

Group of Subjects with Functional Multiplex Data

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For *functional multiplex data*, we will upload a folder containing the functional files for different subjects, and different layers, that belong to the same group. For example, the functional multiplex values could correspond to brain activation signals derived from functional MRI data at different frequencies or time windows. Then a connectivity matrix is computed for each layer using correlations in functional values between each pair of brain regions. This Tutorial explains how to prepare and work with this kind of data.

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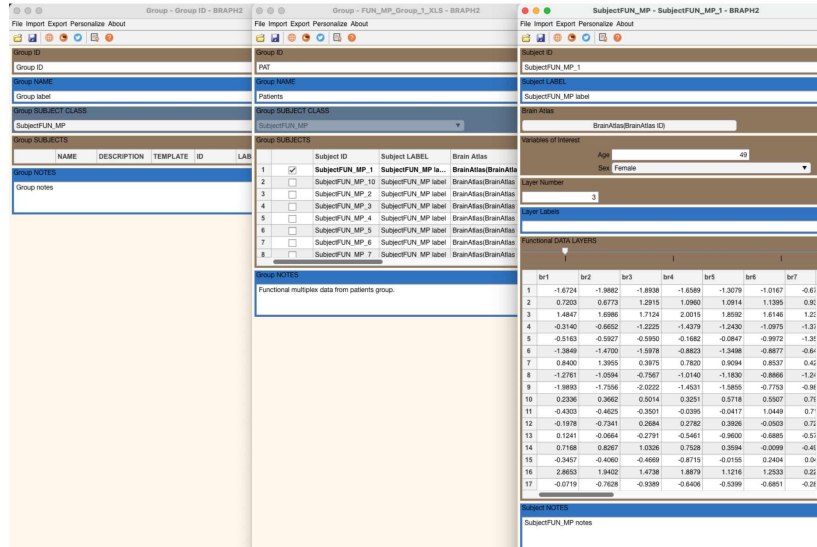


Figure 1: GUI for a group of subjects with functional multiplex data. Full graphical user interface to upload a group with functional multiplex data in BRAPH 2.0.

Generation of Example Data

If you don't have the Example data FUN_MP XLS folder inside functional 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 FUN_MP XLS folder to the functional multiplex pipeline folder.

```
1 test_ImporterGroupSubjectFUN_MP_XLS ①
2 test_ImporterGroupSubjectFUN_MP_TXT ②
```

① generates the example functional multiplex XLS data folder.

② generates the example functional 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".

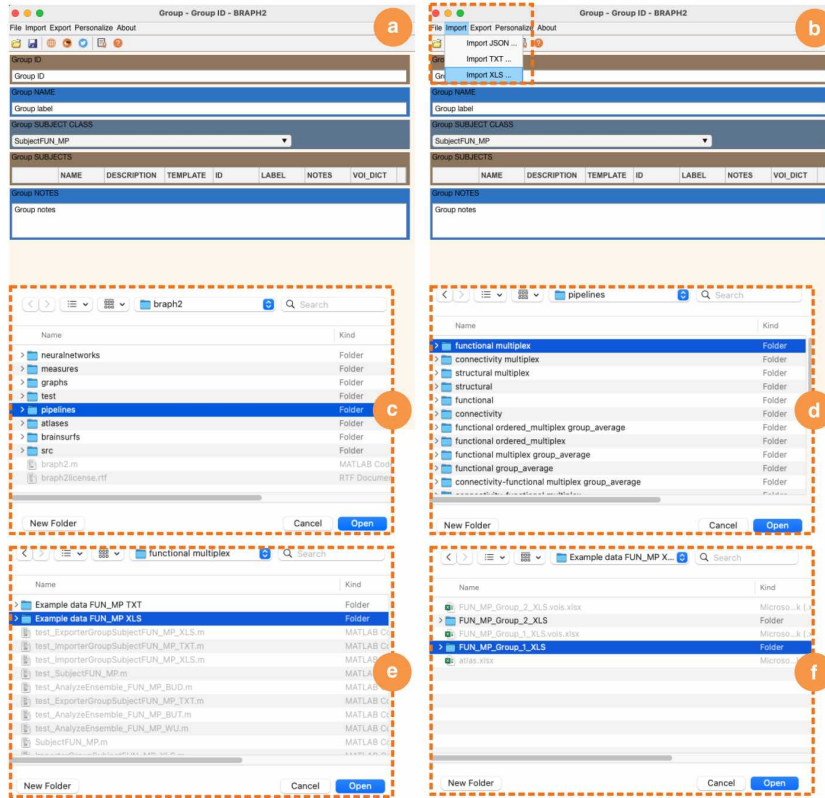


Figure 2: Upload the data of a group of subjects. Steps to upload a group of subjects with functional multiplex data using the GUI and an example dataset: **a** Open the group GUI. **b** Import the folder with the functional multiplex files in XLS or TXT format (see below for details on their format). To upload the test functional multiplex data: **c-f** navigate to the BRAPH 2.0 folder pipelines, **d** functional multiplex, **e** Example data FUN_MP XLS, and **f** select the folder with functional multiplex values of one group FUN_MP_Group_1_XLS.

GUI launch from command line

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

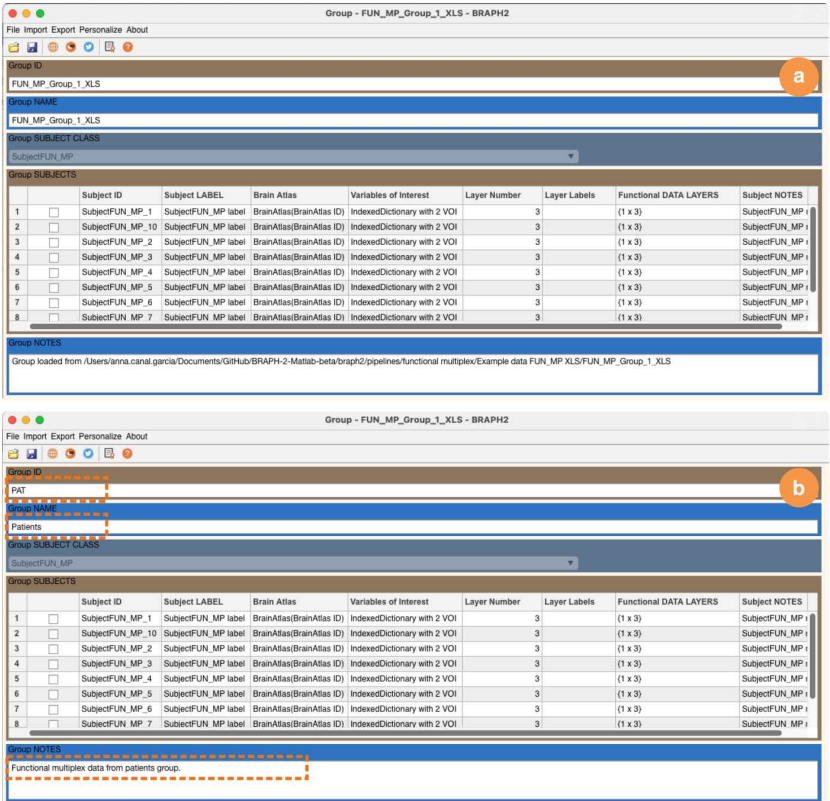
```
1 gr = Group('SUB_CLASS', 'SubjectFUN_MP');
2
3 gui = GUIElement('PE', gr);
4 gui.get('DRAW')
5 gui.get('SHOW')
```

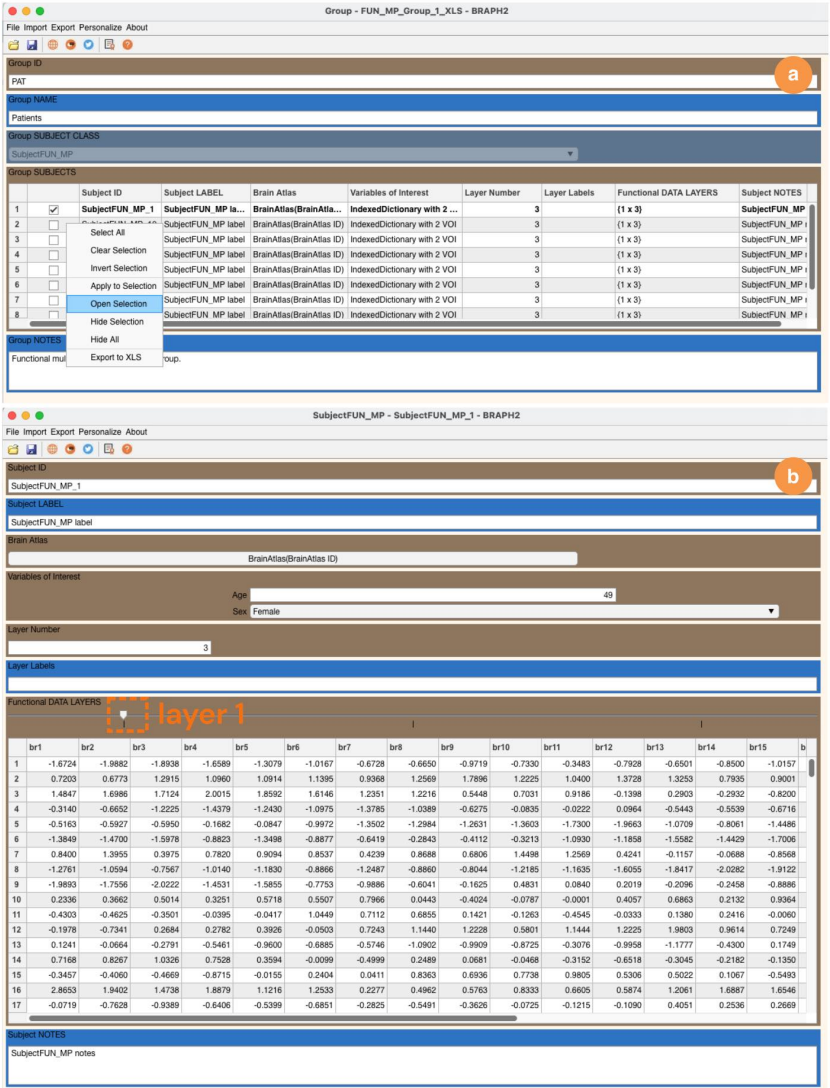
Visualize the Group Data

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





Preparation of the Data to be Imported

To be able to import functional multiplex data into BRAPH 2.0, you need to include the functional values of each layer for all subjects in a single file in excel or text format. All functional layers' files should be inside one group folder. Below you can see how this file should look like.

a

Example data FUN_MP XLS

Name

atlas.xlsx

FUN_MP_Group_1_XLS

SubjectFUN_MP_1.1.xlsx

SubjectFUN_MP_1.2.xlsx

SubjectFUN_MP_1.3.xlsx

SubjectFUN_MP_2.1.xlsx

SubjectFUN_MP_2.2.xlsx

SubjectFUN_MP_2.3.xlsx

SubjectFUN_MP_3.1.xlsx

SubjectFUN_MP_3.2.xlsx

SubjectFUN_MP_3.3.xlsx

SubjectFUN_MP_4.1.xlsx

SubjectFUN_MP_4.2.xlsx

SubjectFUN_MP_4.3.xlsx

SubjectFUN_MP_5.1.xlsx

SubjectFUN_MP_5.2.xlsx

SubjectFUN_MP_5.3.xlsx

SubjectFUN_MP_6.1.xlsx

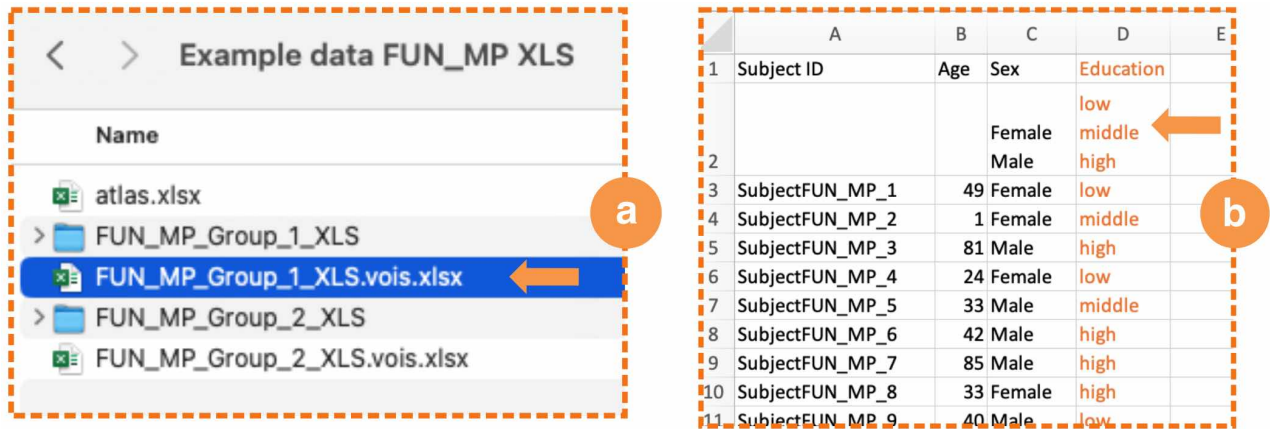
b

-1,672390156	-1,98815299	-1,893844788	-1,658897371	-1,307921925
0,720289986	0,677253286	1,291451874	1,095978576	1,091432568
1,484734638	1,698554865	1,712410901	2,001491281	1,859245818
-0,313965948	-0,665152784	-1,22253116	-1,437864495	-1,243042565
-0,516294577	-0,592661966	-0,594976398	-0,168183833	-0,084708784
-1,384858019	-1,470024513	-1,597793385	-0,882324544	-1,34980661
0,839963008	1,395529074	0,397450707	0,782002919	0,909440519
-1,27613306	-1,059423809	-0,756717866	-1,013956706	-1,182984783
-1,9893382	-1,755586421	-2,022167765	-1,453050572	-1,585489243
0,233580061	0,366216003	0,501422229	0,325056183	0,571832361
-0,430309699	-0,462503334	-0,350109309	-0,039493661	-0,041655491
-0,197810585	-0,734063253	0,268410337	0,27824566	0,392551378
0,124126361	-0,06642991	-0,279135807	-0,546103165	-0,960018641
0,716841634	0,826729956	1,032597573	0,752784755	0,359395261
-0,345737152	-0,406045824	-0,466924433	-0,871474074	-0,015511717
2,865306911	1,94018657	1,47384864	1,887880027	1,12155008
-0,071944751	-0,762825734	-0,938942861	-0,640554831	-0,539935719
-1,429509806	-1,59394494	-1,482077512	-1,109671965	-1,057074243
0,79822574	0,773683136	0,269959589	0,669261236	0,249865341
0,315223303	0,852416981	0,44299629	0,50380225	-0,23352049
-0,455549684	0,438041748	0,214987483	-0,445088812	-0,750126845
0,752667096	-0,129960085	-0,546867102	-0,257037206	-0,192325084
-0,5798844	-0,320194585	-0,139688856	0,45044184	0,143351481
1,36948579	0,857944062	2,080435727	2,399856775	2,110017046
-1,183244942	-0,784456338	-1,527994735	-1,655149562	-1,972824964

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 functional values of one layer from each subject belonging to the same group should be included in a single file (for example, FUN_MP_Group_1.xlsx). **b** This file should contain the subject's IDs, label and any relevant notes, followed by the functional values for each brain region belonging to a brain atlas. In this example, the (simulated) values correspond to brain activation signals of 90 brain regions derived from functional MRI.



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.