What do you notice?

Gulberti et al., 2015
Identifying Rhythmic Bands in a Neural Signal

Adapted from Rangel et al., eLife, 2016
Rhythms are a product of:

- The neurons that are active, and their physiological properties
- The connections between neurons
- The cognitive or behavioral state of the organism

Thus, unique rhythms manifest in each brain region, and they have a relationship to the behavioral and cognitive demands of the organism.
Rhythms of the brain and their common frequency ranges:

- **Delta** (0.5 - 4 Hz)
- **Theta** (4 – 10 Hz)
- **Alpha** (8 – 13 Hz)
- **Beta** (15 – 30 Hz)
- **Gamma** (30 – 90 Hz)

These rhythms are related to specific behavioral and cognitive demands.
An *introduction* to robust instances of delta, theta, alpha, beta, and gamma rhythms
Videos and audio files are available that play sounds at a specific rhythm (e.g., beta 15-30 Hz) to enhance your abilities (e.g., promote sleep, relaxation, or concentration).

*Do you think specific rhythms might be “good” for certain brain functions?*

*Do you think listening to a rhythm could enhance your abilities?*
Delta (0.5 - 4 Hz)

Slow-wave Sleep:
Slow cycles of excitation (up-states) and inhibition (down-states) during stage III sleep.

Human EEG
- REM
- Non-REM stage 1
- Non-REM stage 2 (vegetative state)
- Non-REM stage 3, or slow-wave (vegetative state, coma)

Anesthetized Cats
- EEG
- Cortical neurons

Crunelli and Hughes, *Nature Neuroscience*, 2010
Theta (4 – 10 Hz)

Spatial Navigation:

Local Field Potential in the Rat Hippocampus:

Huxter et al., *Nature Neuroscience*, 2008
Alpha (8 – 13 Hz)

Eye-closing:

LFP in occipital cortex of epileptic patients

Melani et al., *Clin. Neurophys.*, 2013
Beta (15 – 30 Hz)

Motor Movements:

LFP in Macaque Primary Motor Cortex

Grip Task:

Baker et al., *Journal of Neurophysiology*, 1997
Gamma (30 – 90 Hz)

Processing of Sensory Stimuli:

LFP in Macaque Primary Visual Cortex:

Fries, *Neuron*, 2015

LFP in Rat Olfactory Bulb:

Manabe and Mori, *Journal of Neurophysiology*, 2013
Different rhythms can manifest at the same time in same or different locations:

Which slower rhythm manifests at the same time as gamma?

Can you identify any other rhythms in this trace?

Manabe and Mori, 
*Journal of Neurophysiology, 2013*
Different rhythms manifest can manifest at the same time in same or different locations:

**Alpha** Increases in Frontal Eye Fields

Would gamma be a “good” (appropriate) rhythm here while processing this visual stimulus?

**Gamma** Increases in Visual Cortex

Colors indicate a % *increase* (red) or *decrease* (blue) from a baseline

Hipp et al., *Neuron*, 2011
If increases in rhythmic activity occur in two different brain regions (e.g., visual cortex and hippocampus) at the same time, is this evidence that neurons in both regions are cooperatively involved in the same computation?
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Do you think specific rhythms might be “good” for certain brain functions?

Do you think listening to a rhythm could enhance your abilities?

https://www.youtube.com/watch?v=BKF5vI6WvBs