

Group of Subjects with Connectivity Multiplex Data

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For *connectivity multiplex data*, a connectivity matrix per subject is already available for different layers 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.

Contents

Open the GUI	2
Visualize the Group Data	3
Visualize Each Subject's Data	3
Preparation of the Data to be Imported	5
Adding Covariates	5

The screenshot displays three windows from the BRAPH 2 GUI. The leftmost window, titled 'Group - Group ID - BRAPH2', shows a form for group information and a table of subjects. The middle window, titled 'Group - CON_MP_Group_1_XLS - BRAPH2', shows a detailed view of a subject's data, including a table of connectivity data layers (br1 to br8) and a table of variables of interest (Age, Sex, Layer Number, Layer Labels). The rightmost window, titled 'SubjectCON_MP - SubjectCON_MP_1 - BRAPH2', shows a detailed view of a subject's data, including a table of connectivity data layers (br1 to br8) and a table of variables of interest (Age, Sex, Layer Number, Layer Labels).

Subject ID	Subject LABEL	Brain Atlas
1	SubjectCON_MP_1	SubjectCON_MP label
2	SubjectCON_MP_10	SubjectCON_MP label
3	SubjectCON_MP_11	SubjectCON_MP label
4	SubjectCON_MP_12	SubjectCON_MP label
5	SubjectCON_MP_13	SubjectCON_MP label
6	SubjectCON_MP_14	SubjectCON_MP label
7	SubjectCON_MP_15	SubjectCON_MP label
8	SubjectCON_MP_16	SubjectCON_MP label

Layer Labels
br1
br2
br3
br4
br5
br6
br7
br8

Layer Labels
br1
br2
br3
br4
br5
br6
br7
br8

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

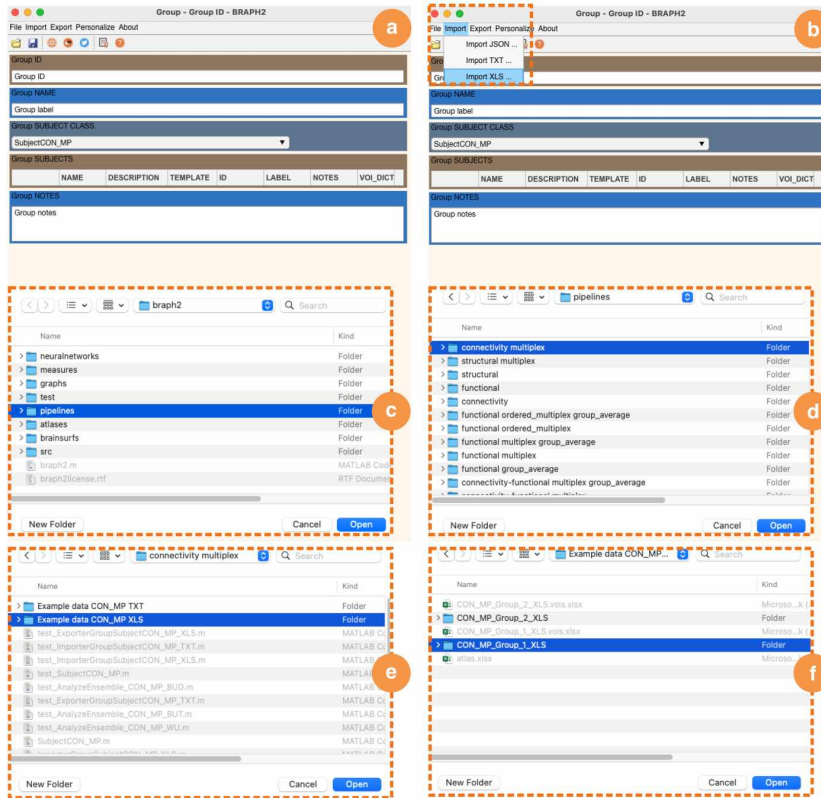


Figure 2: Upload the data of a group of subjects. Steps to upload a group of subjects with connectivity multiplex data using the GUI and an example dataset: **a** Open the group GUI. **b** Import a folder that contains individual subject folders. Each of these subject folders contain one file per layer with the connectivity matrix in XLS or TXT format (see below for details on their format). To upload the test connectivity multiplex data: **c-f** navigate to the BRAPH 2.0 folder pipelines, **d** connectivity multiplex, **e** Example data CON_MP XLS, and **f** select the folder containing the connectivity matrices of one group CON_MP_Group_1_XLS.

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

```
1 gr = Group('SUB-CLASS', 'SubjectCON_MP'); 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 multiplex data, i.e., SubjectCON_MP.

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_MP XLS folder inside connectivity multiplex, 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_MP XLS folder to the connectivity multiplex pipeline folder.

```
1 test_ImporterGroupSubjectCON_MP_XLS ①
2 test_ImporterGroupSubjectCON_MP_TXT ②
```

① generates the example connectivity multiplex XLS data folder.

② generates the example connectivity multiplex 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).

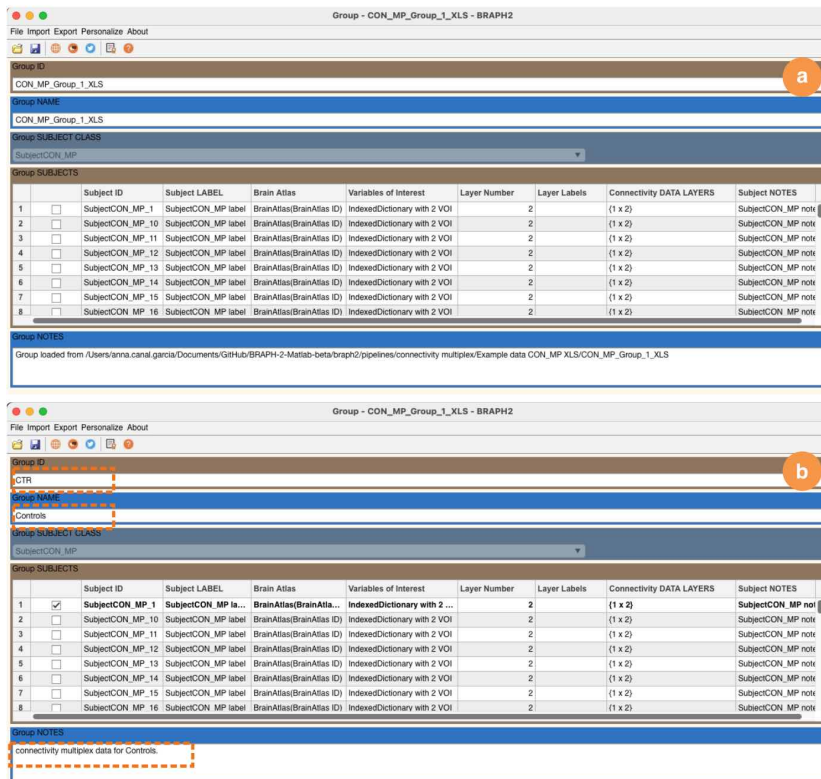


Figure 3: Edit the group metadata. a The GUI of the group's connectivity multiplex data. b The information you see on this GUI that can be changed. In this example, we have edited the ID, name, and notes of the group but can also change the subject's specific information.

Visualize Each Subject's Data

Finally, you can open each subject's connectivity multiplex data by selecting the subject, right click, and select "Open selection" (Figure 4a), which shows the matrix values from layer 1 (Figure 4b). Here, you

can also change the subject's metadata (ID, label, notes), its variables of interest, and the values of its connectivity multiplex data.

a

Group - CON_MP_Group_1_XLS - BRAPH2

File Import Export Personalize About

Group ID: CTR

Group NAME:

Controls:

Group SUBJECT CLASS: SubjectCON_MP

Group SUBJECTS:

	Subject ID	Subject LABEL	Brain Atlas	Variables of Interest	Layer Number	Layer Labels	Connectivity DATA LAYERS	Subject NOTES
1	<input checked="" type="checkbox"/>	SubjectCON_MP_1	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 ...	2		(1 x 2)	SubjectCON_MP not
2	<input type="checkbox"/>	Select All	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not
3	<input type="checkbox"/>	Clear Selection	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not
4	<input type="checkbox"/>	Invert Selection	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not
5	<input type="checkbox"/>	Apply to Selection	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not
6	<input type="checkbox"/>	Open Selection	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not
7	<input type="checkbox"/>	Hide Selection	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not
8	<input type="checkbox"/>	Hide All	SubjectCON_MP label	BrainAtlas(BrainAtlas ID)	IndexedDictionary with 2 VOI	2	(1 x 2)	SubjectCON_MP not

Group NOTES:

connectivity mul... Export to XLS

b

SubjectCON_MP - SubjectCON_MP_1 - BRAPH2

File Import Export Personalize About

Subject ID: SubjectCON_MP_1

Subject LABEL: SubjectCON_MP label

Brain Atlas: BrainAtlas(BrainAtlas ID)

Variables of Interest:

Age: 81

Sex: Male

Layer Number: 2

Layer Labels:

Connectivity DATA LAYERS:

layer 1

	br1	br2	br3	br4	br5	br6	br7	br8	br9	br10	br11	br12	br13	br14	br15	br16
br1	0	0.5703	0.9143	0.7045	0.5715	0.9341	0	0	0	0	0	0	0	0.8450	0.8280	0
br2	0.7294	0	0.6871	0.7770	0.5501	0.5227	0.7223	0	0	0	0	0	0	0	0.7332	0
br3	0.6059	0.7613	0	0.5367	0.8258	0.9381	0.8523	0.5242	0	0	0	0	0	0	0	0
br4	0.5652	0.5551	0.7638	0	0.7568	0.9069	0.8169	0.8267	0.8871	0	0	0	0	0	0	0
br5	0.6062	0.9675	0.6608	0.8123	0	0.6767	0.8255	0.8513	0.9477	0.5223	0	0	0	0	0	0
br6	0.5153	0.7453	0.9426	0.7270	0.6479	0	0.6849	0.7978	0.9950	0.9287	0.8841	0	0	0	0	0
br7	0	0.6896	0.8820	0.9442	0.7696	0.9593	0	0.8489	0.9704	0.7437	0.6890	0.6521	0	0	0	0
br8	0	0	0.8555	0.5478	0.8179	0.6704	0.5040	0	0.8387	0.5140	0.9624	0.6001	0.9680	0	0	0
br9	0	0	0	0	0.6834	0.8599	0.9863	0.5278	0.8201	0	0.6758	0.5166	0.6697	0.9604	0.9859	0
br10	0	0	0	0	0	0.9619	0.5074	0.8246	0.9376	0.8303	0	0.8950	0.7400	0.6885	0.6452	0.8919
br11	0	0	0	0	0	0	0.7303	0.9035	0.6914	0.6902	0.7652	0	0.8341	0.7943	0.5474	0.8481
br12	0	0	0	0	0	0	0	0.5402	0.8222	0.5006	0.7111	0.9847	0	0.6807	0.5671	0.9554
br13	0	0	0	0	0	0	0	0	0.8185	0.6760	0.5443	0.5712	0.8768	0	0.9404	0.7392
br14	0.7138	0	0	0	0	0	0	0	0	0.7301	0.8119	0.6982	0.7444	0.6182	0	0.5874
br15	0.9223	0.5033	0	0	0	0	0	0	0	0.8856	0.5761	0.6296	0.5119	0.7795	0	0
br16	0.7488	0.8368	0.6347	0	0	0	0	0	0	0	0.7477	0.8729	0.6092	0.5621	0.5262	0
br17	0.7161	0.9314	0.6132	0.6630	0	0	0	0	0	0	0	0.5772	0.5322	0.5675	0.8332	0

Subject NOTES:

SubjectCON_MP notes

Figure 4: **Edit the individual subject data.** **a** Each subject's connectivity multiplex data 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 connectivity multiplex data.

Preparation of the Data to be Imported

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

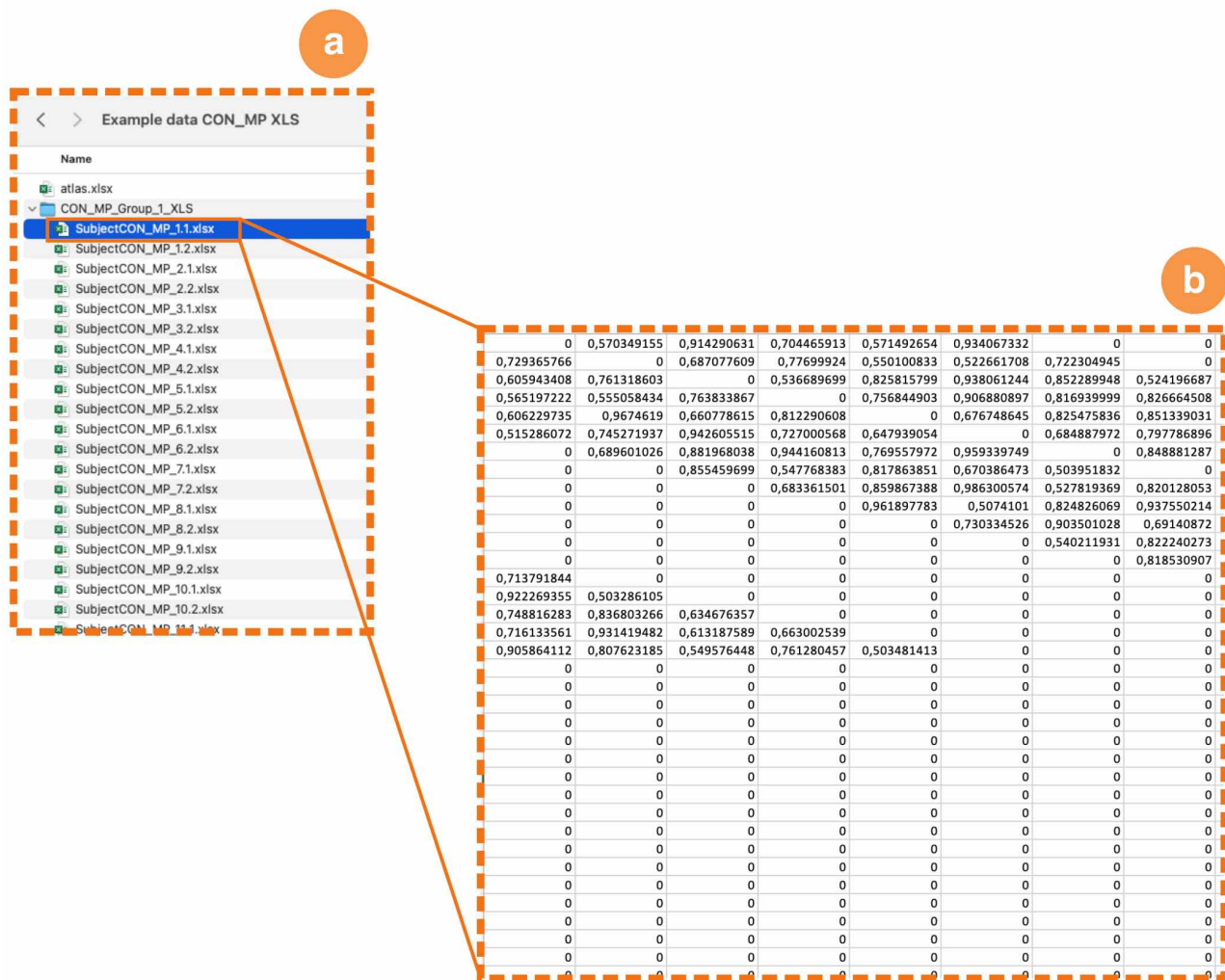


Figure 5: Data preparation. The data should be organised in the following format: **a** The connectivity matrices from each subject and each layer should be included in one folder (for example, `CON_MP_group_1.XLS`). **b** Each matrix should contain the connectivity values between each pair of brain regions denoted by the rows and columns. In this example, the (simulated) values in the matrix correspond to the fractional anisotropy (white matter integrity) of anatomical connections derived from diffusion weighted imaging.

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

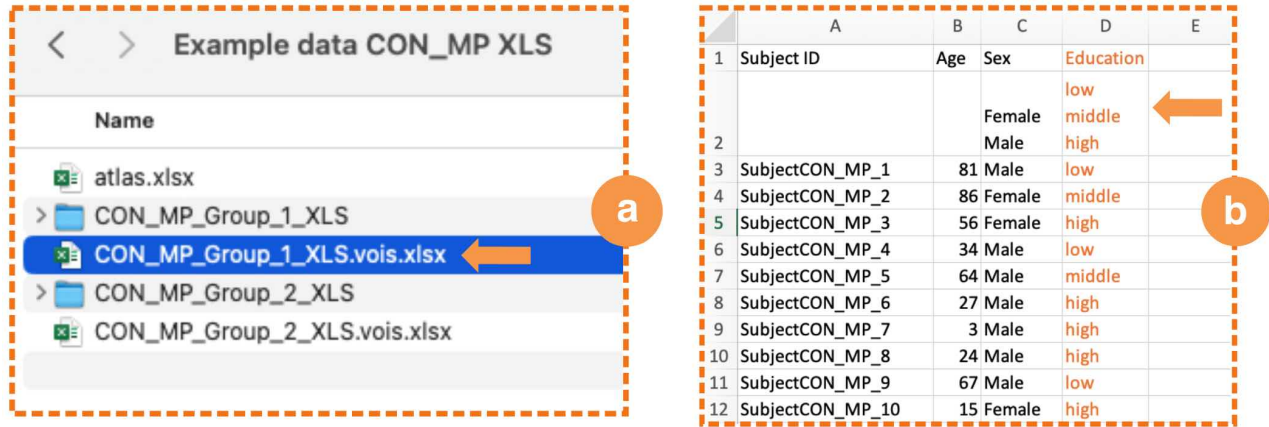


Figure 6: **Edit the Covariates.** Information that can be changed in the Covariates file: **a** The names of the variables of interest (vois). **b** In case the vois are categorical, you can state which categories they have.

and with the same name as the folder followed by .vois (Figure 6a). 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.