EEGLAB: EEG Data Analysis

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ABSTRACT
The following paper will outline basic concepts of EEG data analysis utilizing EEGLAB via MATLAB.

Author Keywords
ASD 101; TD 104; Dataset; Channel; EOG; VEOG; Noise;

INTRODUCTION
To begin, raw data preprocessing for two sample datasets will be discussed. The datasets include ASD 101 and TD 104, respectively. These two .set files are loaded into EEGLAB and plotted in scroll channel data format, as well as channel time-frequency format. Each plot is labeled with a title indicating the ID of the dataset. Two channels, EOG and VEOG will be removed from the scroll channel data. Next, time-frequency characteristics will be analyzed using each set.

Normal or Body Text
Section: **Raw Data Preprocessing**

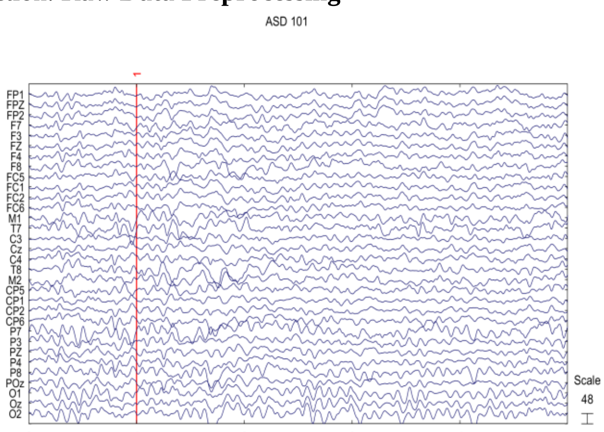

Figure 1.1: ASD Plot Without EOG & VEOG

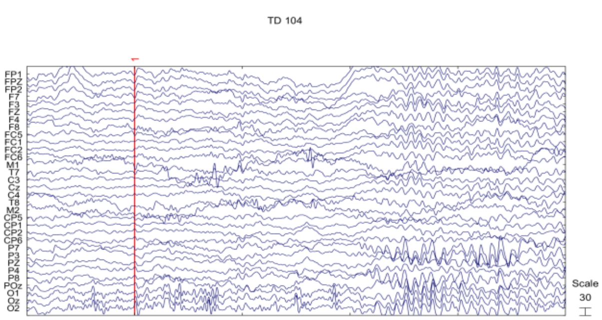

Figure 1.2: TD Plot Without EOG & VEOG

The first data plot resulting in figure 1.1 is derived from the ASD 101 dataset. This result is of the scroll channel data plot type within EEGLAB. The second data analysis produces figure 1.2. This involves the TD 104 raw data set and the plot is also of the scroll channel data type.

Within each plot, two channels have been removed as they are evident outliers within the plot. These channels are EOG and VEOG, which represent eye movement. Eye movement as a measurement is much less stable than other channels as our eyes can move rapidly or focus. EOG results in periods of either highly variable or highly stable movement, thus the data is extremely volatile. VEOG channel data is similar to EOG, except this channel represents vertical eye movement. Our field of vision includes much more range in the horizontal space as opposed to vertical, so it follows that the VEOG data is stable and almost still. The extreme volatility of EOG and the almost linear stability of VEOG data channels presents each as an outlier in the data plot, and have therefore been removed.

Section: **Time-Frequency Characteristics**

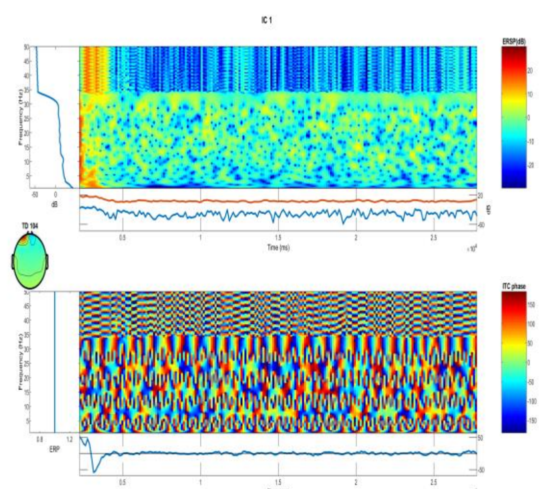

Figure 2.2: TD Time-Frequency Plot

In order to analyze the characteristics of time-frequency plots, a singular channel time-frequency plot showing the first thirty seconds of input as an interval for each dataset will be created and compared. Each plot for ASD 101 and TD 104 are shown in figure 2.1 and 2.2 respectively. For each plot, we are analyzing channel one, or FP1 only.

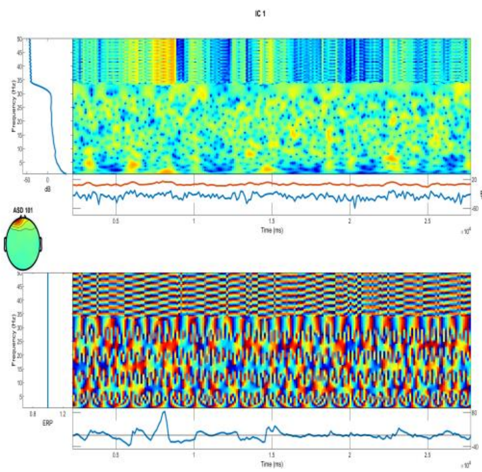

Figure 2.2: ASD Time-Frequency Plot

Upon comparing figures 2.1 and 2.2 described above, it can be seen that the ERSP indicator is much higher at the beginning of the TD 104 dataset, while in the ASD 101 dataset it is much more spread out. Within the frequency axis, measurements 0-12 Hz are indicative of a state of relaxation, where a higher ERSP value in a red hue indicates a less relaxed state, and a lower measurement a more relaxed state. When looking for engagement, we utilize frequency ranges 12-30 Hz. Lower engagement is represented by a lower ESRP in a blueish hue, while higher engagement is indicated by a higher ERSP and a red hue. Upon glancing at Figures 2.1 and 2.2, one may assume that the subject from the TD 104 dataset was in a much less relaxed state at the beginning of data collection. Within less than a second, however, it seems that the data from the subject of TD 104 indicates a much more relaxed and less engaged state. Despite this, we cannot make any substantial assumptions as to the exact cause or meaning of this change of state. The reddish hue present in the beginning of the TD 104 plot very well may be a result of ‘noise’, which reflects meaningless changes in data, or data that was misinterpreted by the EEG device. Next, we will analyze frequency changes occurring in the ASD 101 dataset. As can be seen in figure 2.1, the frequency distribution is much more dispersed than the previous dataset. However, within the distribution the frequencies are more towards the extremes of each color range. Ignoring the first second of the previous dataset and comparing them, we see that within the dispersed data the red hue is more frequent and redder than the TD 104 dataset. Although, we still cannot assume this is a result of the subject experiencing sporadic moments of less relaxation or focus as the figure indicates. Rather, this could be caused by a greater sensitivity in the EEG device, or increased noise within the device due to some external factor.

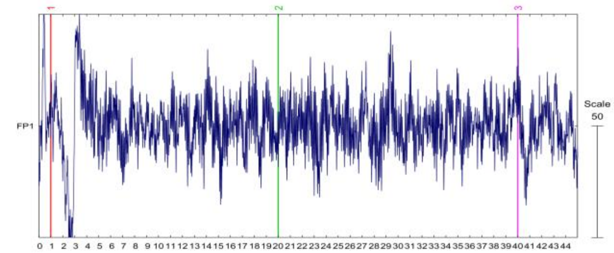

Figure 0.1: ASD 45 Second FP1 Channel Plot

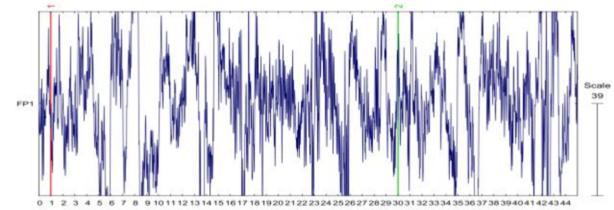

Figure 0.2: TD 45 Second FP1 Channel Plot

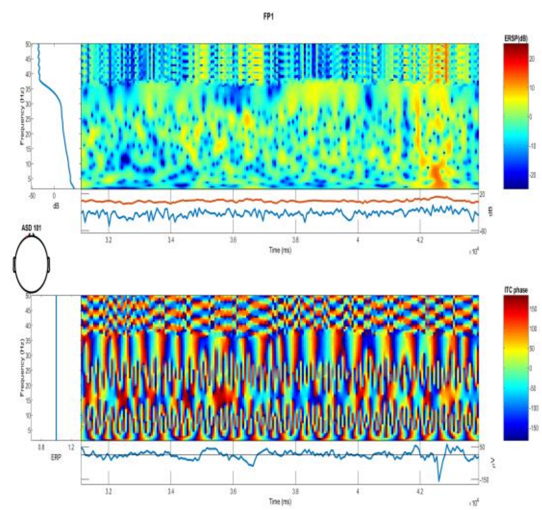

Figure 3.1: ASD [30-45] Second Time-Frequency Plot

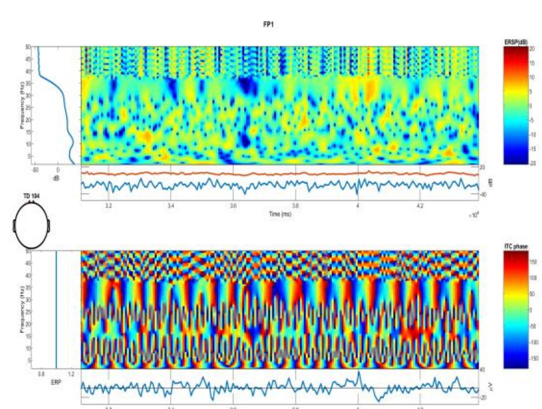

Figure 3.2: TD [30-45] Second Time-Frequency Plot

Our final two plots of data include a time-frequency plot of both datasets at a random interval of 15 seconds. This plot is exclusively for the first channel, FP1. When choosing this interval, I believed it would be most beneficial to select data points in which the frequency volatility of each set were at two extremes. That is, where the ASD 101 volatility was most stable and the TD 104 plot the most volatile. In order to find this, I created a scroll plot of only channel FP1 for each dataset with a range of 45 seconds. From this, I could tell that the interval 30-45 seconds best satisfied my intentions. This process can be seen in figures 0.1 and 0.2 above. As a result of the large volatility in FD 104, I expected greater hue extremes within the blue-red range to be present throughout the time-frequency plot. Within the ASD 101 dataset, I expected equal parts red blue which is reflective of the smaller up and down ticks in the low volatility. When comparing the two via figure 3.1 and 3.2, it can be seen that my predictions were mostly correct. In figure 3.1 representing the ASD 101 data, we see mostly equal parts red and blue present. Additionally, it can be seen at the end of the ASD figure, around 40-43 seconds, the increase in volatility seen from figure 0.1 coincides with the increase in the presence of red hue in figure 3.1. In analyzing figure 3.2 containing the FD 104 data, the presence of a hue is to a greater extent, indicating large and sustained changes in frequency throughout our time interval, which is also reflected in figures 0.2 in our 30-45 second interval.

CONCLUSION

In summary, in writing this paper I gained experience and insight into how EEGLAB and its components can be used. Additionally, I could tell as I went on that my familiarity of the EEGLAB layout improved. Finally, I gained insight on how to interpret data plots, which helped in fortifying my knowledge gained from our course time. Ultimately, I believe working within the program was beneficial to my understanding of EEG data, data analysis, and the SIGCHI report structure.