 8b-c.

The settings window allows you to optimize how the brain regions included in your analysis are visualized. This is often included as a first figure in a manuscript.

Most things in the settings window are intuitive. So we encourage you to try different them out until you achieve the visualization you want. There are many possibilities for visualization. Figure 9 shows just one example.

Each brain region can be represented with spheres, symbols, IDs, and labels. Spheres are objects that are rendered in 3D — often prettier, but also more computationally expensive. Symbols are objects

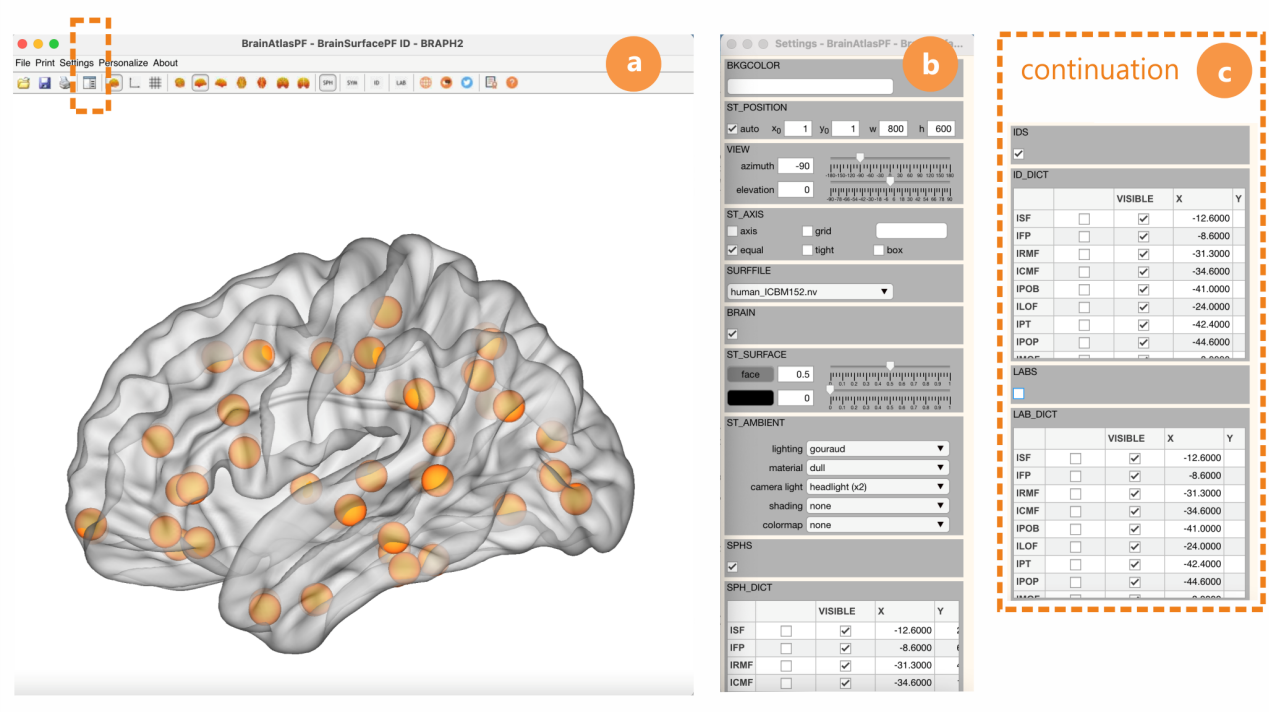


Figure 8: **Visualize the brain atlas. a** The "Settings Brain Surface" button in the toolbar opens **b-c** a window with the settings available for this brain figure.

rendered in 2D — more stylized and less computationally expensive. IDs and lables are the texts associated to the brain region.

If you wish to apply some properties to a set of brain regions, you can select multiple regions with the selectors on the right, and then right-click and select "apply to selection" before applying some property.

Importantly, BRAPH 2.0 provides different brain surfaces, as shown in Figure 10, for the human brain and cerebellum in addition to animals such as the ferret, macaque, mouse, and rat. It is also possible to add additional brain surfaces by added the required NV files in the BRAPH 2.0 folder `brainsurfs`.

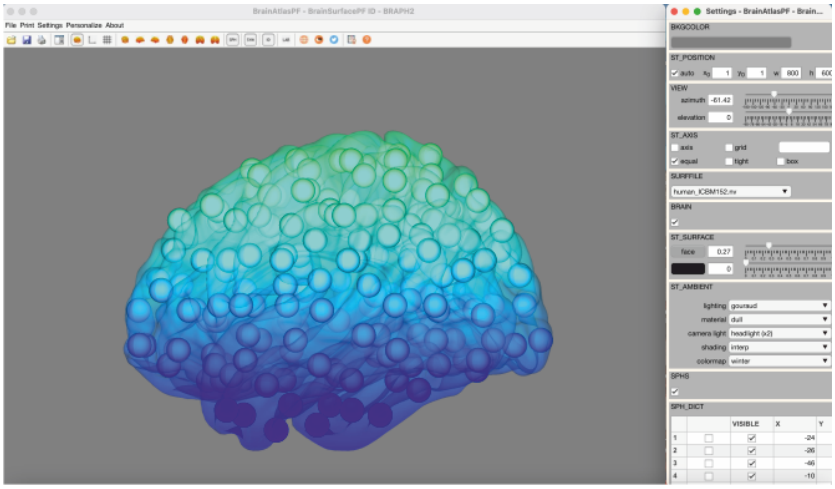


Figure 9: **Example of a visualization of the brain atlas.** A final figure created with BRAPH 2.0 by changing different options in the menu.

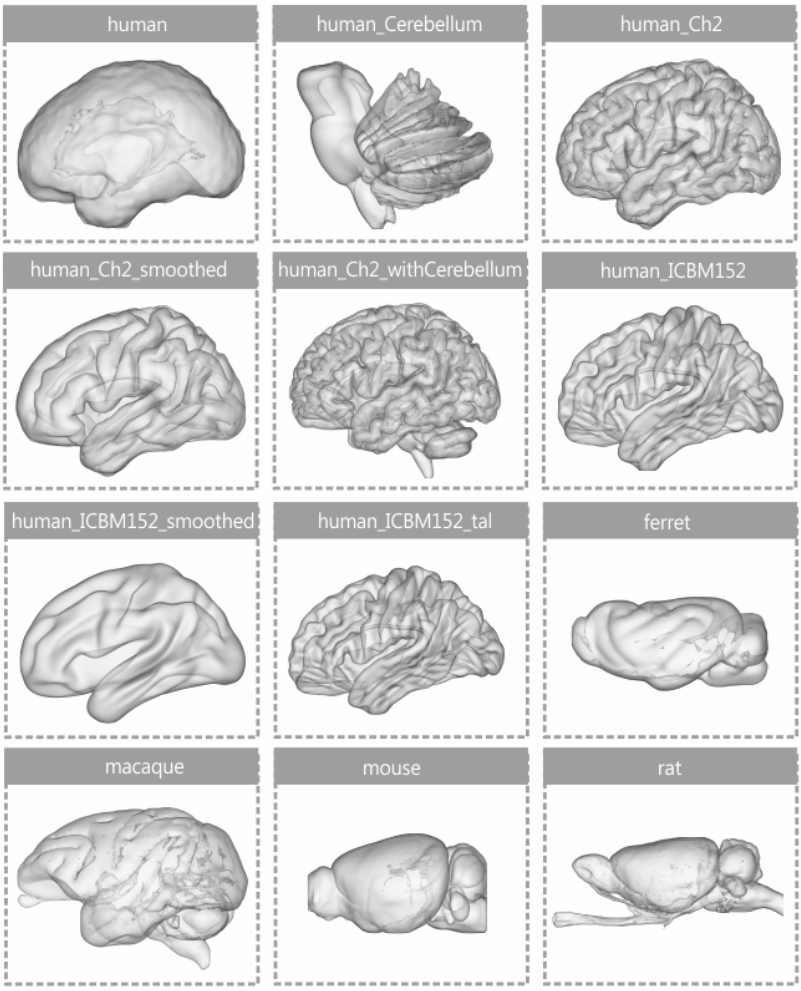


Figure 10: **Brain surfaces in BRAPH 2.0.** Some brain surfaces available in BRAPH 2.0 to plot the brain atlas.
ferret Surface obtained from Hutchinson et al (2017). Population based MRI and DTI templates of the adult ferret brain and tools for voxelwise analysis. Neuroimage. 152:575-589.
macaque Surface obtained from Calabrese et al (2015). A diffusion tensor MRI atlas of the postmortem rhesus macaque brain. Neuroimage. 117:408-416.
mouse Surface obtained from Wang et al (2020). The Allen Mouse Brain Common Coordinate Framework: A 3D Reference Atlas. Cell. 181:936-953.
rat Surface obtained from Papp et al (2014). Waxholm Space atlas of the Sprague Dawley rat brain. NeuroImage 97:374-386.

Export the Figure

To export and save a (publication-ready) figure, you can select "Print" from the brain atlas GUI and select one of the various provided options Figure 11.

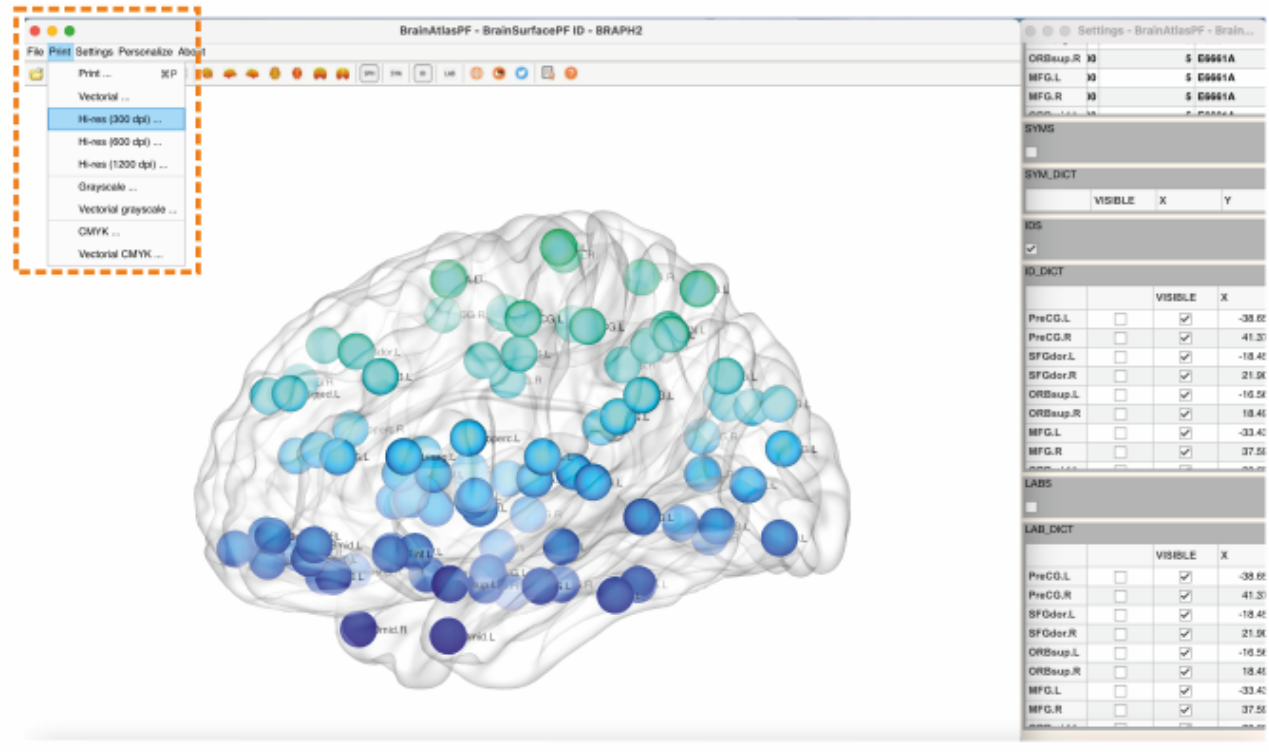


Figure 11: **Save a brain atlas figure.** BRAPH 2.0 provides different options that allow saving a figure with different resolutions and color modes, adequate to any requirement for presentations and publicaitons.