Evaluating ICA components

1. Remove an IC (back-projection)
2. IC ERP envelope
3. IC ERP images - advanced
4. Time-frequency analysis
5. IC ERSPs
6. IC cross coherence
Eye blink correction (remove IC)

Identify eye-blink components:
IC rejection/back-projection

Channels $W$ * Back-project

ICA

Decompose IC activations

$W^{-1}$

Scalp Data

IC scalp maps

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Eye blink correction (remove IC)
Eye blink correction (remove IC)
Eye blink correction (remove IC)
Eye blink correction (remove IC)
Evaluating ICA components

1. Remove an IC (back-projection)
2. IC ERP envelope
3. IC ERP images - advanced
4. Time-frequency analysis
5. IC ERSP
6. IC cross coherence
Extract epochs

EEGLAB v7.1.7.18b
Tools | Plot | Study | Datasets | Help
---|---|---|---|---
Extract epochs
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA

Extract data epochs - pop_epoch()
Time-locking event type(s) ([I]=all)
Epoch limits [start, end] in seconds
Name for the new dataset
Out-of-bounds EEG limits if any [min max]

Cancel | Help | Ok

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Extract epochs
Reject data epochs (automatic)

>> EEG = pop_autorej(EEG, 'nogui', 'on', 'eegplot', 'on');

High enough to keep eye blinks

High standard deviation, multiples passes
Component ERP envelope
Definition: The data envelope

Data (all channels)

Data envelope (max/min traces)
IC back-projection envelope

Figure 11

10

Potential (uV)

-0.05 0 0.05 0.1 0.15 0.2 0.25 0.3

Time (s)

ppa 36.83%
IC back-projection envelope

IC envelopes plotted for simplicity (instead of all back-projected channels)
IC contributions to ERP envelope

Plot component and ERP envelopes – pop_envtopo()

- Enter time range (in ms) to plot:
- Enter time range (in ms) to rank component contributions:
- Number of largest contributing components to plot (1-20):
- Else plot these component numbers only (<21) (Ex: 2,4,7):
- Component numbers to remove from data before plotting:
- Plot title:
- Optional topplot() and spectopo() arguments:

ERP components of faces_4 epochs

Largest ERP components of faces_4 epochs

Potential (uV)

Time (s)
IC contributions to ERP envelope

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Evaluating ICA components

1. Remove an IC (back-projection)
2. IC ERP envelope
3. IC ERP images - advanced
4. Time-frequency analysis
5. IC ERSP
6. IC cross coherence
Component ERP image
Component ERP Images

Select fields:
- Latency
- Type
- Epoch

Event type(s):
- bp1
- bp4

Event time range:
0 to 2000

Sorted Trials:
- Comp. 11
- 0.4 to -0.4
Component ERP Images

Phase-sorted image

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools

Component ERP Images

Phase-sorted alpha power
Component ERP

Same data: Sorted by alpha amplitude

```
>> help erpimage

'ampsort' = [center_ms, prcnt, freq, maxfreq]  Sort epochs by amplitude.
```
Component ERP Images

Component(s): 3
Project to channel #: 10
Smoothing: 1
Downsampling: -800 1000

Figure title:
- Plot scalp map
- Plot ERP
- Plot colorbar

ERP limits: [ ]
Color limits (see Help): [ ]

Same sorting order: Amplitude vs. activations
Evaluating ICA components

1. Remove an IC (back-projection)
2. IC ERP envelope
3. IC ERP images - advanced
4. Time-frequency analysis
5. IC ERSP
6. IC cross coherence
Stationary signals

2 Hz

10 Hz

2+10+20 Hz

Power spectrum

2 Hz

10 Hz

2+10+20 Hz

Power spectrum

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – Analysis Tools
Summing stationary signals and decomposing

Time domain

\[ f(x) \]

Frequency domain

\[ |F(u)| \]

Freq. decomp.  Sum of freq.

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Average of squared absolute values
Overlap 50%

Average of squared amplitudes
Spectrogram or ERSP

Average of squared values
Absolute versus relative power

Absolute = ERS

Relative = ERSP (dB or %)
Difference between FFT and wavelets

- FFT
- Wavelet

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Time-frequency resolution trade off

FFT

High freq. resolution
low time-resolution

Wavelet

Low freq. resolution
high time-resolution
FFT

Pure wavelet
Wavelets factor

Wavelet (0) = FFT

Wavelet (1)

1 Hz
2 Hz
4 Hz
6 Hz
8 Hz
10 Hz

exact same number of wavelets at all freqs
Modified wavelets

Scaled to require more wavelets at higher freqs (less than FFT though)
Evaluating ICA components

1. Remove an IC (back-projection)
2. IC ERP envelope
3. IC ERP images - advanced
4. Time-frequency analysis
5. IC ERSP
6. IC cross coherence
Plot IC ERSP

Time points lost at beginning and end of epoch!
Pure green denotes non-significant points.
Plot IC ERSP

Component 1 power and inter-trial phase coherence (faces, epochs)

padratio = 1

padratio = 2

Increase # freq bins

Use limits, padding 1

 ERP
dB
 padratio = 1
 padratio = 2
 Frequency (Hz)
 Time (ms)
0.02 0.12
 Frequency (Hz)
 Time (ms)
0.02 0.12

Component number
Sub epoch time limits [min max] (msec)
Frequency limits [min max] (Hz) or sequence
Baseline limits [min max] (msec) (0->pre-stim.)
Wavelet cycles [min max fact] or sequence
ERSP color limits [max] (min= max)
ITC color limits [max]
Bootstrap significance level (Ex: 0.01 -> 1%)
Optional newtime() arguments (see Help)
Evaluating ICA components

1. Remove an IC (back-projection)
2. IC ERP envelope
3. IC ERP images - advanced
4. Time-frequency analysis
5. IC ERSP
6. IC cross coherence
Scalp channel coherence confounds

Two EEG channels

Scalp channel coherence includes source confounds!

Is the observed coherence from C getting stronger? Or B and C becoming synchronous?
Scalp channel coherence confounds

MANY EEG channels

Separate out independent EEG components

Measure their synchronization

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
Cross-coherence amplitude and phase

**Animal picture**

<table>
<thead>
<tr>
<th>Amplitude (0-1)</th>
<th>Phase (degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq (Hz)</td>
<td>Freq (Hz)</td>
</tr>
<tr>
<td>0  0.2  0.4  0.6</td>
<td>0  200  400  600</td>
</tr>
<tr>
<td>0  10  20  30  40</td>
<td>0  10  20  30  40</td>
</tr>
<tr>
<td>5  10  15  20  25</td>
<td>180  90  0  -90  -180</td>
</tr>
</tbody>
</table>

**Distractor picture**

- Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
IC cross coherence

Be sure to mask by bootstrap significance limits
IC cross coherence

Figure 5

New EEGLAB software features for IC analysis tools include:
- Channel time-frequency
- Channel cross-coherence
- Component time-frequency
- Component cross-coherence

The figure shows a visualization of coherence and phase lag over time and frequency.
**Exercise**

- **ALL**
  - Load stern.set, epoch on **Memorize** letters, reject noisy epochs

- **Novice**
  - From the GUI, plot component ERPs with maps
  - Plot an IC ERP image; try sorting by RT or phase, is there any effect of the time-locking event on the activation pattern?
  - Try plotting power in a specified frequency band; how consistent are any power changes across trials?

- **Intermediate**
  - Plot ERSPs for an IC; for FFT, vary the 'winsize' and 'padratio'; for wavelets, vary number of 'cycles' and window size factor
  - Compare FFT and wavelet methods; Do the results agree?
  - Plot ERSPs with no baseline and with different baseline periods; how might this affect your results/conclusions?

- **Advanced**
  - Plot cross coherence between two selected ICs
  > Compare this result with cross coherence between two channels that are highly weighted in the respective ICs
Cross-coherence amplitude and phase

2 components, comparison on the same trials

Trial 1

Trial 2

Trial 3

COHERENCE = mean(phase vector)

Norm 0.33
Phase 90 degree

Coherence amplitude 1
Phase coherence 0

Coherence amplitude 1
Phase coherence 90

Coherence amplitude 1
Phase coherence 180
What is the IC ERP difference between these 2 conditions?
IC ERP difference

Novice EEGLAB Workshop, Sept 22, 2011, Mallorca, Spain: Julie Onton – IC Analysis Tools
IC ERP difference

Largest ERP components of Memorize-Ignore epochs

IC Analysis Tools