

# Group of Subjects with Structural Multiplex Data

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August 9, 2024

For *structural multiplex data*, we will upload a folder containing the structural files from different modalities (layers) for different brain areas across subjects that belong to the same group. For example, the structural values could correspond to cortical thickness or gray matter volumes obtained from T1-weighted MRI data, brain perfusion in ASL, or abnormal protein deposition in static PET data. Then a connectivity matrix is computed using correlations in structural values between each pair of brain regions for each layer, and then the layers will be integrated in a multiplex graph. This Tutorial explains how to prepare and work with this kind of data.

## Contents

Generation of Example Data	2
Open the GUI	2
Visualize the Group Data	3
Visualize Each Subject's Data	3
Preparation of the Data to be Imported	6
Adding Covariates	6

The screenshot displays the BRAPH 2 GUI with three main panels. The left panel, titled 'Group - Group ID - BRAPH2', contains fields for Group ID, Group Name, Group Label, and Group Subject Class. The middle panel, titled 'Group - ST\_MP\_Group\_1\_XLS - BRAPH2', shows a table of subjects with columns for Subject ID, Subject Label, and Brain Atlas. The right panel, titled 'Subject1ST\_MP - sub\_1 - BRAPH2', contains fields for Subject Label, Brain Atlas, Age, Sex, and a table of regions with values.

Subject ID	Subject Label	Brain Atlas
1	sub_1	Label 1
2	sub_2	Label 2
3	sub_3	Label 3
4	sub_4	Label 4
5	sub_5	Label 5
6	sub_6	Label 6
7	sub_7	Label 7
8	sub_8	Label 8

Region	Value
Region_1	14.5349
Region_2	13.9949
Region_3	14.4456
Region_4	11.4546
Region_5	9.4481
Region_6	10.7205
Region_7	10.2448
Region_8	11.1096
Region_9	12.3228
Region_10	10.8157
Region_11	9.8482
Region_12	11.1719
Region_13	9.2663
Region_14	13.1897
Region_15	14.2524
Region_16	14.2816
Region_17	13.3864
Region_18	10.8457
Region_19	13.9982

Figure 1: GUI for a group of subjects with structural multiplex data. Full graphical user interface to upload a group with structural multiplex data in BRAPH 2.

## Generation of Example Data

If you do not have the Example data ST\_MP XLS folder inside structural multiplex, then you can generate it by running the commands in Code 1.

**Code 1: Code to generate the example data folder.** This code can be used in the MatLab command line to generate the Example data ST\_MP XLS folder to the structural multiplex pipeline folder.

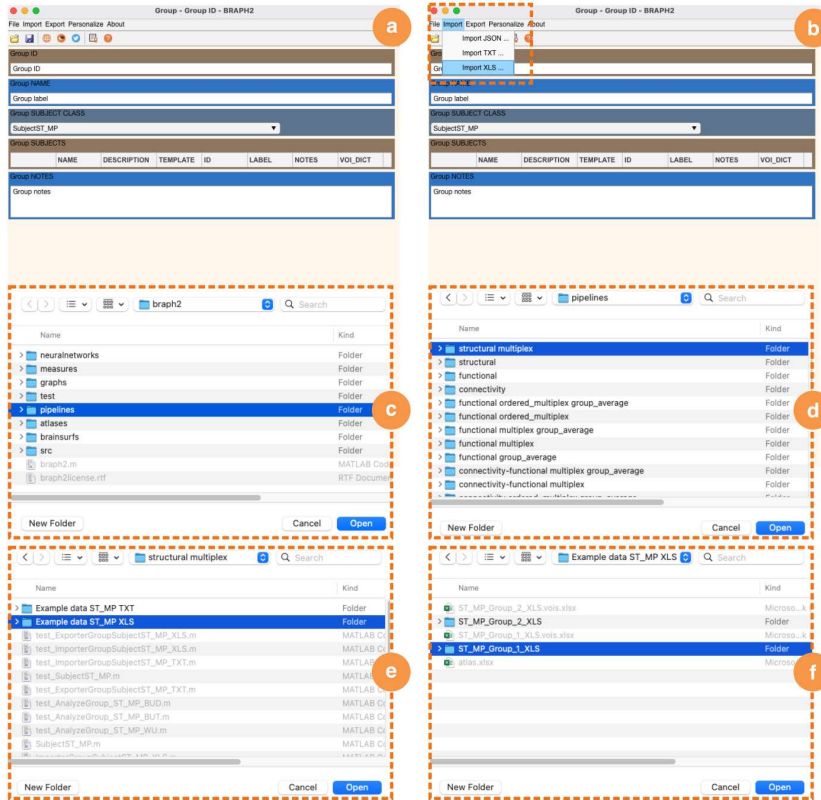
```
1 create_data_ST_MP_XLS() ①
2 create_data_ST_MP_TXT() ②
```

① generates the example structural multiplex XLS data folder.

② generates the example structural multiplex TXT data folder.

## 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 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 directly (Figure 2c-f) after clicking "Load Group".



**Figure 2: Upload the data of a group of subjects.** Steps to upload a group of subjects with structural multiplex data using the GUI and an example dataset: **a** Open the group GUI. **b** Import the folder with the structural multiplex files in XLS or TXT format (see below for details on their format). To upload the test structural multiplex data: **c-f** navigate to the BRAPH 2 folder pipelines, **d** structural multiplex, **e** Example data ST\_MP XLS, and **f** select the folder with structural multiplex values of one group ST\_MP\_Group\_1.XLS.

#### GUI launch from command line

You can also open the GUI and upload the brain structural multiplex data using the command line (i.e., without opening an analysis pipeline) by typing the commands in Code 2. In this case, you can upload the data as shown in Figure 2a-f.

**Code 2: Code to launch the GUI to upload a group of subjects with structural multiplex data.** This code can be used in the MatLab command line to launch the GUI to upload a group of subjects with structural multiplex data without having to open a pipeline.

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

#### *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).

#### *Visualize Each Subject's Data*

Finally, you can open each subject's structural multiplex values by selecting the subject, right click, and select "Open selection" (Figure 4a), which shows the structural values from layer 1 (Figure 4b). Here, you can also change the subject's metadata (ID, label, notes), its variables of interest, and the structural multiplex values.

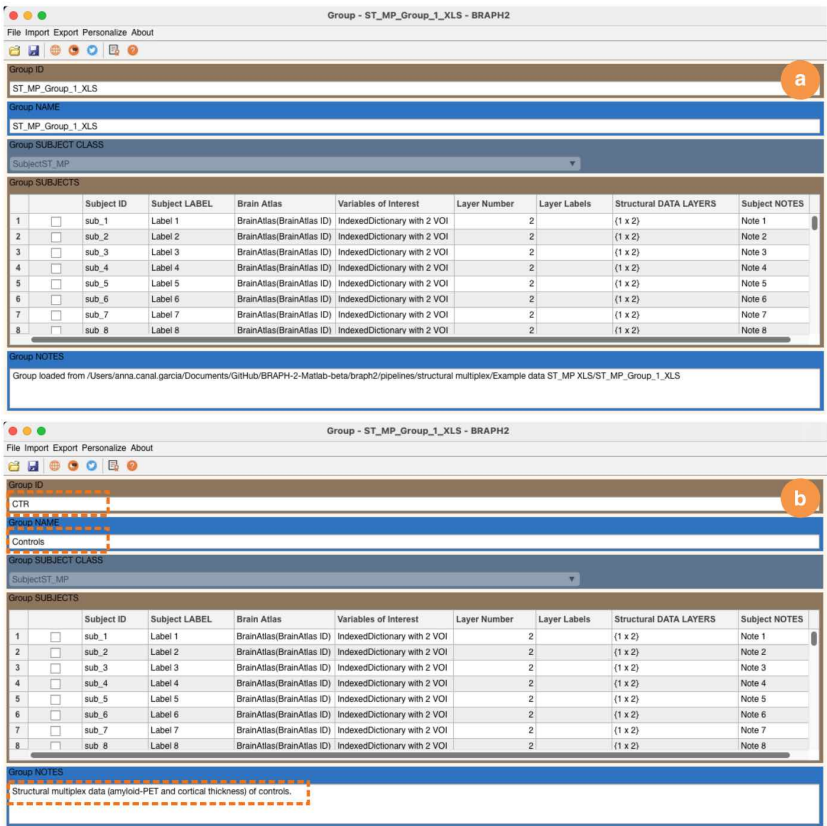


Figure 3: **Edit the group metadata.** **a** The GUI of the group’s structural multiplex data. **b** The information you see on this GUI that can be changed. In this example, we have edited the ID, name, and notes of the group but can also change the subject’s specific information.

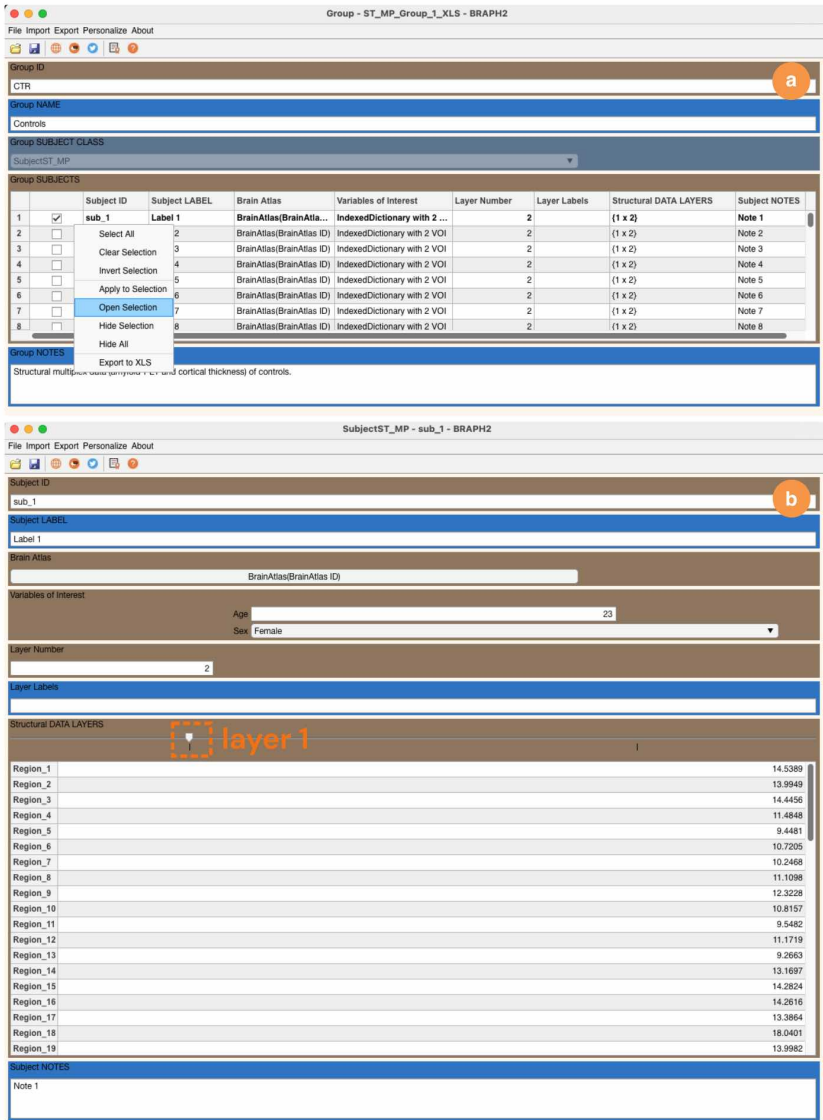
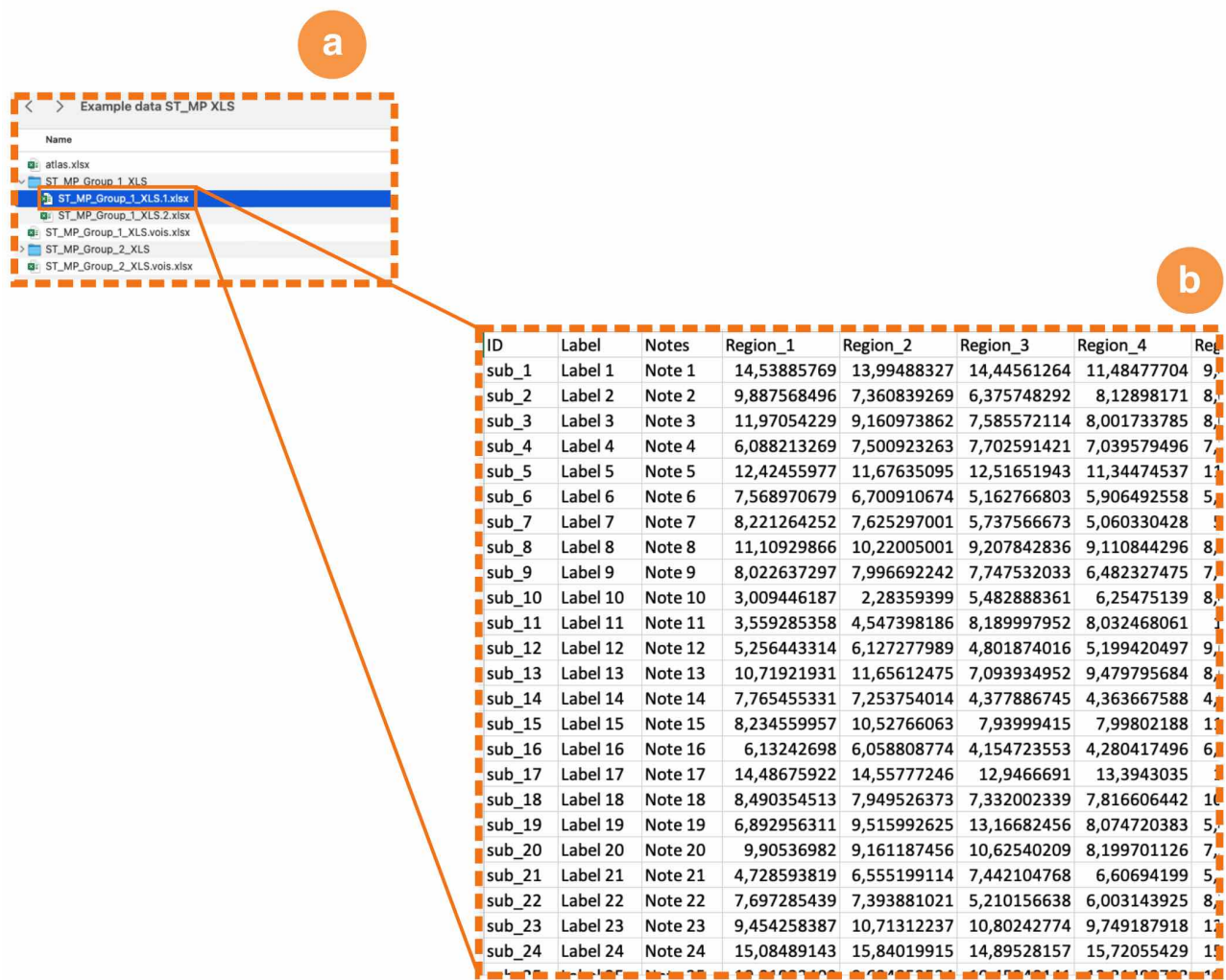


Figure 4: **Edit the individual subject data.** **a** Each subject's structural multiplex values can be opened by selecting the subject, right click, and select "Open selection". **b** In this subject GUI, it is possible to view and edit the metadata of the subject (ID, label, notes), its variables of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

Preparation of the Data to Be Imported

To be able to import structural multiplex data into BRAPH 2, you need to include the structural values of each layer for all subjects in a single file in excel or text format. All structural layers' files should be inside one group folder. Below you can see how this file should look like.



Adding Covariates

It is very common to have *variables of interest* (i.e., *covariates* and *correlates*) in an analysis. In BRAPH 2, 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). This file should have a specific format (Figure 6b):

Figure 5: **Data preparation.** The data should be organised in the following format: **a** The structural values of one layer from each subject belonging to the same group should be included in a single file (for example, ST\_MP\_Group\_1.xlsx). **b** This file should contain the subject's IDs, label and any relevant notes, followed by the structural values for each brain region belonging to a brain atlas. In this example, the (simulated) values correspond to the cortical thickness of 68 brain regions derived from T1-weighted MRI.

**Example data ST\_MP XLS**

Name

- atlas.xlsx
- ST\_MP\_Group\_1\_XLS
  - ST\_MP\_Group\_1\_XLS.1.xlsx
  - ST\_MP\_Group\_1\_XLS.2.xlsx
  - ST\_MP\_Group\_1\_XLS.vois.xlsx**
- ST\_MP\_Group\_2\_XLS
  - ST\_MP\_Group\_2\_XLS.vois.xlsx

**a**

	A	B	C	D	E
1	Subject ID	Age	Sex	Education	
2			Female	low	
3	sub_1	23	Female	low	
4	sub_2	55	Male	middle	
5	sub_3	22	Male	high	
6	sub_4	11	Male	low	
7	sub_5	36	Female	middle	
8	sub_6	68	Female	high	
9	sub_7	48	Female	high	

**b**

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

- **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.