Assignment 10: Blain-Moraes

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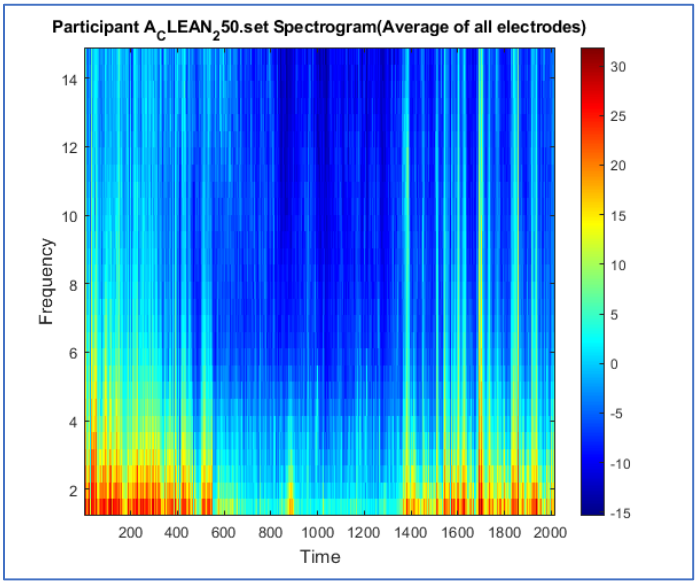
Note: 'Examples for Patient A Figures' and 'Examples for Patient B Figures' are just example figures. For the actual discussion & exploration on which patient is unconscious, see 'DISCUSSION' section, pg.5.

Examples for Patient A Figures:

A) Spectrogram

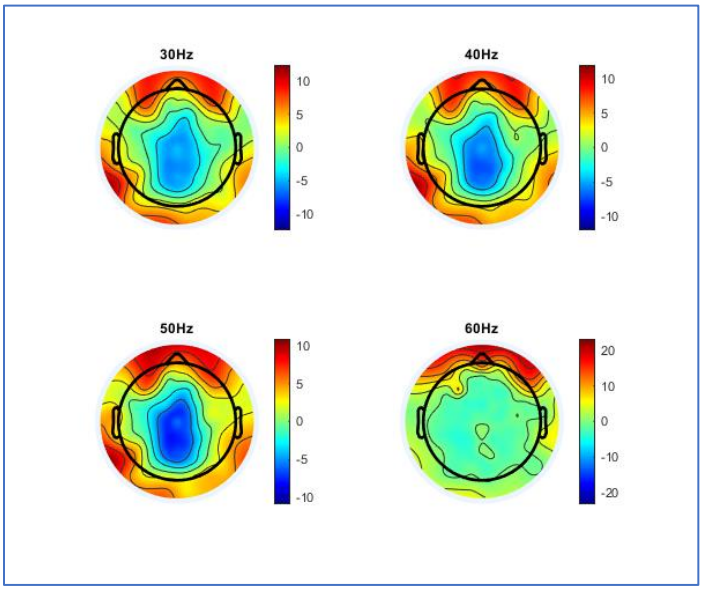



```
Frequency Pass : [1.00HZ 30.00HZ]
Temporal Smoothing Median Filter : 10
Time-Bandwidth Product : 2
Number of Tapers : 3
Windows Length : 2 seconds
Step size : 0.10
```

Given the parameters above, the following spectrogram was generated.

Evidently, there is distinction between the beginning and the end frequency activity compared to the middle/center epoch activity levels.

B) Topographic map




```
Frequencies :  30 40 50 60
```

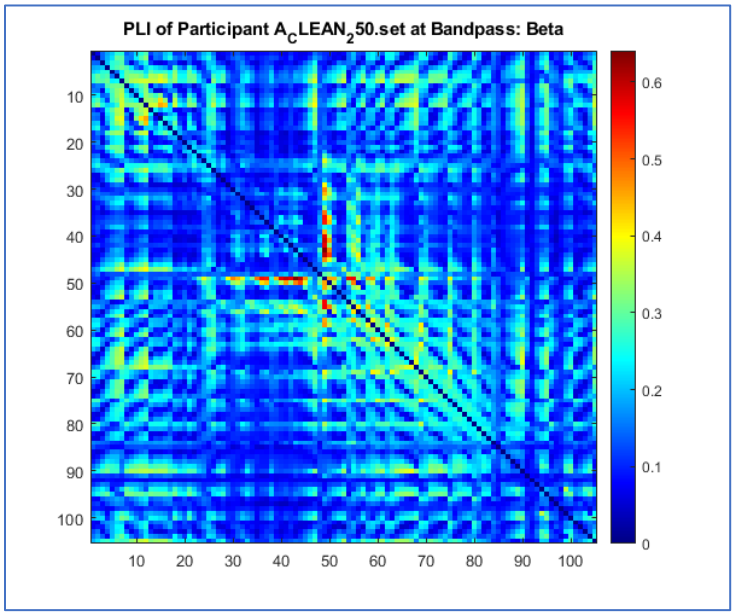
Given the Hz parameter above, the following topographic maps were generated.

High magnitude of alpha intensity observed in anterior/ front of the head.

C) Functional Connectivity

Given that there was no specification on which frequency band to choose from, they were all collected with the parameters of:

```
Length of Analysis Segment: 10 seconds
Number of Permutations : 10
p value for surrogate data analysis : 0.05
```



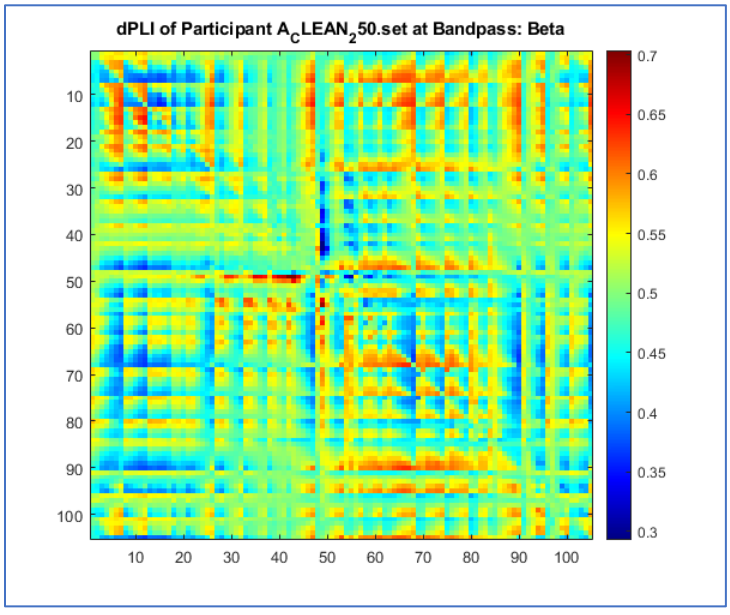
Interestingly, different frequency bands displayed notably distinct results. The Beta bandpass is shown as an arbitrary example.

Other instances which were notably different are included in Appendix A, with the same parameters.

D) Directed Functional Connectivity

Given that there was no specification on which frequency band to choose from, they were all collected with the parameters of:

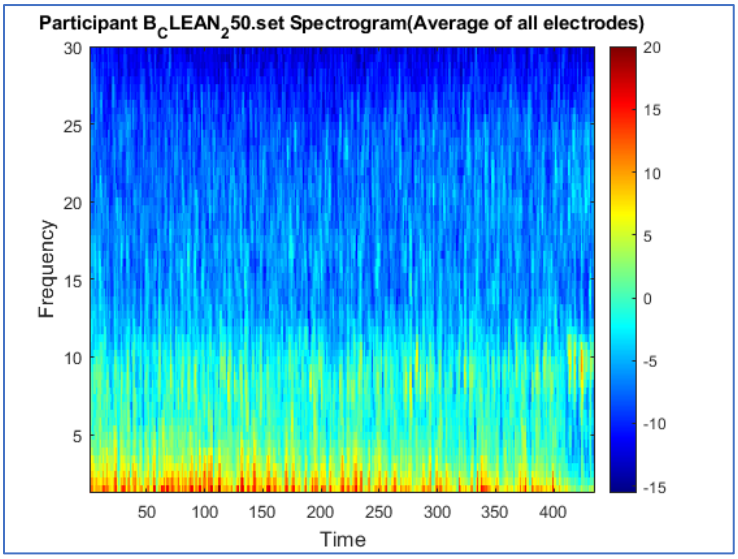
```
Length of Analysis Segment: 10 seconds
Number of Permutations : 10
p value for surrogate data analysis : 0.05
```



The beta bandpass showed the greatest distinctions/differences in magnitude throughout, and thus was shown.

Examples for Patient B Figures:

A) Spectrogram

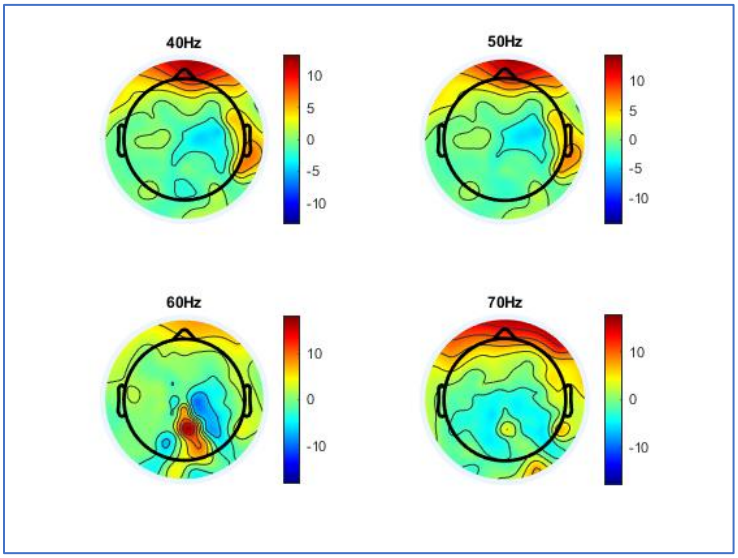



```
Frequency Pass : [1.00HZ 30.00HZ]
Temporal Smoothing Median Filter : 10
Time-Bandwidth Product : 2
Number of Tapers : 3
Windows Length : 2 seconds
Step size : 0.10
```

Given the parameters above, the following spectrogram was generated for patient B.

Unlike patient A, the spectrogram shows consistent activity throughout the recording history. (although the duration itself is much shorter, being ~400+ seconds)

B) Topographic map




```
Frequencies :  40 50 60 70
```

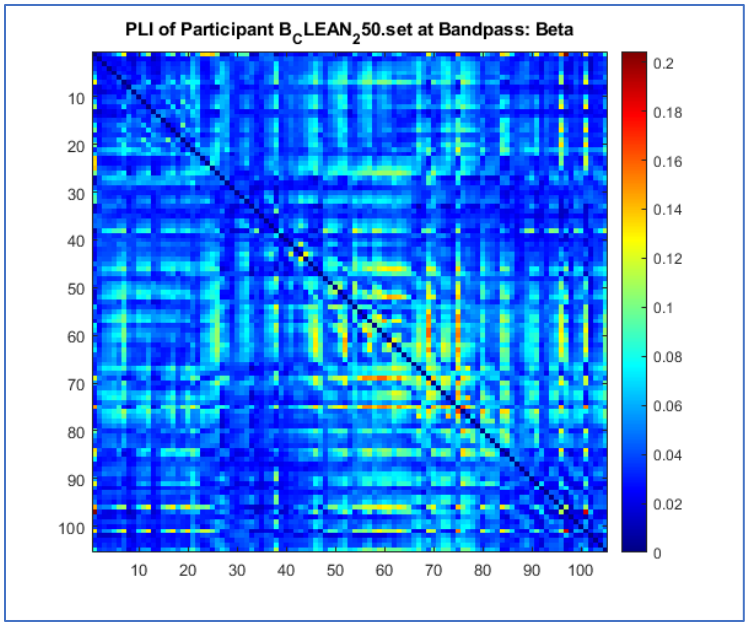
Given the Hz parameter above, the following topographic maps were generated.

Other frequencies were tested, but not shown. Most of them were similar to the 40Hz, 50Hz, and 70Hz frequencies, with the exception of the topographic map near 60Hz, where an increase in magnitude/topography in the parietal/back region is observed.

C) Functional Connectivity

Given the following parameters chosen, the functional connectivity plots were generated:

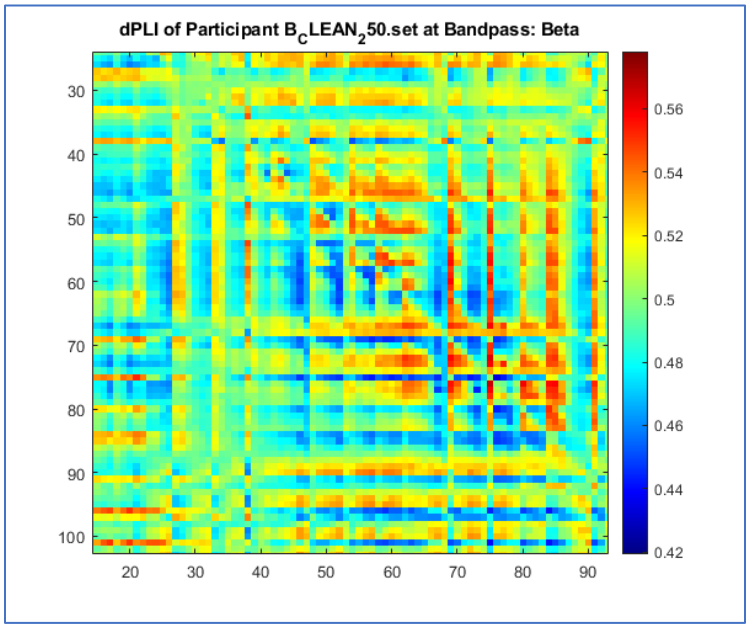
```
Length of Analysis Segment: 10 seconds
Number of Permutations : 10
p value for surrogate data analysis : 0.05
```



Beta is shown because patient A figures were with the beta bandpass, other handpasses are available at Appendix B.

D) Directed Functional Connectivity

```
Length of Analysis Segment: 10 seconds
Number of Permutations : 10
p value for surrogate data analysis : 0.05
```

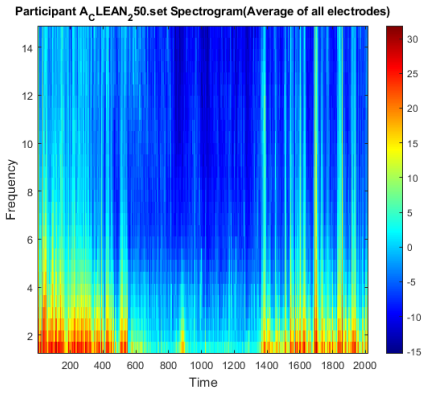
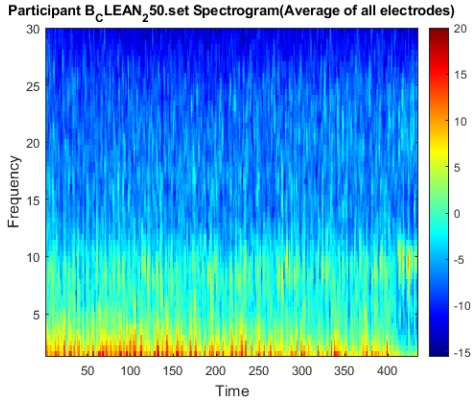


Beta is shown because patient A figures were with the beta bandpass.

DISCUSSION: Which Patient is Conscious?

I deduce that **patient B is conscious**, while **patient A is unconscious**.

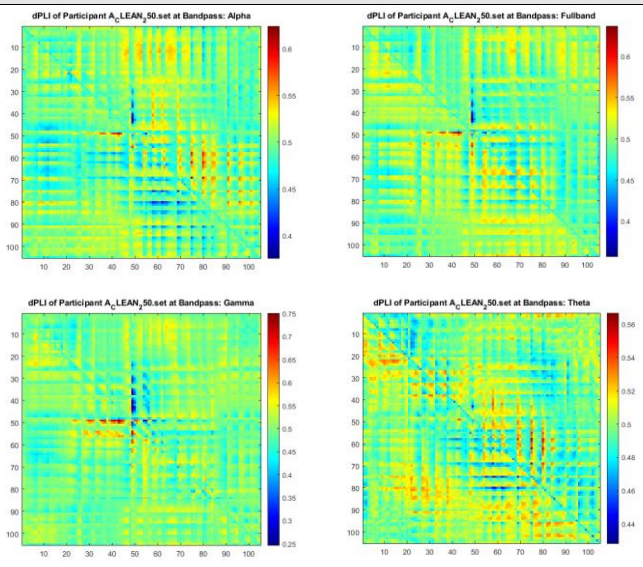
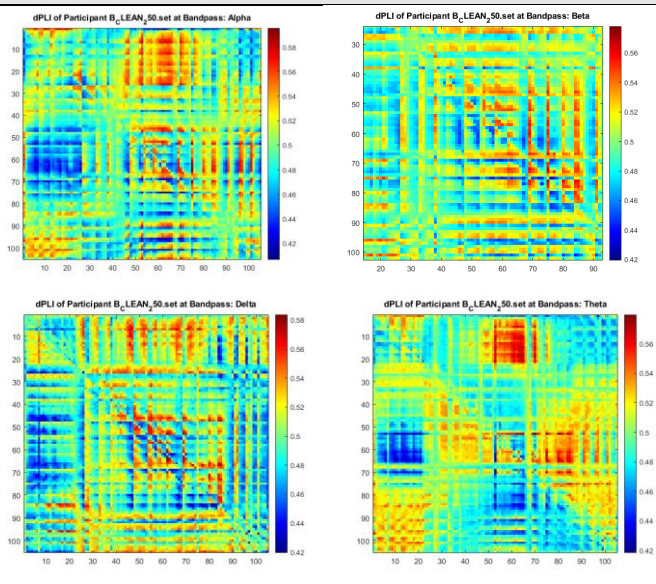
Reasoning from spectrogram:

Patient A	Patient B
	

For the spectrogram, patient A shows highly inconsistent activity (the middle lacks of alpha low-frequency coupling). Same parameters for both patients were used. When unconscious, it is expected to see an increase in alpha (the red). This is observed in patient A in comparison to patient B. Patient B spectrogram consistently has lower levels of alpha observed. However, this is not a definitive marker; the lecture informs that this can also simply be a marker of drugs rather than the state of unconsciousness itself.

Reasoning from directed functional connectivity:

In a conscious individual, when comparing directed functional connectivity the frontal cortex is phase leading, while in contrast in unconscious individuals, this observation is neutralized. All directed functional connectivity heatmaps were obtained with the same parameters and the following are some of the directed heatmaps with different bandpass to compare between patient A and B:

Patient A	Patient B
	

To note: blue regions represent areas that are phase lagging, while red regions represent areas that are phase leading. Consistently throughout different bandpass parameters, there is a general trend where the patient A displays a neutralized lead-lag directed heatmap, where green is predominant with no distinguishable frontal phase leading observed; *this is what is expected of an unconscious recording*.

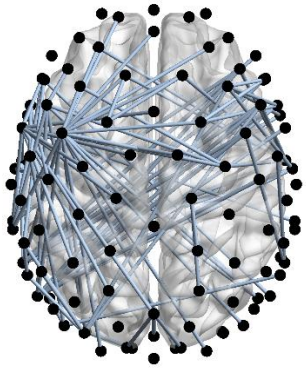
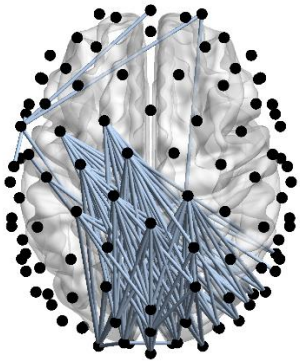
While in contrast for patient B, the frontal regions (~top red pixels regions) tend to be phase leading for alpha, delta, theta, etc. with a noticeable phase lagging in the parietal region (~bottom region with predominantly blue or green). This pattern of frontoparietal feedback-dominant connectivity is particularly noticeable in the theta bandpass heatmap for patient B; *this is what is expected of a conscious recording*.

Reasoning from network hubs:

Network hubs undergo anteriorization during unconsciousness. If this could be observed in patient A, it would support the claim that patient A is unconscious. Elsewise, network hubs are to be expected in the parietal area/regions. Thus, the expected result for patient B is to observe network hubs congregated in the parietal region of the brain.

To note, the graph figures generated from the Graph Theory option on the EEGapp are different from the EEG topographic map shown in lectures. I was not able to determine a way to convert the fields from the graphTheoryData struct in MATLAB to an EEG topological plot. Regardless, here is an example of patient A and patient B given the inputs:

```
Network Threshold: 3, Windows Length: 5, and bandpass: theta
```

Patient A	Patient B
	

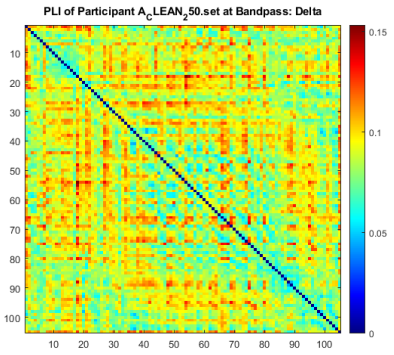
Which appeared to have a visual appearance of vertices (with many edges) congregating in the frontal region in patient A, while patient B's vertices (with many edges) are consolidated in the parietal region.

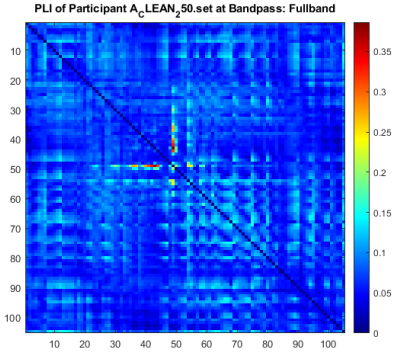
Other:

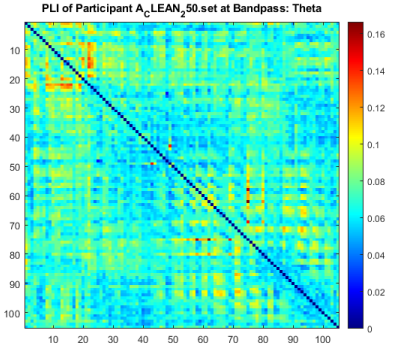
Anteriorization of alpha rhythms, seen on the topographic maps, did not feel appropriate to use as justification for unconsciousness for either patients; both patients essentially had the trait. An exception is noted at 60Hz for patient B, where it was observed to be parietal for the alpha rhythms.

Appendix

Appendix A: Other distinct patterns of Phase Lag Index of Patient A







Appendix B: Other distinct patterns of Phase Lag Index of Patient B