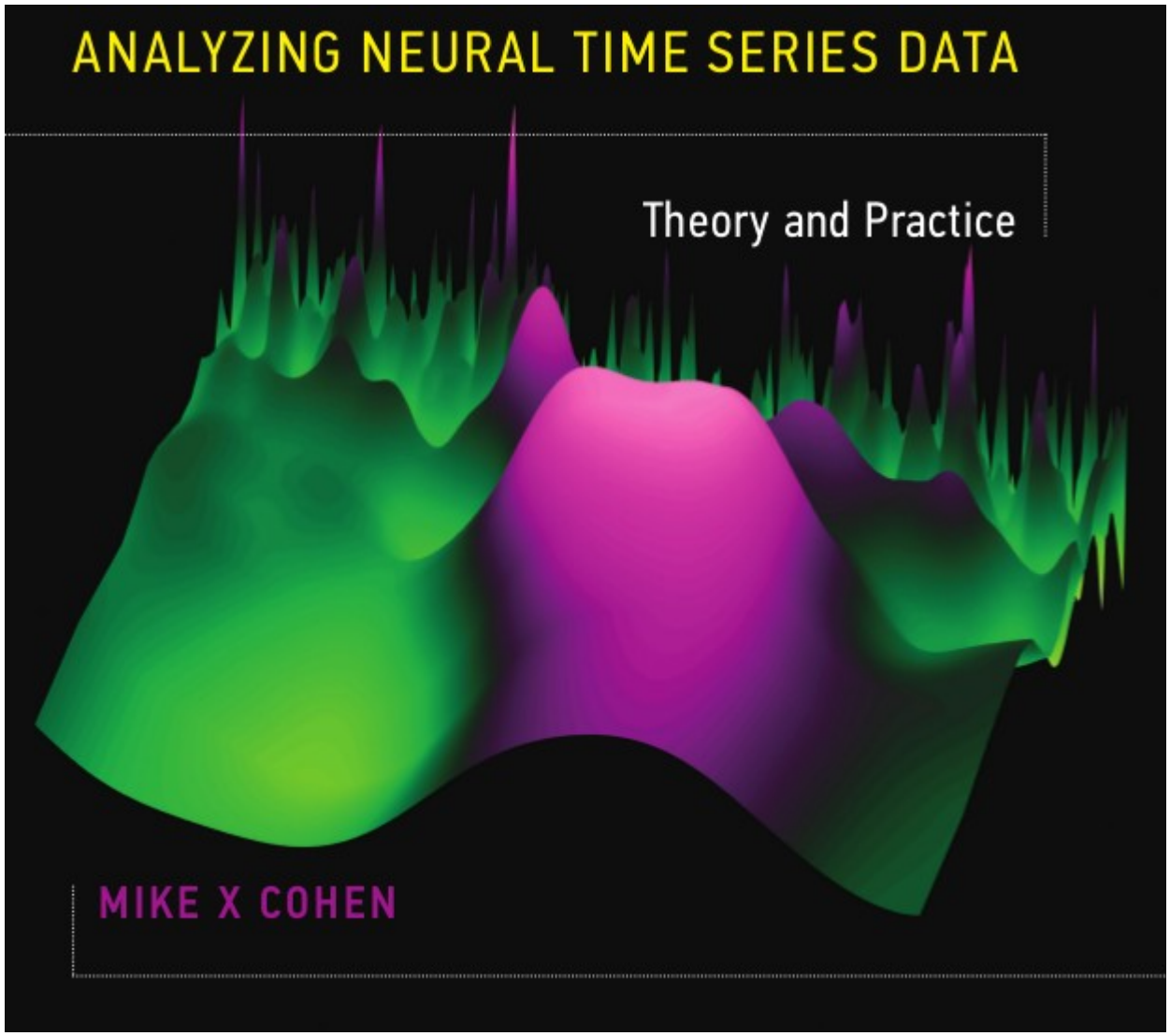
ANALYZING NEURAL TIME SERIES DATA



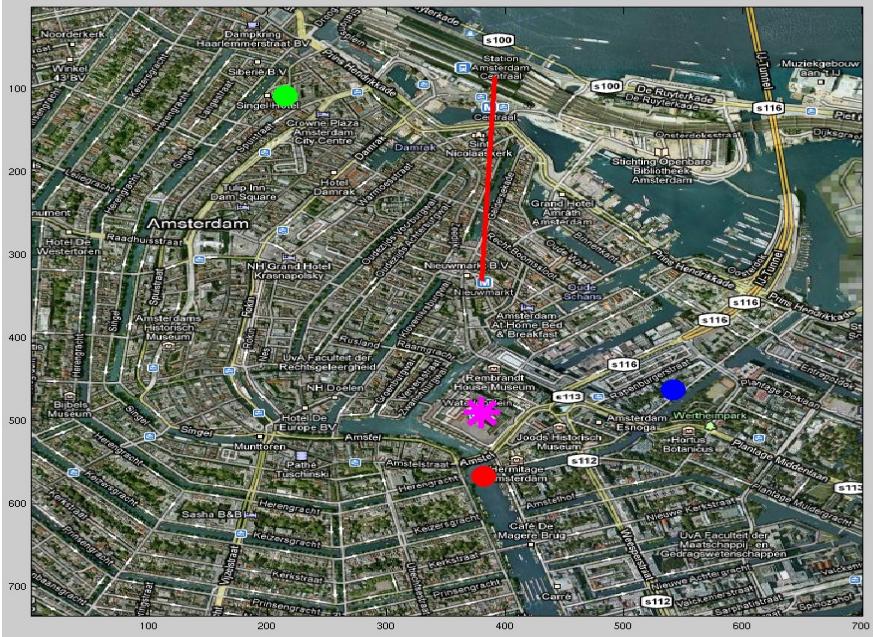
Theory and Practice

MIKE X COHEN

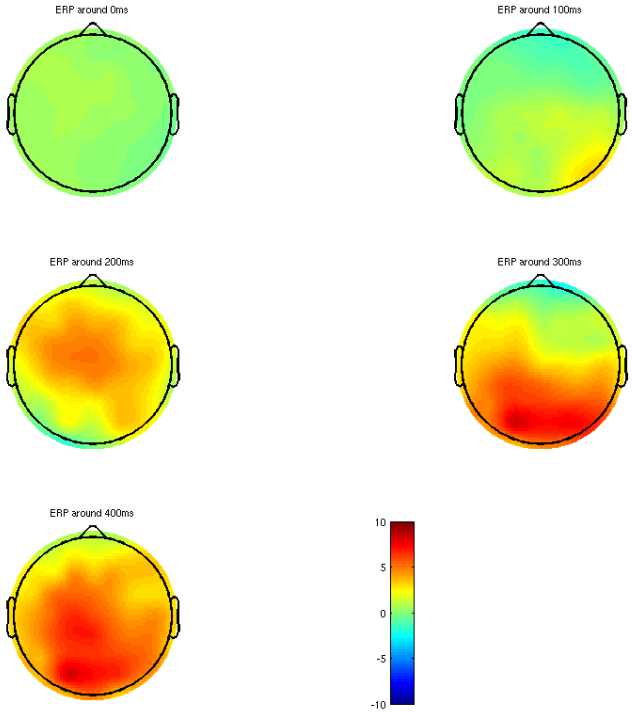
Solutions to end-of-chapter exercises

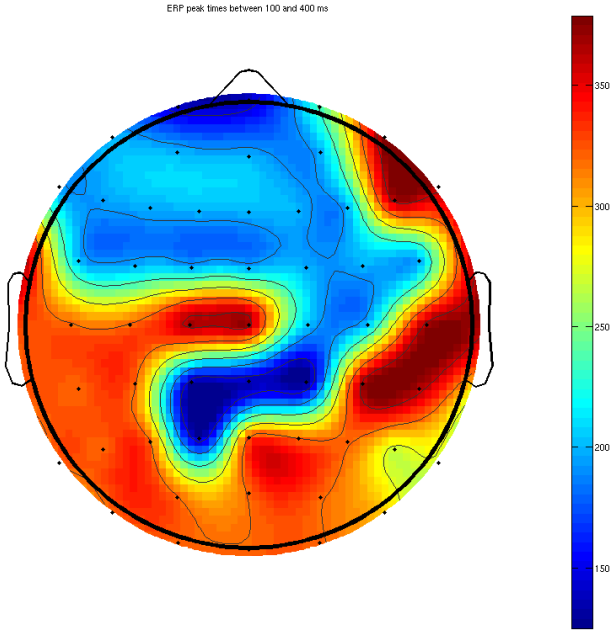
Matlab code is not provided for the exercises at the end of chapters. However, screenshots of Matlab figures are shown, indicating possible solutions. If your solutions look like the ones shown here, it is likely that you correctly solved the exercises. Note, however, that the results may not look identical if you chose different electrodes/time windows/frequencies/etc.

Chapter 4

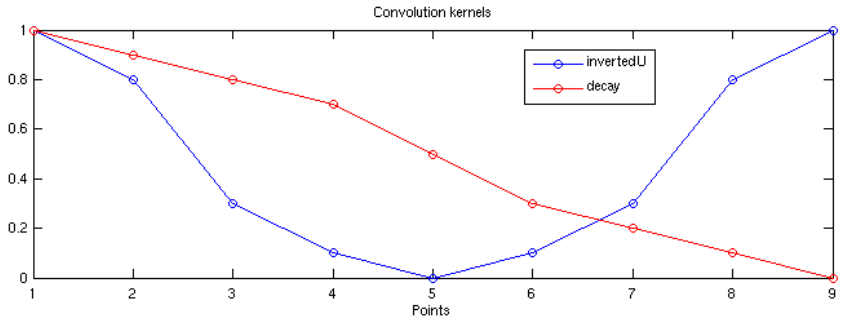

Amsterdam
Station Amsterdam Centraal
Damrak
Rembrandt House Museum
Hotel De Europe BV
Singel Hotel
Crowne Plaza Amsterdam City Centre
NH Grand Hotel Krasnapolsky
Grand Hotel Amrâth Amsterdam
Amsterdam Historisch Museum
Bijbels Museum
Munttoren
Pathé Tuschinski
Joods Historisch Museum
Amsterdam Esnoga
Hortus Botanicus
Stichting Openbare Bibliotheek Amsterdam
Muziekgebouw aan 't IJ
De Ruyterkade
Nieuwmarkt
Café De Magere Brug
Sasha B&B
UvA Faculteit der Rechtsgeleerdheid
UvA Faculteit der Maatschappij- en Gedragswetenschappen
100
200
300
400
500
600
700

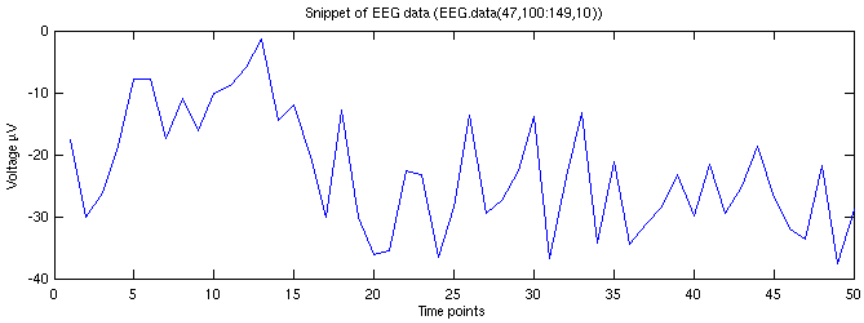
Chapter 9

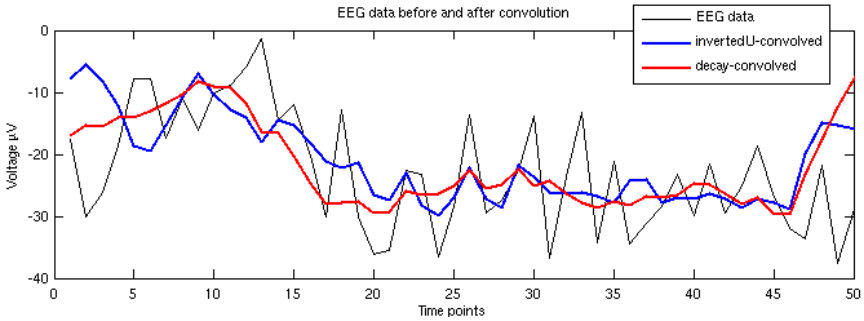

ERP around 0ms
ERP around 100ms
ERP around 200ms
ERP around 300ms
ERP around 400ms
10
5
0
-5
-10


ERP peak times between 100 and 400 ms
350
300
250
200
150

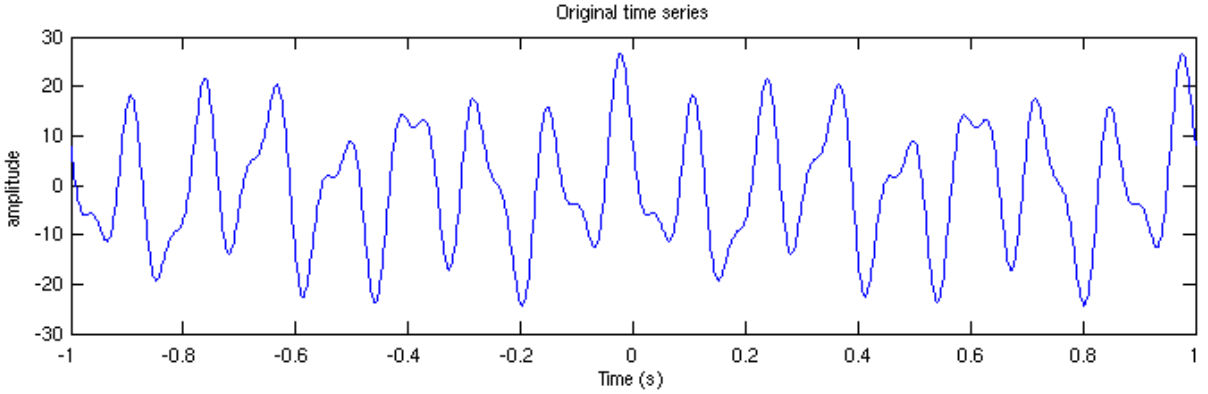
Chapter 10

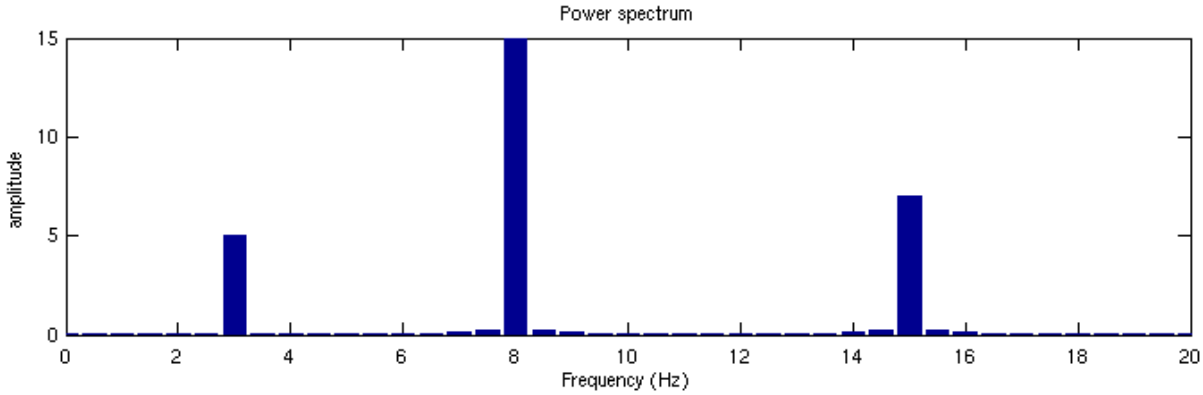

Convolution kernels
invertedU
decay
Points

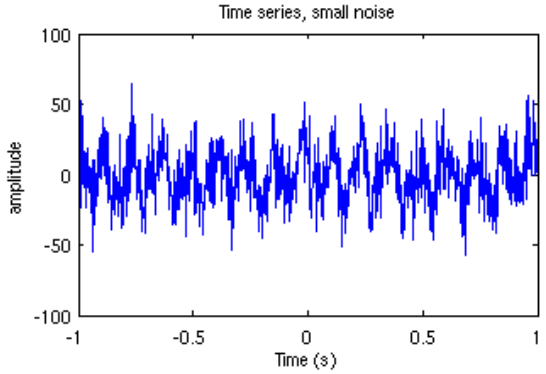

Snippet of EEG data (EEG.data(47,100:149,10))
Voltage µV
Time points

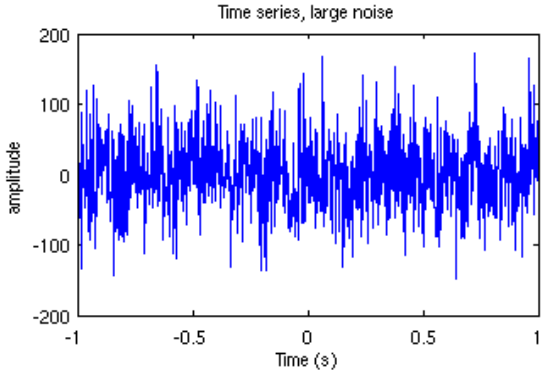

EEG data before and after convolution
EEG data
invertedU-convolved
decay-convolved
Voltage µV
Time points

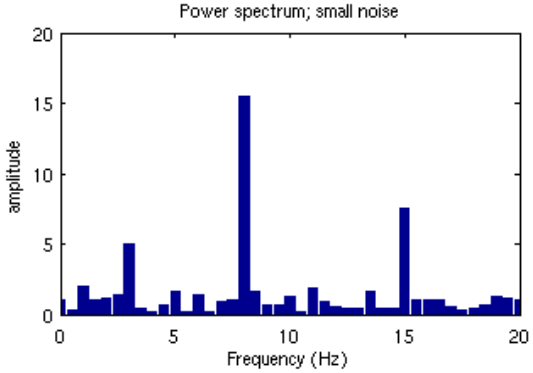
Chapter 11

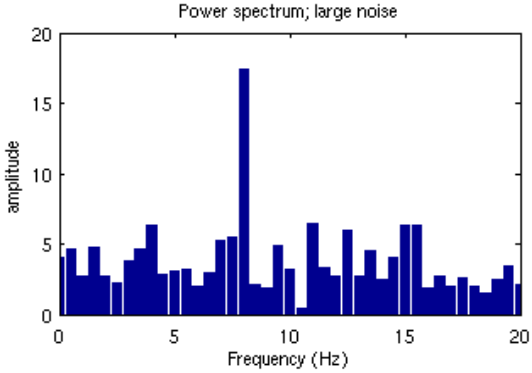

Original time series
amplitude
Time (s)


Power spectrum
amplitude
Frequency (Hz)

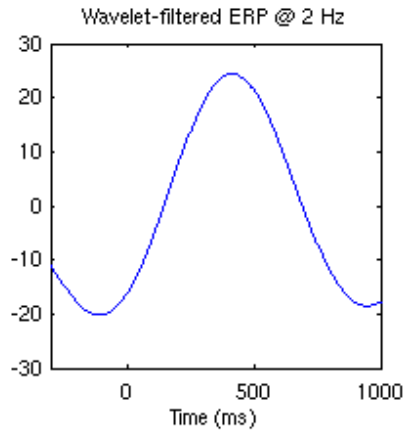

Time series, small noise
amplitude
Time (s)

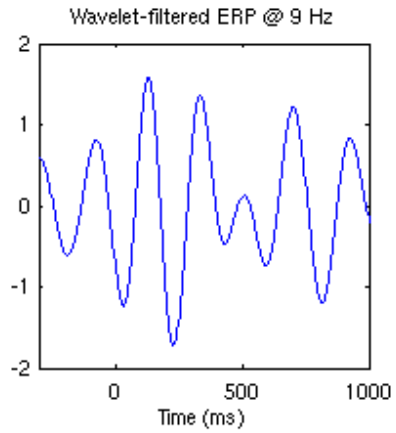

Time series, large noise
amplitude
Time (s)

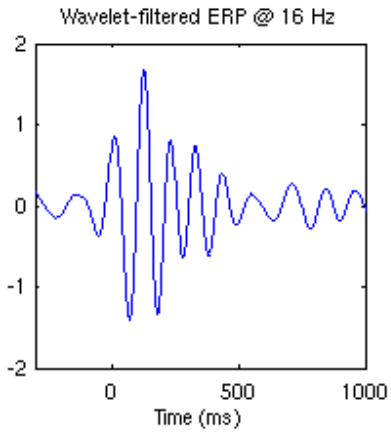

Power spectrum; small noise
amplitude
Frequency (Hz)

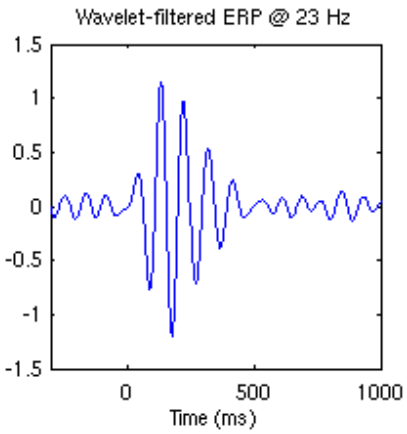

Power spectrum; large noise
amplitude
Frequency (Hz)

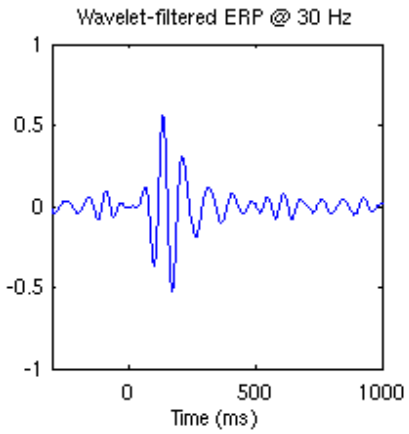
Chapter 12


Wavelet-filtered ERP @ 2 Hz
30
20
10
0
-10
-20
-30
0
500
1000
Time (ms)

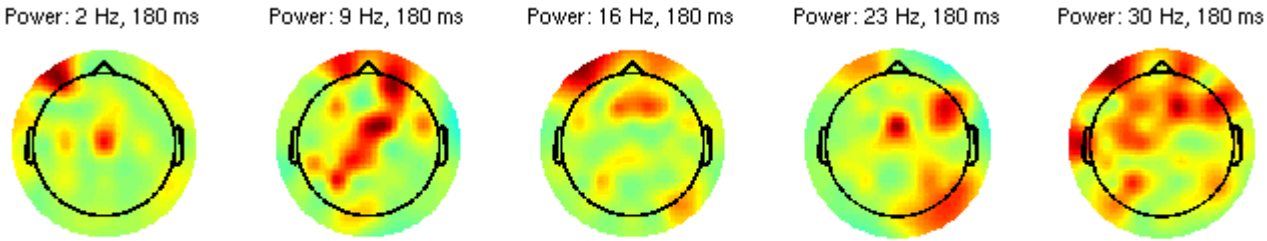

Wavelet-filtered ERP @ 9 Hz
2
1
0
-1
-2
0
500
1000
Time (ms)

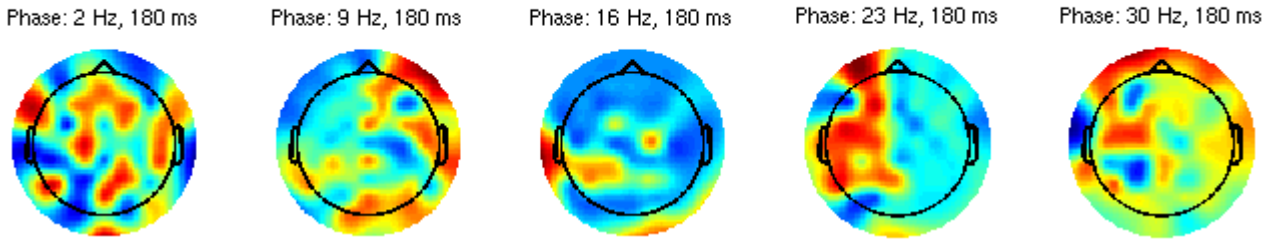

Wavelet-filtered ERP @ 16 Hz
2
1
0
-1
-2
0
500
1000
Time (ms)

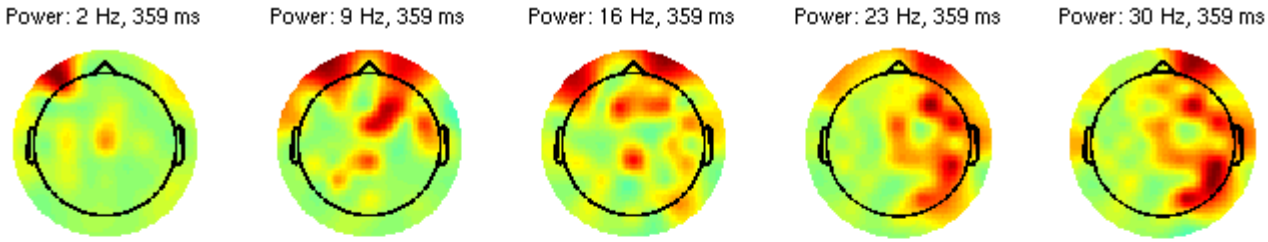

Wavelet-filtered ERP @ 23 Hz
1.5
1
0.5
0
-0.5
-1
-1.5
0
500
1000
Time (ms)

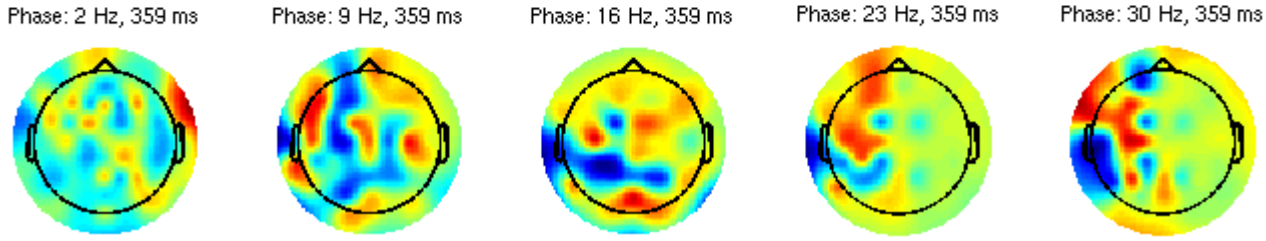

Wavelet-filtered ERP @ 30 Hz
1
0.5
0
-0.5
-1
0
500
1000
Time (ms)

Chapter 13

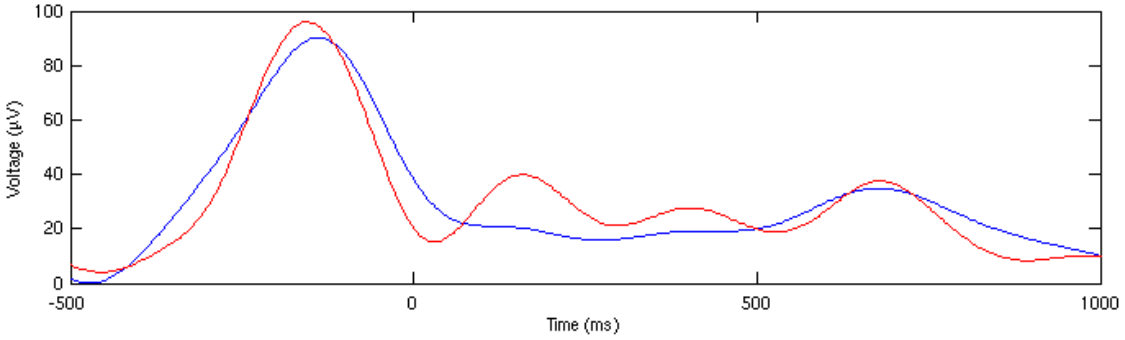

Power: 2 Hz, 180 ms
Power: 9 Hz, 180 ms
Power: 16 Hz, 180 ms
Power: 23 Hz, 180 ms
Power: 30 Hz, 180 ms

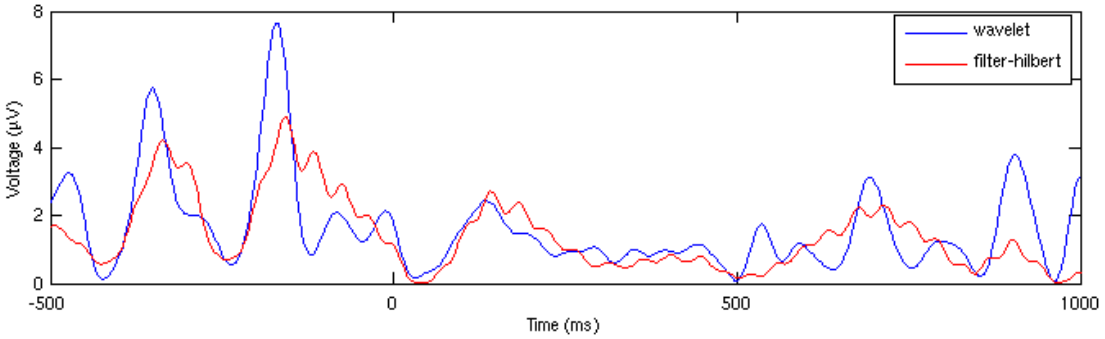

Phase: 2 Hz, 180 ms
Phase: 9 Hz, 180 ms
Phase: 16 Hz, 180 ms
Phase: 23 Hz, 180 ms
Phase: 30 Hz, 180 ms

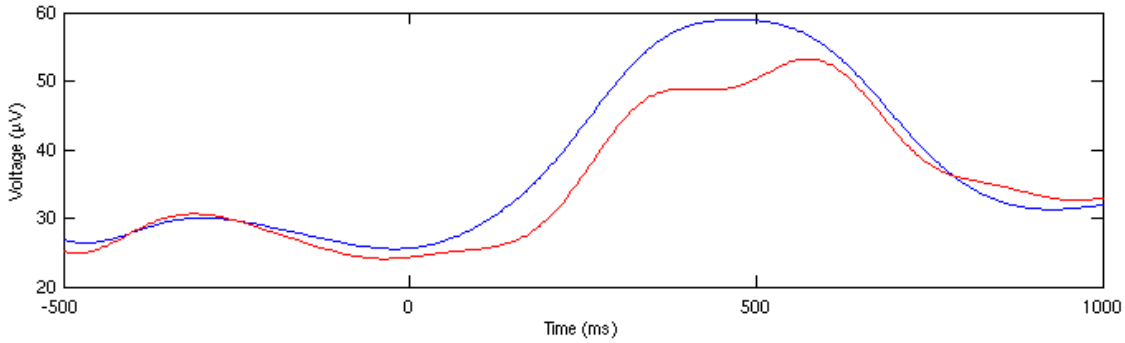

Power: 2 Hz, 359 ms
Power: 9 Hz, 359 ms
Power: 16 Hz, 359 ms
Power: 23 Hz, 359 ms
Power: 30 Hz, 359 ms

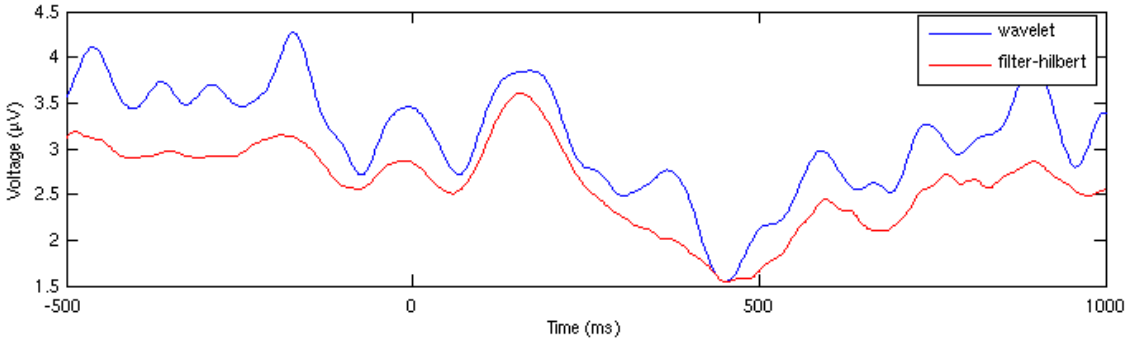

Phase: 2 Hz, 359 ms
Phase: 9 Hz, 359 ms
Phase: 16 Hz, 359 ms
Phase: 23 Hz, 359 ms
Phase: 30 Hz, 359 ms

Chapter 14

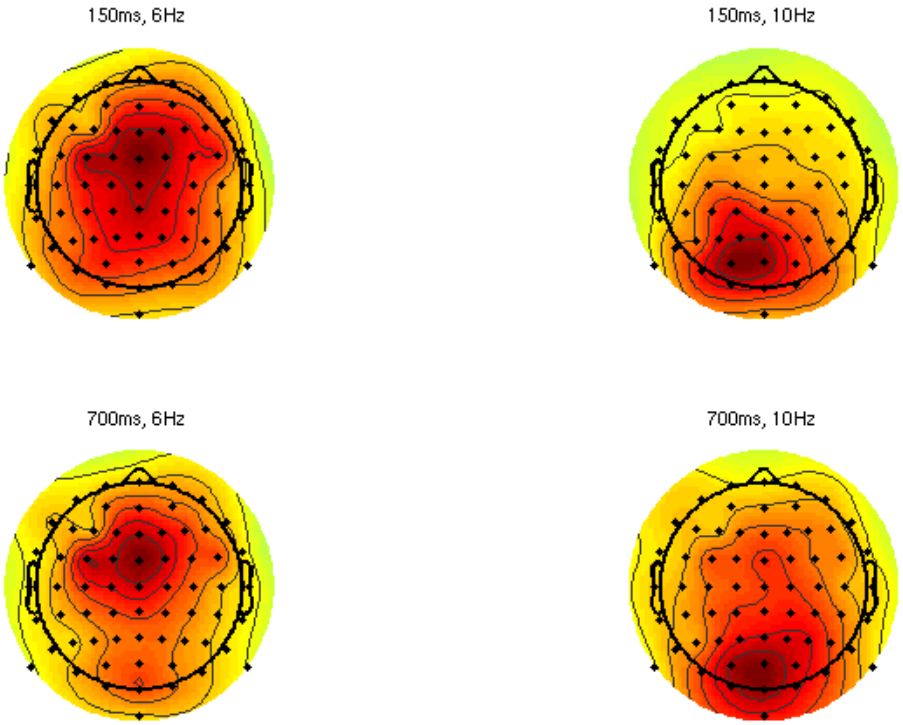

Voltage (μV)
Time (ms)

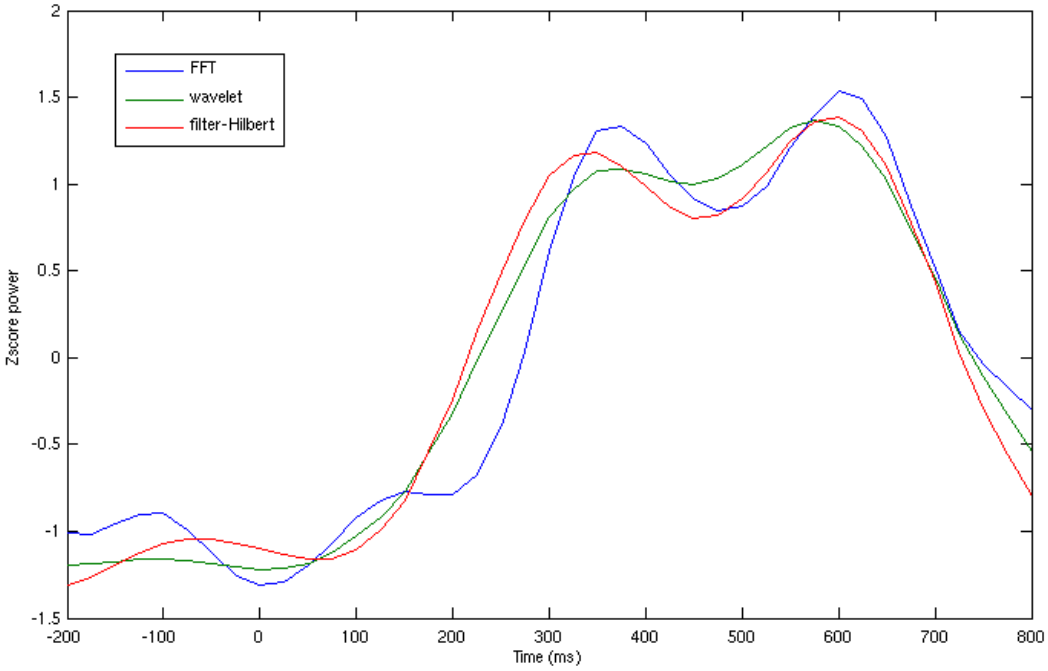

wavelet
filter-hilbert
Voltage (μV)
Time (ms)


Voltage (μV)
Time (ms)


wavelet
filter-hilbert
Voltage (μV)
Time (ms)

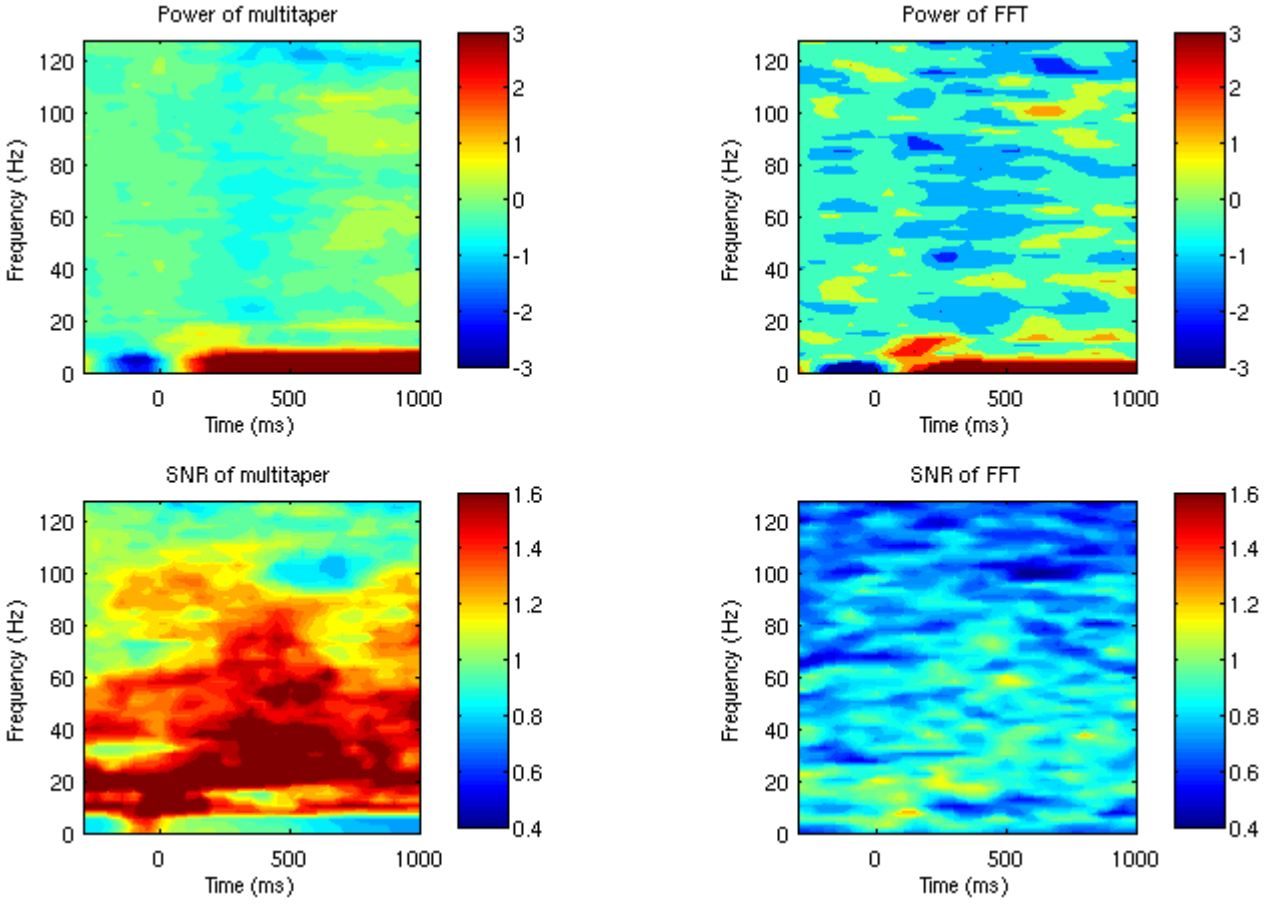
Chapter 15


150ms, 6Hz
150ms, 10Hz
700ms, 6Hz
700ms, 10Hz

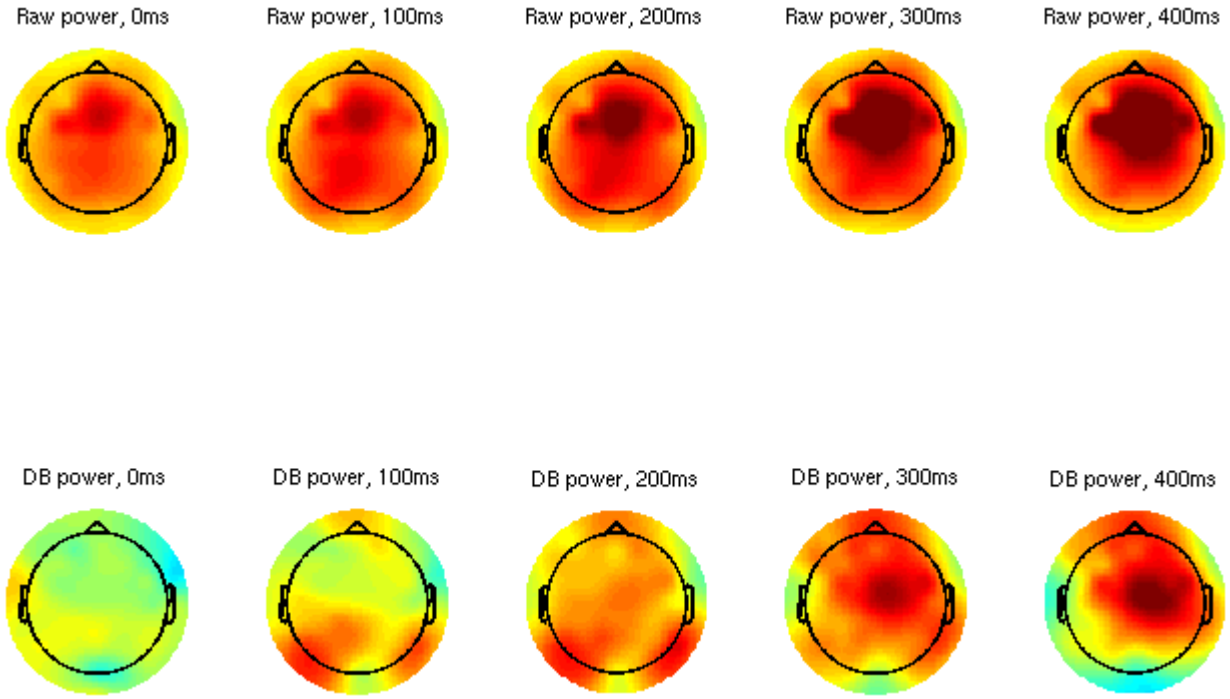

FFT
wavelet
filter-Hilbert
Zscore power
Time (ms)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-200
-100
0
100
200
300
400
500
600
700
800

Chapter 16

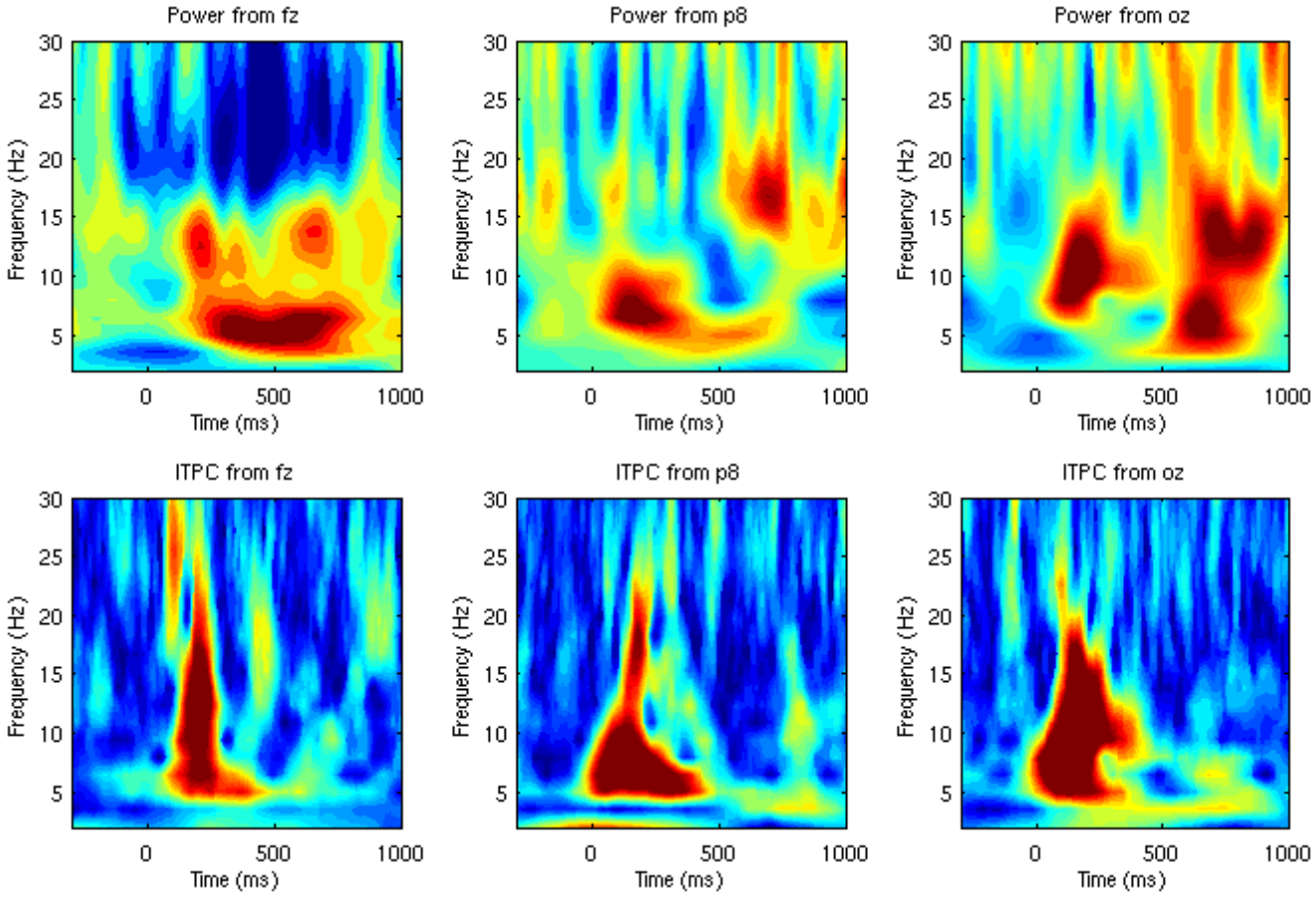
Electrode P7



Chapter 18

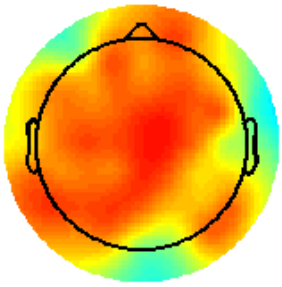

Raw power, 0ms
Raw power, 100ms
Raw power, 200ms
Raw power, 300ms
Raw power, 400ms
DB power, 0ms
DB power, 100ms
DB power, 200ms
DB power, 300ms
DB power, 400ms

Chapter 19

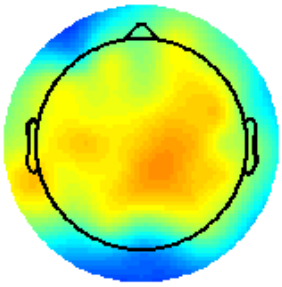

Power from fz
Power from p8
Power from oz
ITPC from fz
ITPC from p8
ITPC from oz
Frequency (Hz)
Time (ms)
30
25
20
15
10
5
0
500
1000

Chapter 20

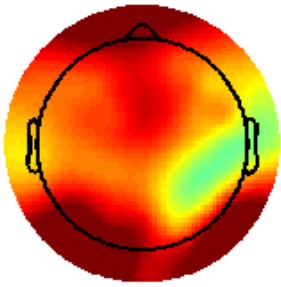
Total (5Hz, 100-300ms)



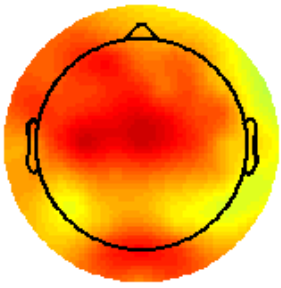
Non-phase-locked (5Hz, 100-300ms)



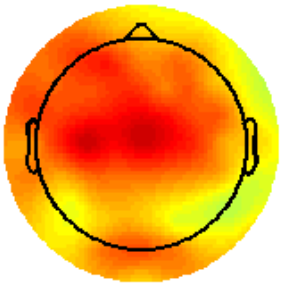
Phase-locked (5Hz, 100-300ms)



Total (5Hz, 600-900ms)

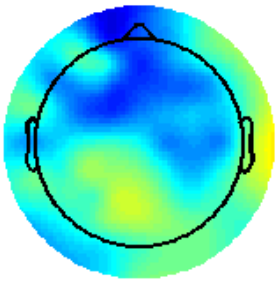


Non-phase-locked (5Hz, 600-900ms)

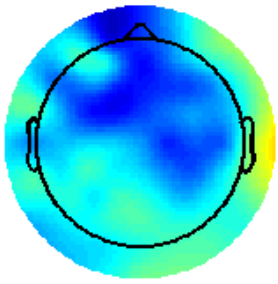


Phase-locked (5Hz, 600-900ms)

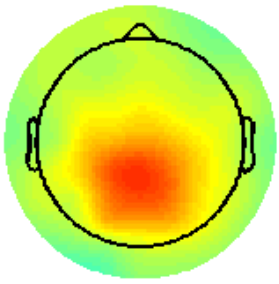
Total (20Hz, 100-300ms)



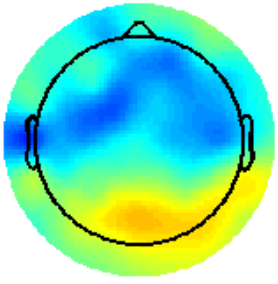
Non-phase-locked (20Hz, 100-300ms)



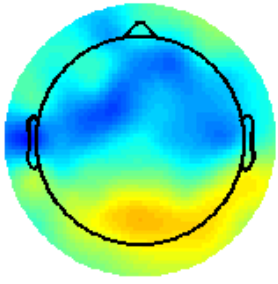
Phase-locked (20Hz, 100-300ms)



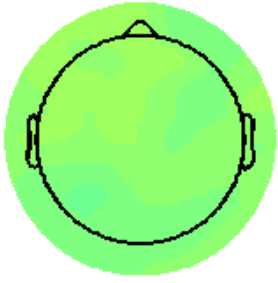
Total (20Hz, 600-900ms)



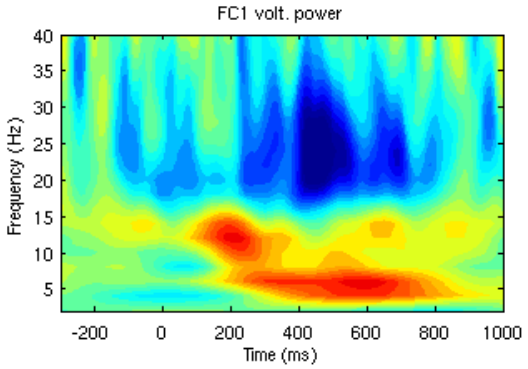
Non-phase-locked (20Hz, 600-900ms)

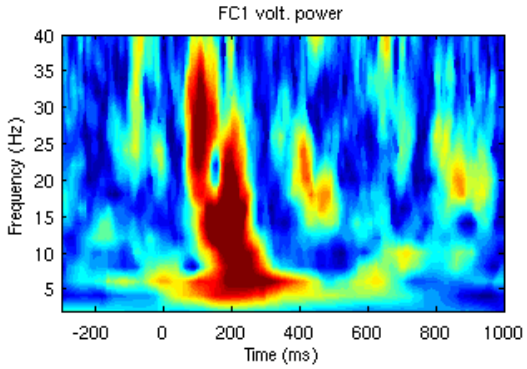


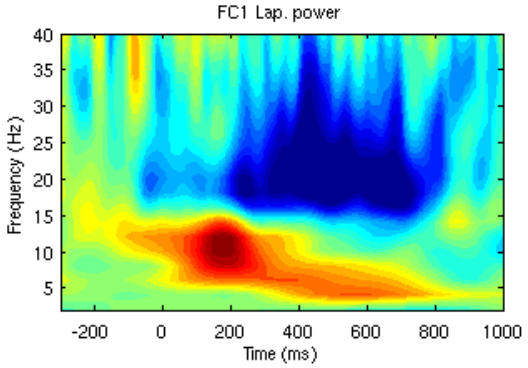
Phase-locked (20Hz, 600-900ms)

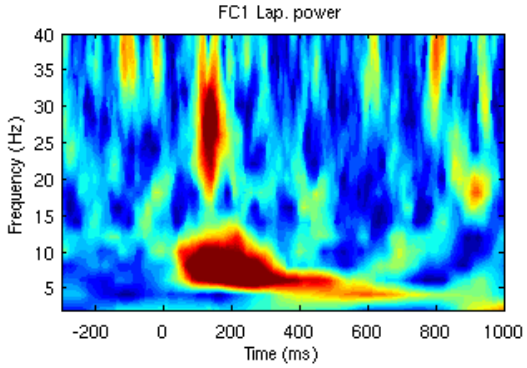


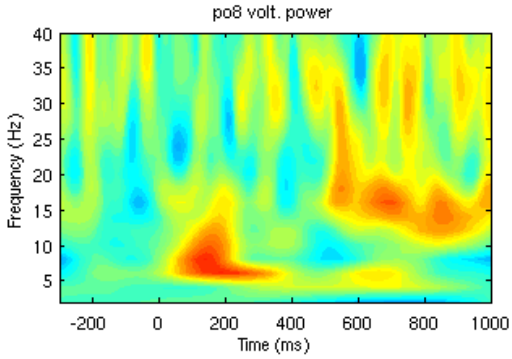
Chapter 22

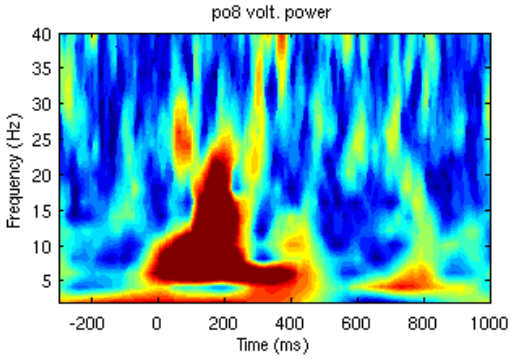

FC1 volt. power
Frequency (Hz)
Time (ms)

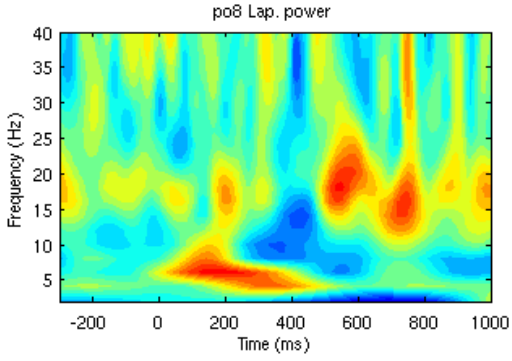

FC1 volt. power
Frequency (Hz)
Time (ms)

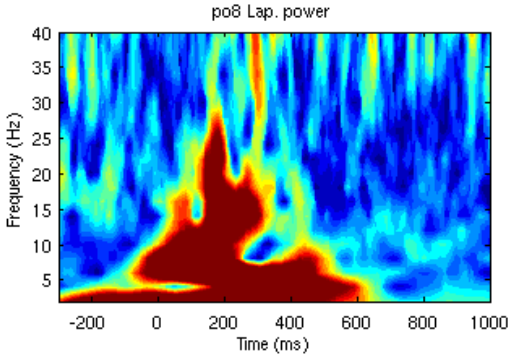

FC1 Lap. power
Frequency (Hz)
Time (ms)


FC1 Lap. power
Frequency (Hz)
Time (ms)

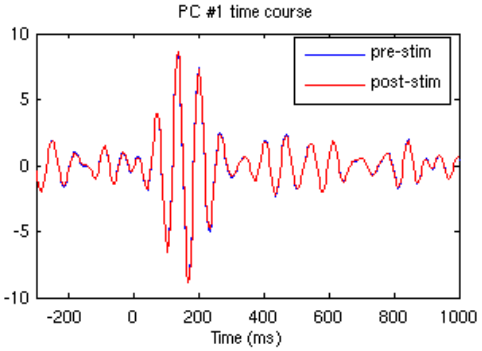

po8 volt. power
Frequency (Hz)
Time (ms)

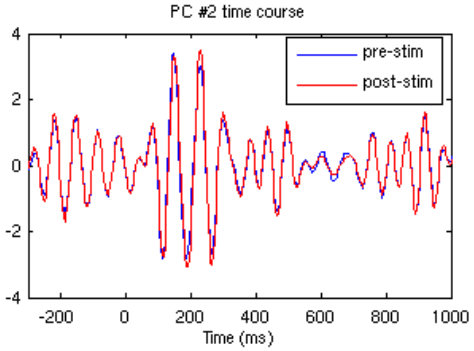

po8 volt. power
Frequency (Hz)
Time (ms)

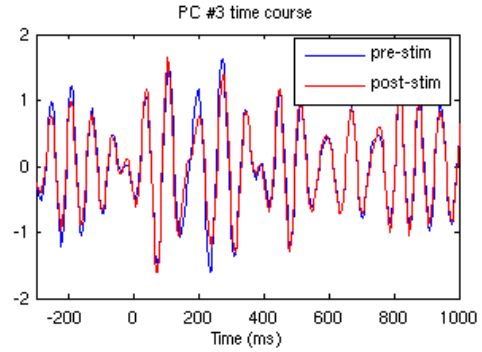

po8 Lap. power
Frequency (Hz)
Time (ms)

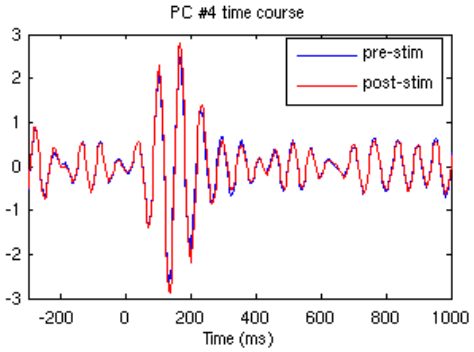

po8 Lap. power
Frequency (Hz)
Time (ms)

Chapter 23


PC #1 time course
pre-stim
post-stim
Time (ms)

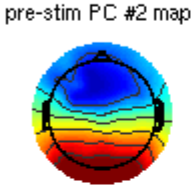

PC #2 time course
pre-stim
post-stim
Time (ms)

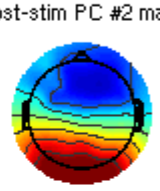

PC #3 time course
pre-stim
post-stim
Time (ms)

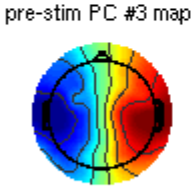

PC #4 time course
pre-stim
post-stim
Time (ms)

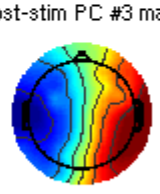

pre-stim PC #1 map

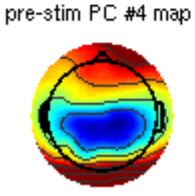

post-stim PC #1 map

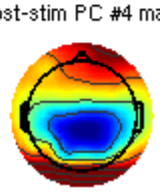

pre-stim PC #2 map


post-stim PC #2 map


pre-stim PC #3 map

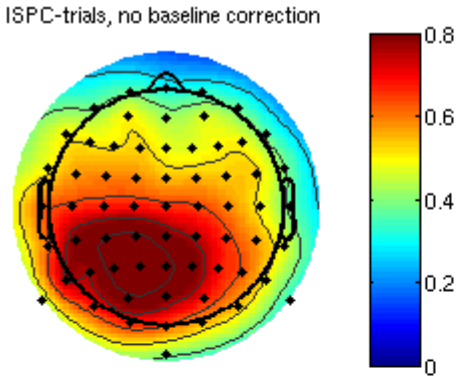

post-stim PC #3 map

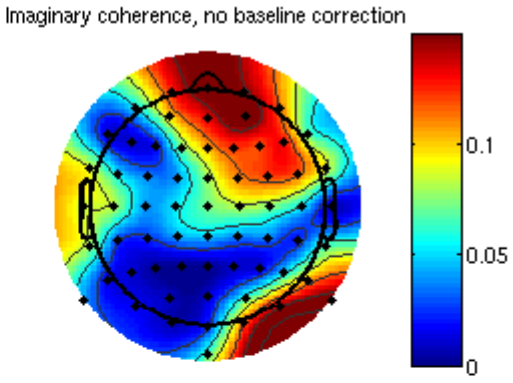

pre-stim PC #4 map

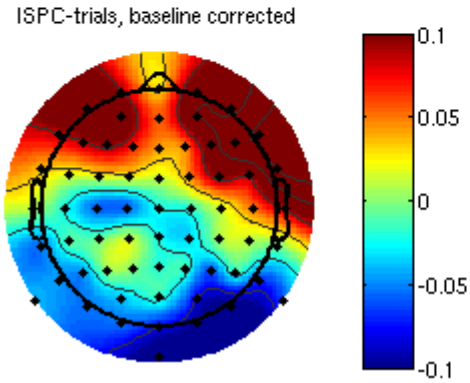

post-stim PC #4 map

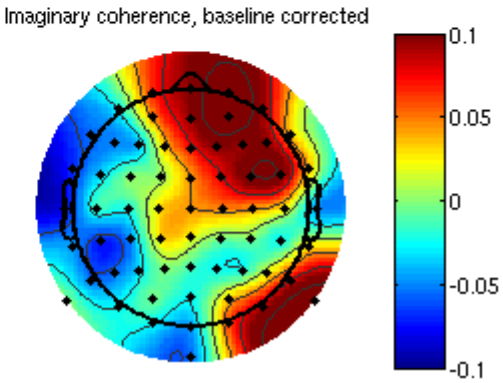
Chapter 26

Seed electrode was P1, 5 Hz

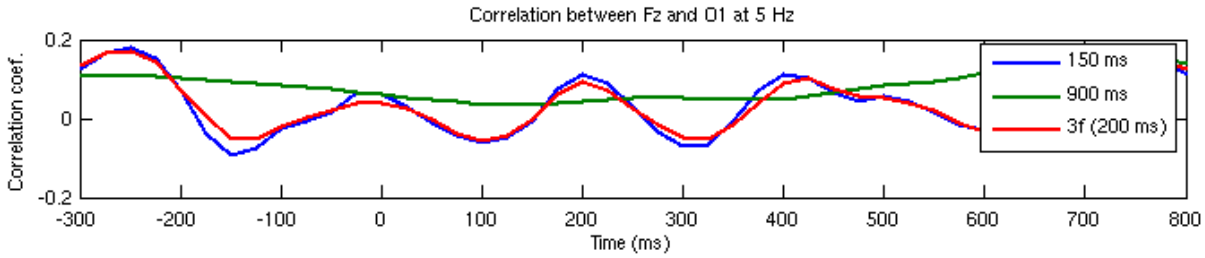


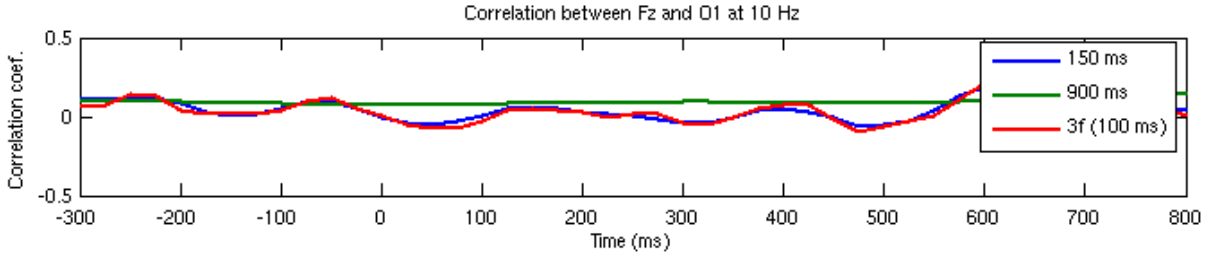


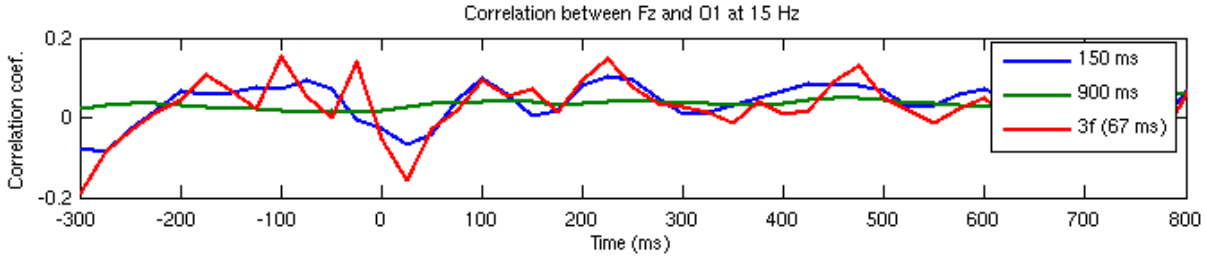


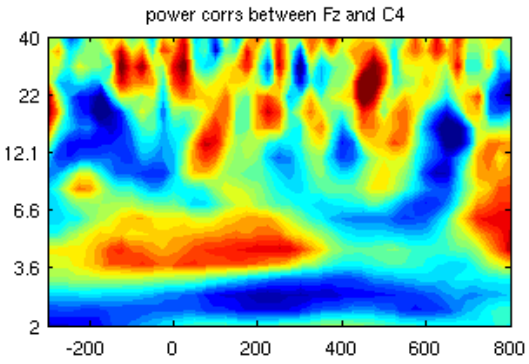


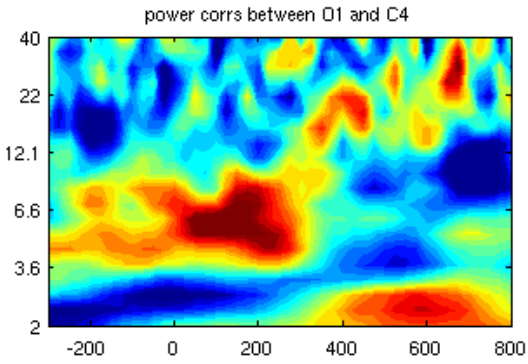
Chapter 27

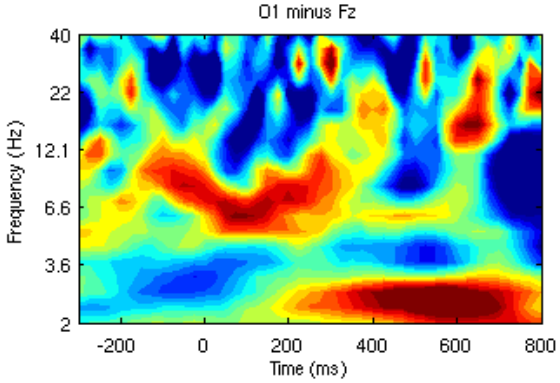

Correlation between Fz and O1 at 5 Hz
Correlation coef.
Time (ms)
150 ms
900 ms
3f (200 ms)

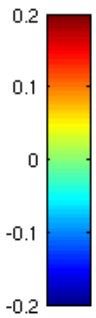

Correlation between Fz and O1 at 10 Hz
Correlation coef.
Time (ms)
150 ms
900 ms
3f (100 ms)


Correlation between Fz and O1 at 15 Hz
Correlation coef.
Time (ms)
150 ms
900 ms
3f (67 ms)


power corrs between Fz and C4

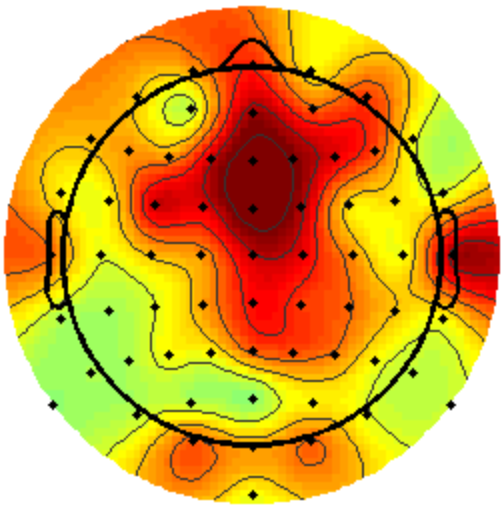

power corrs between O1 and C4


O1 minus Fz
Frequency (Hz)
Time (ms)

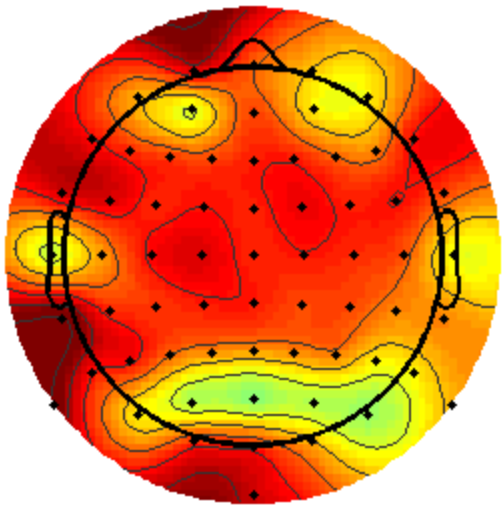


Chapter 28

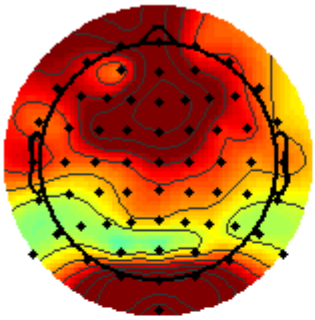
Granger prediction FROM poz (600-1200 ms)



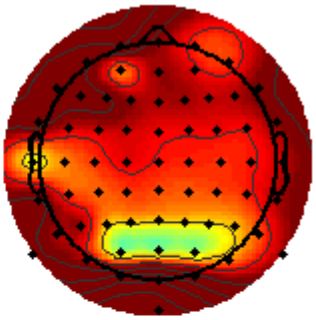
Granger prediction TO poz (600-1200 ms)



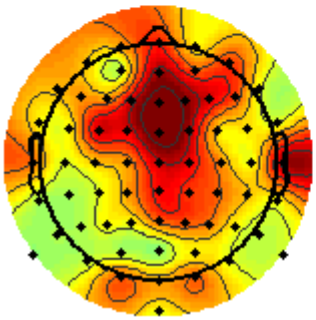
FROM poz (600-1200 ms), first 40



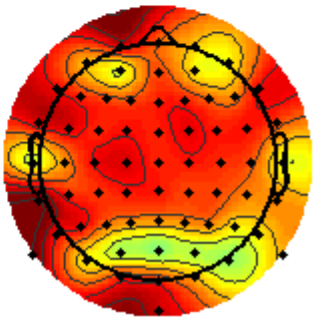
TO poz (600-1200 ms), first 40



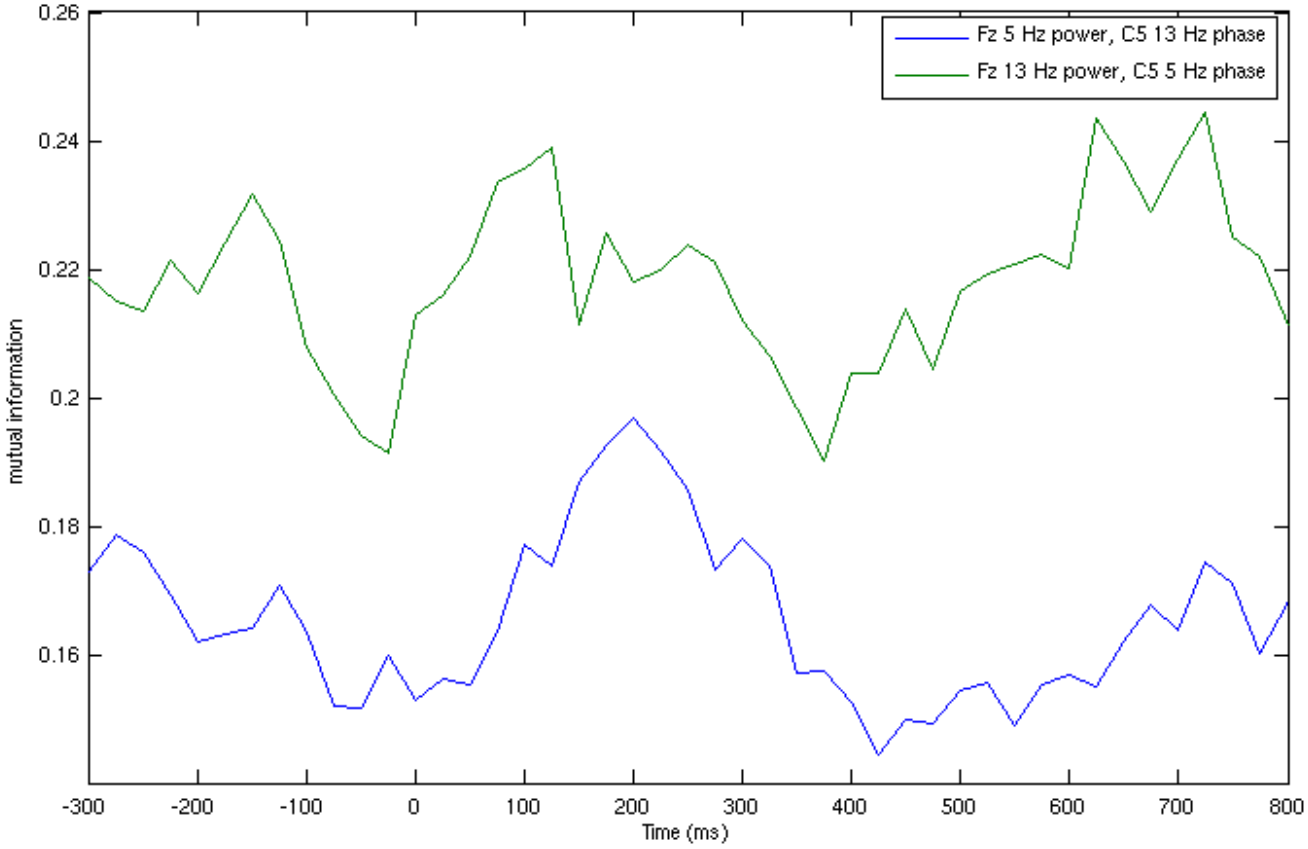
FROM poz (600-1200 ms), last 40



TO poz (600-1200 ms), last 40

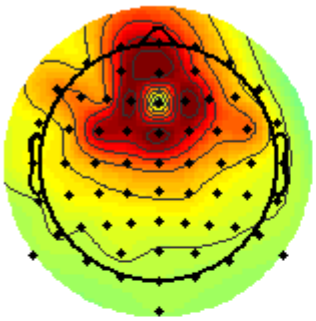


Chapter 29

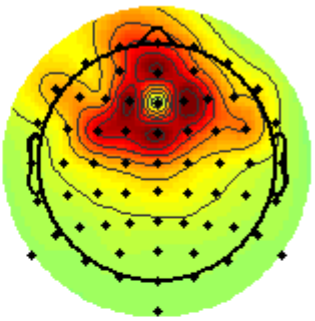

Fz 5 Hz power, C5 13 Hz phase
Fz 13 Hz power, C5 5 Hz phase
mutual information
Time (ms)
0.26
0.24
0.22
0.2
0.18
0.16
-300
-200
-100
0
100
200
300
400
500
600
700
800

Seed electrode: Fz

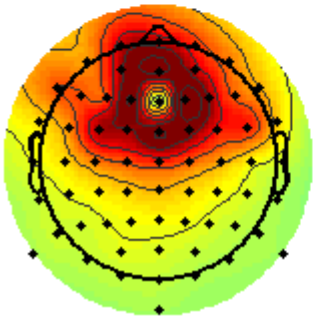
MI: 5 Hz,prestim



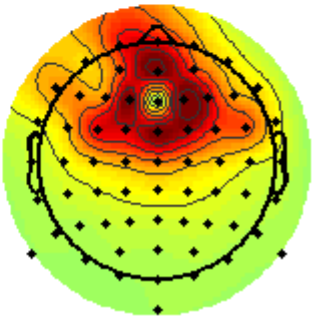
MI: 13 Hz,prestim



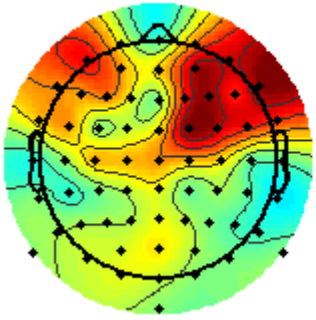
MI: 5 Hz,poststim



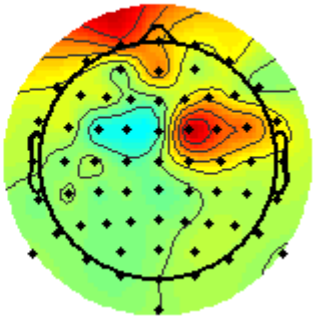
MI: 13 Hz,poststim



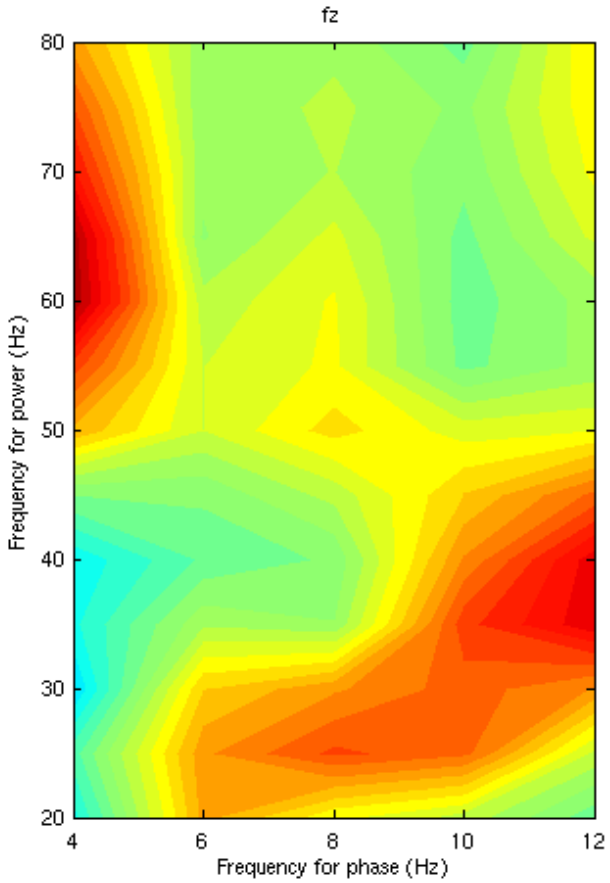
MI task-baseline: 5 Hz,poststim

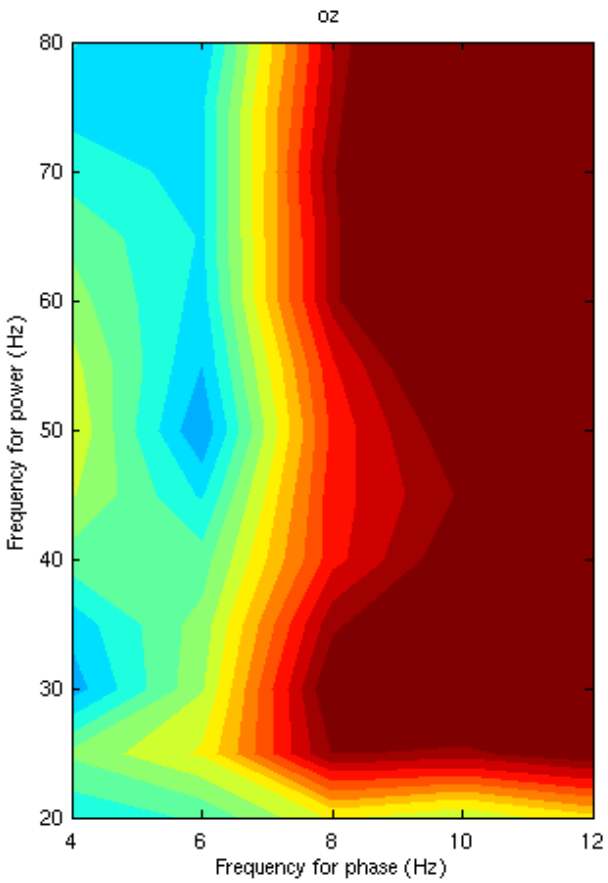


MI task-baseline: 13 Hz,poststim



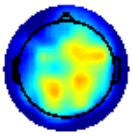
Chapter 30


fz
80
70
60
50
40
30
20
Frequency for power (Hz)
4
6
8
10
12
Frequency for phase (Hz)

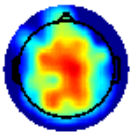

oz
80
70
60
50
40
30
20
Frequency for power (Hz)
4
6
8
10
12
Frequency for phase (Hz)

Chapter 31

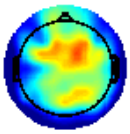
Degree (6 Hz, -200 ms, first 40 trials)



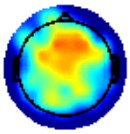
Degree (6 Hz, -200 ms, last 40 trials)



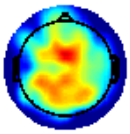
Degree (11 Hz, -200 ms, first 40 trials)



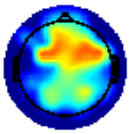
Degree (11 Hz, -200 ms, last 40 trials)



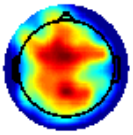
Degree (6 Hz, 400 ms, first 40 trials)



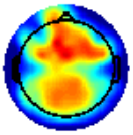
Degree (6 Hz, 400 ms, last 40 trials)



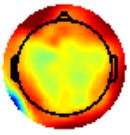
Degree (11 Hz, 400 ms, first 40 trials)



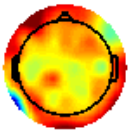
Degree (11 Hz, 400 ms, last 40 trials)



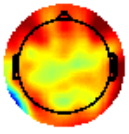
Degree (6 Hz, -200 ms, first 40 trials)



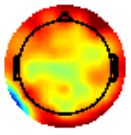
Degree (6 Hz, -200 ms, last 40 trials)



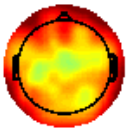
Degree (11 Hz, -200 ms, first 40 trials)



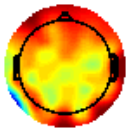
Degree (11 Hz, -200 ms, last 40 trials)



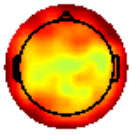
Degree (6 Hz, 400 ms, first 40 trials)



Degree (6 Hz, 400 ms, last 40 trials)



Degree (11 Hz, 400 ms, first 40 trials)



Degree (11 Hz, 400 ms, last 40 trials)

Chapter 31, continued