

# An Introduction to Mathematical Physiology

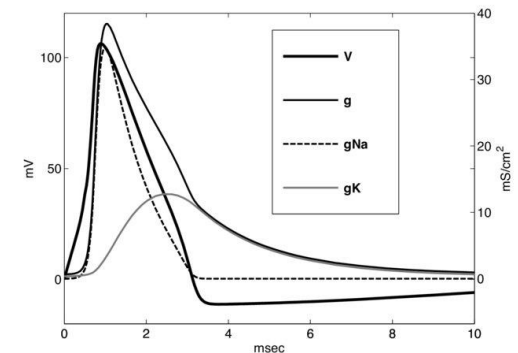
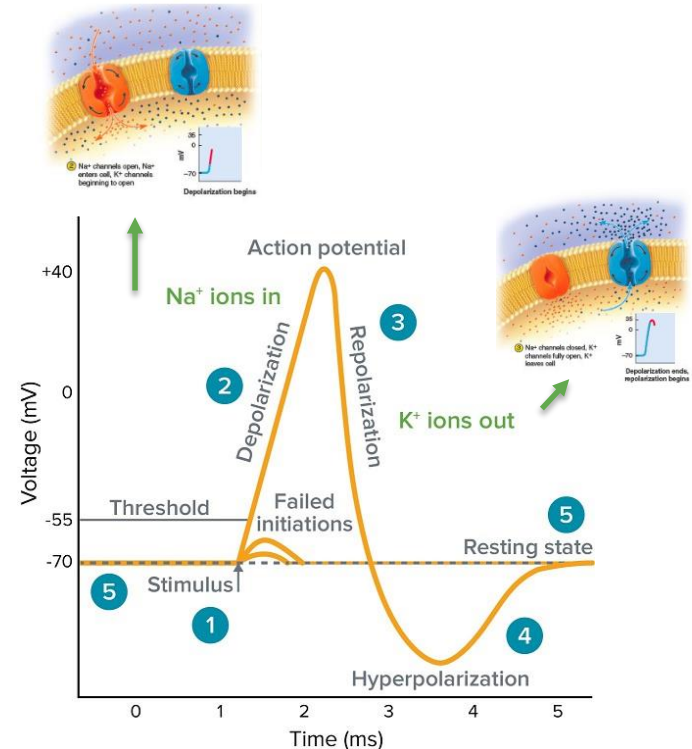
From model to measurement and intervention

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# Action potentials

- Action potentials (AP's) are the rapid rise and falls of a neuron's membrane potential
- AP's travel through a neuron and cause more APs in adjacent neurons
- This happens via opening and closing of voltage gated ion channels (modeled by Hodgkin & Huxley, 1952)

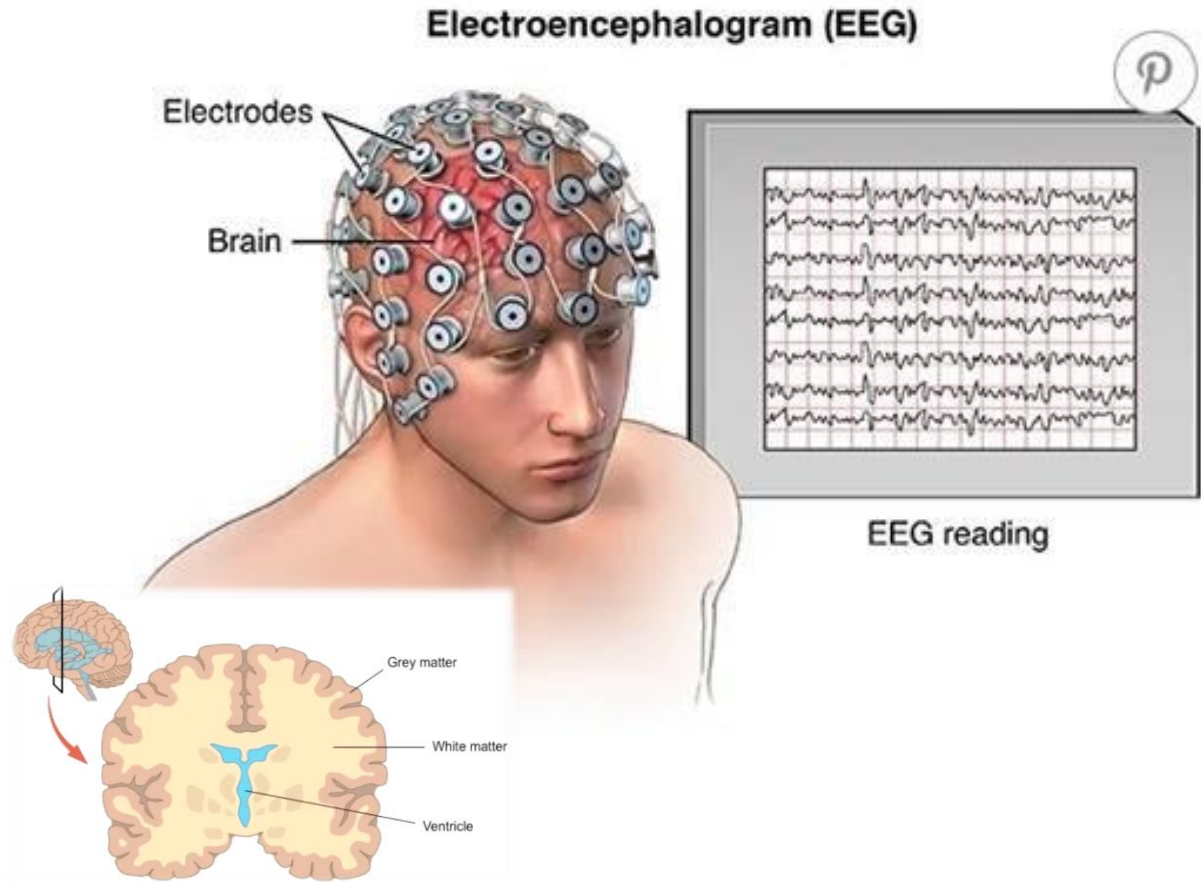
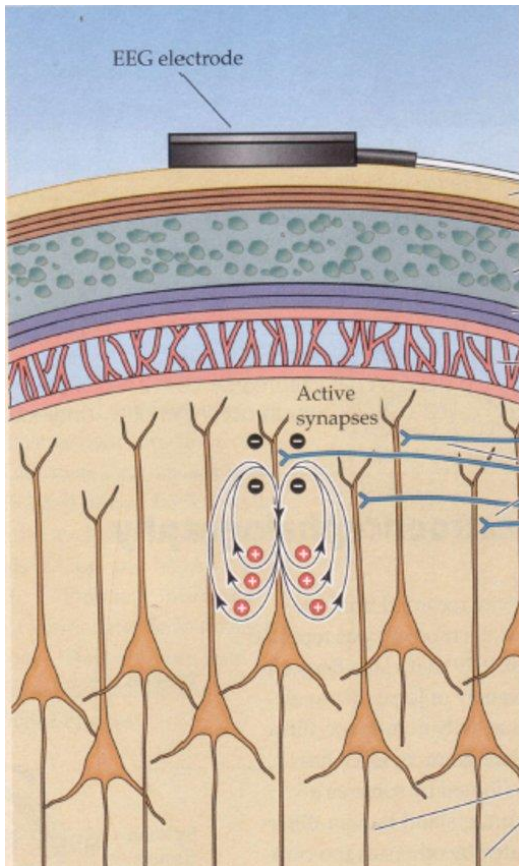


# What fires together, wires together

- Of particular interest are clusters of neurons
- We can measure membrane potentials when they co-occur in multiple cells close by (event related potentials)
- We can also measure periodic activity in these so-called networks



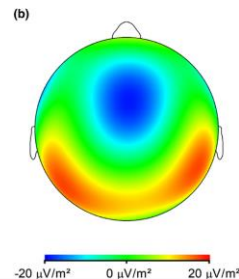
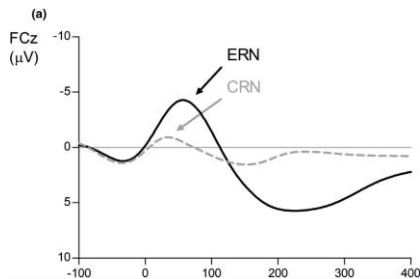
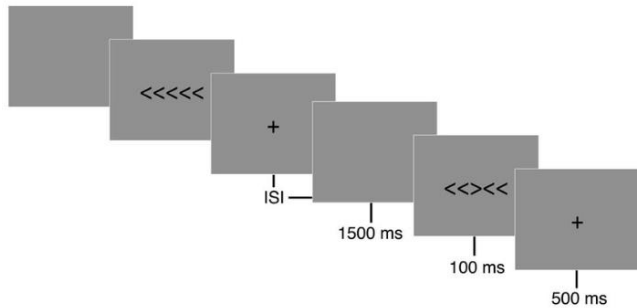
# Electroencephalography (EEG)



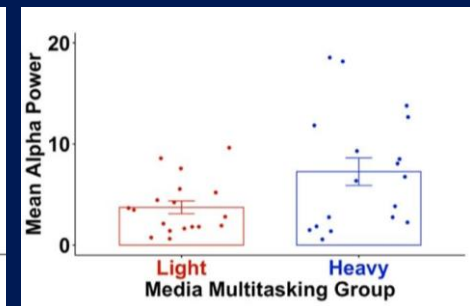
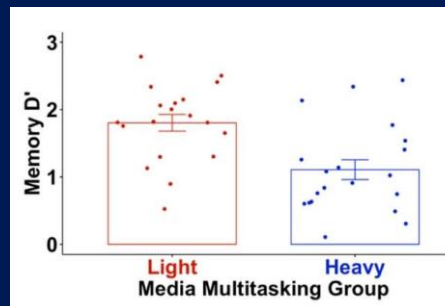
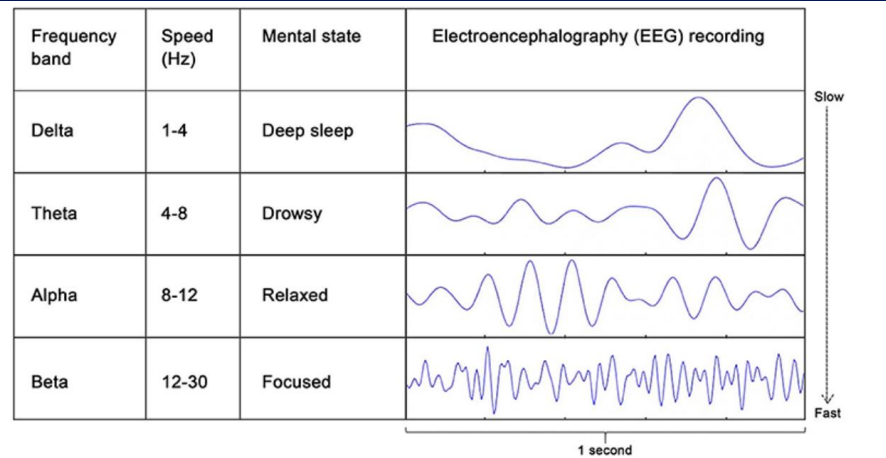


# EEG measures

## ERPs



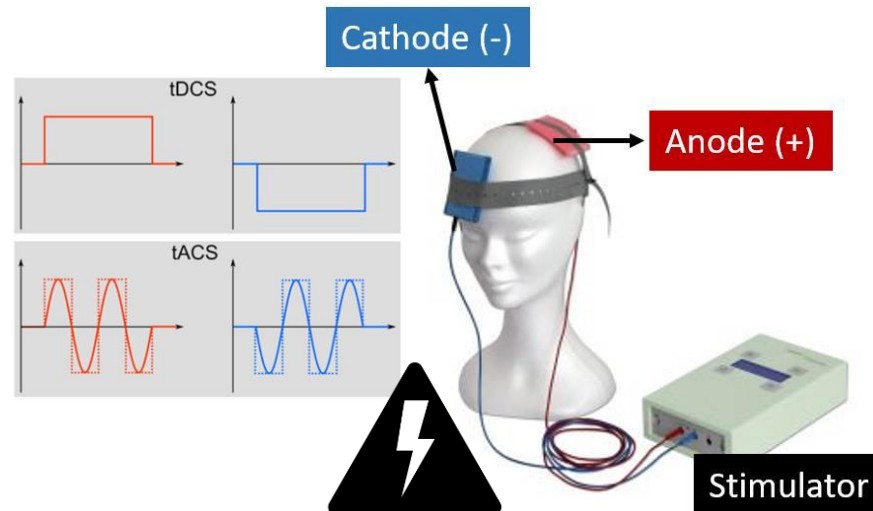
## Oscillations



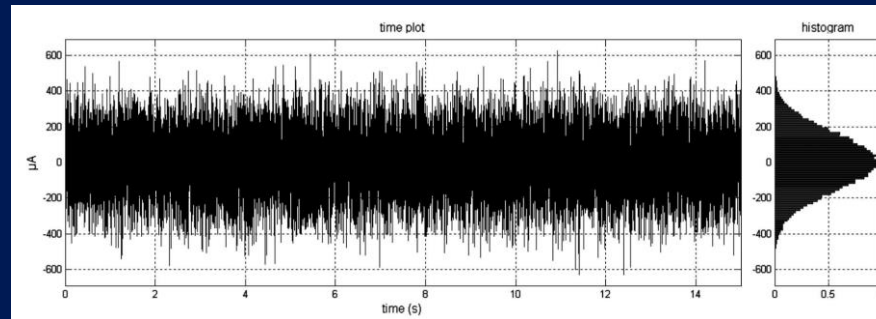
# Intervention

- There are various methods for intervention of neural firing in the cortex and in deeper structures of the brain (chemical, magnetic, ultrasound, etc.)

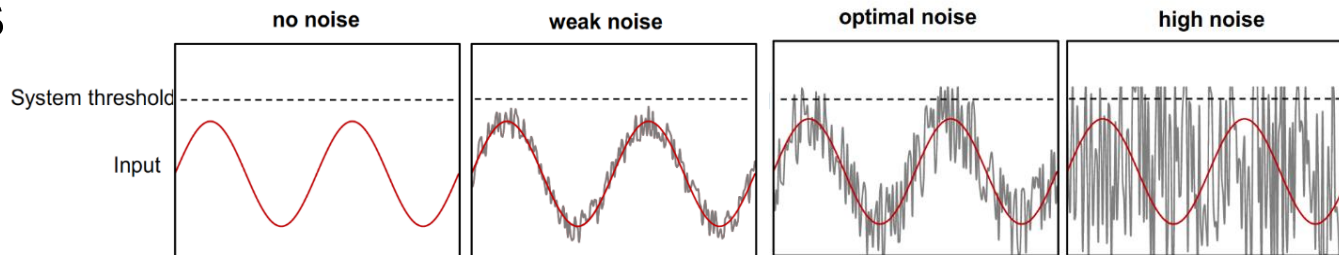
## Transcranial Electrical Stimulation (tES)

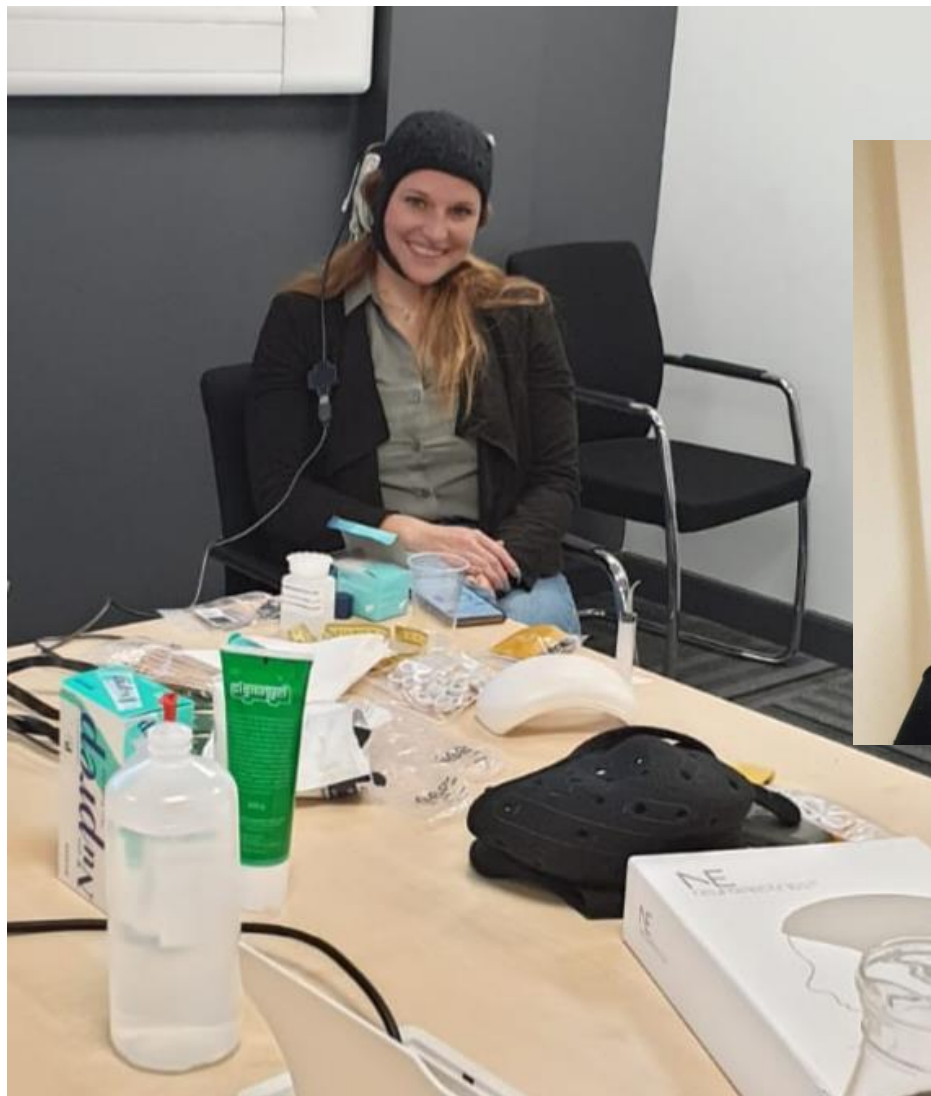


# transcranial Random Noise Stimulation (tRNS)



- High frequency noise ( $\sim$  white noise) enhancing cortical activity in a state-dependent manner (stochastic resonance)

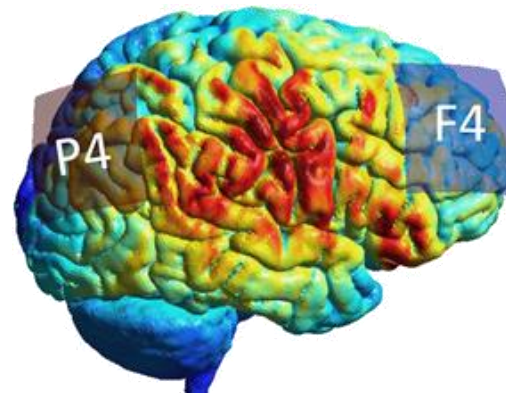
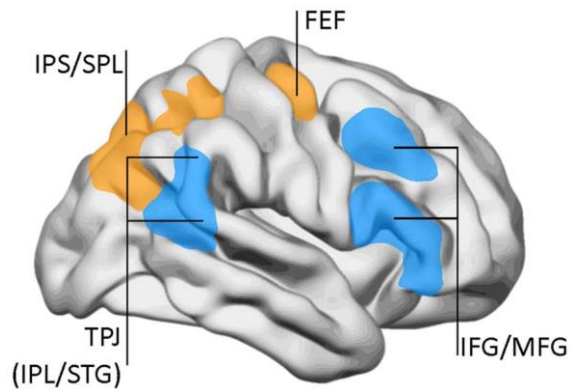
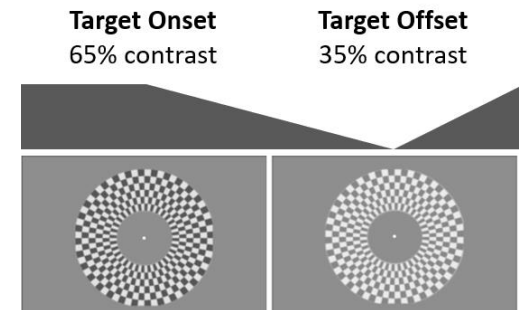






# Behaviour

- Sustained attention: Maintaining attention over long periods of time associated with right frontoparietal activity



# References

- Riesel (2019)
- Madore et al. (2020)
- Antal & Herrmann (2016)
- Terney et al. (2008)
- van der Groen (2017)
- van der Groen & Wenderoth (2016)
- Esterman & Rothlein (2019)
- Harty & Cohen Kadosh (2019)
- Mackworth (1948)
- Karstens & Cohen Kadosh (2023), manuscript in preparation