Introduction to EEG recordings and analysis

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What is Electroencephalogram?

- First used in humans by Hans Berger in 1924.
- A tracing of voltage fluctuations vs time recorded from electrodes placed over scalp in a specific array.
- Recording of spontaneous electrical activity of the cortex.
- Neuro-electric signals are recorded as potential differences between electrodes.
EPSPs and IPSPs

- Summation of EPSPs and IPSPs → EEG waves
- EPSP- Post synaptic neuron is depolarised to threshold and an action potential is generated.
- IPSP- Keeps cell at a highly negative state (hyperpolarised).

Summation.

- Temporal summation
- Spatial summation
Uses of EEG

• Clinical use.
A routine clinical EEG recording typically lasts 20–30 minutes (plus preparation time) and usually involves recording from scalp electrodes.

• Research use
EEG, and its derivative, ERPs, are used extensively in neuroscience, cognitive science, cognitive psychology, and psychophysiological research.
Polysomnographic recordings in rats

Classification of sleep-wake cycle.
Wake state- active wake and quiet wake
NREM sleep- Slow wave sleep S1 and S2

Waking –NonREM sleep transition  
NREM-REM transition
Cortical oscillations associated with cognitive behaviour.

- **Theta rhythm (4-8 Hz)**
  Prominent during exploration, spatial navigation etc. In humans theta rhythm is found to be enhanced during working memory task.

- **Ultrafast oscillations (>100Hz)**

- **Beta rhythm (15-30 Hz)**
  Electrophysiological studies of humans and monkeys generally confirmed that beta rhythm is associated with preparation and inhibitory control of motor system.

- **Gamma rhythm (30-80 Hz)**
  “..[Oscillations are] not independent events that impose timing on neuronal spiking but rather are a reflection of *self-organized interactions* of those same neurons that detect, transfer, and store information”.

- **Delta waves**
  Predominant during slow wave sleep
Theta rhythm (4-8 Hz)
Prominent during exploration, spatial navigation etc.

In humans theta rhythm is found to be enhanced during working memory task.
Cortical sleep spindles and hippocampal ripples.
Neural recordings consists of spikes and Local field potentials

Spikes are discrete or digital signals
LFPs are analog signals
Analysis of brain signals

• Analysis in the time domain
  Auto correlation
  Cross correlation
  Zero crossing

• Analysis in the frequency domain
  Fast fourier Transform
  Coherence

• Time frequency analysis
  spectrogram
Any complex wave can be represented as the sum of sin and cosine waves.