Understanding EEG

Introduction to EEG

Terminology

The method of electrode placement follows the international 10-20 system, relying on Nasion, Inion, and pre-auricular points. With precise measurements, electrodes are positioned across the head as illustrated below.

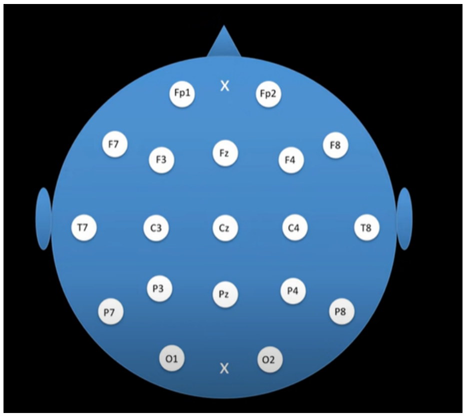
The numbering system designates odd numbers for the left and even numbers for the right. These numbers indicate the distance from the midline, with 'z' denoting zero.

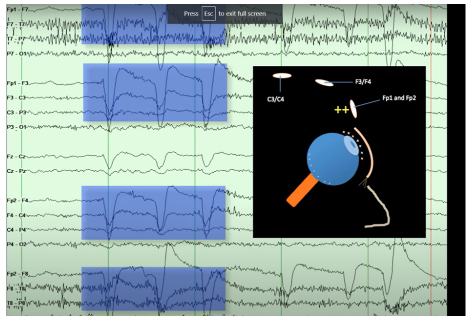
How EEG is recorded

EEG recordings employ a differential amplifier that enhances only the discrepancies between electrodes, effectively eliminating commonalities.

How EEG is displayed

EEG data is captured by analyzing voltage differences between pairs of scalp electrodes using a differential amplifier. These differences, termed channels or derivations, are then aggregated into a single EEG waveform, known as a





montage. Various montage types, formed by different channel arrangements, unveil diverse aspects of brain activity.

Montage Types

Anterior-Posterior Bipolar Montage: Visualize observing the subject's head from above. In this montage, channels connect electrodes in a vertical alignment, progressing from the front (Fp1) to the back (O1) of the head.

Transverse Bipolar Montage: In this view, resembling the subject facing forward, channels are established by linking electrodes horizontally, such as from one ear to the other. This montage facilitates the study of central brain activity during sleep.

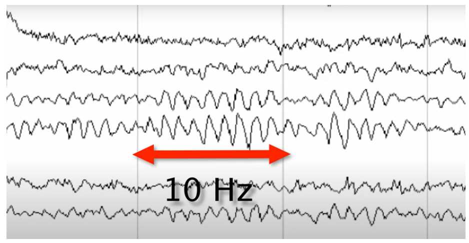
Reference Montages: These montages employ one electrode as a reference point. Channels are formed by comparing the voltage of other electrodes to this reference. Two primary types of reference montages are:

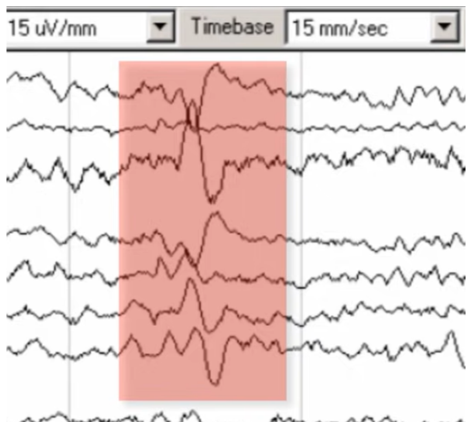
- Common Reference Montage: Designates one electrode as the reference, comparing all other electrodes to it to establish channels.
- Common Average Montage: Similar to the common reference montage, but instead of a single reference electrode, the average voltage of all remaining electrodes is utilized as the reference.

Reference Contamination: This phenomenon occurs when electrical activity concentrated in one brain region influences the readings of other electrodes, particularly when using a reference electrode. As a result, originally average readings from other electrodes may appear lower than usual due to this external influence.

Common EEG Patterns

Eye Blink: An eye blink, caused by the movement of the eyeball upwards due to Bell's Phenomenon, generates a positive signal in EEG, owing to the negatively charged retina and positively charged cornea. **Alpha Rhythm:** The most prevalent rhythm during wakefulness, prominently observed when eyes are closed, typically oscillating around 10Hz. **Focal Epileptiform Discharges:**





Can serve as an indicator of the brain's susceptibility to seizures, thus serving as an indicator for epilepsy. **Generalized Epileptiform Discharges:** Involves the entire head simultaneously, often characterized by 3Hz Generalized spike-wave discharges, commonly associated with childhood absence epilepsy.

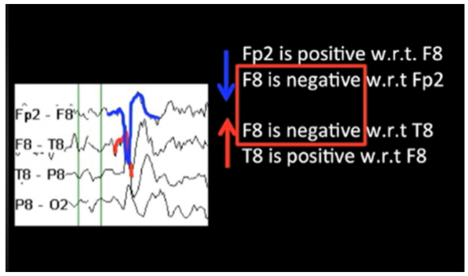
Diagnostic Yield of EEG

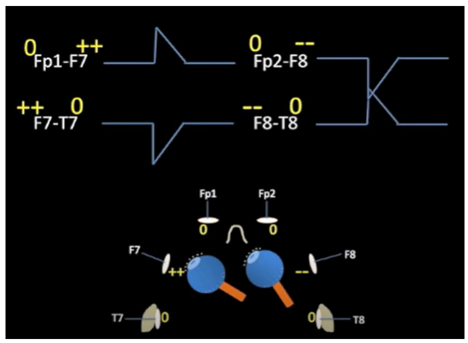
EEG conducted within 24 hours after a seizure yields higher results than those conducted afterward. However, a 24-hour recording significantly enhances the diagnostic yield. The main determinants of scalp abnormality include the area and location of the cortex involved. Larger cortical areas are more likely to detect abnormalities, whereas abnormalities in deeper cortical areas may be more challenging to detect.

Polarity Rules

An upward deflection in a channel for (input1-input2) indicates that input 1 is negative with respect to input 2, or input 2 is positive with respect to input 1. Conversely, a downward deflection suggests that input 1 is positive with respect to input 2, or input 2 is negative with respect to input 1.

These rules can be applied to abnormalities in an EEG graph, such as concluding that F8 is a general area for negative regions.





Eye Movements on EEG

Fp1 and Fp2 exhibit the highest positive activity due to their proximity to the cornea. F3/F4 display minimal charge, while C3/C4 exhibit negligible charge. Consequently, predictions for blinking graphs can be made (with a similar graph on the opposite side of the head). Similar logic applies to horizontal movements, where electrodes closer to the eye in the direction of movement exhibit higher positive charge. This principle is evident in the graph for looking left.

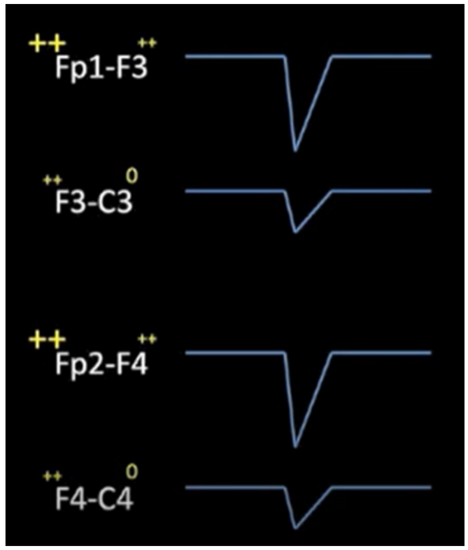
EEG Montages

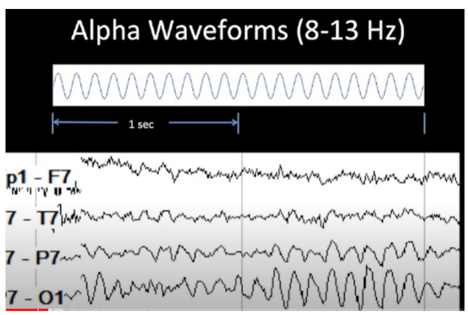
EEG ouput is always relative.

1. Bipolar Montages: These compare the signal from one electrode to its neighbor. They are good for general checking but not ideal for specific findings.

2. Common Reference Montages: These compare every electrode to one reference point. They're good for wide problems but not so much for specific ones.

3. Average Reference Montages: These compare each electrode to the average of all the others. They're versatile but can sometimes give misleading results.





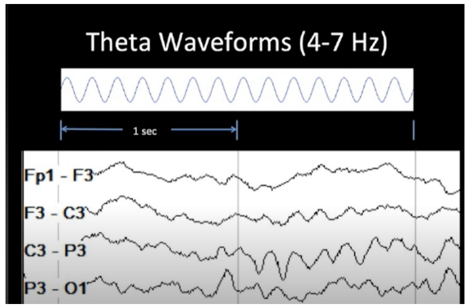
4. Laplacian Montages: These compare each electrode to its nearby ones. They're great for pinpointing specific issues but not for broad ones.

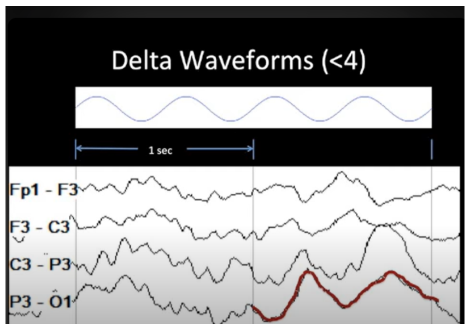
Each montage has its strengths and weaknesses, so it's important to use different ones depending on what you're looking for. And it's a good idea to experiment with different montages to get a clearer picture of brain activity. EEG recordings portray brain activity as a squiggly line. This line can provide doctors with valuable insights into what's happening inside your head! However, to comprehend it, we need to break down some basics.

Brain waves: Visualize the brain communicating with itself through tiny electrical signals. These signals manifest as waves on the EEG recording.

Frequencies: Brain waves occur at different speeds, measured in Hertz (Hz). Slower waves resemble leisurely conversations, while faster waves resemble rapid discussions.

- **Alpha waves (chill vibes):** 8-13 Hz, associated with relaxation (imagine resting with your eyes closed).

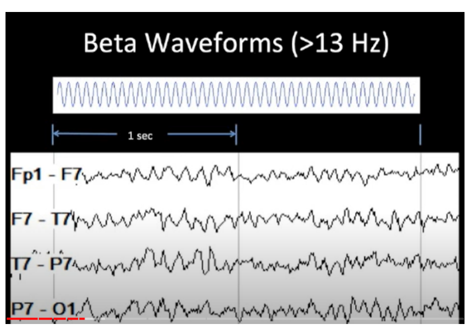


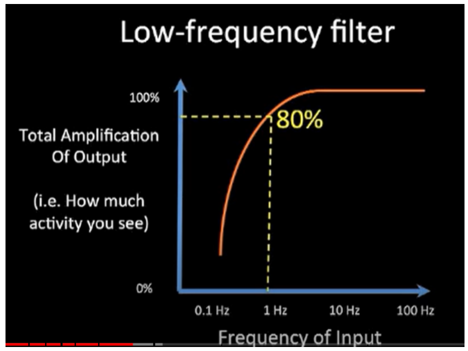


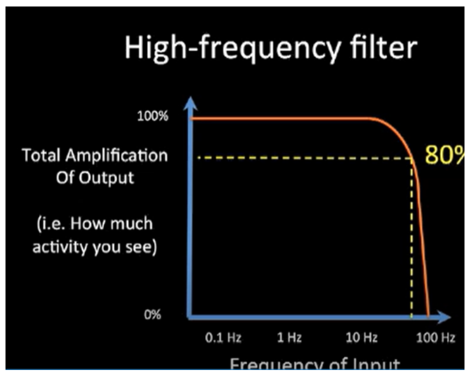
- **Theta waves (drowsy chats):** 4-7 Hz, linked to daydreaming or light sleep.
- **Delta waves (deep sleep talks):** Below 4 Hz, most prominent during deep sleep.
- **Beta waves (busy brain):** Above 20 Hz, observed when you're concentrating or alert.

Filters: These act as tools that refine the squiggly line.

- **Low-pass filter:** Eliminates very slow waves (below a certain frequency) that aren't relevant for brain activity.







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- **High-pass filter:** Removes extremely fast wiggles (above a certain frequency) that might originate from power lines rather than your brain.
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- **Notch filter:** Specifically targets and eradicates electrical noise from power lines (usually at 50 or 60 Hz).
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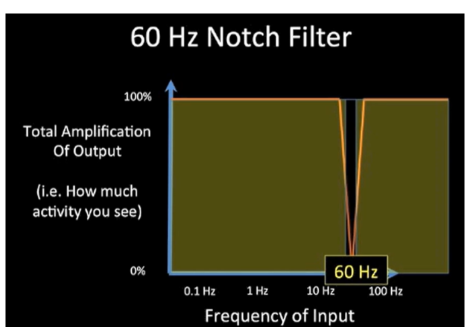


Fine-tuning the view: We can adjust how the squiggly line appears on the screen:

- **Sensitivity:** Modifies the size of the waves.
- **Time base:** Governs the duration of time displayed in a single section of the recording. A shorter time base slows down the appearance of waves, while a longer time base accelerates them.

Once we grasp these fundamentals, doctors can utilize EEG recordings to gain deeper insights into how your brain functions!

Understanding Normal Awake EEG

In this report, we will delve into the normal awake EEG (Electroencephalogram), a method utilized to record brain activity. Our focus will be on elucidating the technical aspects of EEG setup and comprehending normal brain wave patterns, particularly the alpha rhythm, alongside other common findings.

Technical Setup

To commence, it is advisable to begin EEG analysis with a clean recording devoid of any interference. Typically, a meticulous examination of a 10-second snapshot of brain activity during wakefulness is undertaken. This initial step is pivotal as it furnishes valuable insights into brain function.

Technical Settings

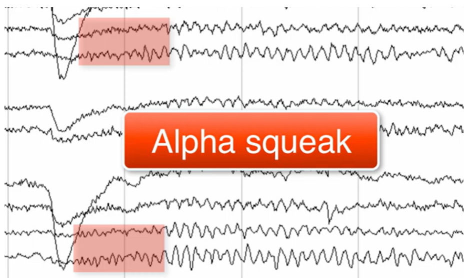
The settings of the EEG machine, exhibited at the top of the page, are calibrated to filter out specific frequencies and optimize sensitivity and time base settings. These adjustments are imperative to procure a lucid and precise depiction of brain activity.

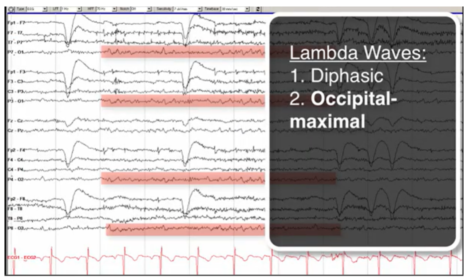
Alpha Rhythm

Transitioning to brain wave patterns, our primary focus lies on the alpha rhythm. This rhythmic pattern predominantly manifests at the posterior (back) region of the head. It resembles a gentle wave and tends to intensify when the eyes are closed, diminishing when they are open. The frequency of the alpha rhythm, typically around 11 cycles per second, is gauged. Any significant deviation from this range may indicate abnormal brain activity.

Height and Symmetry

Additionally, the amplitude or height of the alpha rhythm is assessed, with variations considered within a normal range. Furthermore, symmetry between both sides of the head is scrutinized, as excessive asymmetry could signify underlying issues.





Localization

The most pronounced manifestation of the alpha rhythm is typically observed at the posterior region of the head, termed the posterior dominant rhythm. This localization serves as another indicator of normal brain function.

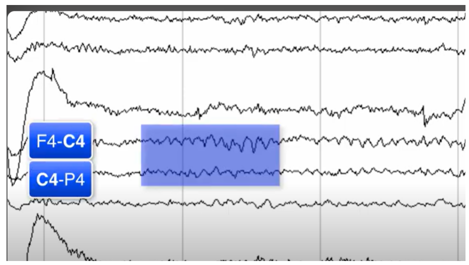
EEG Patterns Beyond Alpha Waves

EEG recordings furnish valuable insights into brain activity, unveiling more than just alpha waves. Here are some other patterns that medical professionals might encounter during EEG analysis:

- **Alpha Squeak:** A burst of brain activity observed when eyes are closed. This phenomenon is distinct from the regular alpha rhythm and signifies a transient change in brain function.

- **Lambda Waves:** Brain wave patterns resembling the shape of the Greek letter lambda (λ). These waves are closely associated with visual processing and are often observed during tasks or activities requiring visual attention.

- **Mu Rhythm:** Analogous to alpha waves, the mu rhythm is another type of brain wave pattern. However, unlike alpha waves, primarily linked to relaxation and wakefulness, the mu rhythm is specifically associated with relaxed muscles during wakefulness. It indicates a state of muscular relaxation and is commonly observed in individuals when awake and at rest.



Conclusion

In conclusion, analyzing an EEG during wakefulness provides valuable insights into normal brain function. By comprehending the technical aspects and interpreting brain wave patterns such as the alpha rhythm, healthcare professionals can glean crucial information about brain health and function.