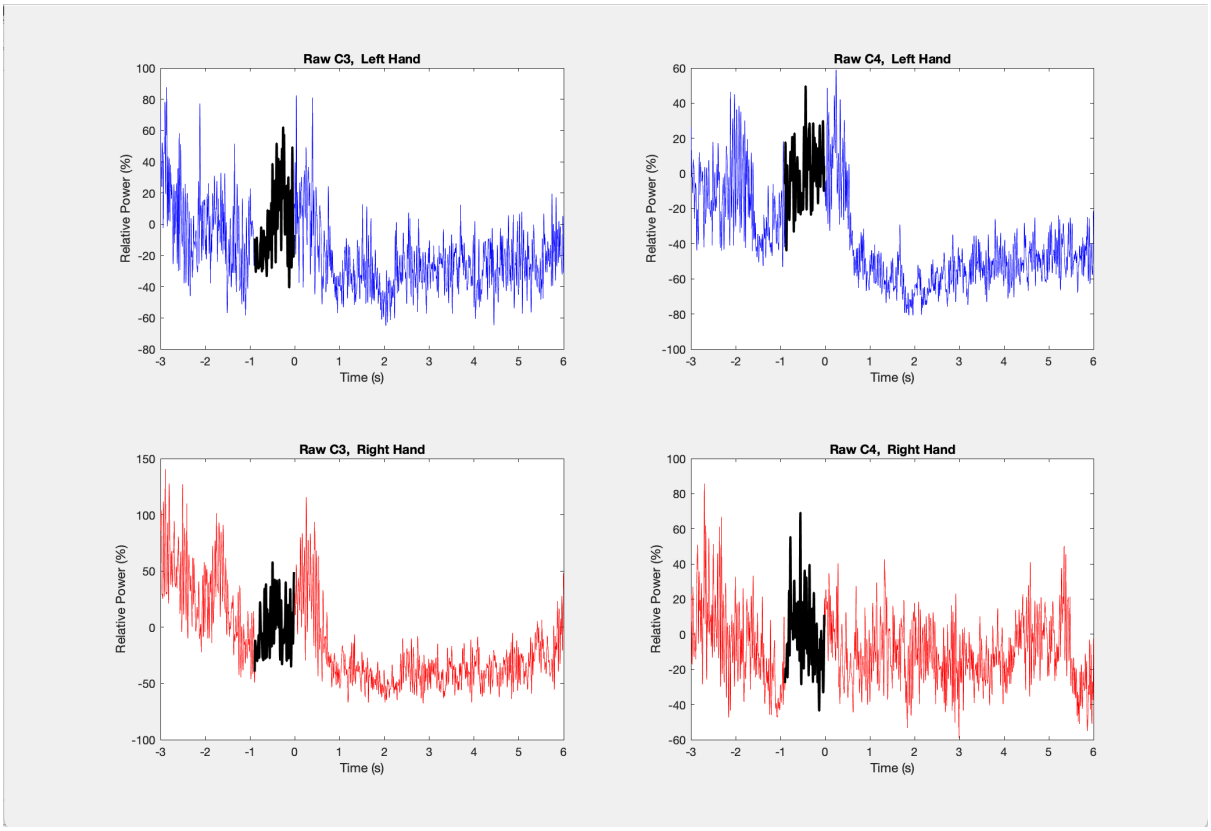
Question #1

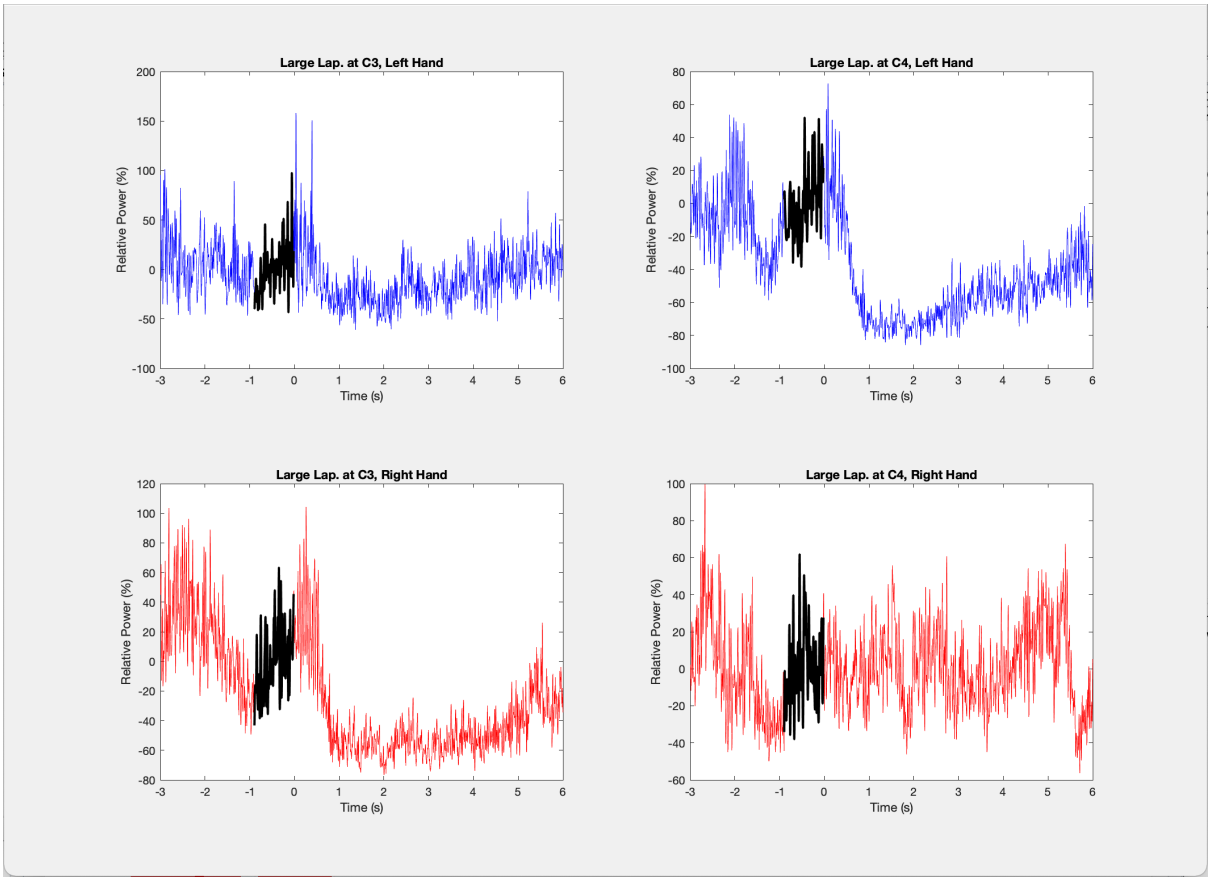


It should be first noted that based on the sensory attention tasks for this EEG, the SMR plots are associated with the Mu and High Beta frequency bands (8 - 26 Hz). Thus, we are dealing with the observation of motor and sensory tasks, concentrated near the occipital region of the brain.

For the Left Hand task, it can be observed that there is a decrease in power in the C4 electrode signal, after the baseline period - this suggests an ERD. Since the C4 electrode is placed on the right half of the brain, it is contralateral to the left hand task that is being concentrated on by the subject. In the C3 electrode signal for Left Hand task, there is no significant increase or decrease in power, suggesting that the ipsilateral portion of the brain (left half) is not involved.

For the Right Hand task, it can be observed that there is a decrease in power in the C3 electrode signal, after the baseline period - this suggests an ERD. Since the C3 electrode is placed on the left half of the brain, it is contralateral to the right hand task that is being concentrated on by the subject. In the C4 electrode signal for Right Hand task, there is no significant change in power level, suggesting that the ipsilateral portion of the brain (right half) is not involved.

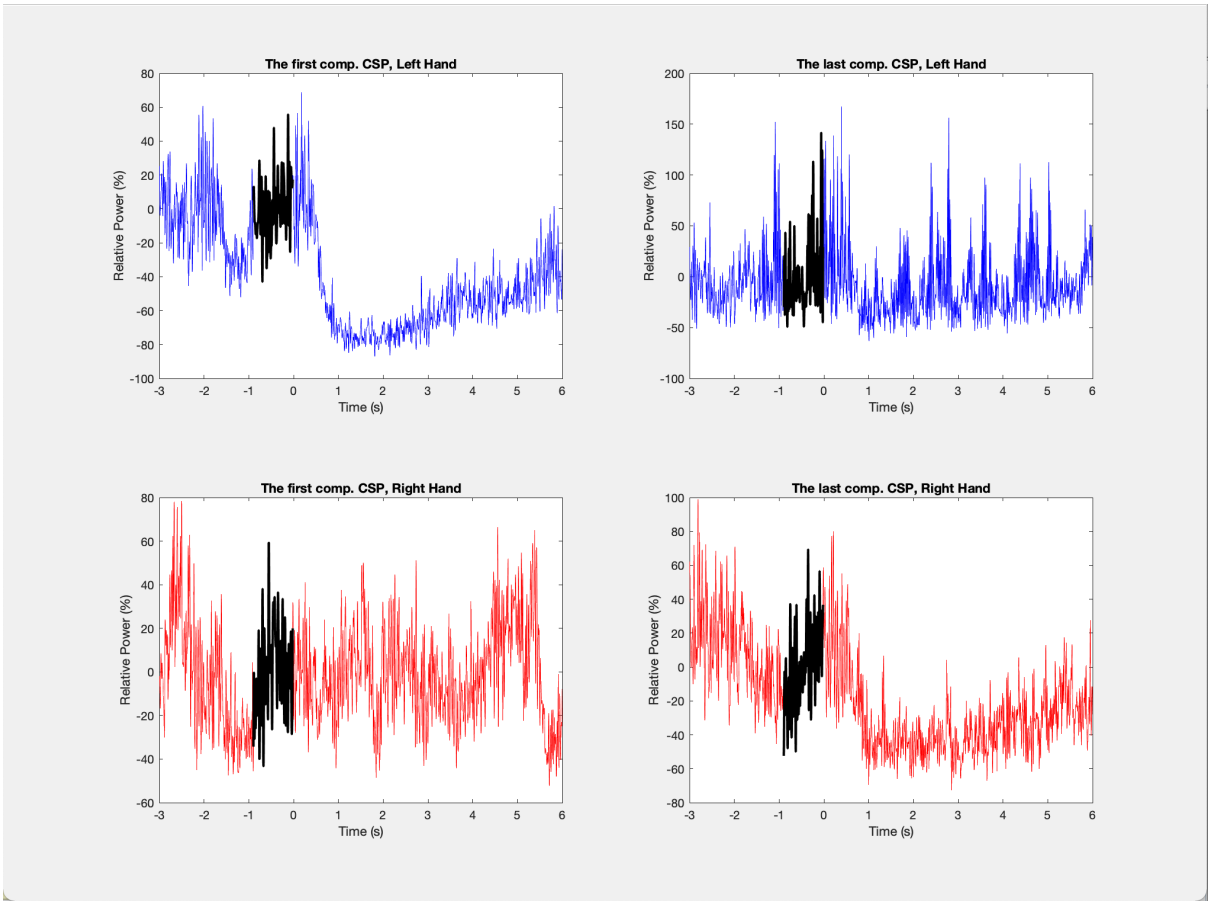
Question #2



Compared to question 1, in general, the SMR plots provide more clarity in terms of the trends. This is due to the application of the large Laplacian filter. The large Laplacian increases the source estimation quality at an individual component, and reduces the effects of all surrounding sources (of non-interest). In this case, we applied the large Laplacian to accentuate the signal at electrodes C3 and C4, for left and right hand tasks, respectively.

For all SMR plots, the same trends as observed in question 1, can still be observed after application of the large Laplacian filter. Similar to question 1, there is attenuation of power in the C4 electrode signal for the Left Hand task, suggesting an ERD, and thus, contralateral (right half) brain activity. Also, there is attenuation of power in the C3 electrode signal for the Right Hand task, suggesting an ERD, and thus, contralateral (left half) brain activity.

Question #3



The goal of CSP is to enhance signal quality of certain regions of the brain when there are two sets of sources (left and right hand tasks) with different spatial profiles. For this analysis, this is done through spatial profiles (eigenvectors) that accentuate the signals at brian regions associated with this sensory attention task (around C3 and C4 cortical areas).

Based on this, we can realize that the first component of CSP filtered SMR encompasses the spatial profile associated with left hand task, and the last component of CSP filtered SMR encompasses the spatial profile associated with right hand task.

Compared to questions 1 and 2, the same, general trends can be observed. The first component CSP, Left Hand SMR plot represents the signal when the first eigenvector of W filters out all, but the spatial profile associated with the left hand task. An attenuation of power, after the baseline period can be observed (ERD). This ERD signifies concentration of the subject on the left hand task due to contralateral brain activation. As a result, when the last eigenvector of W is applied to the left hand task (The last component CSP, Left Hand SMR plot), there is no ERD/ERS because spatial profile associated with right hand task is not activated during left hand task concentration.

The last component CSP, Right Hand SMR plot represents the signal when the last eigenvector of W filters out all, but the spatial profile associated with the right hand task. An attenuation of power, after the baseline period can be observed (ERD). This ERD signifies concentration of the subject on the right hand task due to contralateral brain activation. As a result, when the first eigenvector of W is applied to the right hand task (The first component CSP, Right Hand SMR plot), there is no ERD/ERS because spatial profile associated with left hand task is not activated during right hand task concentration.

In questions 1 and 2, the focus was on specific brain regions around the C3 and C4 electrodes. In question 3, the focus is on spatial profiles associated with each of the left and right hand tasks, thus it brings further clarity to the EEG signal. Overall, the first component CSP, Left Hand SMR plot is characterizing the signals shown in C4, Left Hand SMR plots in questions 1 and 2. Similarly, the last component CSP, Right Hand SMR plot is characterizing the signals shown in C3, Right Hand SMR plots in questions 1 and 2.