DIY Open Science Workshop: Science Guide

The Brain and Cognitive Science behind the Hardware

What is EEG?

EEG is an initialism for electroencephalography, which means we are measuring the electrical activity generated by the brain. This technique was developed in 1924 by Hans Berger. The EEG is constructed by non-invasively attaching electrodes to the scalp with a corresponding reference and ground, and we passively record the voltage changes. We can think of each electrode paired with the reference as a voltmeter, we are measuring the voltage from a scalp with comparatively high conductance to a reference (e.g. ear lobe, nose) with comparatively poor conductance.

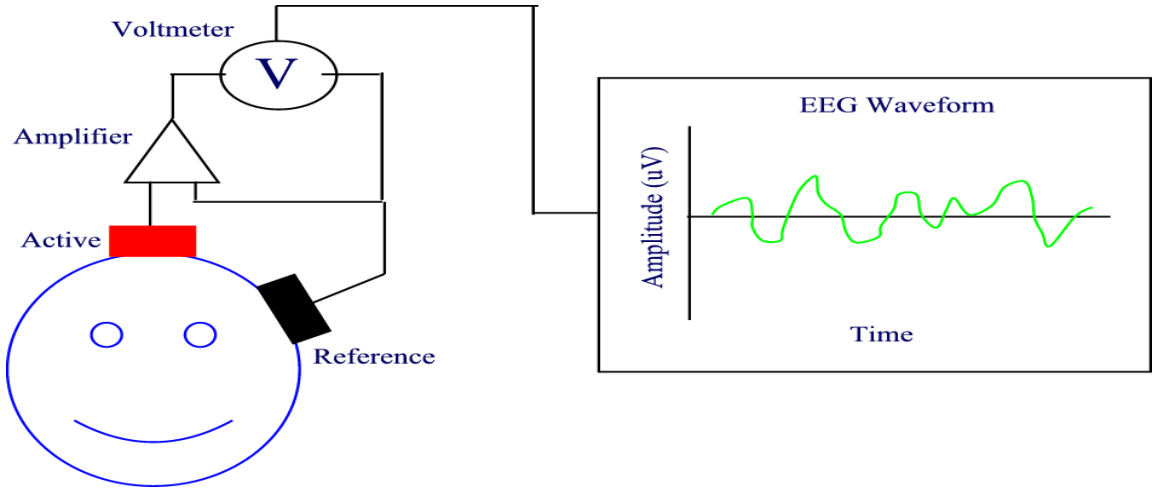

Figure 1. Cartoon of a EEG setup

History of Hans Berger

❝When Hans Berger was serving a year in the German military, in 1892, he was thrown from a horse. This in itself wasn't strange. But later that day, as the neurologist David Millett recounts in *Perspectives in Biology and Medicine*, Berger got a telegram from his father, just checking on his well being. Berger's father had never sent him a telegram before. But his older sister had just had a feeling …

For Berger, this uncanny encounter determined a lifetime of research in medicine and psychology. How did the brain—the mind—interact with the outside world? What was it that prompted his sister to worry about him that day and tell his father to check in on him? He began his work trying to understand and measure the psychic energy of the brain.

Only recently, though, have researchers really begun to understand what gives rise to uncanny feelings in the brain, and though Berger's research project began grandly, it narrowed, over decades, to a much simpler goal—he wanted to record the electrical signals of the brain.❞

Standardizing Electrode Locations

Jasper came up with a conventional layout for EEG electrode position to allow researchers to have a common location reference when describing different electrical changes occurring on the scalp.

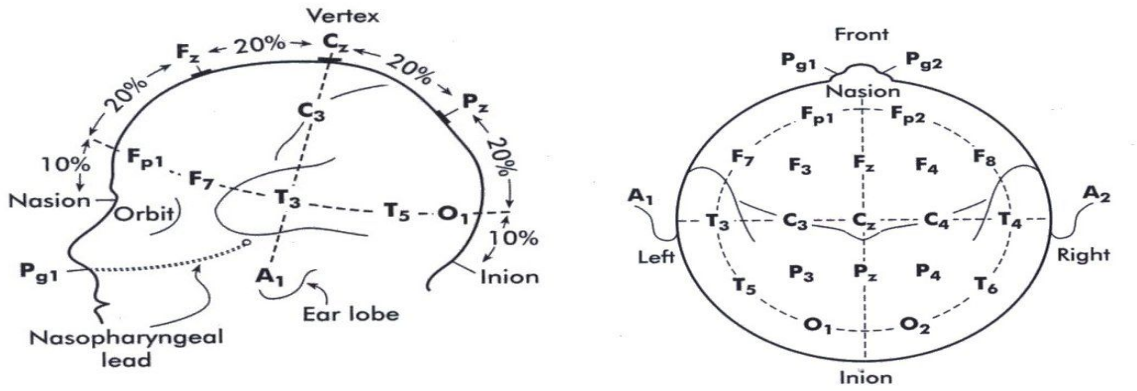

Figure. 10-20 system - electrodes positioning (monopolar montage)

Types of EEG

Today, we have three different types of EEG on the market:

Figure 1. Research-oriented EEG (many electrodes, low portability)

Figure 2. Consumer-oriented EEG (fewer electrodes, high portability)

Figure 3. DIY Hacker EEG (customizable, high portability)

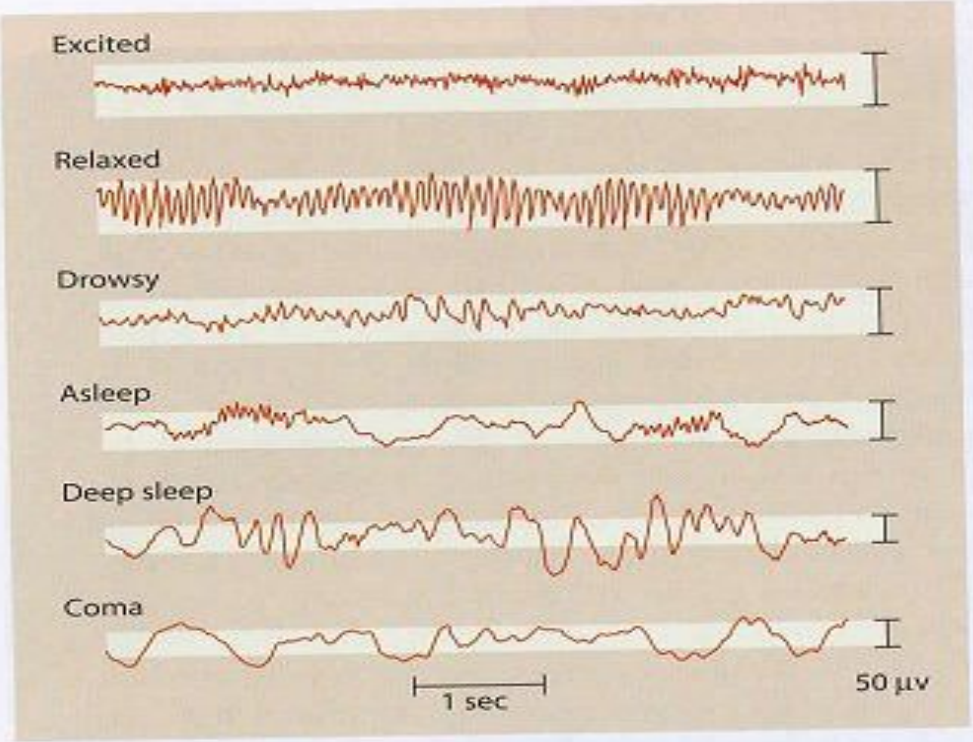

Figure 4.24 EEG profiles obtained during various states of consciousness. From Kolb and Whishaw (1986) after Penfield and Jasper (1954).

EEG Experiment: Mismatch Negativity

What is Eyetracking?

Eye tracking is a methodology for tracking the eye position when it **gazes** or fixates on a given location or object or when the eye is **saccading** moving with respect to a stationary head.

Javal described eye movements during reading in the late 19th century. He reported that eyes do not move continuously along a line of text, but make short rapid movements (saccades) intermingled with short stops (fixations). Javal's observations were characterised by a reliance on naked-eye observation of eye movement in the absence of technology.

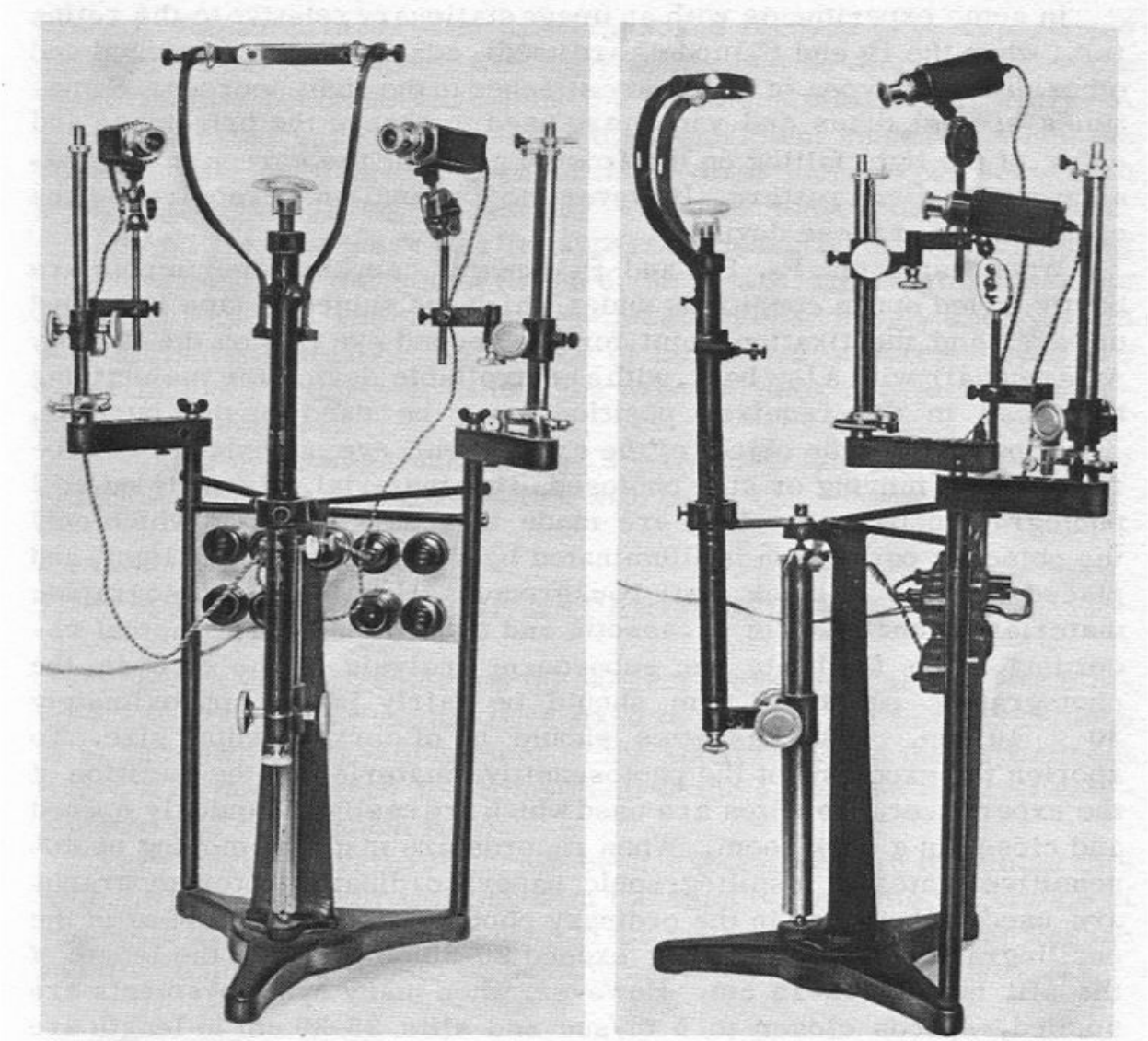

Fig. 21. The apparatus used in recording eye movements.

Figure. Eye tracker from the 1960s.

Modern eyetrackers come in a few different styles:

Figure. Display-mounted eyetracker

Figure. Head-mounted eyetracker

Eye-tracking Experiment: Stroop Task