STUDY design and plotting overview

STEP 1
Build a STUDY

STEP 2
Build design(s)

STEP 3
Precompute the data

STEP 4
Plot the data

Exercise...
Memory options should change when using STUDY vs single dataset.
Create simple ERP STUDY

This interface creates a simple STUDY and computes its condition grand average ERPs. For each subject, trials for each condition must first be stored in a separate dataset. Create other STUDY using the standard editor.

- Number of conditions: 2
- Number of subjects: 15

[Options: Help, Cancel, Ok]
Create simple ERP STUDY

STUDY set name: Letter memorization task

<table>
<thead>
<tr>
<th>Condition 1 name</th>
<th>Condition 2 name</th>
</tr>
</thead>
<tbody>
<tr>
<td>letter-ignore</td>
<td>letter-memorize</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition 1 datasets</th>
<th>Condition 2 datasets</th>
</tr>
</thead>
<tbody>
<tr>
<td>/data/STUDY/S01/Ignore.set</td>
<td>/data/STUDY/S01/Memorize.set</td>
</tr>
<tr>
<td>/data/STUDY/S02/Ignore.set</td>
<td>/data/STUDY/S02/Memorize.set</td>
</tr>
<tr>
<td>/data/STUDY/S03/Ignore.set</td>
<td>/data/STUDY/S03/Memorize.set</td>
</tr>
</tbody>
</table>

When using more than 1 condition, datasets on each line must correspond to the same subject.
Create simple ERP STUDY
Exercises

Suggestion for exercise

1. From the GUI, select “File > Create STUDY > Simple ERP STUDY”
2. Enter 2 conditions “letter-ignore” and “letter-memorize”
3. In the column for “letter-ignore” select datasets “ignore.set” for 3 subjects S01, S02, S03 (in the STERN folder)
4. In the column for “letter-memorize” select datasets “memorize.set” for 3 subjects S01, S02, S03 (in the STERN folder)
5. Press OK.
Create design

1x3 design
Design independent of # of files per subject

<table>
<thead>
<tr>
<th>Dataset Name</th>
<th>Subject</th>
<th>Session</th>
<th>Condition</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>C:Users\Julien\Documents\Word</td>
<td>S01</td>
<td></td>
<td>memorize</td>
<td>Comp: 3.5. Clear</td>
</tr>
<tr>
<td>C:Users\Julien\Documents\Word</td>
<td>S02</td>
<td></td>
<td>memorize</td>
<td>Comp: 5.6. Clear</td>
</tr>
<tr>
<td>C:Users\Julien\Documents\Word</td>
<td>S03</td>
<td></td>
<td>ignore</td>
<td>Comp: 6.7. Clear</td>
</tr>
<tr>
<td>C:Users\Julien\Documents\Word</td>
<td>S04</td>
<td></td>
<td>memorize</td>
<td>Comp: 1.2. Clear</td>
</tr>
</tbody>
</table>

Number of event fields is unlimited.
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Exercise...
Precompute data measures
Choose which channel

Choose which subject
Computing Spectrum

Select and compute component measures for later clustering -- pop_prectp()
Choose which channel

Choose which subject
Computing ERSP

'cycles', [3 0.8], 'nfreqs', 50, 'ntimesout', 100
ERP-image across subjects

STUDY name 'Sternberg' - 'Comparing conditions'

Select channel to plot: All CZ

Select subject(s) to plot:
- All subjects
- S01 CZ
- S02 CZ
- S03 CZ
- S04 CZ
- S05 CZ
- S06 CZ
- S07 CZ
- S08 CZ
- S09 CZ

Plot ERPs
Plot spectra
Plot ERP Image

General statistical parameters
- Compute 1st independent variable statistics
- Compute 2nd independent variable statistics
- Use single trials (when available)

Use EEGLAB statistics
- Use parametric statistics
- Use FDR correction
- Statistical threshold (p-value): 0.05
- Randomization (n): auto

Use Fieldtrip statistics
- Use analytic/parametric statistics
- Do not correct for multiple comparisons
- Statistical threshold (p-value): 'method', 'triangulation'
- Randomization (n): 'clusterstatistic', 'maxsum'

Figure 4: Channel ERP
ERP - CZ
Potential (u V)
Time (ms)
std_stat() function in EEGLAB
Exercises

1. Load “stern.study” file in STUDY folder

2. Edit STUDY design and delete current variable(s)

3. Create a new indep. Variable design to compare Ignore vs. Memorize letter

4. Recompute spectrum and ERP.

5. Plot spectrum and ERP for electrode Cpz

6. Plot scalp topography at 10 Hz (spectrum) and 200-300 ms (ERP) for both conditions

7. Plot spectrum for electrode CPz within 1 to 50 Hz and compute parametric statistics (with and without FDR correction)

8. Plot scalp topography at 10Hz for both conditions using permutation statistics cluster correction (Fieldtrip – statistics)
EEGLAB and BIDS

- Export EEGLAB STUDY to BIDS
- Import BIDS to EEGLAB STUDY
- HED support (meta-tags)
- Mapping the BIDS architecture

https://github.com/sccn/bids-matlab-tools
BIDS data structure...

- changes compared to previous release of data
- scripts and program to process/convert the data
- description of dataset in JSON format
- description of participants table file columns (below)
- participants table files in tab delimited format
- readme file for users
- original raw data if converted to a supported format
- original stimuli (sound files and images)
- anonymized subject 1 folder
- file describing channels
- raw EEG data file (not all raw formats are possible)
- amplifier and recording information
- events in tabular format

Preprocessing pipeline

1. Import into EEGLAB
2. Remove unwanted channels
3. High pass filter (~0.5 – 1 Hz)
4. Re-reference/down-sample (if necessary)
5. Identify/reject bad channels
6. Reject large artifact time points
7. Re-reference
8. Run ICA
9. Reject components

ASR

ICLabel

Raw EEG data
Tim R. Mullen, Christian Kothe, et al.(2015) Real-time neuroimaging and cognitive monitoring using wearable dry EEG. Published in IEEE Transactions on Biomedical Engineering. DOI:10.1109/TBME.2015.2481482

Pairwise correlation to find bad channels

Bad data

Good data

ASR finds and reconstructs bad portions of data

Reference window $X_r$

$M = \sqrt{\text{Cov}(X_r)}$

Current window $X$

$V = \text{PCA}(X)$

EEG sample $x(t)$ to clean look-ahead

$\hat{x}(t) = V \ast M \ast (M\cdot U)^* \ast V^T \ast x(t)$

Fig. 3. The Artifact Subspace Reconstruction method. High-variance
IC label

% Create Stern STUDY
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
pop_editoptions( 'option_storedisk', 1);
subjects = {'S01' 'S02' 'S03' 'S04' 'S05' 'S06' 'S07' 'S08' 'S09' 'S10' 'S11' 'S12'};
filepath = '/Users/arno/temp/STUDY'; % XXXXX Change path here XXXXX
if ~exist(filepath), error('You need to change the path to the STUDY'); end;
commands = {}; % initialize STUDY dataset list

% Loop through all of the subjects in the study to create the dataset
for loopnum = 1:length(subjects) % for each subject
    IgnoreFile = fullfile(filepath, subjects{loopnum}, 'Ignore.set');
    MemorizeFile = fullfile(filepath, subjects{loopnum}, 'Memorize.set');
    ProbeFile = fullfile(filepath, subjects{loopnum}, 'Probe.set');
    commands = {commands{:} ...
                {'index' 3*loopnum-2 'load' IgnoreFile 'subject' subjects{loopnum} 'condition' 'Ignore'} ...
                {'index' 3*loopnum-1 'load' MemorizeFile 'subject' subjects{loopnum} 'condition' 'Memorize'} ...
                {'index' 3*loopnum 'load' ProbeFile 'subject' subjects{loopnum} 'condition' 'Probe'}};
end;
% Uncomment the line below to select ICA components with less than 15% residual variance
% commands = {commands{:} {'dipselect', 0.15)};
[STUDY, ALLEEG] = std_editset(STUDY, ALLEEG, 'name','Sternberg','commands',commands,'updatedat','on');

% Update workspace variables and redraw EEGLAB
CURRENTSTUDY = 1; EEG = ALLEEG; CURRENTSET = [1:length(EEG)];
[STUDY, ALLEEG] = std_checkset(STUDY, ALLEEG);
eeglab redraw

[STUDY ALLEEG] = std_precomp(STUDY, ALLEEG, {}, 'rmicacomps','on','interp','on','recompute','on','erp','on');
STUDY = pop_erpparams(STUDY, 'topotime', [200 300]);
[STUDY erpdata] = std_erpplot(STUDY,ALLEEG, 'channels',{'LEYE' 'REYE' 'OZ' 'O2' 'FP1' 'FP2' 'FP10' 'TP9' ...
                                'AF3' 'AFZ' 'AF4' 'AF8' 'F9' 'F7' 'F5' 'F3' 'F1' 'F2' 'F4' 'F6' 'F8' 'F10' 'FT9' ...
                                'FT7' 'FC5' 'FC3' 'FC1' 'FCZ' 'FC2' 'FC4' 'FC6' 'FT8' 'FT10' 'T7' 'C5' 'C3' 'C1' 'CZ' ...
                                'C2' 'C4' 'C6' 'T8' 'TP9' 'TP7' 'CP5' 'CP3' 'CP1' 'CPZ' 'CP2' 'CP4' 'CP6' 'CP8' 'TP8' 'TP10' ...
                                'P7' 'P5' 'P3' 'P1' 'PZ' 'P2' 'P4' 'P6' 'P8' 'PO9' 'PO7' 'PO3' 'POZ' 'PO4' 'PO8' 'PO10' 'O1'});
dlmtree('erpfie.txt',squeeze(erpdata{1}),'delimiter', '	', 'precision', 2);
dlmtree('erpfie.txt',squeeze(erpdata{2}),'-append', 'roffset', 1, 'delimiter', '	', 'precision', 2);
dlmtree('erpfie.txt',squeeze(erpdata{2}),'-append', 'roffset', 1, 'delimiter', '	', 'precision', 2);