RHYTHMS COURSE

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Content-goals:

(1) Classical models of brain rhythms

(2) Basic experimental/analysis techniques for rhythms

Skill-goals:

(1) Read experimental rhythms papers

(2) Ask questions and hypothesize at the edge of the field

(3) Turn experimental results into psuedo-computational models

Assignments:

- Day 1: Papers accompanied by comprehension worksheets
  - Restate
  - Interpret data/figures
- Day 2: Synthesis assignment
  - Extrapolate/hypothesize
  - Pose questions
  - Design model

Tools:

- Qualitative analysis of vector fields in phase plane

By week:

(1) Introductory week
  - Syllabus
  - Review the neuron
    - Neurons maintain electrical potential difference with environment
    - Different types of ions are conducted in and out through channels, affecting potential

        * Terminology: INWARD vs. OUTWARD, Polarizing vs. Hyperpolarizing
        * Terminology: Conductance
      - Some ion channels open and close with voltage
      - Neurons interface at synapses
        * Some open INWARD excitatory channels
        * Some open OUTWARD inhibitory channels.
  - Introduce 2D vector fields
      - The spike: V vs. n
      - STATE determines DIRECTION
  - Introduce the frequency domain
      - How to read a power spectrum
        * What does a sine wave look like in the freq domain?
        * What does a sum of sine waves look like?
        * Look at other signal/spectrum pairs
      - How to read a spectrogram

(2) Gamma 1: What does the data say?
  - Fast-spiking cells are critical.
  - Frequency is connected to inhibition time constant

(3) Gamma 2: What neural mechanism creates it?

(4) Gamma 3: What function might it serve? (Consequences of model.)
  - Binding
  - Gating
  - Synchrony
      - Spike doublets.
      - Changing frequency - more regions involved, lower the frequency.

PART 1: Cortico-thalamic rhythms

(5) Alpha 1: What does the data say?
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(6) Alpha 2: What neural mechanisms create it?

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(7) Beta 1: What does the data say?

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(8) Beta 2: What neural mechanisms create it?

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PART 2: Hippocampal rhythms

(9) Theta 1: What does the data say?

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(10) Theta 2: What neural mechanisms create it?

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(11) Ripples 1: What does the data say?

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(12) Ripples 2: What neural mechanisms create it?

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(13) Ripples/Theta: What functions are theta and ripples serving

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(14) Projects 1

(15) Projects 2

(16) Projects 3

OLD OUTLINE

16 weeks

1a. Introduction: what are rhythms? 1b. Methods:

Gamma Themes: Synchronous spiking, feedback inhibition 1. 2. 3.

PART 1: Cortico-thalamic rhythms

Alpha Themes: (Negative) attention, central control by thalamus, bursting Papers: Topics: 4. 5.

Beta Themes: Top-down control, laminar architecture 6. 7.

Delta 8.

PART 2: Cortico-hippocampal rhythms

Theta Themes: Nested rhythms, phase coding 9. 10. 11.

SWR Themes: Sequences, plasticity 12. 13.

14-16 Projects

1. References