Case Western Reserve University

Human Reactions Under Emergent

Behaviors in Driving Safety

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EBME 318: Biomedical Engineering Laboratory I

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***Abstract— Recent studies show that during hand movement, the cortical hemisphere on the contralateral (opposing) side of the body is activated. The μ rhythm (also called the μ wave), traditionally defined as an 8-12 Hz band, is related to the motor information. When brought into the context of driving safety, there are countless implications that can be inferred from observing and analyzing the direct effect on μ waves, as a result of various acute stressors, especially those arising in emergency situations.***

1. **Introduction**

The purpose of this experiment is to study the brainwave frequencies during five different states of mind: a state of relaxation, moving the left hand, *imagining* moving the left hand, moving the right hand, and finally *imagining* moving the right hand. Using all fourteen channels of EEG signals recorded during these tests, the data can be analyzed to explore the difference between the relaxation and moving states.

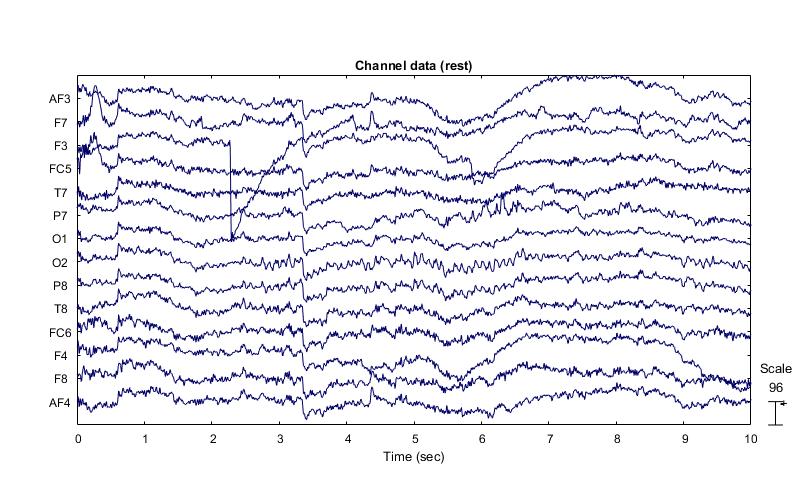
1. **Methods**

Data acquisition in this experiment was performed via the Brainwear® wireless neuroheadset known as the EMOTIV Epoc+. To ensure a properly conductive interface between the subject’s scalp and the headset, the device’s electrode leads were soaked in a saline solution. With the subject in a seated, relaxed position, the data collection protocol was initiated.

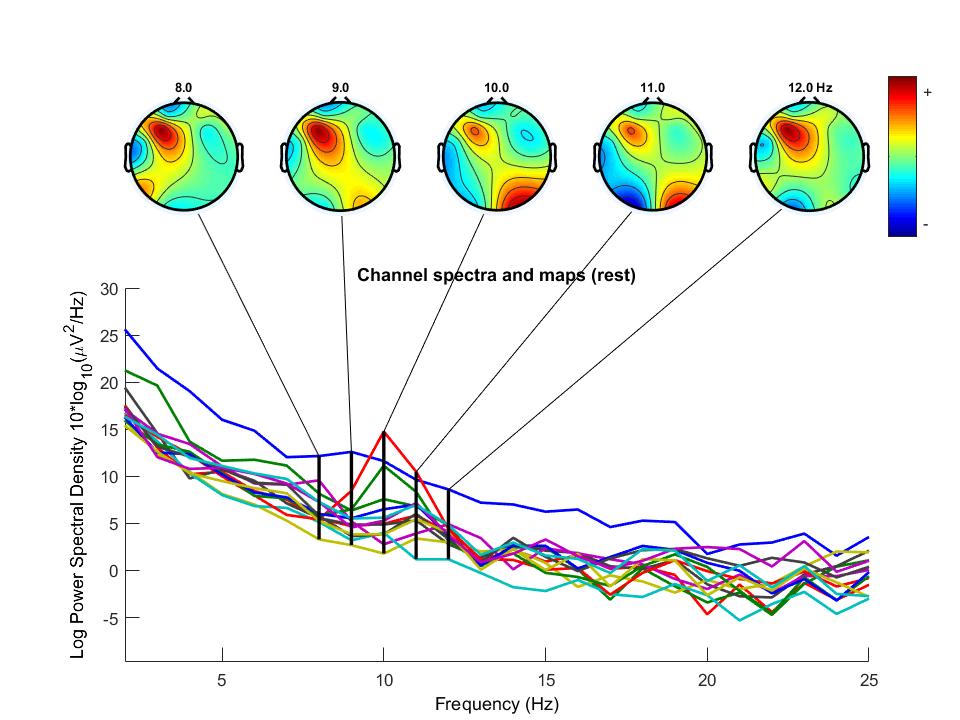
For each aforementioned state of mind, EEG data was recorded in 10-second intervals. Once this baseline was established, the subject performed a sequence of imagined movements (i.e. of the left and right hands) over the course of one long trial, mimicking actions performed by a person while driving.

1. **Results**

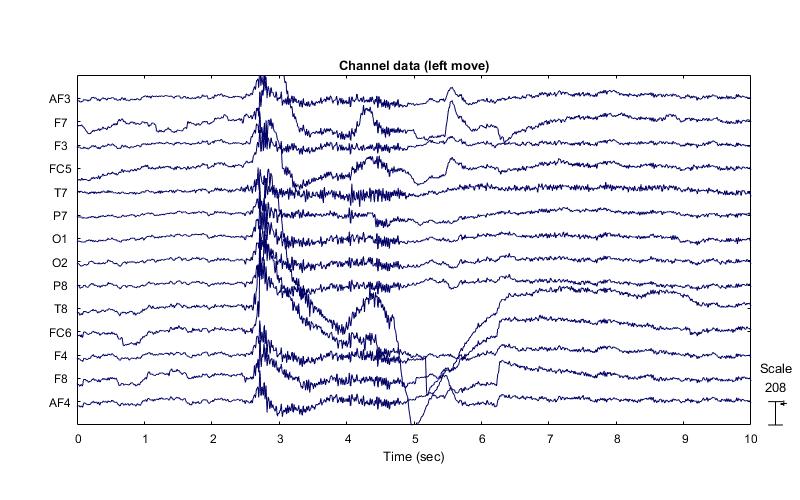
The results of this experiment can be visualized thanks to the MATLAB add-on called EEGLAB, a widely used toolbox for processing electrophysiological data. We can analyze the data from each of the five configurational trials mentioned earlier. Now, before continuing, allow me to preface this section by saying that *I was the subject*, and considering how hectic and overwhelming this semester has been for me, it is hardly a surprise that my results are abnormal –or far from “excellent data.” Nevertheless, my results can be observed in both the time and frequency domains, respectively in the subsequent ten figures:



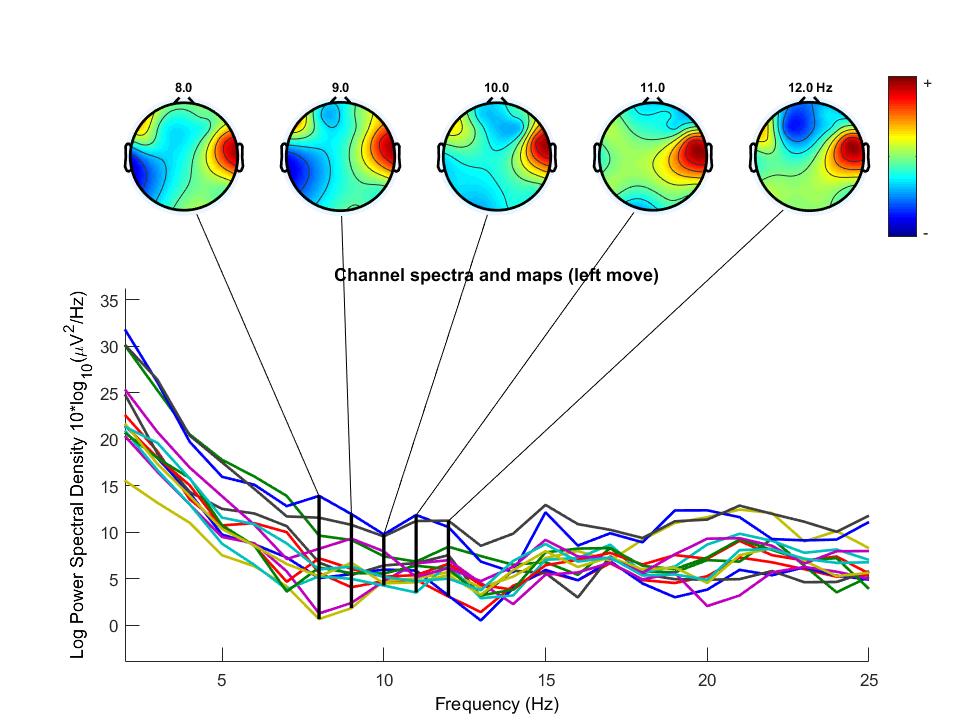
**Fig. 1.** Plot of channel data (scrolling), represented in the time domain, while in a relaxed state of mind. It is interesting that the scale of magnitude of these brainwaves is quite large, as compared to subsequent ‘moving’ states of mind. I believe I recall accidentally blinking during this trial, or perhaps there was someone walking by outside the room, who caught my attention. This could explain sudden unprecedented neural activity at certain points in the 10-second window.



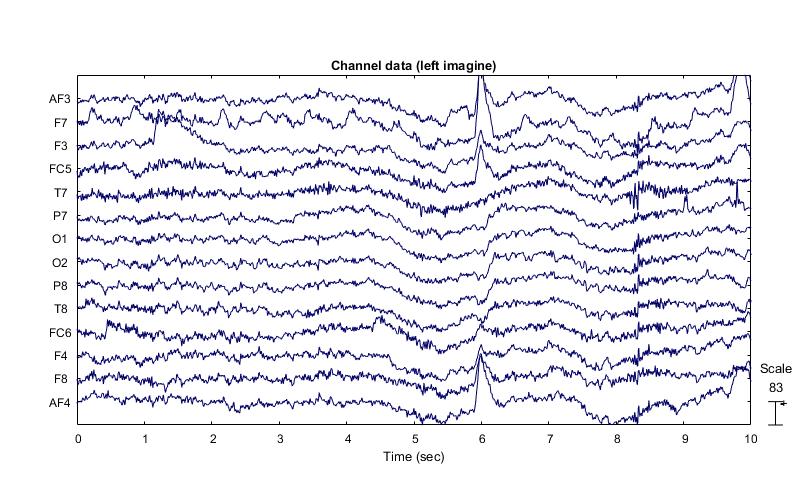
**Fig. 2.** Plot of channel spectra and maps, represented in the frequency domain, while in the state of relaxation.



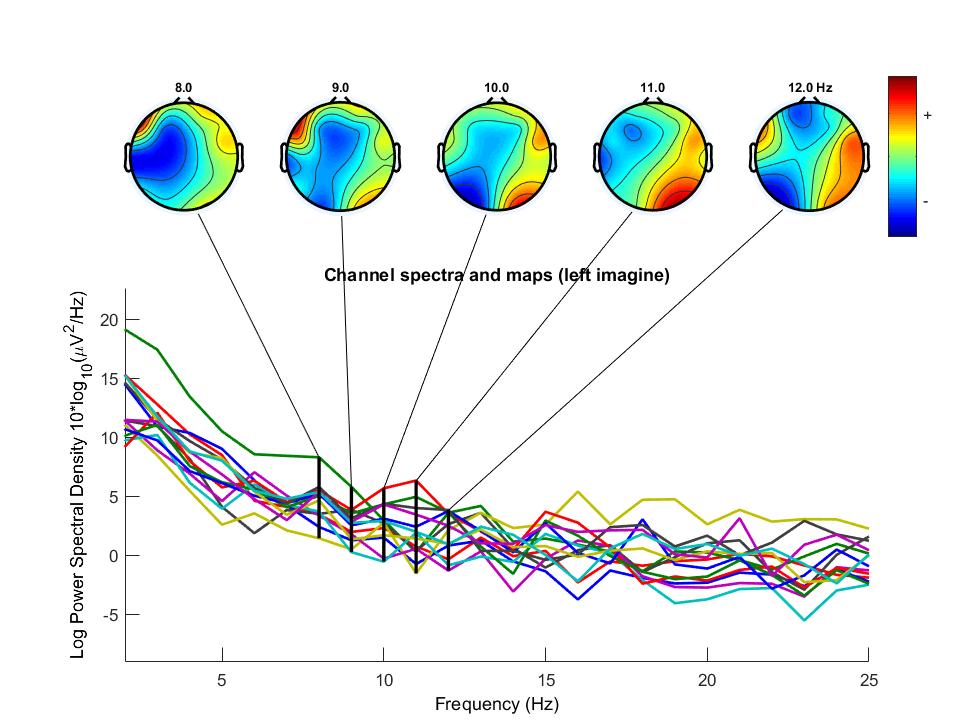
**Fig. 3.** Plot of channel data (scrolling), represented in the time domain, while moving my left hand.



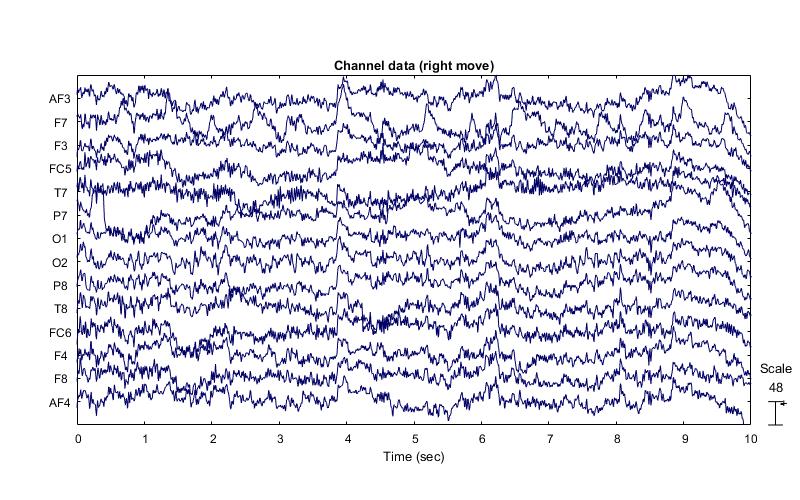
**Fig. 4.** Plot of channel spectra and maps, represented in the frequency domain, while moving my left hand. Note the prevalence of neural activity in the right cortical hemisphere. This instance of contralateral activation supports the recent studies mentioned in the abstract.



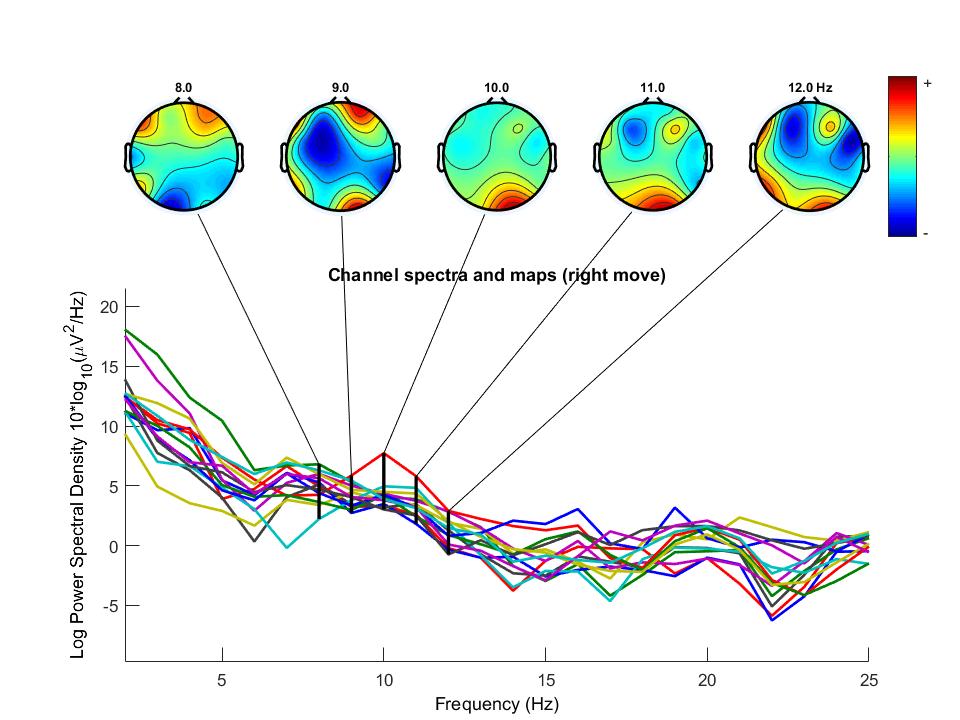
**Fig. 5.** Plot of channel data (scrolling), represented in the time domain, while imagining moving my left hand.



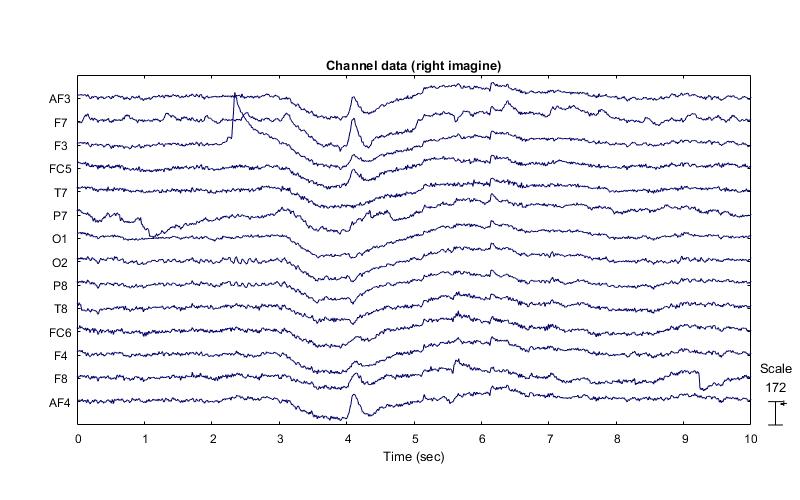
**Fig. 6.** Plot of channel spectra and maps, represented in the frequency domain, while imagining moving my left hand. Note that, although there is a presence of contralateral neural activity, it is hardly comparable to magnitudes observed while actually moving the hand (as seen in Fig. 4).



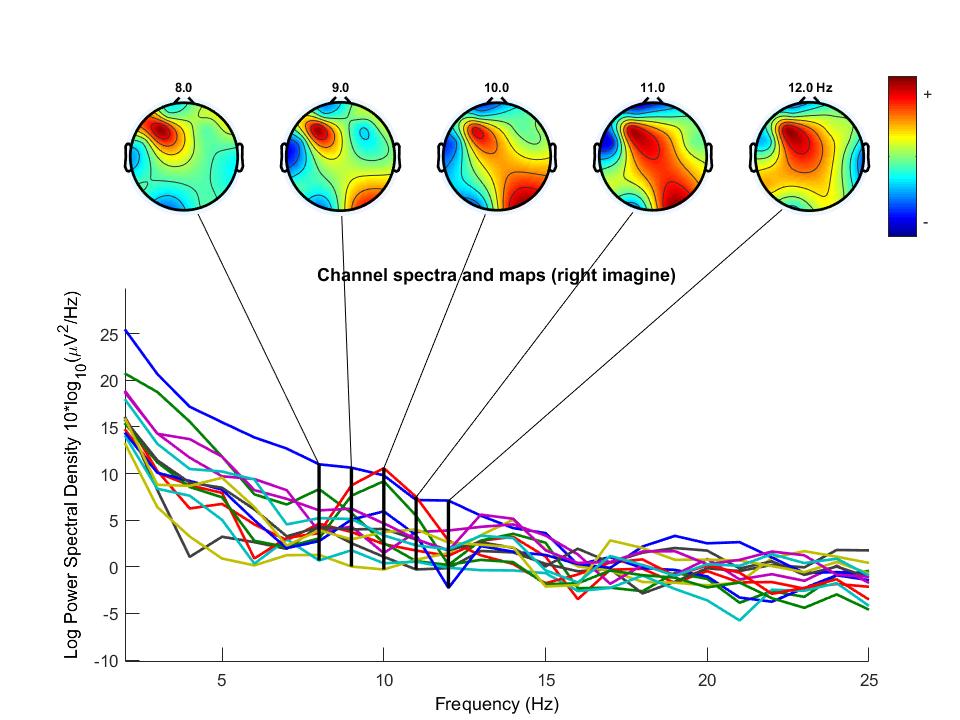
**Fig. 7.** Plot of channel data (scrolling), represented in the time domain, while moving my right hand. Although visibly more erratic, note that the scaling factor here is drastically lower than those in other trials. It is hard to say why this is. Perhaps moving my right hand required less neural activity since I am right-handed, or I had not performed these motions with as much energy as I had while moving my left hand (Fig. 3-4).



**Fig. 8.** Plot of channel spectra and maps, represented in the frequency domain, while moving my right hand.



**Fig. 9.** Plot of channel data (scrolling) represented in the time domain, while imagining moving my right hand.



**Fig. 10.** Plot of channel spectra and maps, represented in the frequency domain, while imagining moving the right hand. Note that there is clearly an increase in neural activity in the left cortical hemisphere, which is again in accordance with the studies mentioned in the abstract. However, there is still some peculiar activity in the right caudal region of my brain, noticeable in 9-11 Hz band of the μ rhythm.

1. **Discussion**

The discussion goes here

1. **Conclusion**

The conclusion goes here

**Acknowledgement**

I would like to take a moment to thank both Dr. Yu and Yang for the exciting experience as well as the opportunity to observe and participate in such a fascinating experiment!