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Biopac Student Lab® Lesson 4

# ELECTROENCEPHALOGRAPHY (EEG) II
## Introduction

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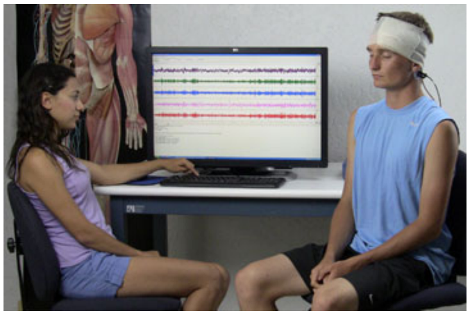
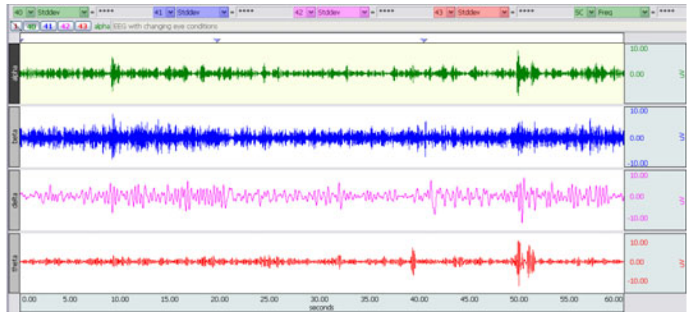




## I. Introduction

The brain constantly receives sensory input and integrates the information. The sensory information is relayed from the periphery through lower centers in the brain, and then the information is sent to specific regions of the **cerebral cortex** where it is processed. For example, the **occipital lobe** processes visual information while the **parietal lobe** processes non-visual, sensory information such as cutaneous pain (Fig. 4.1). If you choose to, you can direct your attention to particular bits of sensory information; you can access memories associated with the sensory information; or you can selectively ignore this sensory input.

The **blood/brain barrier** separates cerebral spinal fluid from the blood. Oxygen, glucose, and carbon dioxide can cross the blood/brain barrier, but the hydrogen ion can not. The brain requires oxygen and glucose for energy. Without a relatively constant source of oxygen and glucose, the brain ceases to function. Levels of carbon dioxide in the spinal fluid can change the pH of the spinal fluid, which can in turn change the body's respiration rate.

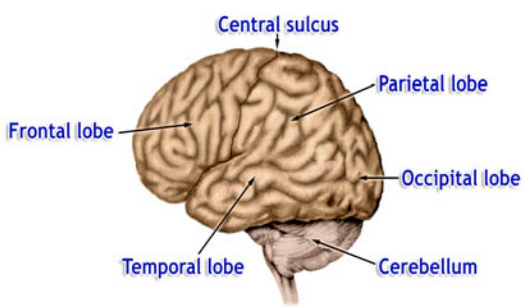
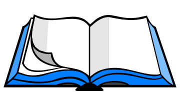



**Fig. 4.1 Brain anatomy**

Because brain activity is related to ions and charge movement, this activity can be detected by **electrodes**. The record of the brain's activity is called an **electroencephalogram** (**EEG**) from the root words of *electro* (electrical,) *encephalo* (brain,) and *gram* (record).

The EEG records the electrical activity on the surface of the cerebral cortex. The EEG is complex and variable between adults, although under certain conditions, the EEG exhibits simpler, rhythmic activity. Simpler patterns in the EEG occur when many cells **synchronize** their input to the surface of the cerebral cortex. The more synchronized the charge movement, the more rhythmic the EEG.



Your EEG changes as you grow. The development of EEG is rapid with newborns. As neural development proceeds, the EEG recorded from the posterior regions of the brain of an infant of 3-4 months begins to resemble EEGs recorded from the posterior region of adults. The difference is that the 3-4 month old infants have EEGs in the frequency range of 3-4 Hz, whereas adults tend to have average frequencies of 10 Hz. By the time the infant is one year old, the posterior region EEG is approximately 6 Hz, by three years, 8 Hz, and by 13-14 years (puberty,) the average frequency is 10 Hz (similar to adults).

One of the simpler patterns is the **alpha rhythm**. The alpha rhythm is characterized by a frequency of 8-13 Hz and amplitudes of 20-200 µV. Each region of the brain has a characteristic frequency of alpha rhythm. Alpha waves of the greatest amplitude tend to be recorded from the occipital and parietal regions of the cerebral cortex.

Just as the EEG is variable depending upon the mental state of an individual, the frequency and amplitude of alpha rhythms within an individual change as well. In general, the alpha rhythm is the prominent EEG wave pattern of an adult in a relaxed, inattentive state with eyes closed.

More specific conditions of alpha rhythms are listed below:

- **Hyperventilation** (breathing abnormally quickly and deeply) causes the gas composition of the blood to change. During hyperventilation, the carbon dioxide levels of the blood fall, pH levels increase, and blood pressure decreases. These effects of hyperventilation are associated with changes in brainwave activity. With hyperventilation, the overall electrical activity of the brain increases, with the amplitude of the alpha rhythms often increasing as well.
- Females tend to have higher mean frequencies of alpha waves than males, although the differences are small.

- Frequency may affect the speed of "remembering" during memory tests and may be approximately 1 Hz higher for high-scoring subjects than subjects who scored lower.
- Amplitudes tend to be higher in subjects who are more "outgoing" and extroverted.
- Amplitudes vary with the difficulty of mental tasks performed with the eyes closed.
- Amplitudes of alpha waves diminish when subjects open their eyes and are attentive to external stimuli. Thus, instead of getting the wave-like synchronized pattern of alpha waves, **desynchronization** occurs.
- Amplitudes increase when subjects are less alert and tend to be higher from 1:30-4:30 pm.

In this lesson, you will record the EEG and alpha rhythm under several conditions. At the same time, the root-mean-squared of the alpha rhythm (**alpha-RMS**) and an "alpha thermometer" will be displayed. Alpha-RMS and the "alpha thermometer" are indices of the activity levels of the alpha rhythm.