Eighth lecture

Electromyogram (EMG)

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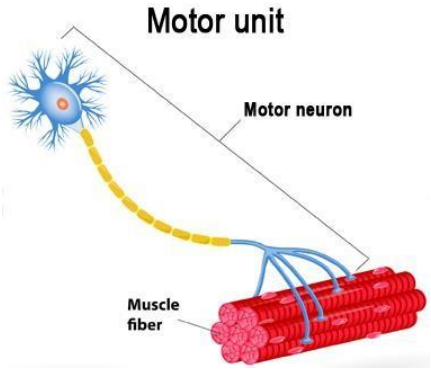
Electrical signals from the muscles- Electromyogram (EMG)

- The muscle is the force-generating component of a human body. It is responsible for movements of the body.
- It is a system of many tiny contractile fibers placed in parallel. The muscle fibers consists of 75% water, 20% protein and 5% mineral salts, glycogen and fat. These fibers are organized in-groups. The motor unit control groups of muscle fiber.



Electromyogram (EMG)

EMG measures the electrical activity of muscle during rest, slight contraction, and forceful contraction.

4-1 Electrical signals muscles - At

rest:

Resting potential across a nerve fiber = Resting potential across the muscle fiber

-At muscles action

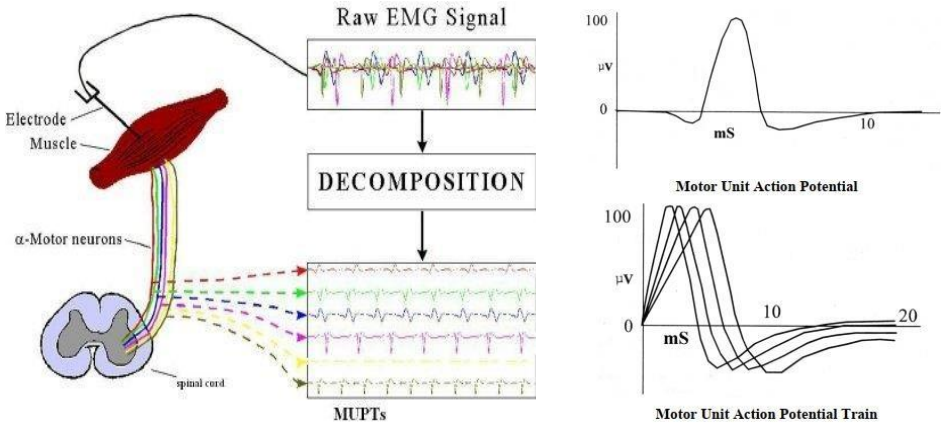
1) A single motor neuron transmit impulses (or action potential) from the central nervous system into muscle fibers.

2) A motor impulse at the muscle caused an action potential of muscle fibers

3) This action potential is propagated throughout the muscle cells, resulting in muscle contraction.

4) The contraction of muscle fiber involves the depolarization and repolarization of cells, resulting in electrical potentials called myoelectric signals.

5) The record of electrical signals generated by a contracting muscle is called the electromyogram, or EMG.



The measured EMG waveform is sum of all the action potentials (motor unit) generated from activity of muscle fibers.

The electrical potentials generated by the muscle range from 5 microvolt to 5 mill volts and their duration range between 2 to 15 milliseconds. The frequency of EMG signals approximately falls between 10 to 3000 Hz.

EMG Recording

There are two types of electrode used for EMG recording signals:

1. Surface electrode

- attached to the skin
- measures the electrical signals from **many motor units**

2. Concentric needle electrode

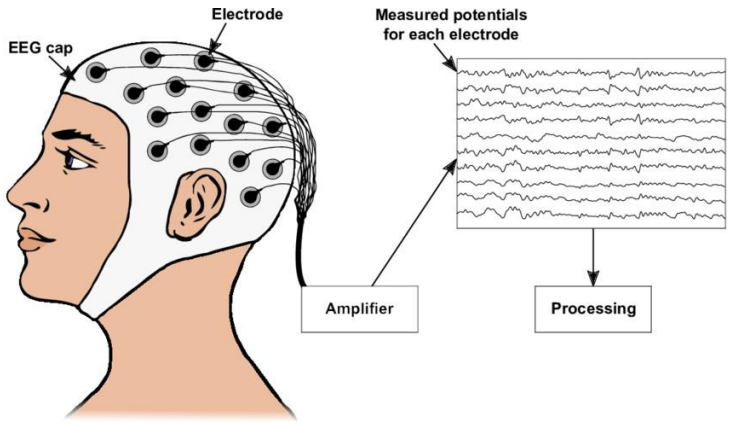
- inserted under the skin
- measures the electrical signals from **single motor** unit activity

5- Electrical signals from the brain- Electroencephalogram (EEG)

Electroencephalography (EEG) is the recording of electrical signals of the brain, which are due primarily to the electrical activity of the neurons in the cortex of the brain.

Electrical signals from the brain

1. The brain's electrical charge is maintained by billions of neurons.
2. Neurons are electrically charged (or "polarized") by membrane transport proteins that pump ions across their membranes.
3. Ions of similar charge repel each other, and when many ions are pushed out of many neurons at the same time, they can push their neighbours, who push their neighbours, and so on, in a wave.
4. When the wave of ions reaches the electrodes on the scalp, they can push or pull electrons on the metal in the electrodes.
5. Since metal conducts the push and pull of electrons easily, the difference in push or pull voltages between any two electrodes can be measured by a voltmeter.
6. The electric potential generated by thousands or millions of neurons that have similar spatial orientation picked up by EEG as wave.



The EEG waveforms have voltage range around 5m V to 100 mV and frequencies between 0.5 Hz to 30 Hz. The frequency of the EEG seems to be affected by the mental activity of a person and varies greatly with different behavioral states of the human being. EEG signals are mainly classified on the basis of frequency.

Delta wave: ≤ 4 Hz

Theta wave: 4-8 Hz

Alpha wave: 8-13 Hz

Beta wave: 13 Hz or higher

Identification and Interpretation of the waveforms:

Delta waves:

1. They normally are seen in deep sleep in adults as well as in infants and children.
2. Delta waves are abnormal in the awaked adult.
3. Often, they have the largest amplitude of all waves.
4. Delta waves can be focal (local pathology) or diffuse (generalized dysfunction).

Theta wave:

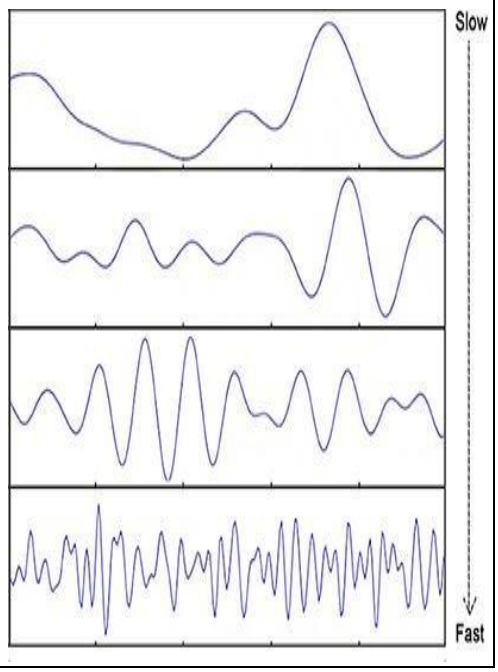
1. Theta waves normally are seen in sleep at any age.
2. In awaked adults, these waves are abnormal if they occur in excess.
3. Theta and delta waves are known collectively as slow waves.

Alpha waves

1. Alpha waves generally are seen in all age groups but are most common in adults.
2. They occur rhythmically on both sides of the head but are often slightly higher in amplitude on the non - dominant side, especially in right - handed individuals.
3. Higher in amplitude on the non - dominant side, especially in right – handed individuals
4. They tend to be present posteriorly more than anteriorly and are especially prominent with closed eyes and with relaxation
5. Alpha activity disappears normally with attention (e.g. mental arithmetic, stress opening eyes). In most instances, it is regarded as a normal waveform.
6. An abnormal exception is alpha coma, most often caused by hypoxic - ischemic encephalopathy of destructive processes in the pones (e.g. intracerebral haemorrhage). In alpha coma, alpha waves are distributed uniformly both anteriorly and posteriorly in patients who are unresponsive to stimuli.

Beta waves:

1. Beta waves are observed in all age groups.
2. They tend to be small in amplitude and usually are symmetric and more evident anteriorly
3. Many drugs, such as barbiturates and benzodiazepines, augment beta waves.

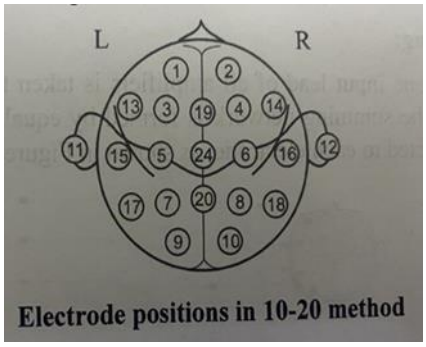
Wave	description	waveform
Delta	Unconscious/ Instinct :Survival , deep sleep , coma , dreamless sleep , complex problem solving	
Theta	Conscious /Emotion : Drives, feelings, dreams creativity, insight , deep States	
Alpha	Conscious /Consciousness: Relaxed, Aware of the body , integration of feelings , alert and peaceful , reading, meditation	
Beta	Conscious /Thought: Normal waking state , thinking , focus , sustained attention	

EEG Electrodes

Electrodes for recording the signals are often **small discs** of chloride silver. They are attached to the head at locations that depend upon the part of the brain to be studied. These electrodes out on the head at area records only the different potential response to that area.

The international standard 10-20 system of electrode location. The electrode (even numbers denote the right side of the head and odd number the left side of the head). The reference electrode is usually attached to the ear (A_1 or A_2).

Since asymmetrical activity is often an indication of brain disease, the right side signals are often compared to the left side signals.



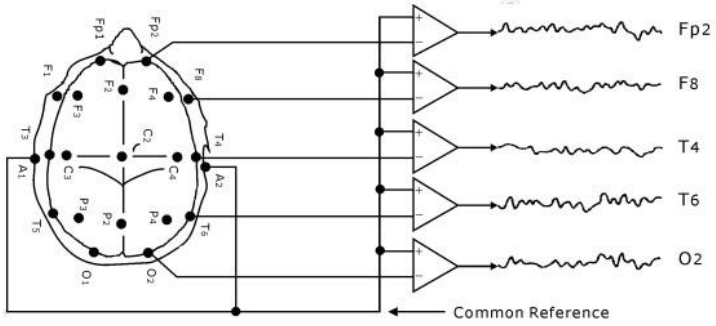
Electrode positions in 10-20 method

EEG Recording

Three different recording methods are used in the EEG recording, they are:

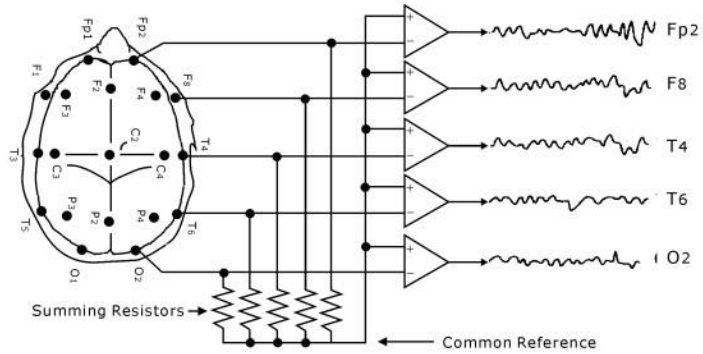
1. **Unipolar or Monopolar Recording**
   This method is used to record an active potential of each electrode at only one point on the scalp. Ears are connected together to form

reference common electrode as shown in Figure. The electrode from which no active potential comes in is called a reference electrode and the electrode from which an active potential comes in is called an active electrode.



2. Average Recording

In this method one input lead of all amplifiers is taken to the common point of a summing network, as shown in Figure.



3. Bipolar Recording

Bipolar recording: In this method the potential difference between a pair of electrodes is measured. Itis amplified by one amplifier channel.