Brain Atlas

The BRAPH 2 Team

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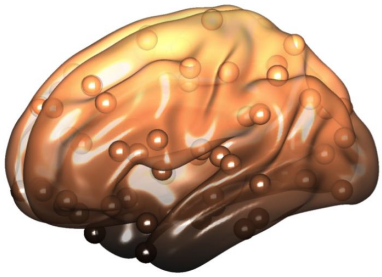

Figure 1: **Brain atlas figure created with BRAPH 2.0.** Example of a brain surface image with some nodes representing brain regions.

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.

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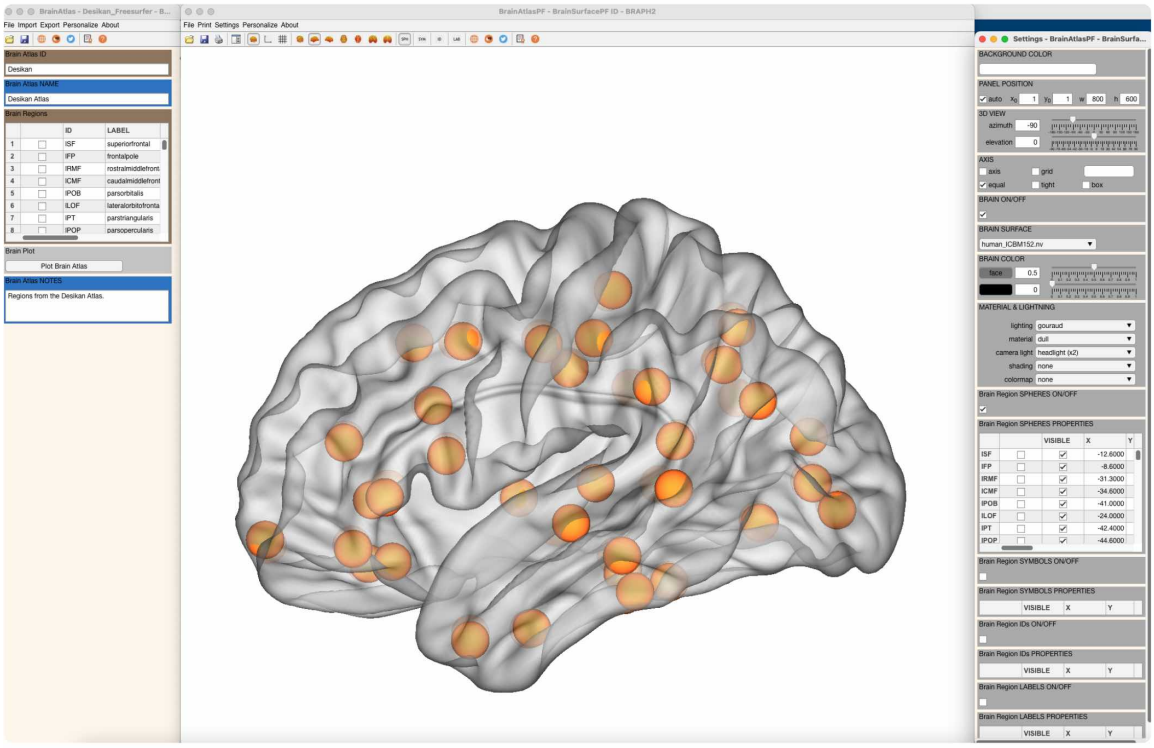

Figure 2: **Brain Atlas GUI.** Full graphical user interface to work with a brain atlas in BRAPH 2.0.

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 MatLab's terminal, which allows you to select a pipeline containing the steps required to perform your analysis. The initial step is typically to upload the brain atlas directly (Figure 3c-d) after clicking "Load Atlas".

You can also open the GUI and upload the brain atlas using the command line (i.e., without opening an analysis pipeline) by typing the commands in Code 1. In that case, you can upload the atlas as shown in Figure 3a-d.

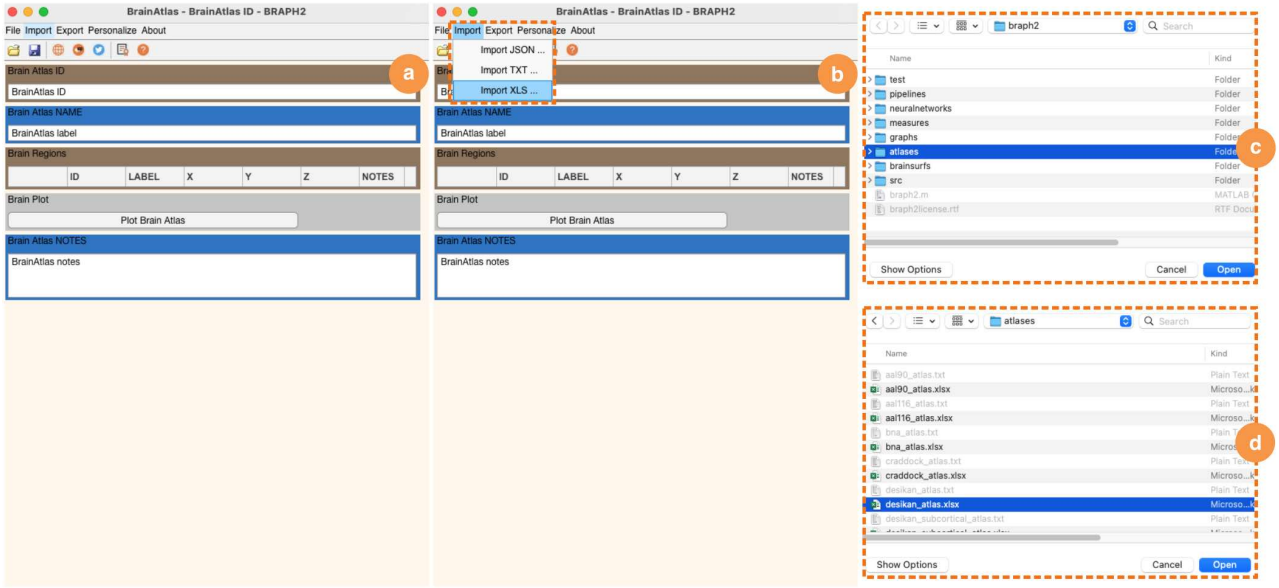

Figure 3: **Upload a brain atlas.** The different steps you need to follow to open a brain atlas using the GUI: **a** Open the brain atlas GUI. **b** Import a brain atlas from an XLS or TXT file. **c** Navigate to the BRAPH 2.0 folder `atlases`. **d** Select the desired atlas.

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.

```
ba = BrainAtlas(); (1)

gui = GUIElement('PE', ba); (2)
gui.get('DRAW') (3)
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).

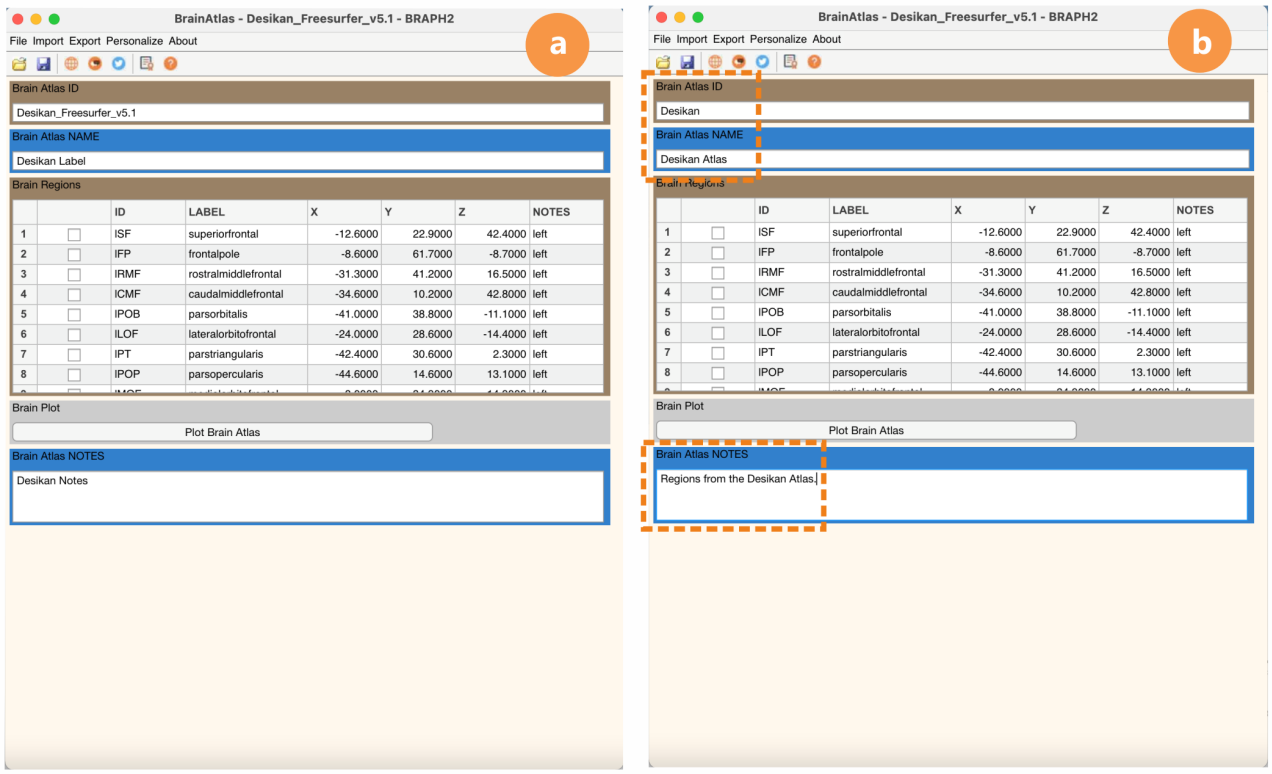

Figure 4: **Edit the brain atlas information.** In the brain atlas GUI: **a** We can see the ID, name, brain regions and notes of the brain atlas. **b** All of this information can be changed, in this example we have renamed the ID, name and notes of the brain atlas but you can also edit the IDs, labels, 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/`).

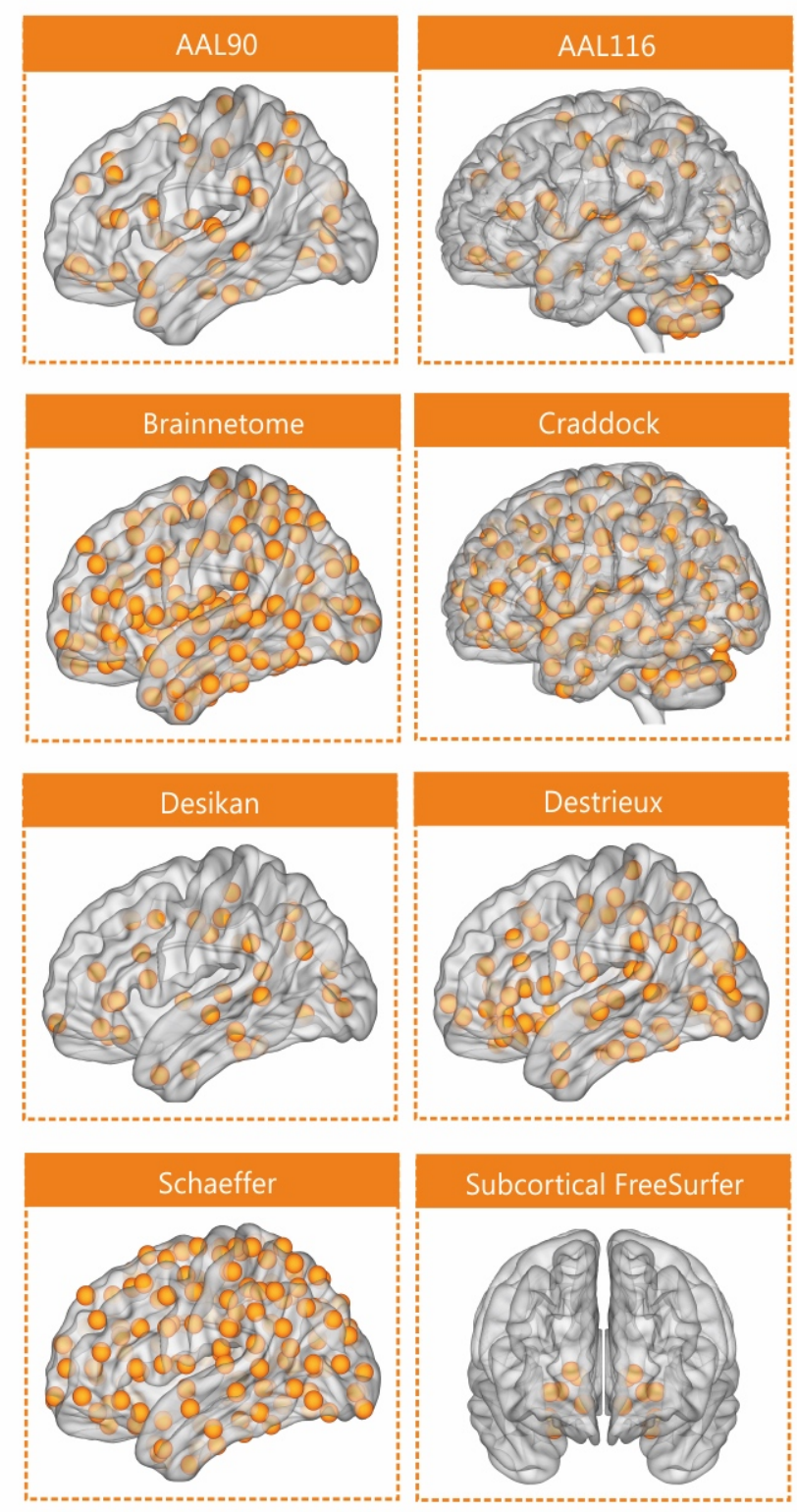

Figure 5: **Brain Atlases.** Some brain atlases provided by BRAPH 2.0:
AAL90 Automated Anatomical Labelling atlas with 90 cortical and subcortical regions.
AAL116 Automated Anatomical Labelling atlas with 116 cortical and subcortical regions, including cerebellar areas.
BNA Brainnetome atlas with 246 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`.)

a

1	Desikan_Freesurfer					
2	Desikan Label					
3	Desikan Notes					
4	BrainMesh_ICBM152.nv					
5	lSF	superiorfrontal	-12,6	22,9	42,4	left
6	lFP	frontalpole	-8,6	61,7	-8,7	left
7	lRMF	rostralmiddlefrontal	-31,3	41,2	16,5	left
8	lCMF	caudalmiddlefrontal	-34,6	10,2	42,8	left
9	lPOB	parsorbitalis	-41	38,8	-11,1	left
10	lLOF	lateralorbitofrontal	-24	28,6	-14,4	left
11	lPT	parstriangularis	-42,4	30,6	2,3	left
12	lPOP	parsopercularis	-44,6	14,6	13,1	left
13	lMOF	medialorbitofrontal	-8	34,9	-14,9	left
14	lRAC	rostralanteriorcingulate	-6,8	33,9	1,6	left
15	lCAC	caudalanteriorcingulate	-6,6	18	26,1	left
16	lINS	insula	-34,2	-4,3	2,2	left
17	lPRC	precentral	-37,8	-10,7	42,1	left
18	lPOC	postcentral	-42,3	-23,8	43,6	left
19	lSUPRA	supramarginal	-50,4	-38,8	31	left
20	lSP	superiorparietal	-22,8	-60,9	46,3	left
21	lIP	inferiorparietal	-40	-66,4	27,3	left
22	lPARA	paracentral	-10	-28,7	56,1	left
23	lPCG	posteriorcingulate	-7,3	-17,4	35,7	left
24	lIST	isthmuscingulate	-9,8	-44,8	16,9	left
25	lPREC	precuneus	-11,6	-57,5	36,7	left
26	lCUN	cuneus	-8,7	-79,6	18	left
27	lPERI	pericalcarine	-13,9	-80,6	6	left
28	lLIN	lingual	-16,5	-66,8	-4,3	left
29	lLO	lateraloccipital	-29,7	-86,9	-1	left
30	lTRANS	transversetemporal	-44	-24,2	6	left
31	lBKS	bankssts	-52,7	-44,5	4,6	left
32	lST	superiortemporal	-52,1	-17,8	-4,4	left
33	lMT	middletemporal	-55,6	-31,1	-12,9	left
34	lIT	inferiortemporal	-48,9	-34,4	-22,2	left
35	lTP	temporalpole	-32,8	8,4	-34,8	left
36	lENT	entorhinal	-25,8	-7,6	-31,6	left

continuation b

37	lPHIP	parahippocampal	-24,7	-31,2	-17,4	left
38	lFUS	fusiform	-35,7	-43,3	-19,7	left
39	rSF	superiorfrontal	13,4	24,7	42	right
40	rFP	frontalpole	10,3	61,1	-10	right
41	rCAC	caudalanteriorcingulate	7,3	18,7	26,3	right
42	rCMF	caudalmiddlefrontal	34,9	11,8	43	right
43	rPOB	parsorbitalis	42,1	39,2	-10	right
44	rLOF	lateralorbitofrontal	23,6	28,5	-15,2	right
45	rPT	parstriangularis	45	29,7	4,5	right
46	rPOP	parsopercularis	44,9	14,4	14,2	right
47	rMOF	medialorbitofrontal	8,8	35,7	-14,8	right
48	rRMF	rostralmiddlefrontal	32,3	40,9	17,3	right
49	rRAC	rostralanteriorcingulate	8	33,5	2,1	right
50	rINS	insula	35,1	-3,9	2,4	right
51	rPRC	precentral	36,8	-9,9	43,5	right
52	rPOC	postcentral	41,6	-22,4	43,8	right
53	rSUPRA	supramarginal	50,6	-33,3	30,7	right
54	rSP	superiorparietal	22,6	-59,5	48,1	right
55	rIP	inferiorparietal	42,8	-60,9	28,1	right
56	rPARAC	paracentral	9,9	-27,4	55,6	right
57	rPCG	posteriorcingulate	7,6	-17,1	36,2	right
58	rIST	isthmuscingulate	8,9	-45,4	17,6	right
59	rPREC	precuneus	11,7	-56,5	37,7	right
60	rCUN	cuneus	8,7	-80,1	19	right
61	rPERI	pericalcarine	14	-79,7	6,7	right
62	rLIN	lingual	16,8	-66,3	-3,6	right
63	rLO	lateraloccipital	30,3	-86,3	0,5	right
64	rTRANS	transversetemporal	44,8	-22,4	6,5	right
65	rBKS	bankssts	51,9	-40,6	5,6	right
66	rST	superiortemporal	53	-14	-5,5	right
67	rMT	middletemporal	55,9	-29,5	-12,9	right
68	rIT	inferiortemporal	49,3	-31,7	-23	right
69	rTP	temporalpole	34	8,4	-33,1	right
70	rENT	entorhinal	26,2	-6,8	-31,9	right
71	rPHIP	parahippocampal	26,1	-31,3	-16,2	right
72	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).

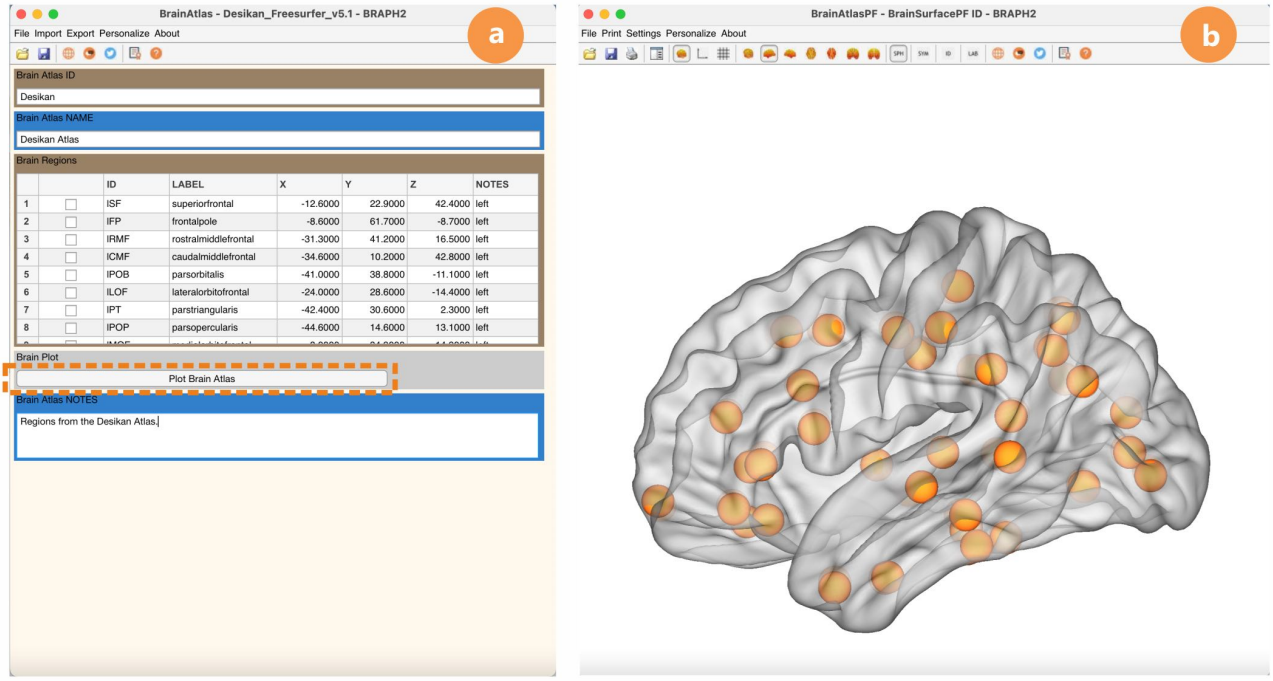

Figure 7: **Brain atlas visualization.** Plotting the nodes of a brain atlas on a 3D brain surface.

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" (highlighted 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 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

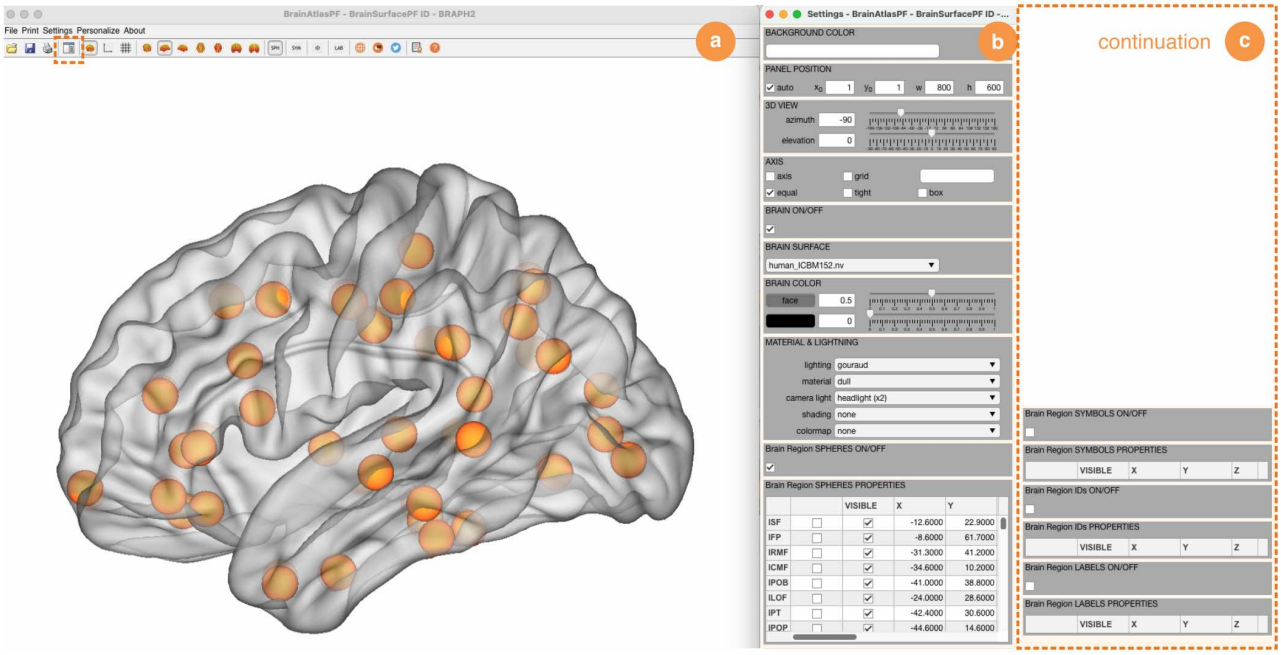

Figure 8: **Visualize the brain atlas. a** The "Settings Brain Surface" button in the toolbar opens **b-c** A window with the settings available for this brain figure.

rendered in 2D — more stylized and less computationally expensive. IDs and labels 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 by clicking on the checkboxes 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 adding the required NV files in the BRAPH 2.0 folder `brainsurfs`.

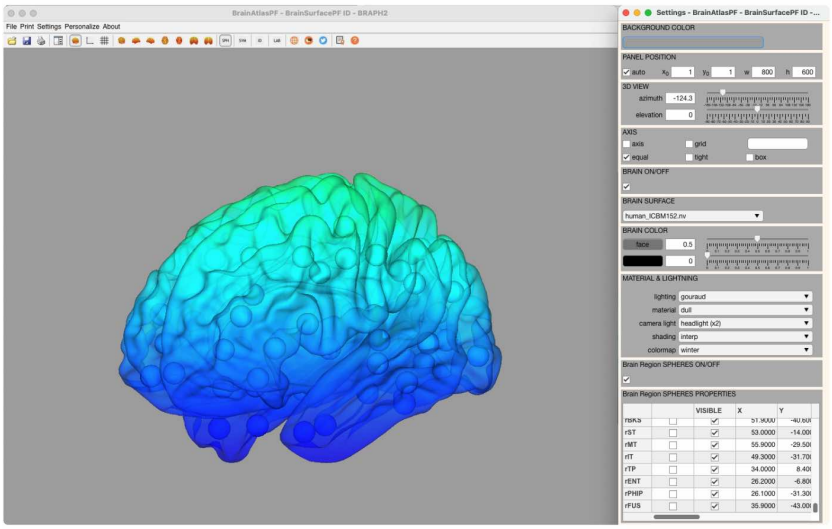

Figure 9: **Example of a visualization of the brain atlas.** A final figure was created with BRAPH 2.0 by changing different options in the menu.

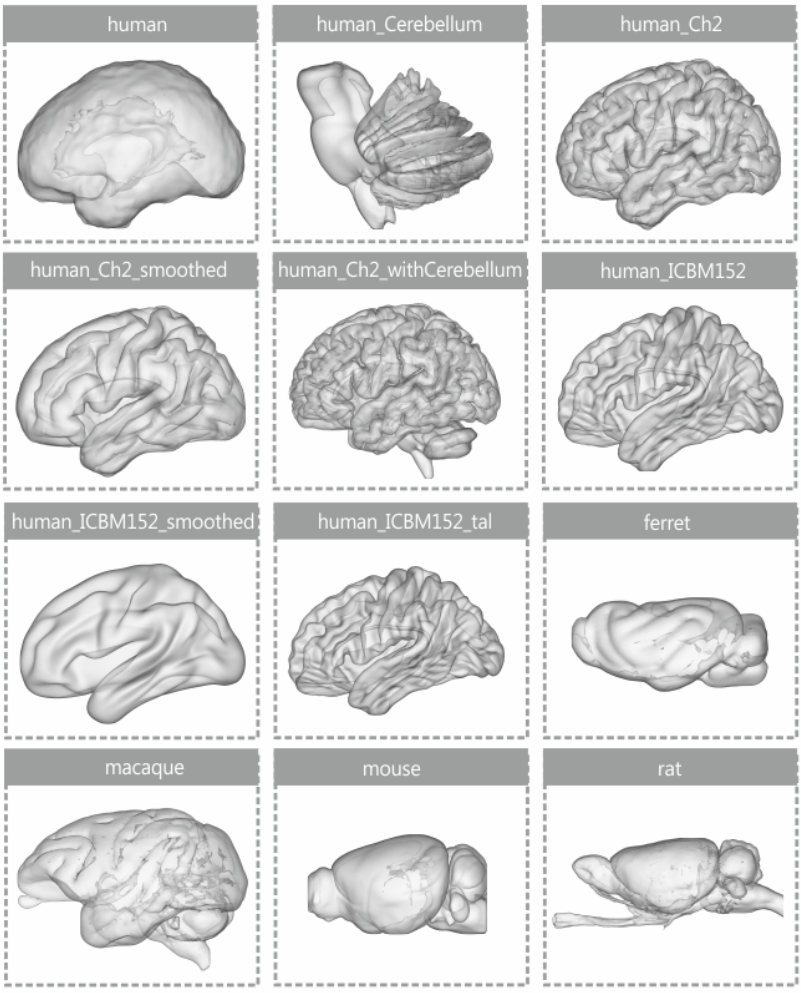

Figure 10: **Brain surfaces in BRAPH 2.0.** Some of the brain surfaces available in BRAPH 2.0 to plot the brain atlas.

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.

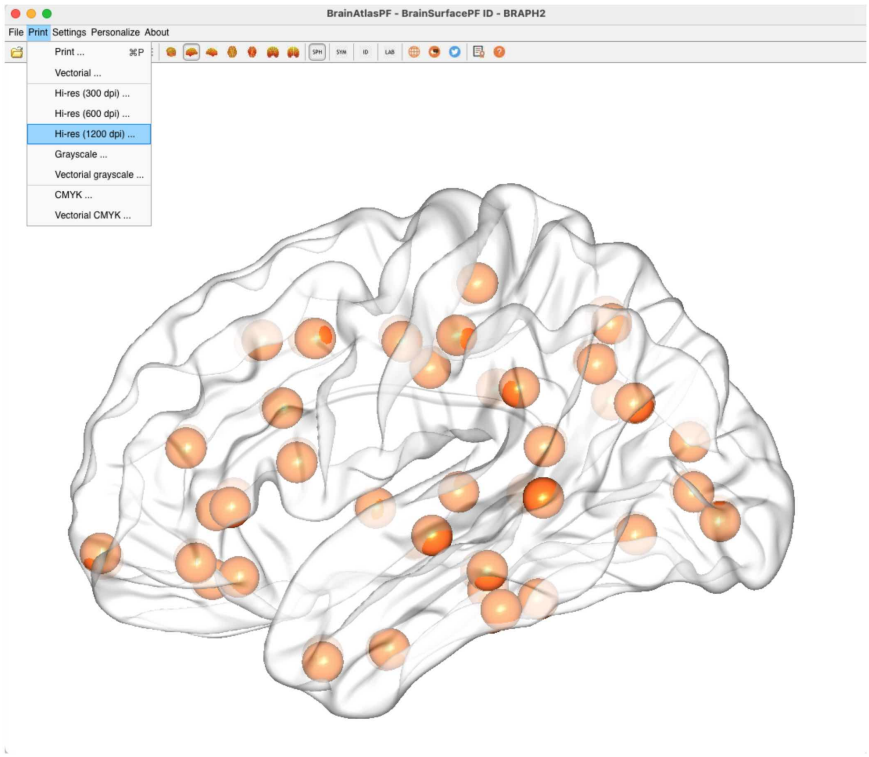

Figure 11: **Save a brain atlas figure.** BRAPH 2.0 provides different options that allow saving a figure with different resolutions and color modes, adequate to any requirement for presentations and publications.