Experiment HP-1: The Electroencephalogram (EEG) ~ Wireless

Equipment Required

PC or Mac Computer

IXTA, USB cable and power supply

ROAM-EEG and EEG Headstrap

Conductive gel

This lab involves keeping the eyes open for longer durations of time. People with contacts are advised to not be test subjects for this lab

ROAM Setup

Select one person from your group to be the subject in this experiment.

1. Locate the ROAM-EEG.

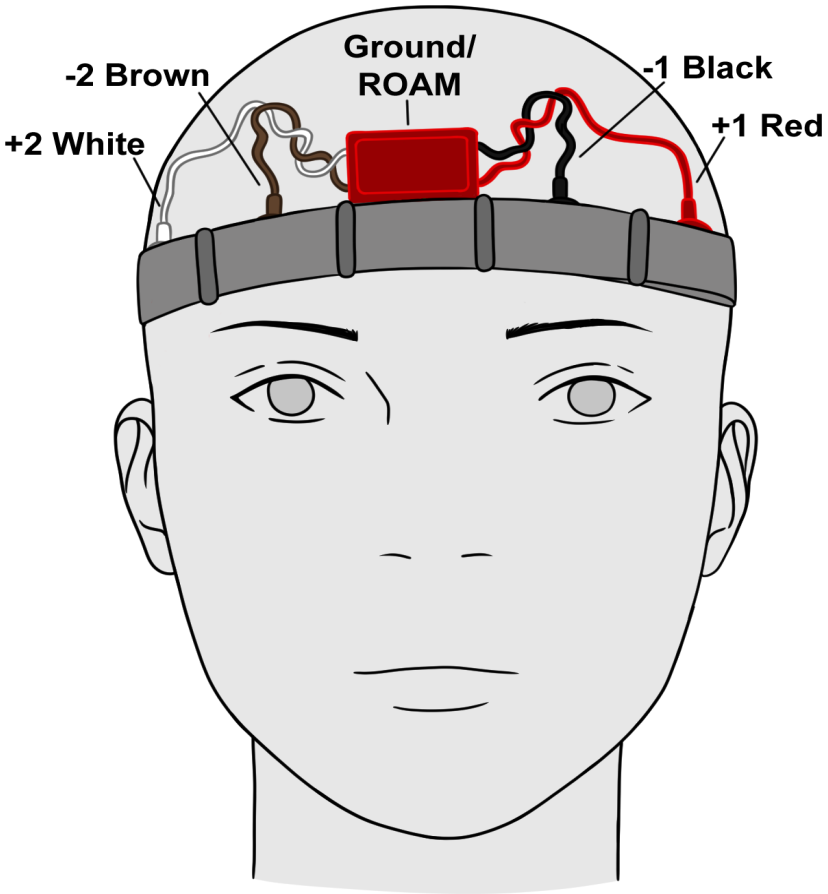

Figure HP-1-S1: The ROAM – EEG.

2. Remove the ROAM from the top of the TA and attach the ROAM to the headband as shown.
4. Put on the head strap:
    - Place a small amount of electrode gel on the electrodes just enough to cover the electrodes.
    - Place the headband on the head such that the ROAM transmitter is at the center of the forehead.
    - Make sure that all electrodes are making contact with the skin.
    - You are now ready to record EEG.

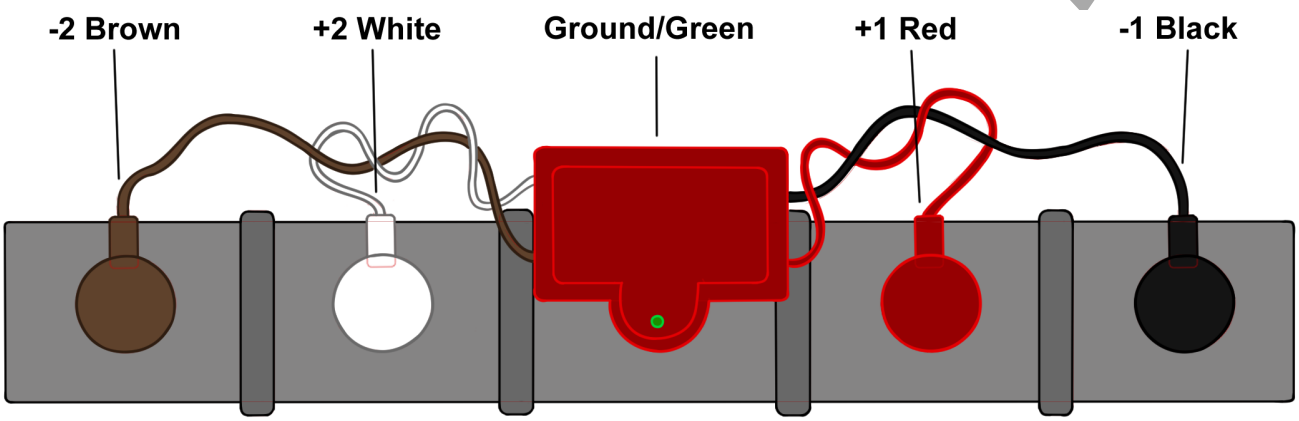

Figure HP-1-S2: The ROAM – EEG electrode placement.

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Experiment HP-1: The Electroencephalogram (EEG)

Exercise 1: Common EEG Artifacts

Aim: To learn how to record an EEG and to become familiar with identifying EEG artifacts, especially those related to motion in the subject.

Approximate Time: 20 minutes

This exercise involves keeping the eyes open for longer durations of time. People with contacts are advised to not be test subjects for this lab.

Procedure

1. Ask the subject to sit quietly and not move unless told to do so, and to keep their eyes open during this phase of the experiment.
2. Click on the Record button.
3. Click on the AutoScale All button. Your recording should look like the Figure HP-1-L1 below.
4. Type the **Resting EEG** in the Mark box. Click the mark button. Continue recording.
5. Instruct the subject to blink their eyes when asked, during the next thirty seconds of the recording. Type the letter **B** for Blink) in the Mark box before each time the subject is asked to blink. Click the mark button to mark the recording when each blink occurs.
6. Instruct the subject to frown or smile (contracting their facial muscles) when asked, during the next thirty seconds of the recording. Type the letter **F or S** in the Mark box before each time the subject is asked to do so. Click the mark button to mark the recording when each frown or smile occurs.
7. Instruct the subject to rotate or tilt their head when asked, during the final thirty seconds of the recording. Type the letter **R or T** in the Mark box before each time the subject is asked to do so. Click the mark button to mark the recording when each rotation or tilt occurs.
8. Click Stop to halt recording.
9. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

Data Analysis

1. Scroll through the recording using the scroll bar at the bottom of the Main window. Stop at marks (vertical lines in the EEG record) where you have entered comments.
2. Notice that movement of any kind will cause artifacts in the EEG record. Learn to recognize these types of motion artifacts and eliminate them from any EEG analysis by placing the cursors to not include them. Actual variations in waking brain activity are potentials with amplitudes that are significantly lower than the amplitudes of artifacts.

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Exercise 2: Alpha and Beta EEG Patterns

Aim: To identify Alpha and Beta EEG patterns from a subject with open and closed eyes.

Approximate Time: 20 minutes

Procedure

1. Instruct the subject that they need to avoid any movement other than opening or closing their eyes when asked. The subject should have their eyes open at the beginning of the recording.
2. Click Record, and then click the AutoScale All button. You should observe an EEG recording similar to the two topmost traces in Figure HP-1-L1.
3. Type the letter **O** for Eyes Open in the Mark box. Click the mark button to mark the recording. Record for 10-15 seconds.
4. While the subject has their eyes open, type the letter **C** for Eyes Closed in the Mark box. Click the mark button to mark the recording as you instruct the subject to close their eyes. Record the subject's EEG pattern with their eyes closed for 10-15 seconds.
5. Continue to record the subject's EEG pattern for a total of 3 minutes as the subject alternates having their eyes open and then closed for 10-15 second periods. Mark the recording with an **O** or a **C** each time the subject opens or closes their eyes.
6. Click Stop to halt recording.
7. Select Save in the File menu.

Data Analysis

1. Scroll through the data recorded in this exercise and find an artifact-free section of data recorded while the subject's eyes were open.
2. Use the Display Time icons in the LabScribe toolbar to adjust the Display Time of the Main window to show a ten second artifact-free section of data on the Main window. This section of data can also be selected by:
    - Placing the cursors on either side of the data recorded while the subject's eyes were open.
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the period to the width of the Main window.

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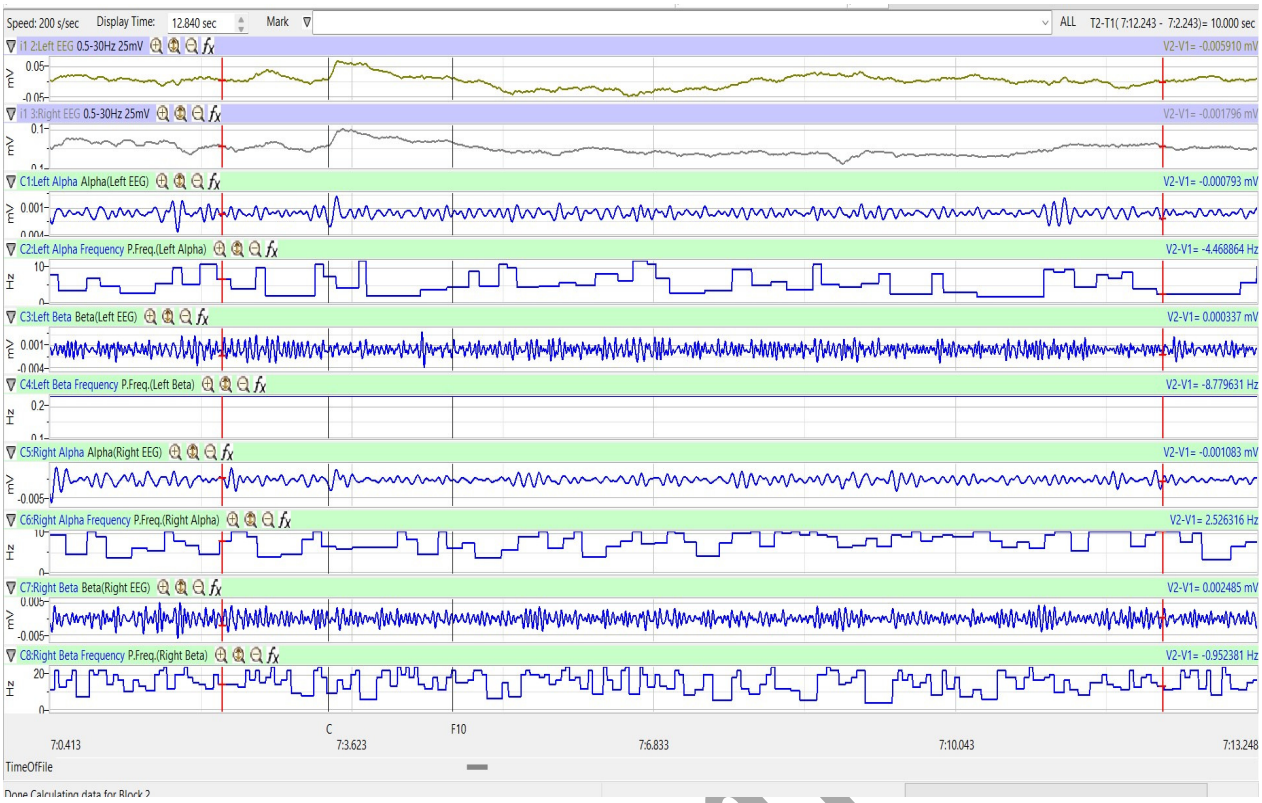

Figure HP-1-L1: Recording of EEG from the left and right temporal regions of the brain displayed on the Main window. The complete EEG signals are displayed in the two uppermost channels. The Alpha and Beta waves derived from the complete EEG signals and the frequencies of those waves from each temporal region are displayed on the lower channels

3. Click on the Analysis window icon.
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical function used in the analysis, Max-Min and Mean appears in this table. The values for Max-Min and Mean on each channel are seen in the table across the top margin of that channel.

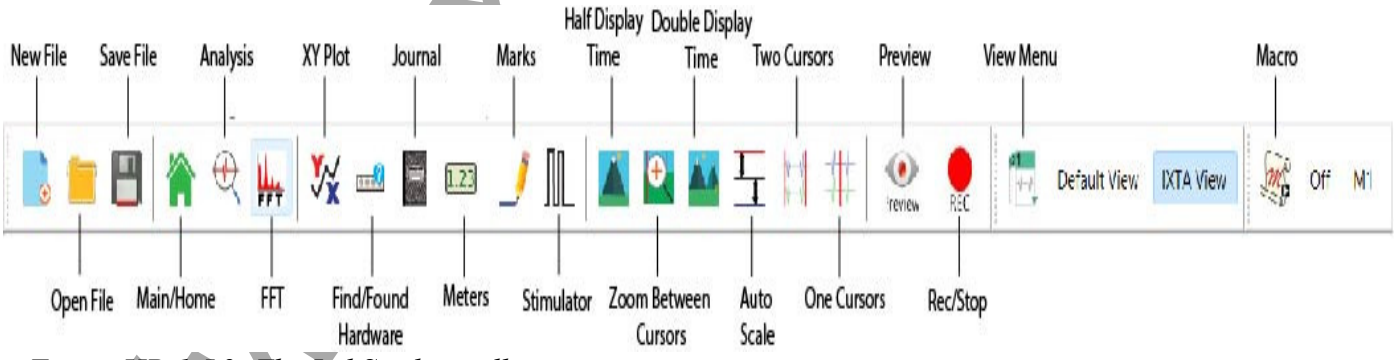

Figure HP-1-L2: The LabScribe toolbar.

Not for Sale

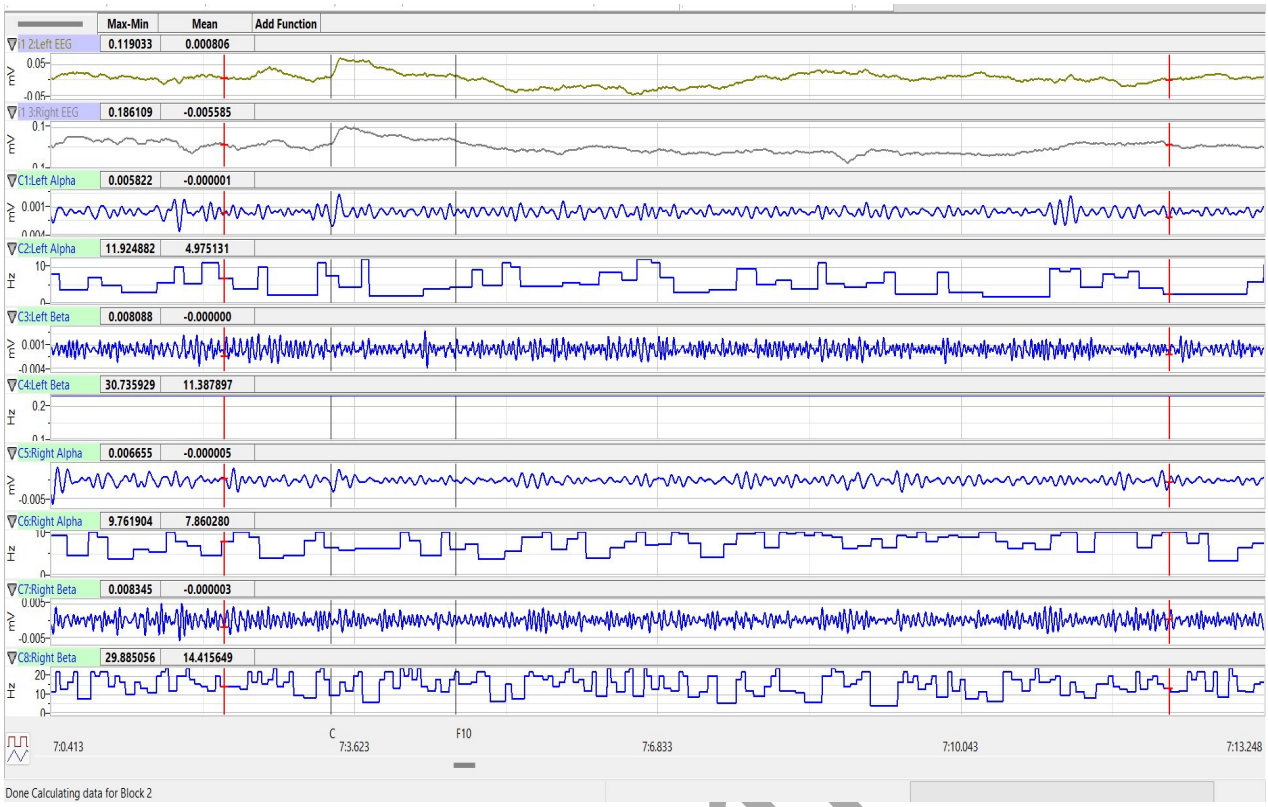

Figure HP-1-L3: Recording of the complete EEG signals, derived Alpha and Beta waves, and the wave frequencies displayed in the Analysis window.

5. Use the mouse to click on and drag a cursor to each margin of the data displayed on the Analysis window. The values for the following parameters should be recorded:
    - The differences between the maximum and minimum wave amplitudes (Max-Min) of the waves displayed on the Left Alpha (C1), Left Beta (C3), Right Alpha (C5), and Right Beta (C7) Wave channels.
    - The mean frequency (Mean) of the waves displayed on the Left Alpha (C2), Left Beta (C4), Right Alpha (C6), and Right Beta (C8) Frequency channels.
6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the means into the Journal. To use these functions:
    - Place the cursors at the locations used to measure the values for the parameters of the EEG waves in the selected region of data.
    - Transfer the name of the mathematical function used to determine the values of the parameters to the Journal using the Add Title to Journal function in the pull-down menu of any channel.
    - Transfer the values of the parameters of the EEG waves to the Journal using the Add Ch. Data to Journal function in the Left EEG Channel pull-down menu.

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7. Once the cursors are placed in the correct positions for determining the difference between the maximum and minimum amplitudes and the mean frequency of the waves in a ten-second section of data, the values of these parameters can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal, and in Table 1.
8. After recording the values found in Step 5 in the Journal and in Table 1, return to the Main window. Scroll through the recording and find a 10 second artifact-free section of data recorded while the subject's eyes were closed.
9. Repeat Steps 2 through 7 on an artifact-free section of data recorded while the subject's eyes were closed. Find the values of the parameters of each type of wave and enter this data into the Journal and in Table 1.
10. Select Save in the File menu.

Table HP-1-L1: EEG Frequencies & Amplitudes - Different Environmental Stimulation

	Max-Min Amplitude (mV)		Mean Frequency (Hz)	
	Eyes Open	Eyes Closed	Eyes Open	Eyes Closed
Left Alpha Waves				
Left Beta Waves				
Right Alpha Waves				
Right Beta Waves				

Questions

1. Do both hemispheres have a higher level of Alpha wave activity (higher difference in maximum-minimum Alpha amplitude and a mean frequency within an 8-13 Hz range) during the Eyes Closed or Eyes Open condition?
2. Do both hemispheres have a higher level of Beta wave activity (higher difference in maximum-minimum Beta amplitude and a mean frequency within a 14-30 Hz range) during the Eyes Closed or Eyes Open condition?
3. Is the Alpha wave level of activity higher in one hemisphere than in the other during the Eyes Closed condition?
4. Is the Beta wave level of activity higher in one hemisphere than in the other during the Eyes Open condition?
5. Do these results demonstrate that the subject had an increased state of arousal when their eyes were open or closed? Give the reasoning.
6. Do these results demonstrate one hemisphere had a higher state of arousal than the other? Give the reasoning.

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Exercise 3: The Alpha Block

Aim: To identify the presence of the Alpha Block that occurs when the subject's eyes are closed and their mind is focused on problem solving.

Approximate Time: 20 minutes

Procedure

1. Before beginning this exercise, inform the subject of the experimental conditions:
    - The subject should sit quietly with eyes closed throughout the recording period.
    - Following a quiet period when the subject's resting EEG pattern is established, the subject will be given a mental arithmetic problem to solve. The right or wrong answer does not matter, just trying to solve the problem is important.
    - When the subject has completed the problem, they should say the answer out loud, and then resume sitting quietly with no particular mental focus.
    - The person operating the computer will enter appropriate comments on the recording to indicate the beginning of the quiet period, the time at which the question was asked, the time when the subject speaks the answer, and the time when the recording ended.
2. Type **Resting EEG** in the Mark box. Click on the Record button. Click the mark button.
3. Click on the AutoScale All button. Continue recording while the subject is sitting quietly with their eyes closed. Obtain a thirty second segment of Alpha EEG data that is free of artifacts.
4. Type **P1** for Problem 1 in the Mark box. Ask the subject to solve a mental arithmetic problem, such as multiplying 46 by 28; or, dividing 157 by 16. The problem should be delivered to the subject quickly. Click the mark button to mark the recording as soon as the problem is given to the subject.
5. Quickly, type **EP1** for End of Problem 1 in the Mark box. When the subject finishes the problem and announces the answer out loud, click the mark button to mark the end of the problem solving period.
6. Ask the subject to solve two other arithmetic problems. Repeat Steps 5 and 6 using a different problem labeled as **P2 (EP2)** and **P3 (EP3)**.
7. Click Stop to halt recording.
8. Select Save in the File menu.

Data Analysis

1. Scroll through the recording and find the section of data that was recorded while the subject was resting with their eyes closed, prior to the first arithmetic problem being given to the subject. The Alpha EEG wave pattern in this section of data should be similar to pattern recorded when the subject's eyes were closed.
2. Use the Display Time icons to adjust the Display Time of the Main window to show a five to ten second artifact-free section of this data on the Main window. This section of data can also be selected by using the Zoom between Cursors function.

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3. Click on the Analysis window icon.
4. Use the mouse to click on and drag a cursor to each margin of the data displayed on the Analysis window. The values for the following parameters should be recorded:
    - The differences between the maximum and minimum wave amplitudes (Max-Min) of the waves displayed on the Left Alpha (C1) and Right Alpha (C5) Wave channels.
    - The mean frequency (Mean) of the waves displayed on the Left Alpha (C2) and Right Alpha (C6) Frequency channels.
5. Use one of the techniques described in Exercise 2 to record the names and values of the parameters measured in Step 5 to the Journal. Also, record these values in Table 2.
6. Return to the Main window. Scroll through the recording and locate the section of data recorded when the subject was solving the first problem (P1).
7. Repeat Steps 2 through 5 on the section of data collected while the subject was solving the first problem (P1). While the subject is solving the first problem, the predominant Alpha EEG rhythm should have disappeared. This phenomenon is known as **Alpha Block**. Enter this data into the Journal and in the table.
8. Repeat step 8 for both P2 and P3, see if Alpha block continues to occur.
9. Select Save in the File menu.

Table HP-1-L2: EEG Frequencies & Amplitudes During Low Environmental Stimulation

Subject_____	Resting	Problem1	Problem Solved	Problem 2	Problem Solved
Max-Min Left Alpha Amplitude (mV)					
Mean Left Alpha Frequency (Hz)					
Max-Min Right Alpha Amplitude (mV)					
Mean Right Alpha Frequency (Hz)					

Questions

1. Does either hemisphere have a lower level of Alpha wave activity (lower difference in maximum-minimum Alpha amplitude and a mean frequency above the 8-13 Hz range) during the problem-solving tasks than during the rest period?
2. Does either hemisphere have a higher level of Alpha wave activity (higher difference in maximum-minimum Alpha amplitude and mean frequency within the 8-13 Hz range) during the periods after the problems are solved than during the problem-solving tasks?

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3. How do the levels of Alpha wave activity in the periods after the problems are completed compare to the Alpha wave activity in the rest period?
4. Is the level of Alpha wave activity higher in one hemisphere than in the other during the rest period? During the problem-solving tasks? During the periods after the problems are completed?
5. Do your results demonstrate the presence of Alpha Block in the subject?

Exercise 4: EEG Pattern in Psychological States

Aim: To test whether a subject's left hemisphere is more active (alert, aroused), than the right hemisphere, when the subject is engaged in language processes.

And, to test whether a subject's right hemisphere is more active (alert, aroused) than the left hemisphere, when the subject is engaged in spatial processes.

Approximate Time: 30 minutes

Evidence for a more active, or more alert, brain is a higher EEG frequency and a lower EEG amplitude (faster and shorter in height). Conversely, evidence for a less active, or less alert, brain is a lower EEG frequency and a higher EEG amplitude (slower and larger in height).

Procedure

1. There are three experimental conditions in this exercise. During the exercise, you will also need to enter comments to indicate:
    - Control Task: Sitting quietly with eyes closed for a minute.
    - Spatial Task: Sitting quietly with eyes closed for one minute. During that one minute period, the subject should mentally "walk" through their house using imagery to "see" the rooms and their contents. The subject should not use verbal guidance, nor label what is seen, as they "walk" from room to room. The subject should imagine each room as they "walks" slowly through it.
    - Language Task: Sitting quietly with eyes closed for one minute. The subject should use mental language to "name" each object known to be in their kitchen (or any other chosen room of the house). Name as many objects as possible in the one minute of time. The subject should not visualize or try to picture the objects, just name them.
2. Explain each of the three conditions to the subject. Emphasize that the spatial task should involve imagery without language, and that the language task should involve naming without visual imagery. All tasks are performed silently with the eyes closed.
3. The control task is the first in the sequence. Pick the experimental task you would like to do after the control task.
4. Type **Control Task** in the Mark box. Click on the Record button. Click the mark button to attach the comment to the data.

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5. Click on the AutoScale All button.
6. Before the end of the one-minute control task, type **ECT** for End Control Task in the Mark box. As you instruct the subject to end the control task, click the mark button to mark the recording. Continue to record.
7. Following the control task, administer one of the two experimental tasks. Remind the subject which task to perform and what is supposed to be done in the task.
8. Type **LT** for Language Task, or **ST** for Spatial Task, in the Mark box. As you instruct the subject to begin the task, click the mark button to mark the recording. Continue to record for at least one minute.
9. Depending on the task performed, type **ELT** or **EST** when you end the tasks, in the Mark box. As you instruct the subject to end the task, click the mark button to mark the recording. Continue to record.
10. Administer the second experimental task. Again, remind the subject which task to perform and what is supposed to be done in the task. Repeat Steps 9 and 10 on the final experimental task.
11. Click Stop to halt recording.
12. Select Save in the File menu.

Data Analysis

1. Scroll through the recording and find the section of data that was recorded while the subject was performing the control task.
2. Use the Display Time icons to adjust the Display Time of the Main window to show a ten second artifact-free section of this data on the Main window. This section of data can also be selected by using the Zoom between Cursors function.
3. Click on the Analysis window icon.
4. Use the mouse to click on and drag a cursor to each margin of the data displayed on the Analysis window. The values for the following parameters should be recorded:
    - The differences between the maximum and minimum wave amplitudes (Max-Min) of the waves displayed on the Left Alpha (C1), Left Beta (C3), Right Alpha (C5), and Right Beta (C7) Wave channels.
    - The mean frequency (Mean) of the waves displayed on the Left Alpha (C2), Left Beta (C4), Right Alpha (C6), and Right Beta (C8) Frequency channels.
5. Use one of the techniques described in Exercise 1 to record the names and values of the parameters measured in Step 4 to the Journal. Also, record these values in Table 3.
6. Return to the Main window. Scroll through the recording and locate the section of data recorded when the subject was the first experimental task.
7. Repeat Steps 2 through 5 on the section of data collected while the subject was performing the first experimental task. Enter this data into the Journal and the table as done previously.

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8. Return to the Main window. Scroll through the recording and locate the section of data recorded when the subject was the second experimental task.
9. Repeat Steps 2 through 5 on the section of data collected while the subject was performing the second experimental task. Enter this data into the Journal and the table as done previously.
10. Select Save in the File menu.

Questions

1. Does one hemisphere have more Beta wave activity than the other during the language task? Does one hemisphere have more Alpha wave activity than the other during the same task?
2. Does one hemisphere have more Beta wave activity than the other during the spatial task? Does one hemisphere have more Alpha wave activity than the other during the same task?
3. Does the subject have more Alpha or Beta EEG activity during either of the experimental tasks than during the control task?
4. Do these results support the hypothesis put forth at the beginning of this exercise?

Table HP-1-L3: EEG frequencies & Amplitudes - Different Psychological States.

	Control Task	Language Task	Spatial Task
Max-Min Left Alpha Amplitude (mV)			
Mean Left Alpha Frequency (Hz)			
Max-Min Left Beta Amplitude (mV)			
Mean Left Beta Frequency (Hz))			
Max-Min Right Alpha Amplitude (mV)			
Mean Right Alpha Frequency (Hz)			
Max-Min Right Beta Amplitude (mV)			
Mean Right Beta Frequency (Hz))			

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Exercise 5: EEG and Personality

Aim: To test Eysenck's hypothesis that during baseline conditions, introverts will show greater cortical arousal compared to extroverts.

Approximate Time: 30 minutes

This exercise involves keeping the eyes open for longer durations of time. People with contacts are advised to not be test subjects for this lab.

The hypothesis predicts that subjects scored as introverts should have a baseline EEG with higher frequencies and lower amplitudes than the EEG from subjects scored as extraverts.

Procedure

1. Each person in your group and the class will have the opportunity to serve as a subject for this exercise.
2. While recordings are being made, the subject should sit quietly with no particular mental focus. Others in the room should also be quiet.
3. Type the **Eyes Open** in the Mark box. Click Record, and then click the AutoScale All button. Click the mark button. Record the subject's EEG for 30 seconds while their eyes are open. Continue to record
4. Type **Eyes Closed** in the Mark box. Instruct the subject to close their eyes and the mark button is pressed to attach the comment to the recording. Record the subject's EEG for 30 seconds while their eyes are closed.
5. Click Stop to halt recording. Then click Save.

Data Analysis

1. Scroll through the recording and find the section of data that was recorded when the subject's eyes were open.
2. Use the Zoom between Cursors function to select the correct section of data.
3. Click on the Analysis window icon.
4. Use the mouse to click on and drag a cursor to each margin of the data displayed on the Analysis window. The values for the following parameters should be recorded:
    - The differences between the maximum and minimum wave amplitudes (Max-Min) of the waves displayed on the Left Alpha (C1), Left Beta (C3), Right Alpha (C5), and Right Beta (C7) Wave channels.
    - The mean frequency (Mean) of the waves displayed on the Left Alpha (C2), Left Beta (C4), Right Alpha (C6), and Right Beta (C8) Frequency channels.
5. Use one of the techniques described in Exercise 2 to record the names and values of the parameters measured in Step 4 to the Journal. Also, record these values in Table 4.
6. Return to the Main window. Scroll through the recording and locate the section of data recorded when the subject's eyes were closed.
7. Repeat Steps 2 through 5 on the data collected while the subject's eyes were closed.

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Personality Rating Scale

1. Read each statement from Table 6. Pick the number which best indicates the extent to which the statement is characteristic of your personality. Circle the number for each statement.
2. Total the numbers that are circled. The highest score possible is 50, and the lowest score possible is 10. Introverts should have low scores; extroverts should have high scores.

Table HP-1-L4: EEG Frequencies & Amplitudes - Different Environmental Stimulation

Subject_____	Eyes	
Personality Score_____	Open	Closed
Max-Min Left Alpha Amplitude (mV)		
Mean Left Alpha Frequency (Hz)		
Max-Min Left Beta Amplitude (mV)		
Mean Left Beta Frequency (Hz))		
Max-Min Right Alpha Amplitude (mV)		
Mean Right Alpha Frequency (Hz)		
Max-Min Right Beta Amplitude (mV)		
Mean Right Beta Frequency (Hz))		

Class Data

1. The recordings from each subject should be analyzed using the instructions from Exercise 5.
2. On their own copy of Table 3, each subject should enter their Identification code and personality score. For both experimental conditions, the subject should enter their:
    - The differences between the maximum and minimum wave amplitudes (Max-Min) of the waves displayed on the Left Alpha (C1), Left Beta (C3), Right Alpha (C5), and Right Beta (C7) Wave channels.
    - The mean frequency (Mean) of the waves displayed on the Left Alpha (C2), Left Beta (C4), Right Alpha (C6), and Right Beta (C8) Frequency channels.
3. Sort the subjects into two groups based on the personality scores (low vs. high). Use the median score of the class as the division between groups.
4. Calculate the group averages for the differences between the maximum and minimum wave amplitudes and the mean frequency of the waves for each experimental condition in both personality groups. Enter these group averages in Table 5.

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Questions

1. Does the group with lower personality scores (introverts) have a higher level of activity (higher mean frequency/lower difference in the maximum-minimum EEG amplitude) than the group with higher personality scores (extraverts) during the Eyes Open condition?
2. Does the group with lower personality scores have a higher level of activity than the group with higher personality scores during the Eyes Closed condition?
3. Does the group with lower personality scores have a higher level of activity than the group with higher personality scores from both hemispheres during both eye conditions?
4. Does the class data support the hypothesis that introverts have a higher level of baseline arousal than extraverts?

Table HP-1-L5: Group Averages of Alpha and Beta Activity in Subjects Classified by Personality Score

	Average of Group with Personality Score Below Median		Average of Group with Personality Score Above Median	
	Eyes Open	Eyes Closed	Eyes Open	Eyes Closed
Max-Min Left Alpha Amplitude (mV)				
Mean Left Alpha Frequency (Hz)				
Max-Min Left Beta Amplitude (mV)				
Mean Left Beta Frequency (Hz))				
Max-Min Right Alpha Amplitude (mV)				
Mean Right Alpha Frequency (Hz)				
Max-Min Right Beta Amplitude (mV)				
Mean Right Beta Frequency (Hz))				

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Table HP-1-L6:Personality Rating Scale

	Rating				
	1	2	3	4	5
Statement	Very Uncharacteristic				Very Characteristic
1. I prefer parties with lots of people to ones with just a few.	1	2	3	4	5
2. I generally like to study in groups rather than alone.	1	2	3	4	5
3. One of the last things I would do when I have time off is read a book.	1	2	3	4	5
4. When I go on vacation I prefer exciting places with lots of stimulation.	1	2	3	4	5
5. I am often bored when I am home alone and there is seemingly nothing to do.	1	2	3	4	5
6. I prefer to have a lot of people I consider as close friends.	1	2	3	4	5
7. I consider myself an “action” person; I don’t spend a lot of time in deep thought.	1	2	3	4	5
8. My friends see me as outgoing and always available for a good time.	1	2	3	4	5
9. I would not like to spend New Year’s Eve in a quiet place with just a few friends.	1	2	3	4	5
10. For physical activity I like team sports rather than individual sports.	1	2	3	4	5

Score _____

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