Brain Computer Interaction

EEG Artifacts

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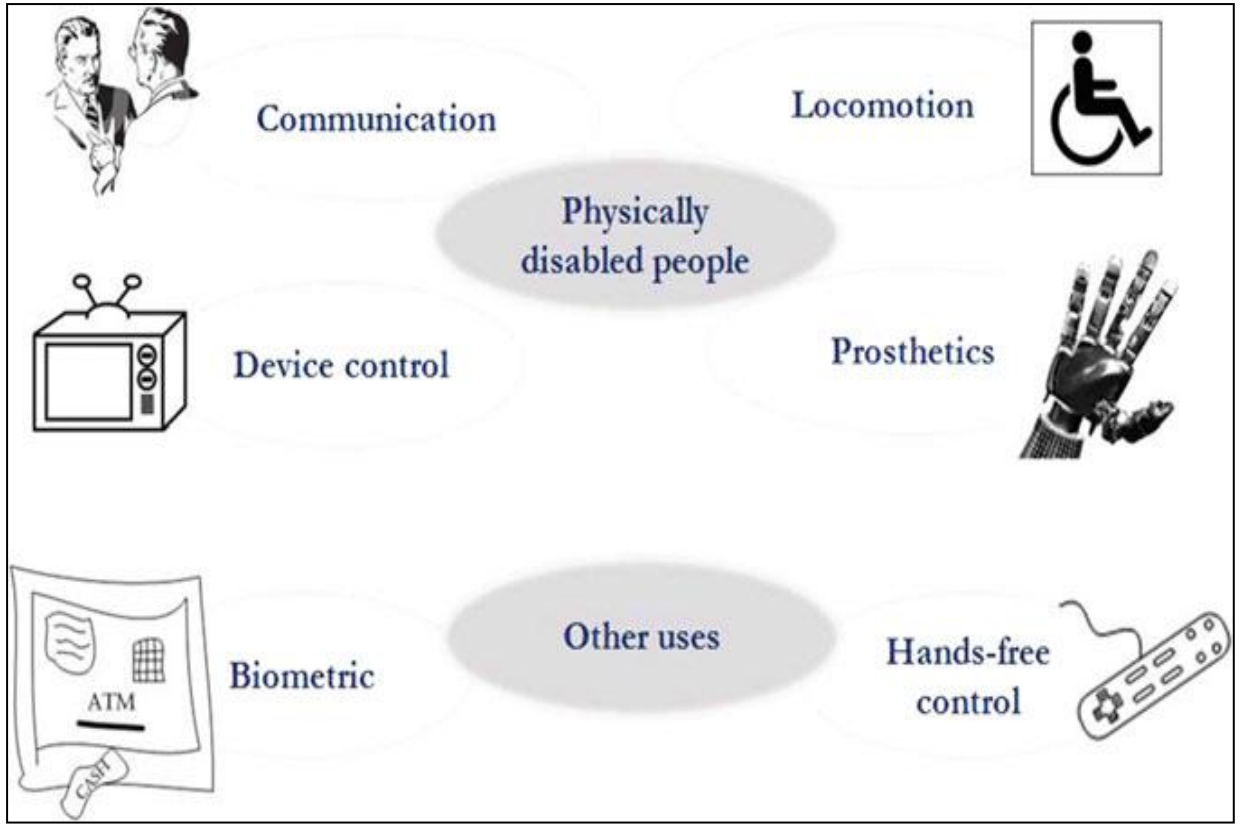
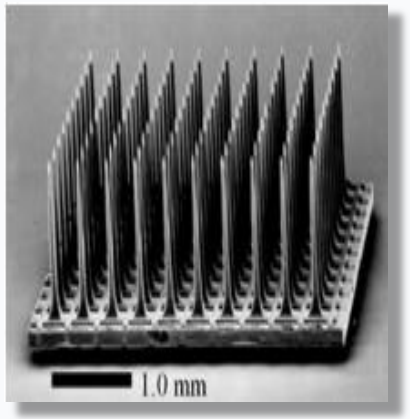
What is BCI?

A Brain Computing Interface (BCI) is a "communication system in which messages or commands that an individual sends to the external world do not pass through the brain's normal output pathways of peripheral nerves and muscles" [Wolpaw, 2002].

A Brain Computing Interface (BCI) is a system that allows a person to communicate or control things without using their hands, voice, or other typical body movements. Instead, the BCI reads signals directly from the person's brain and translates them into actions. This means that the person can send messages or commands to a computer or device just by thinking about them, without the need for any physical movement or output. It's like having a direct connection between your brain and the outside world!



BCI Devices



Sub Electrode Array

ECoG

Functional MRI

Positron Emersion Tomography

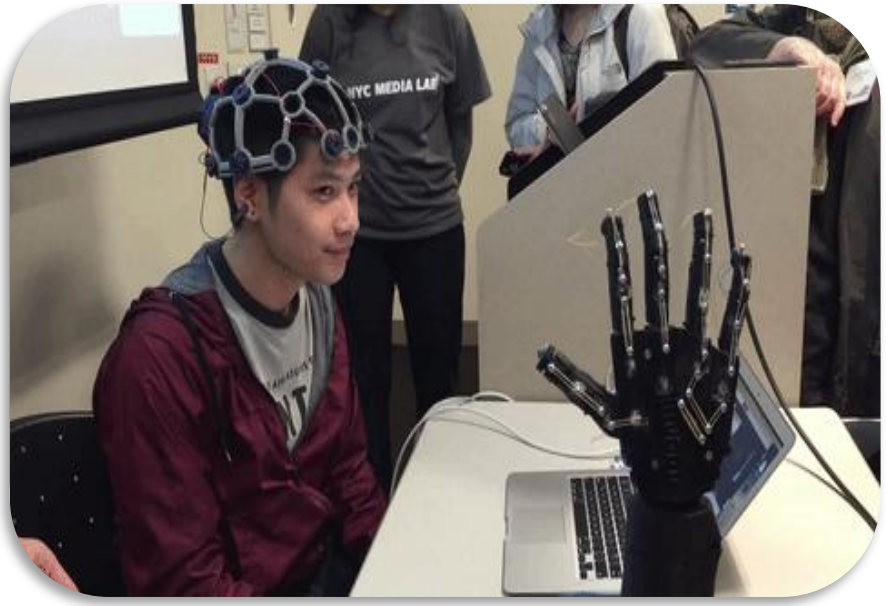
MEG

Functional NIRS

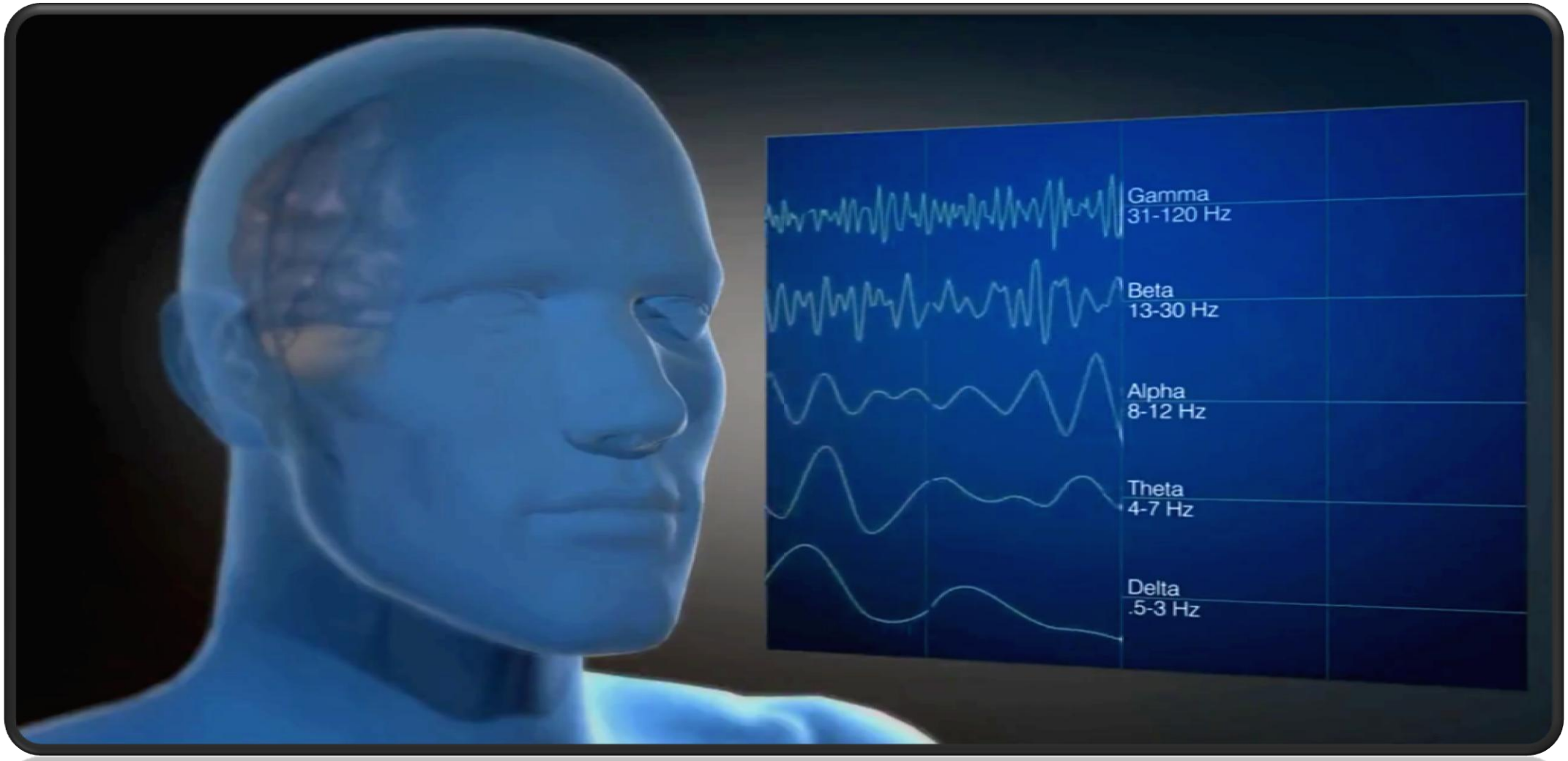
EEG

Why EEG?


Less expensive
Simple way to capture the brain signal accurately
Wireless
Non-invasive
User-friendly
EEG devices are



Signal bands present in the EEG signal



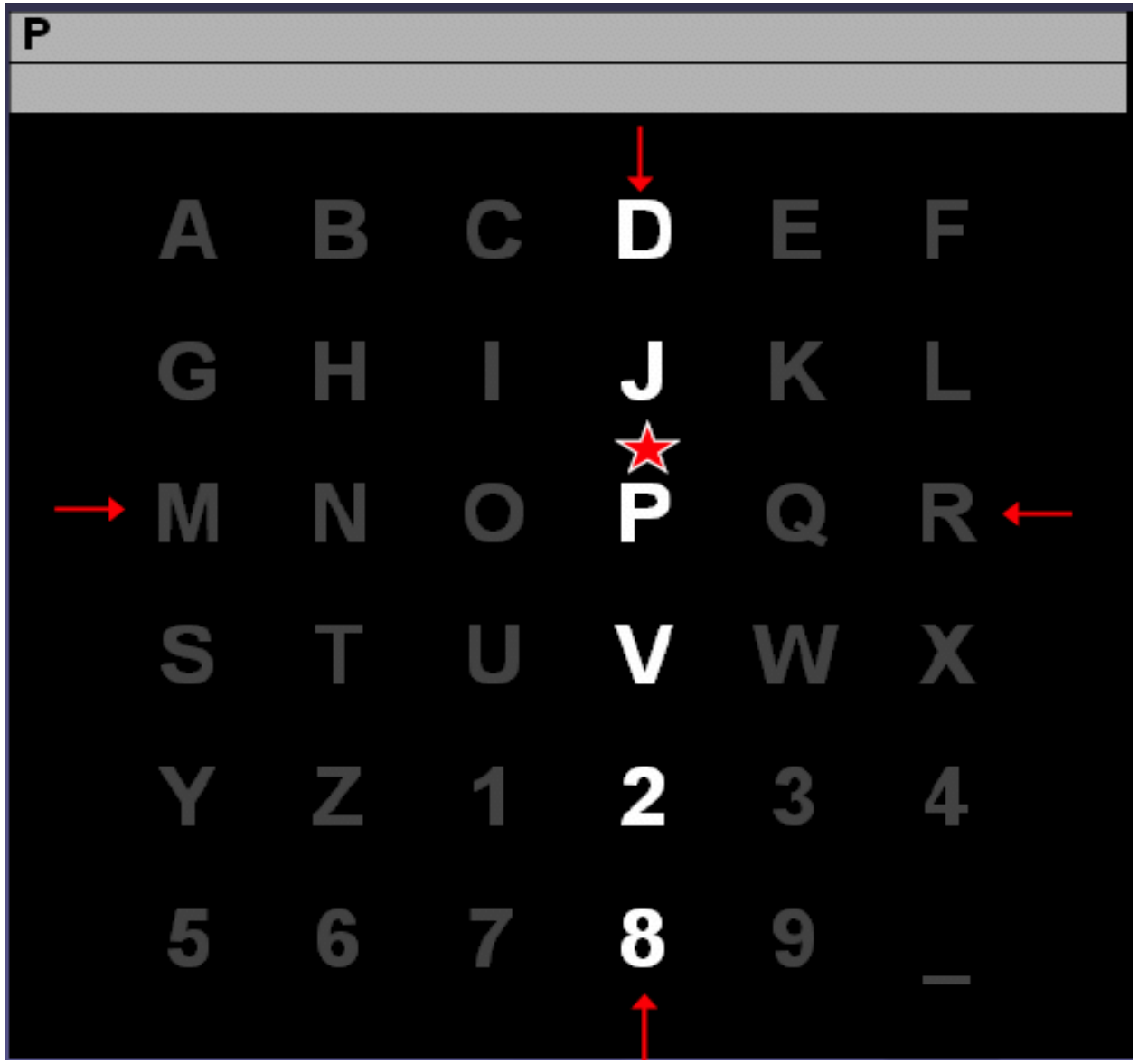
EEG Paradigms

01 P300

02 SCPs

03 SSVEPs

04 SMRs



Useful Links

https://www.frontiersin.org/articles/10.3389/fnhum.2020.583358/full

https://www.youtube.com/watch?v=9SIBtW1QqT8

https://www.youtube.com/watch?v=XIr2cRKFolY

https://www.youtube.com/watch?v=z9_R2YM48Jk

https://www.youtube.com/watch?v=8bgvbYVJplM

https://www.youtube.com/watch?v=U_WxaDHNw6I

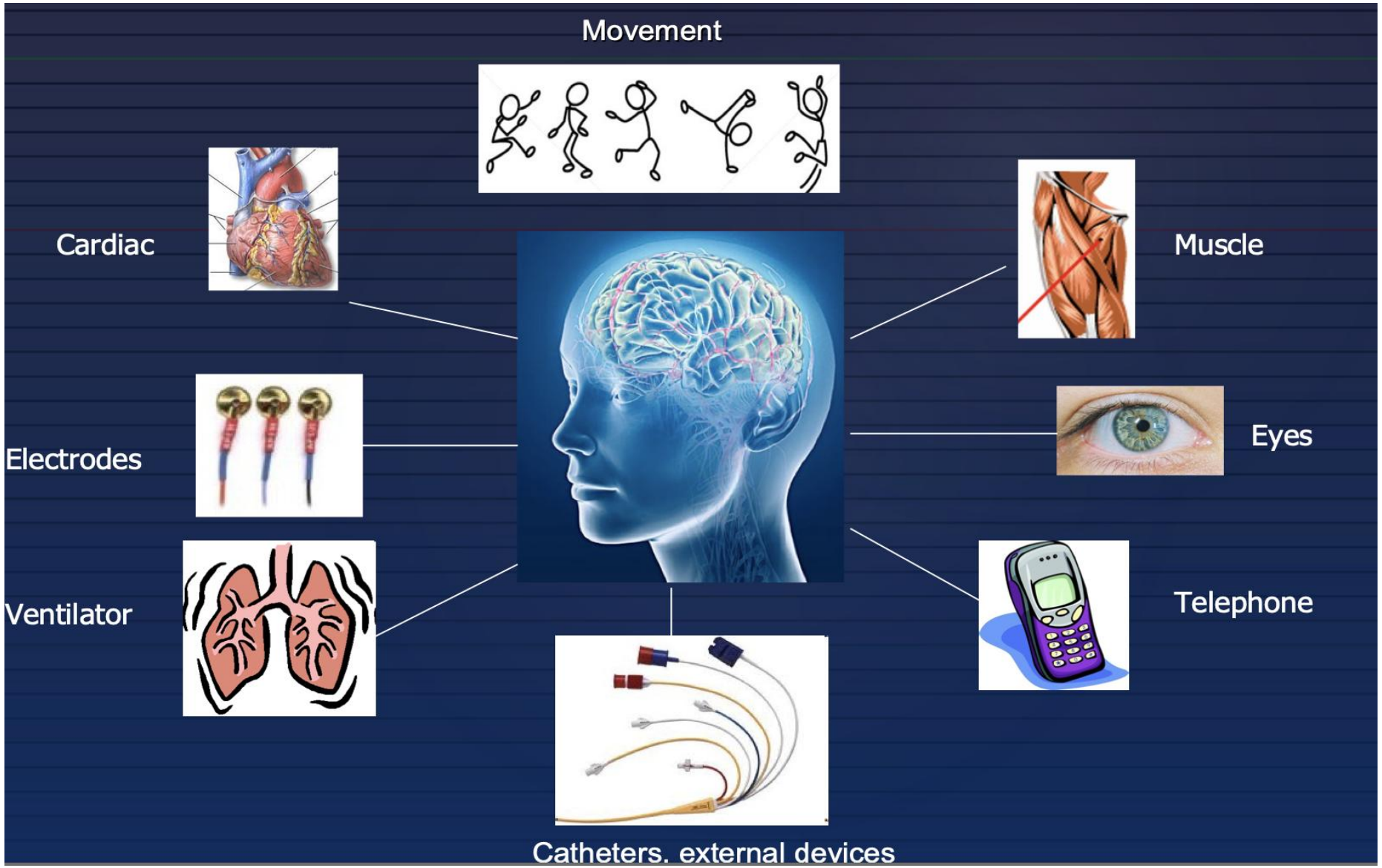
EEG Artifacts

- The electrical artifacts that is not of cerebral origin.
- Anything that is NOT of cerebral origin is termed as **ARTIFACT**
- Physiological and Electrophysiological artifacts.
- Physiological – source (generated other than brain ie. Body)
- Electrophysiological – arise outside the body - equipment and environment
- Some readily distinguished, others closely resemble cerebral activity.

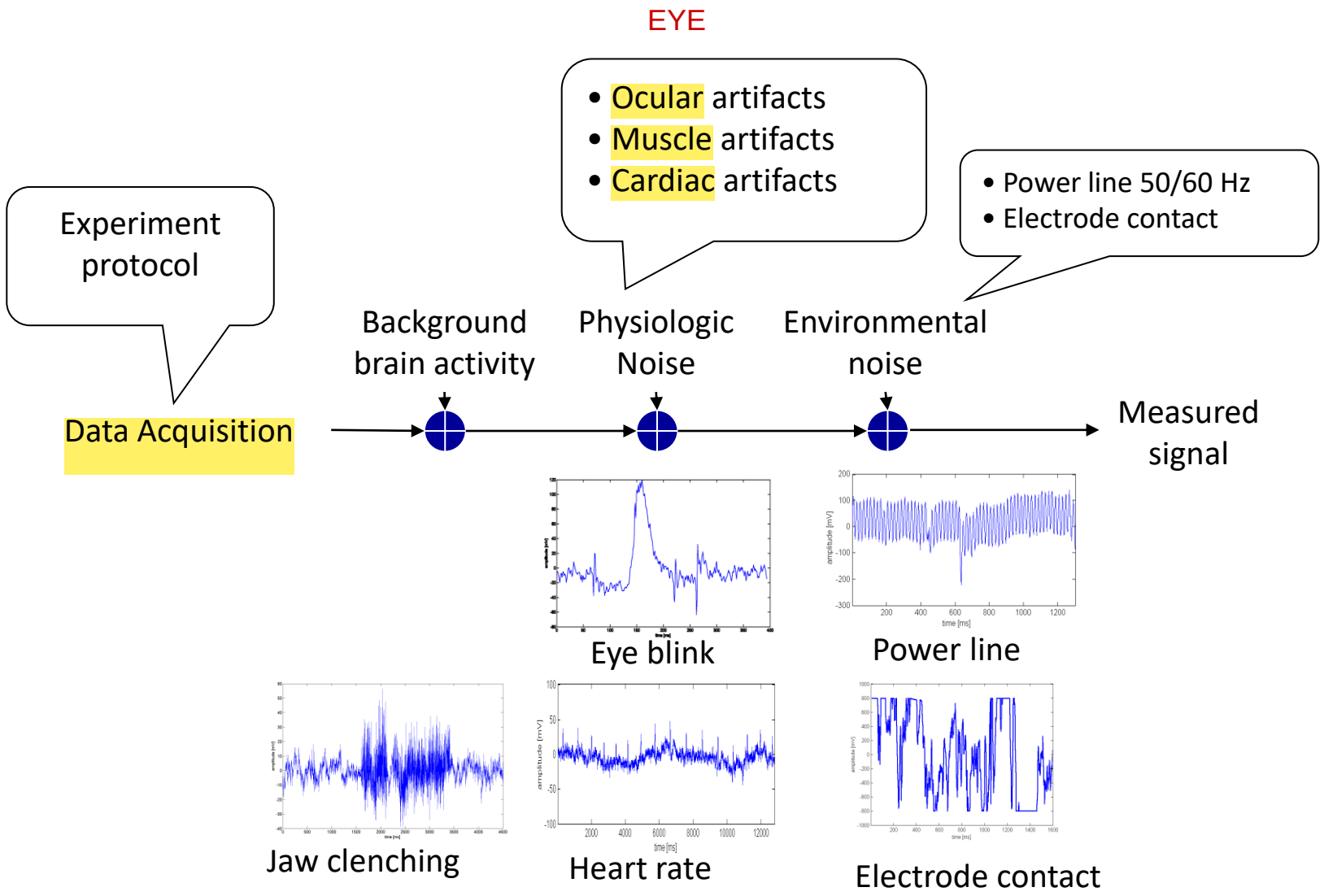
KEY TO AN ARTIFACT FREE RECORDING

- Good, clean preparation
- Good hook-up, neatly bundled electrodes
- Place jack-box close to patients head
- Keep the subject cool, not cold
- Unplug all electrical items close to patient, i.e. bed, radio, fan, etc.

EEG Artifacts

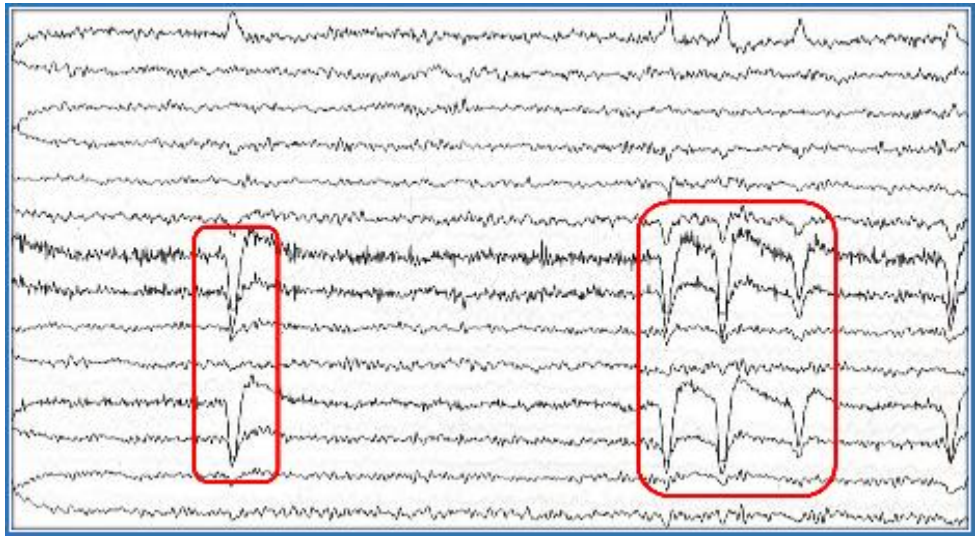


Captured EEG Signal

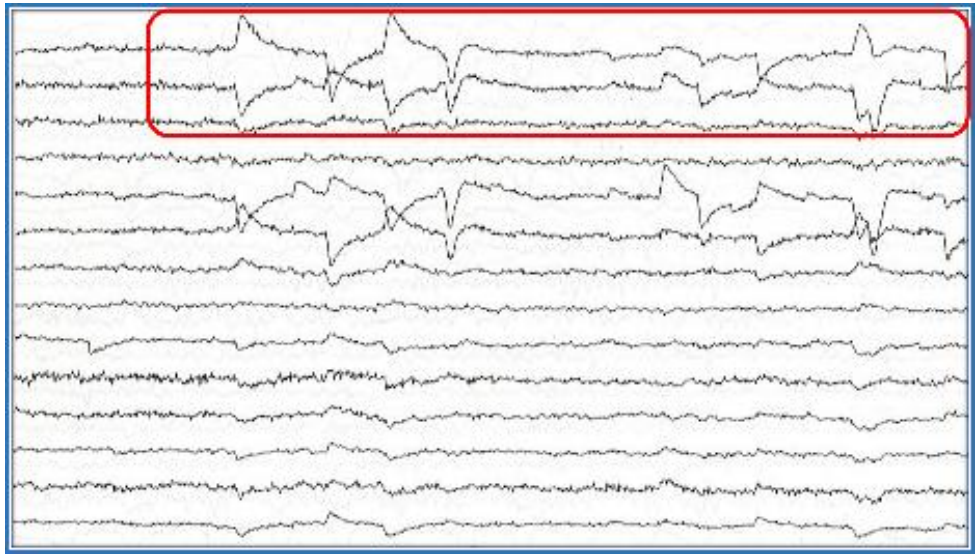


Ocular Artifacts

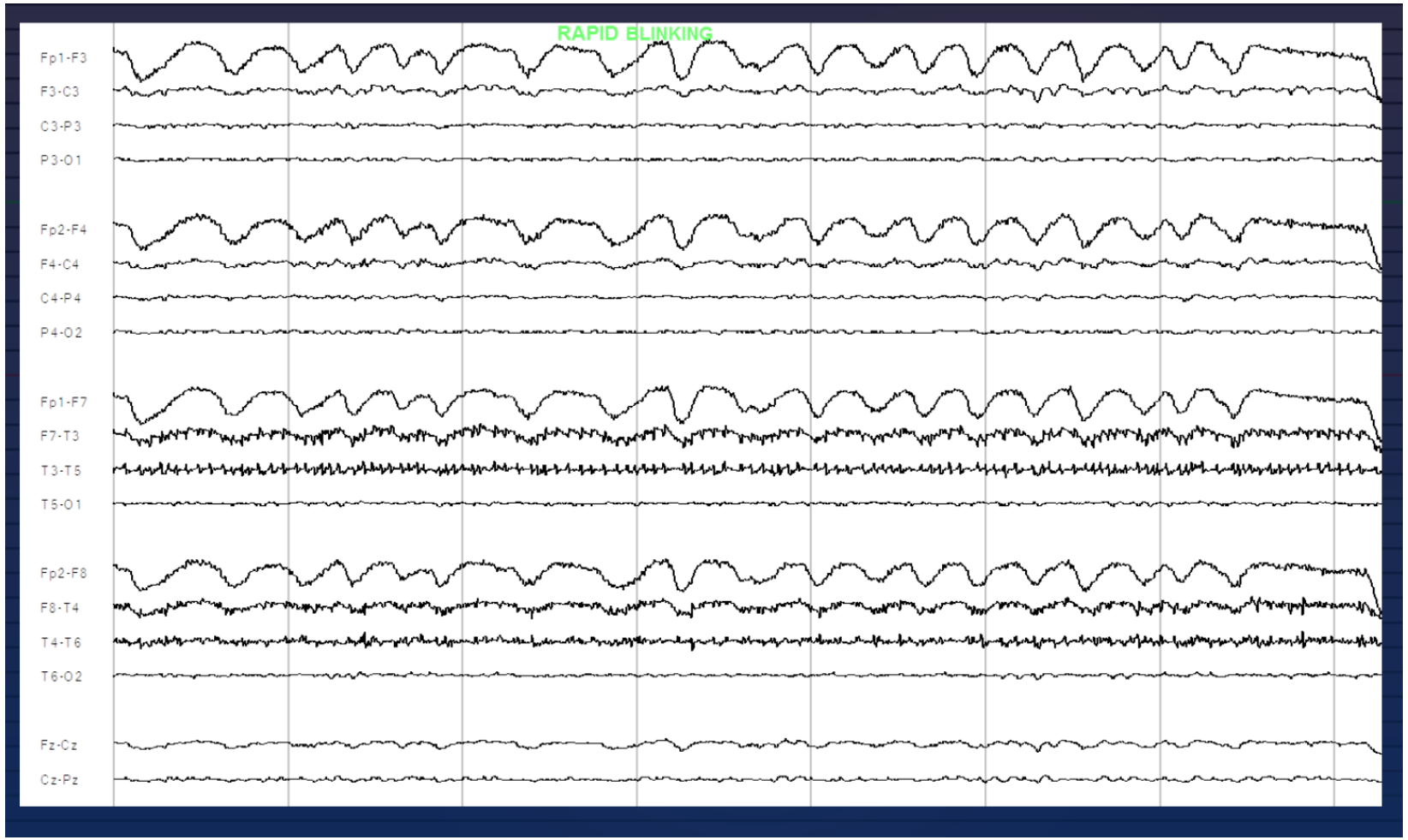
- Blinks
- Eye flutter
- Lateral gaze
- Slow/roving eye movement
- Rapid eye movement
- Electroretinogram (ERG) - that measures the electrical activity of the retina in response to a light stimulus. The ERG arises from currents generated directly by retinal neurons.



Blink



Slow Eye Movement


RAPID BLINKING
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
Fp1-F7
F7-T3
T3-T5
T5-O1
Fp2-F8
F8-T4
T4-T6
T6-O2
Fz-Cz
Cz-Pz

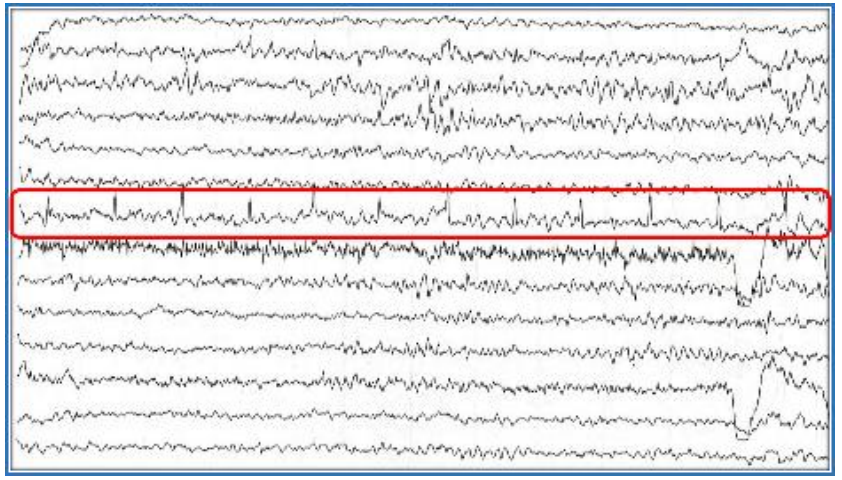
Eye Flutter

Cardiac Artifacts

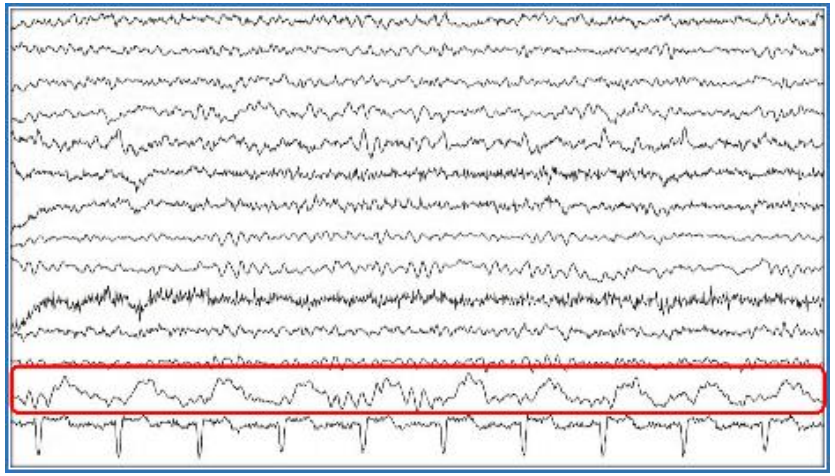
- Mechanical and Electrical
- ECG, Pacemaker - Electrical
- Pulse, Ballistocardiographic – Mechanical

✓ Mostly these are high in amplitude and prominent in babies, obese and short neck persons.

✓ Referential montages picks up cardiac artifacts.



Cardiac (Electrical)



Cardiac (Mechanical)

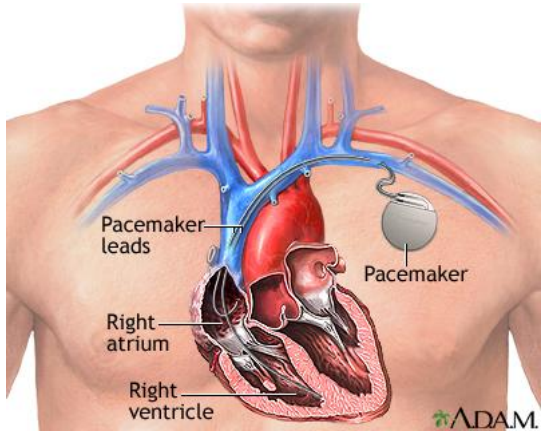
Cardiac Artifacts

ECG:

- The artifact created by the electrical signals
- generated by the heart
- Looks like a QRS complex
- More prominent in pts with short, thick necks
- More prominent in montages that use ear as reference

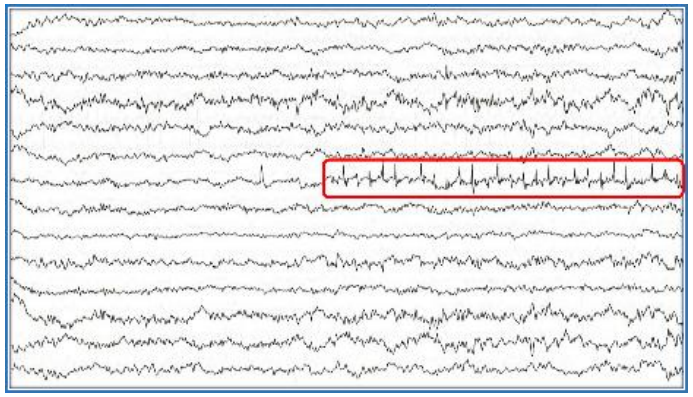
Pulse:

- The artifact created by placing an electrode over a pulsating artery.
- Most common in central, temporal electrodes.
- Irregular heart rate will create arrhythmic delta.

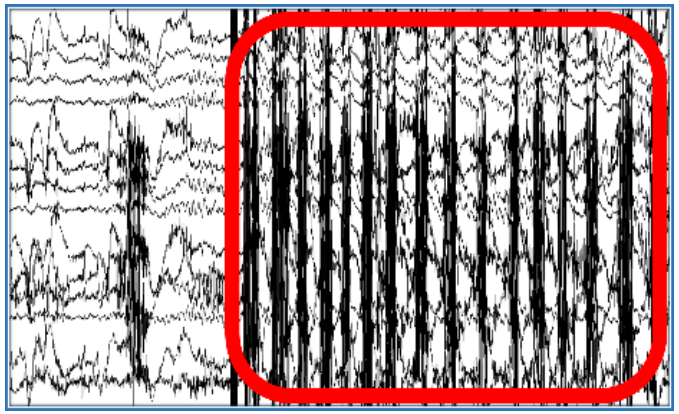


Muscle Artifacts

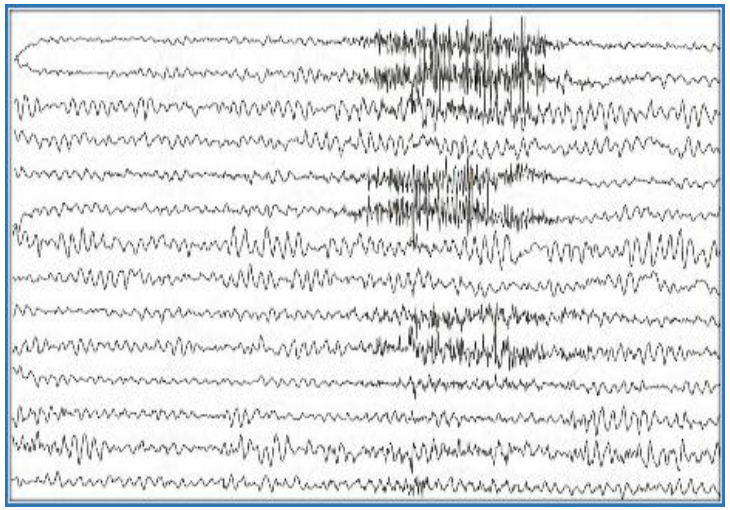
- ✓ Glossokenetic (related to tongue movements, Chew and swallow)
- ✓ Photomyogenic/ Photo-myoclonic (When flash of light falls over the face, the activity occurs due to myoclonus of the facial muscles).
- ✓ Surface EMG (Electromyography) – used to measure electrical activity during muscle contractions and relaxation cycles.



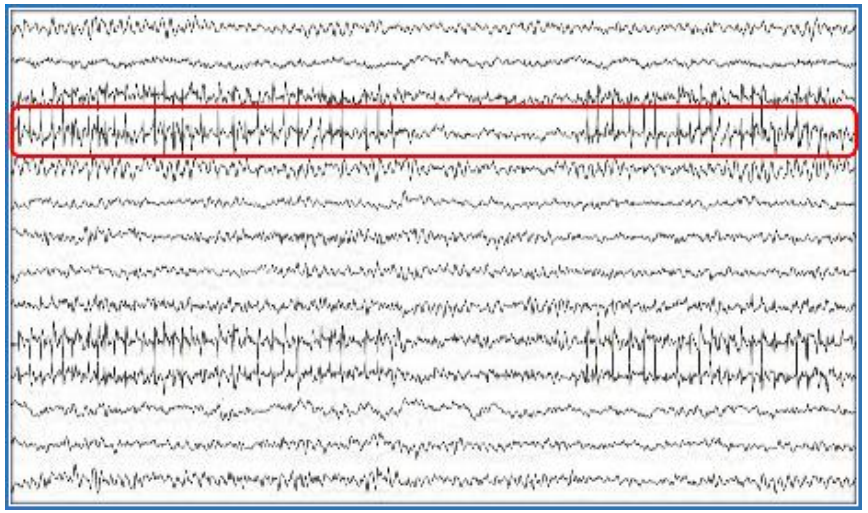
Photomyogenic



Chewing



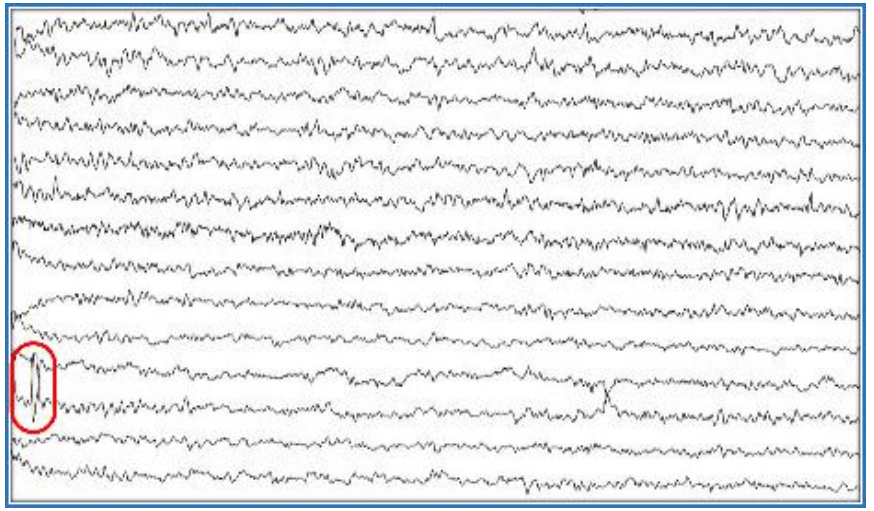
Electromyography (Scalp)



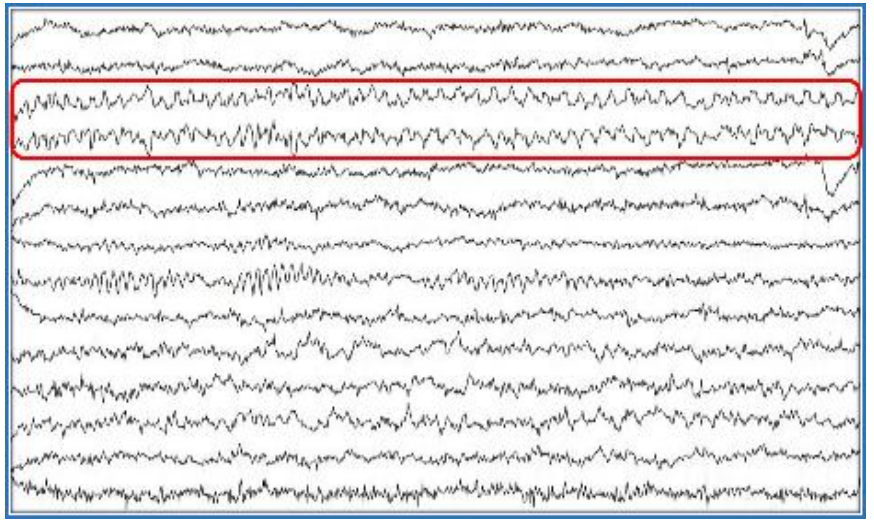
Electromyography (Facial)

Electrode and Equipment Artifacts

- ✓ Electrode pop, electrode contact, electrode movement
- ✓ Perspiration – the process of sweating
- ✓ salt bridge – differs from perspiration by low amplitude.
- ✓ Movement artifacts - Movement of head, body and limbs produce irregular high voltage potentials
- ✓ 50/60 Hz ambient electrical noise.
- ✓ Ventilators, circulatory pumps.
- ✓ Telephone, mobile.



Electrode Pop



Electrode Movement

Electrode and Equipment Artifacts

- Seen due to smearing of the electrode paste between electrodes or presence of perspiration across the scalp
- Forms an unwanted electrical connection between the electrodes forming a channel

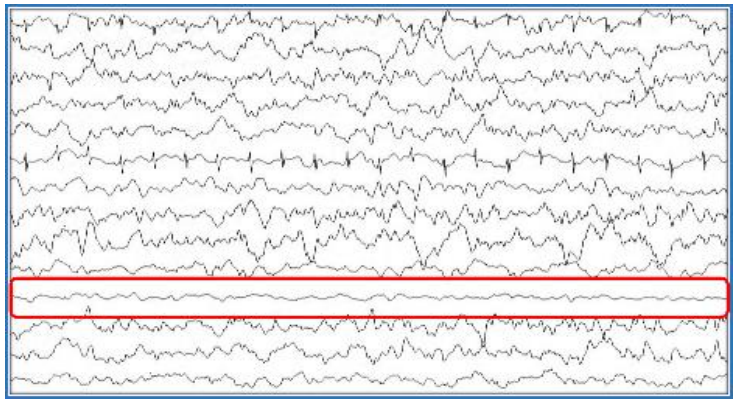
✓Perspiration artifact

- manifests as low amplitude
- undulating (smooth) waves
- duration is typically greater than 2 sec

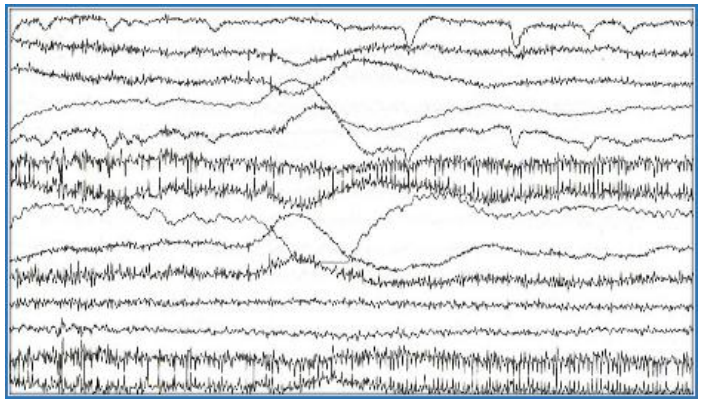
✓Slat bridge artifact

- lower in amplitude
- not wavering with low frequency oscillation - typically include only one channel
- It may appear flat and close to isoelectric

Electrode and Equipment Artifacts

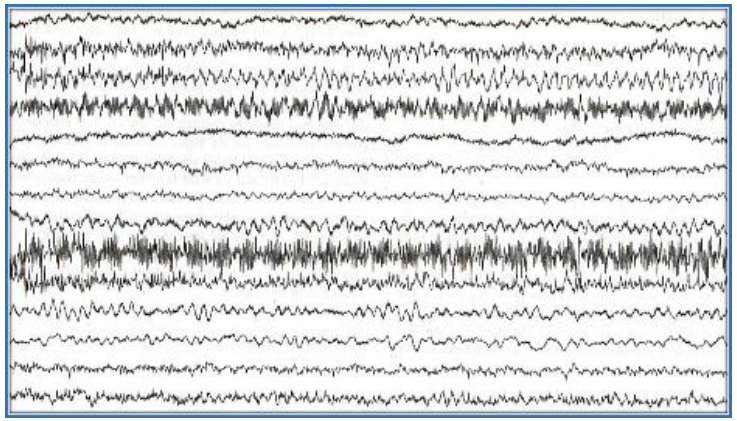


Salt Bridge

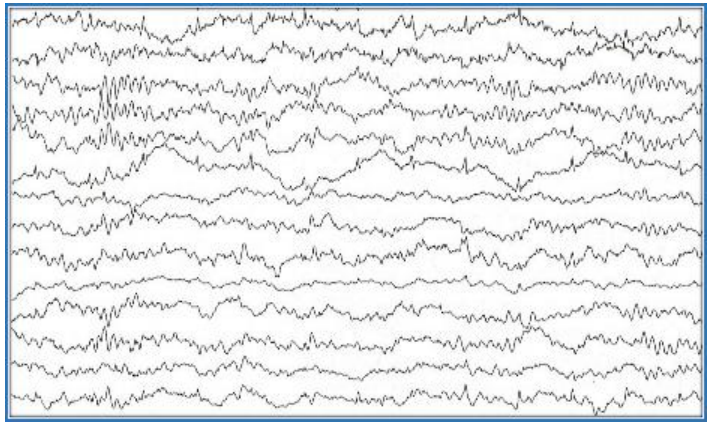


Electrode Lead Movement

Electrical Motor



60 Hz



Perspiration

Phone

Thank You!