

Group of Subjects with Connectivity Data

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For *connectivity data*, a connectivity matrix per subject is already available and can be directly imported into the relative analysis pipeline. For example, the connectivity matrix could correspond to white matter tracts obtained from dMRI or pre-calculated coactivations maps obtained from fMRI data. This Tutorial explains how to prepare and work with this kind of data.

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The figure displays three sequential screenshots of the BRAPH2 graphical user interface (GUI) for loading a group of subjects with connectivity data.

Left Screenshot (Group - Group ID - BRAPH2): Shows the initial setup for a new group. Fields include Group ID, Group NAME, Group label, Group SUBJECT CLASS (set to SubjectCON), and a table for Group SUBJECTS with columns NAME, DESCRIPTION, TEMPLATE, ID, and L. A Group NOTES section is also present.

Middle Screenshot (Group - CON_Group_1_XLS - BRAPH2): Shows the group loaded from a file. The Group ID is 'CON_Group_1_XLS'. The Group SUBJECTS table lists subjects (SubjectCON_1 to SubjectCON_16) with checkboxes for selection. The Group NOTES section contains the text: 'Group loaded from /Users/joana.pereira/Documents/GitHub/BRAPH-2-Matlab-beta/braph2/pipelines/connectivity/Example data CON XLS/CON_Group_1_XLS'.

Right Screenshot (SubjectCON - SubjectCON_1 - BRAPH2): Shows the details for a specific subject (SubjectCON_1). Fields include Subject ID, Subject LABEL, SubjectCON label, Brain Atlas (BrainAtlas(BrainAtlas ID)), and a table for Variables of Interest (ID, V). The Connectivity DATA table shows a matrix of values for subjects br1 through br8 across various brain regions.

	br1	br2	br3	br4	br5	br6	br7	br8
br1	0	0.6239	0.9557	0	0	0	0	0
br2	0.6239	0	0.8746	0	0	0	0	0
br3	0.9557	0.8746	0	0.6810	0.9619	0	0	0
br4	0	0	0.6810	0	0	0	0	0
br5	0	0	0.9619	0	0	0	0	0
br6	0	0	0	0.9855	0	0	0	0
br7	0	0	0	0	0	0.6502	0	0
br8	0	0	0	0	0	0	0	0

Figure 1: GUI for a group of subjects with connectivity data. Full graphical user interface to upload a group of subjects with connectivity data in BRAPH 2.0.

Open the GUI

In most analyses, the group GUI is the second step after you have selected a brain atlas. You can open it by typing `braph2` in the MatLab's terminal, which allows you to select a pipeline containing the steps required to perform your analysis and upload a brain atlas. After these steps have been completed you can upload your group's data, as shown in Figure 2.

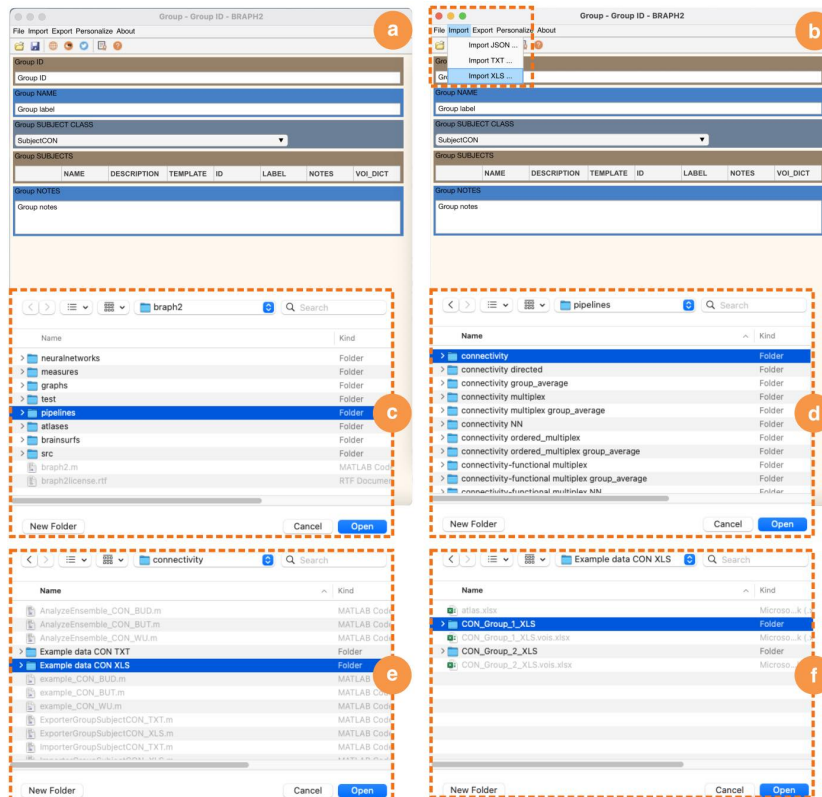


Figure 2: **Upload the data of a group of subjects.** Steps to upload a group of subjects with connectivity data using the GUI and an example dataset: **a** Open the group GUI. **b** Import a folder containing the connectivity matrices in XLS or TXT format (see below for details on their format). To upload the test connectivity data: **c-f** navigate to the BRAPH 2.0 folder pipelines, **d** connectivity, **e** Example data CON XLS, and **f** select the folder containing the connectivity matrices of one group `CON_Group_1_XLS`.

To open the GUI and upload the brain connectivity data, 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 GUI to upload a group of subjects with connectivity data. This code can be used in the MatLab command line to launch the GUI to upload a group of subjects with connectivity data without having to open a pipeline.

```
1 gr = Group('SUB_CLASS', 'SubjectCON'); (1)
2
3 gui = GUIElement('PE', gr); (2)
4 gui.get('DRAW')(3)
5 gui.get('SHOW')(4)
```

(1) creates a new object Group with subjects with connectivity data, i.e., SubjectCON.

(2) creates a GUI to upload the group data.

(3) draws the GUI.

(4) shows the GUI.

Moreover, if you don't have the Example data CON XLS folder inside connectivity, then you can generate it by running the commands in Code 2.

Code 2: Code to generate the example data folder. This code can be used in the MatLab command line to generate the Example data CON XLS folder to the connectivity pipeline folder.

```
1 test_ImporterGroupSubjectCON_XLS ①
2 test_ImporterGroupSubjectCON_TXT ②
```

① generates the example connectivity XLS data folder.
② generates the example connectivity TXT data folder.

Visualize the Group Data

After completing the steps described in Figure 2, you can see the data (Figure 3a), and change the Group ID, name, and notes (Figure 3b).

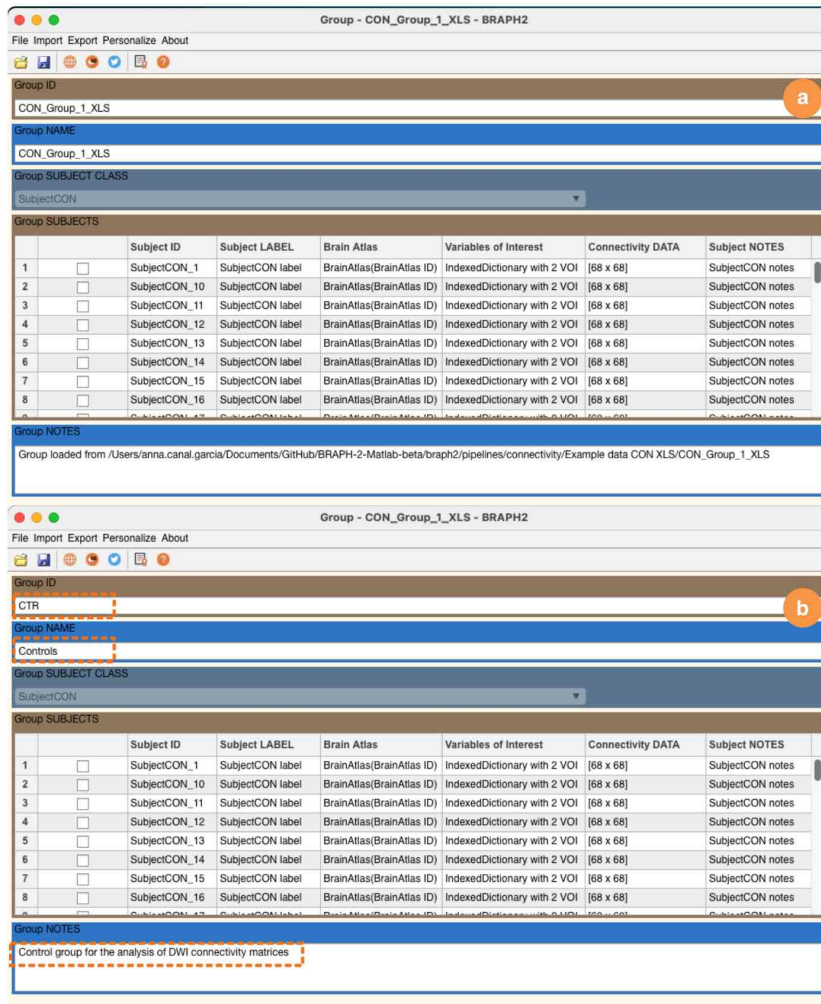


Figure 3: Edit the group metadata. a The GUI of the group's connectivity data. **b** The information you see on this GUI that can be changed. In this example, we have edited the ID, name, and notes of the group but can also change the subject's specific information.

Visualize Each Subject's Data

Finally, you can open each subject's connectivity matrix by selecting the subject, right click, and select "Open selection" (Figure 4a), which shows the matrix values (Figure 4b). Here, you can also change the subject's metadata (ID, label, notes), its variables of interest, and the values of its connectivity matrix.

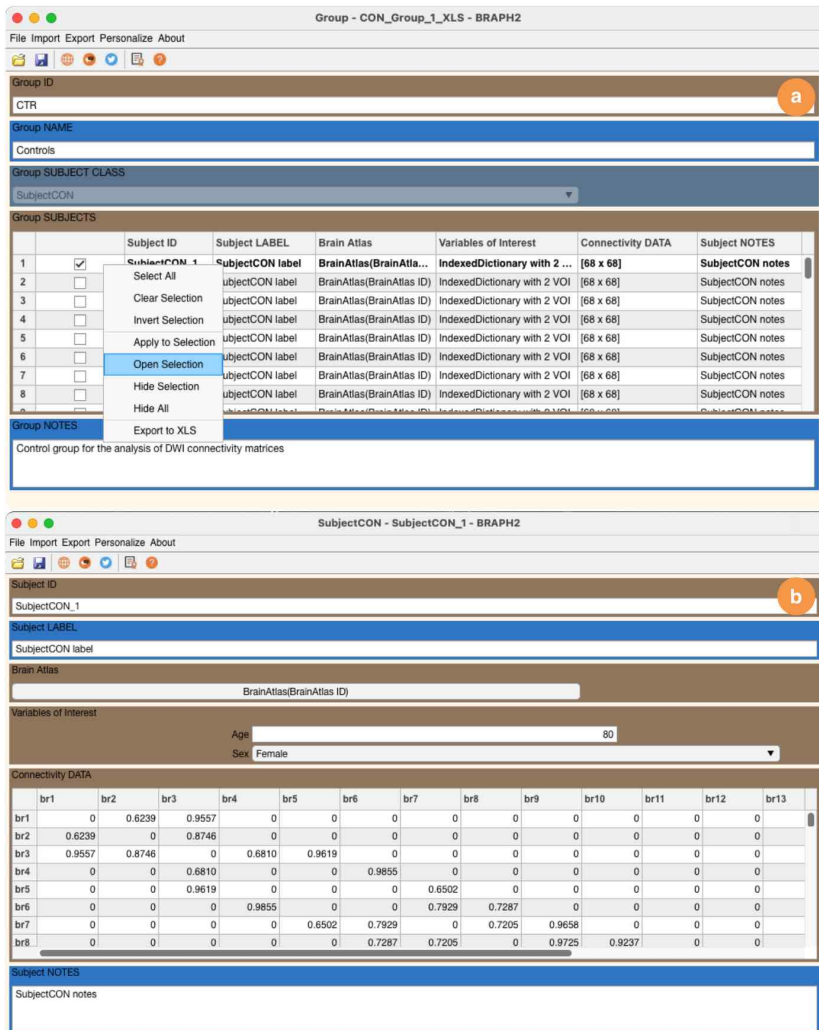
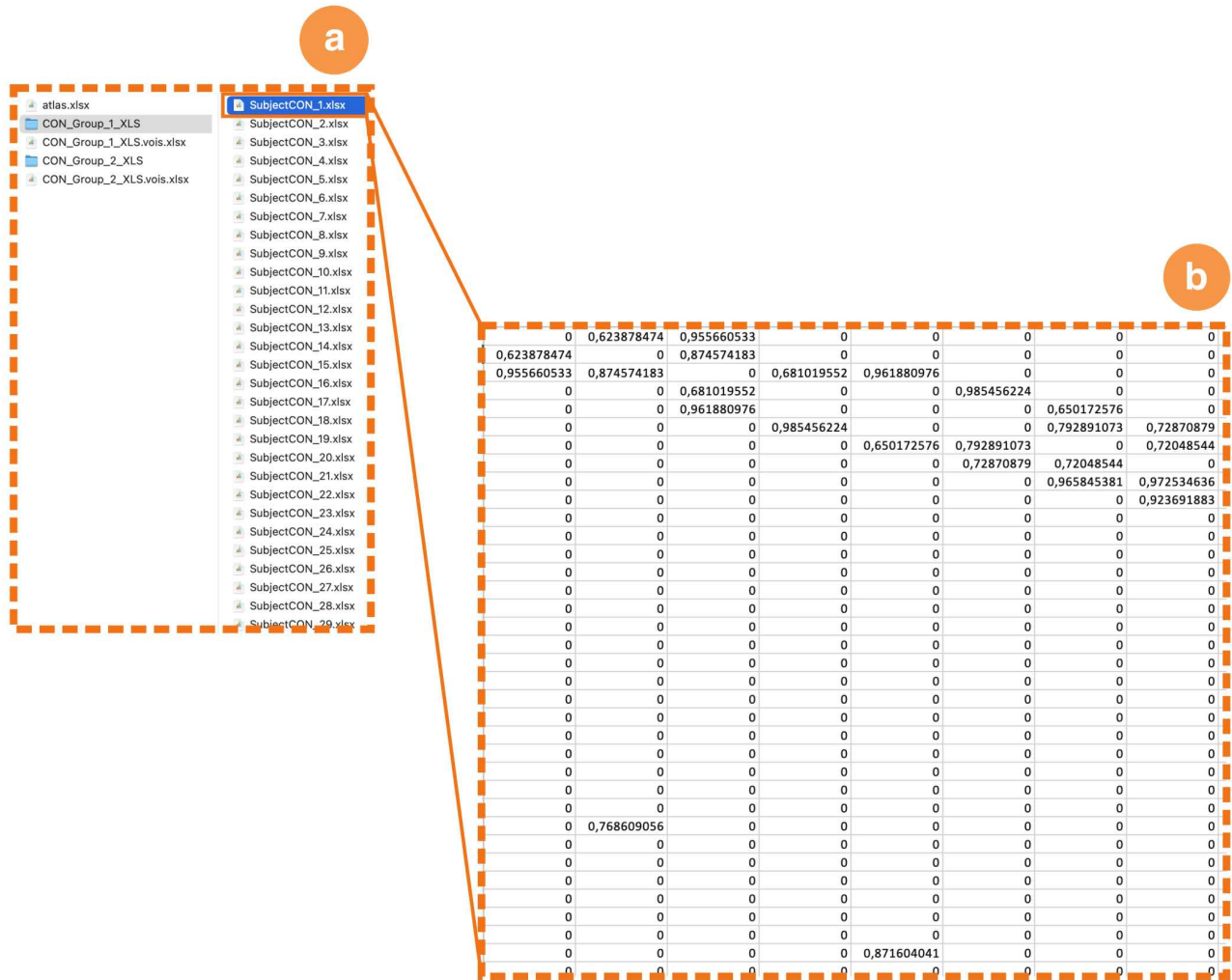


Figure 4: **Edit the individual subject data.** **a** Each subject's connectivity matrix can be opened by selecting the subject, right click, and select "Open selection" **b** In this subject GUI, it is possible to view and edit the metadata of the subject (ID, label, notes), its variables of interest (in this case, age and sex), and the values of the connectivity matrix.

Preparation of the Data to be Imported

To be able to import connectivity data into BRAPH 2.0, you need to include the connectivity matrices for each subject in excel or text format inside a folder with the name of the group. Below you can see how your group directory should look like as well as an example of a brain connectivity matrix.



Adding Covariates

It is very common to have *variables of interest* (i.e., *covariates* and *correlates*) in an analysis. In BRAPH 2.0, these variables of interest should be included in a separate excel file placed just outside the group's folder and with the same name as the folder followed by *.vois* (Figure 6a).

Figure 5: **Data preparation.** The data should be organised in the following format: **a** The connectivity matrices from each subject should be included in one folder (for example, CON_group_1_XLS). **b** Each matrix should contain the connectivity values between each pair of brain regions denoted by the rows and columns. In example, the (simulated) values in the matrix correspond to the fractional anisotropy (white matter integrity) of anatomical connections derived from diffusion weighted imaging.

a

b

	A	B	C	D	E
1	Subject ID	Age	Sex	Education	
2			Female		
3	SubjectCON_1	80	Female	low	
4	SubjectCON_2	7	Female	low	
5	SubjectCON_3	77	Male	high	
6	SubjectCON_4	17	Male	high	
7	SubjectCON_5	88	Male	high	
8	SubjectCON_6	74	Male	high	
9	SubjectCON_7	41	Female	low	
10	SubjectCON_8	76	Male	low	
11	SubjectCON_9	76	Male	high	
12	SubjectCON_10	22	Male	high	
13	SubjectCON_11	3	Male	high	
14	SubjectCON_12	59	Female	low	

Figure 6: **Edit the Covariates.** Information that can be changed in the Covariates file: **a** The names of the variables of interest (vois). **b** In case the vois are categorical, you can state which categories they have.

This file should have a specific format (Figure 6b):

Subject IDs (column A). Column A should contain the subject IDs starting from row 3.

Variables of interest (column B and subsequent columns). Column B (and subsequent columns) should contain the variables of interest (one per column). In this example we have “Age” and “Sex”, as in the example file, as well as the additional “Education”. In each column, row 1 should contain the name of the variable of interest, row 2 should contain the categories separated by a return (only for categorical variables of interest, like “Sex” and “Education”), and the subsequent rows the values of the variable of interest for each subject.