Exercise 5

BIOENG-310: Neuroscience Foundations for Engineers

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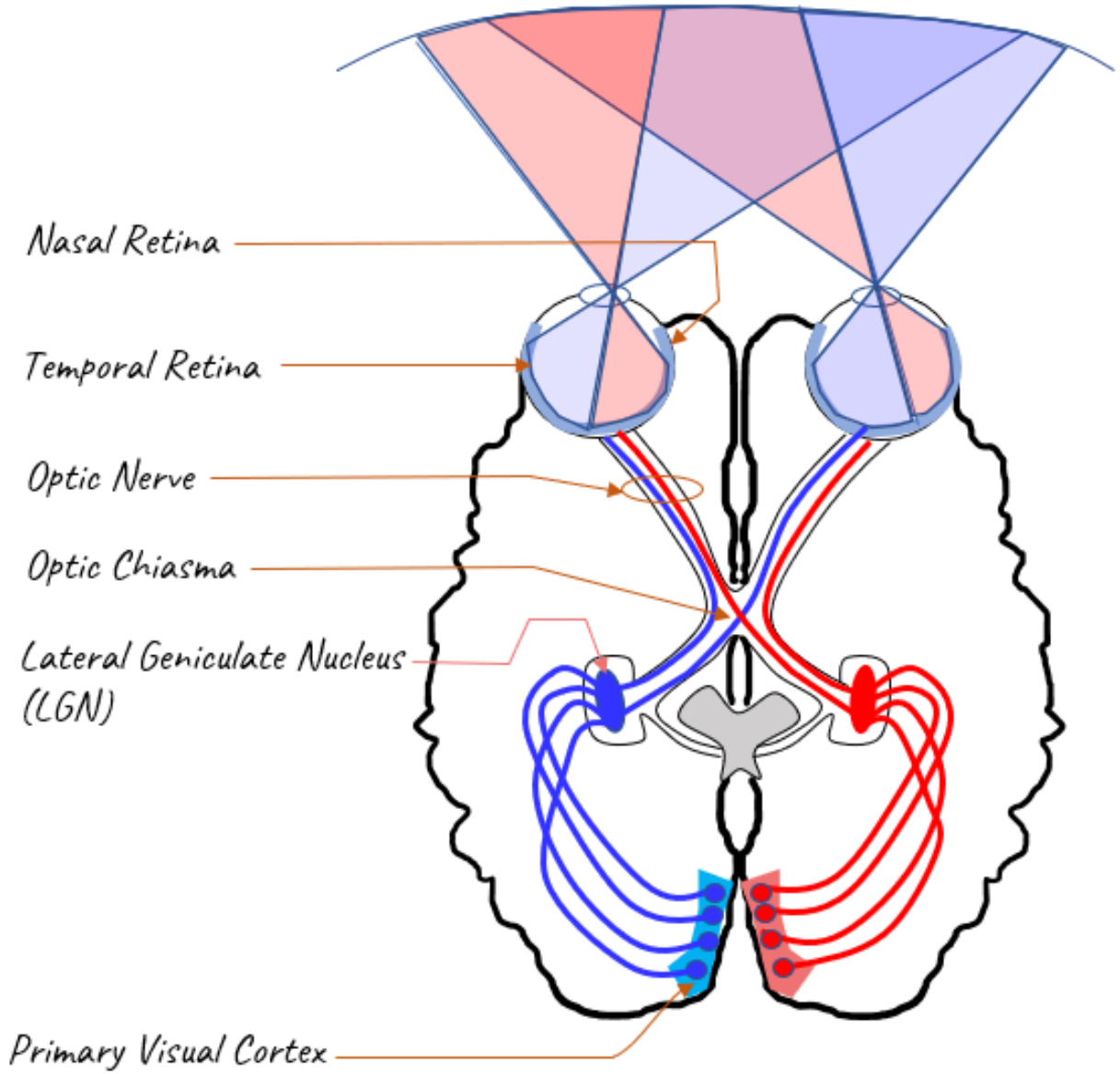
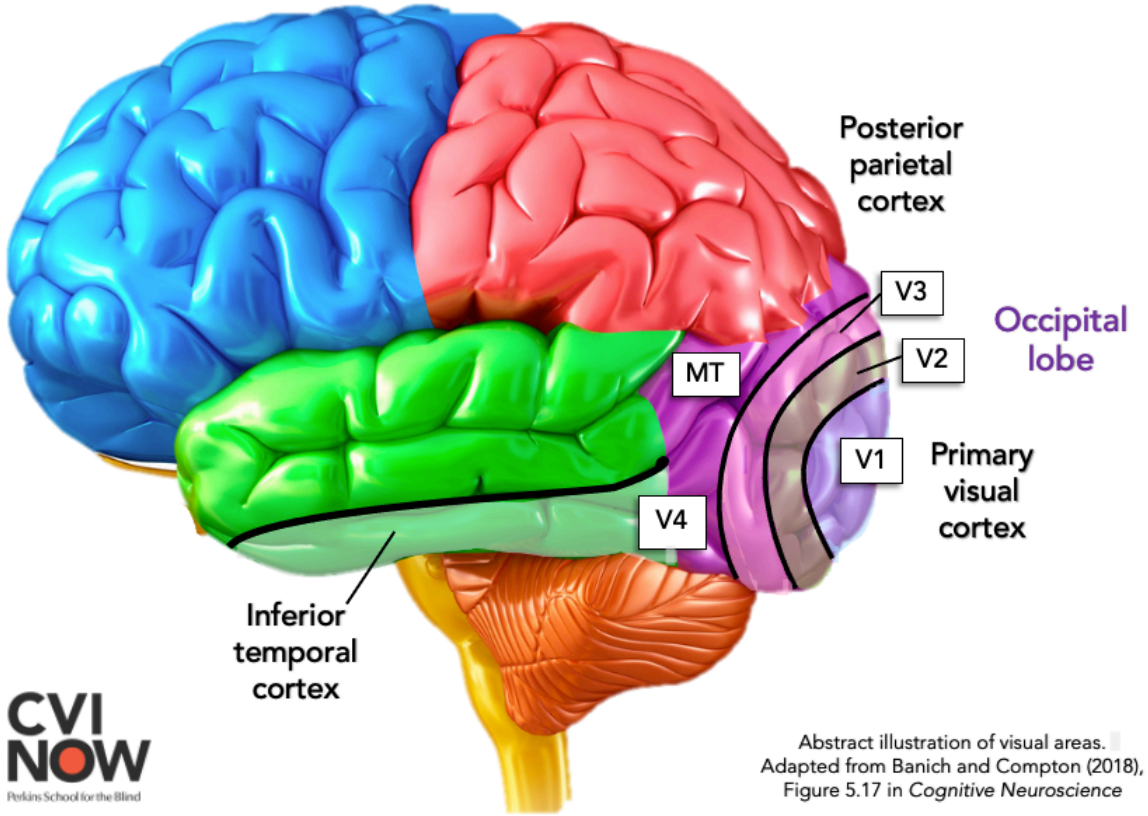
Context of the Exercise

- We will use a dataset from Freeman & Ziemba, 2013, a study on V1 and V2 responses to visual textures in macaque monkeys.
- **Objective:** Learn how to manipulate and interpret neural response data.
  1. Downloading and understanding the dataset.
  2. Visualizing the stimulus images used in the study.
  3. Visualizing and manipulating the neural activity data.
  4. Applying Linear Readout / Linear Probing to analyze responses.



Overview of the visual system

Overview of visual cortex V1 and V2



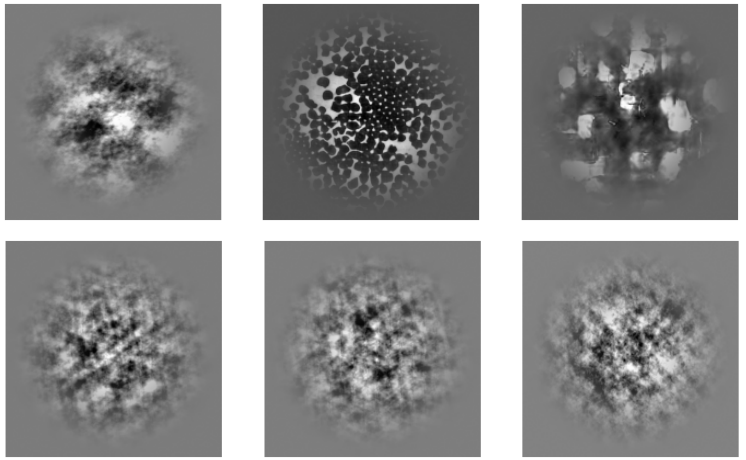
Abstract illustration of visual areas.
Adapted from Banich and Compton (2018), Figure 5.17 in *Cognitive Neuroscience*

- **V1** → Detects basic visual features: edges, orientation, contrast. **Simple feature detection**
- **V2** → Builds on V1 information to detect **textures and complex patterns**.

Experimental Methodology

Subjects: Anesthetized macaque monkeys.

Stimuli: Synthetic images were generated to match natural textures or contain randomized noise.

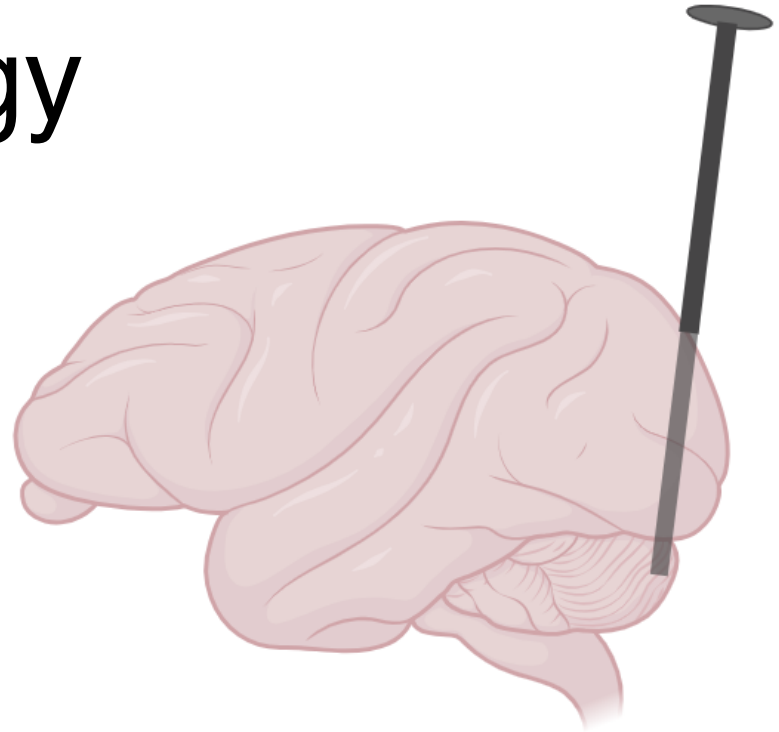


Experimental Methodology

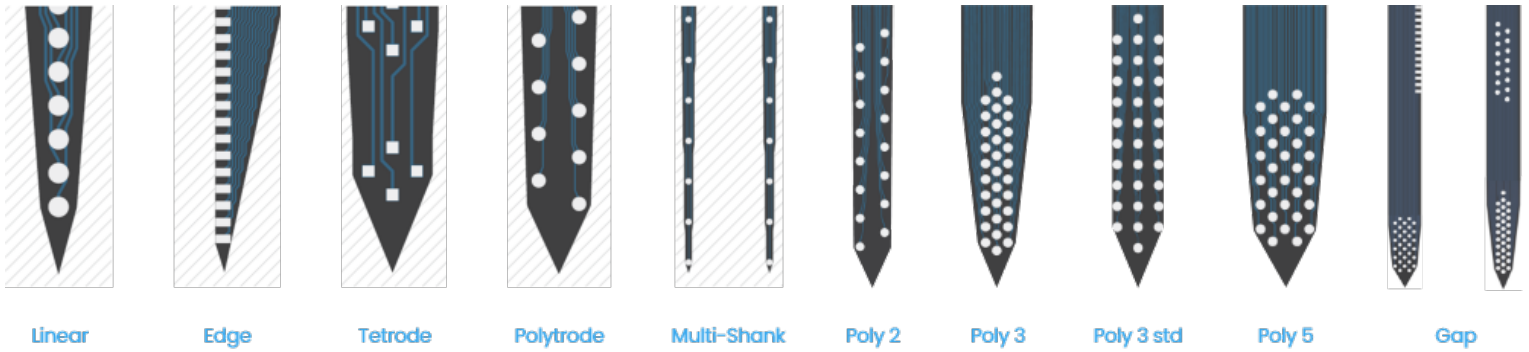
Electrophysiological recordings:

Several quartz platinum-tungsten microelectrodes (Thomas Recording) implanted in the V1 and V2 cortex.

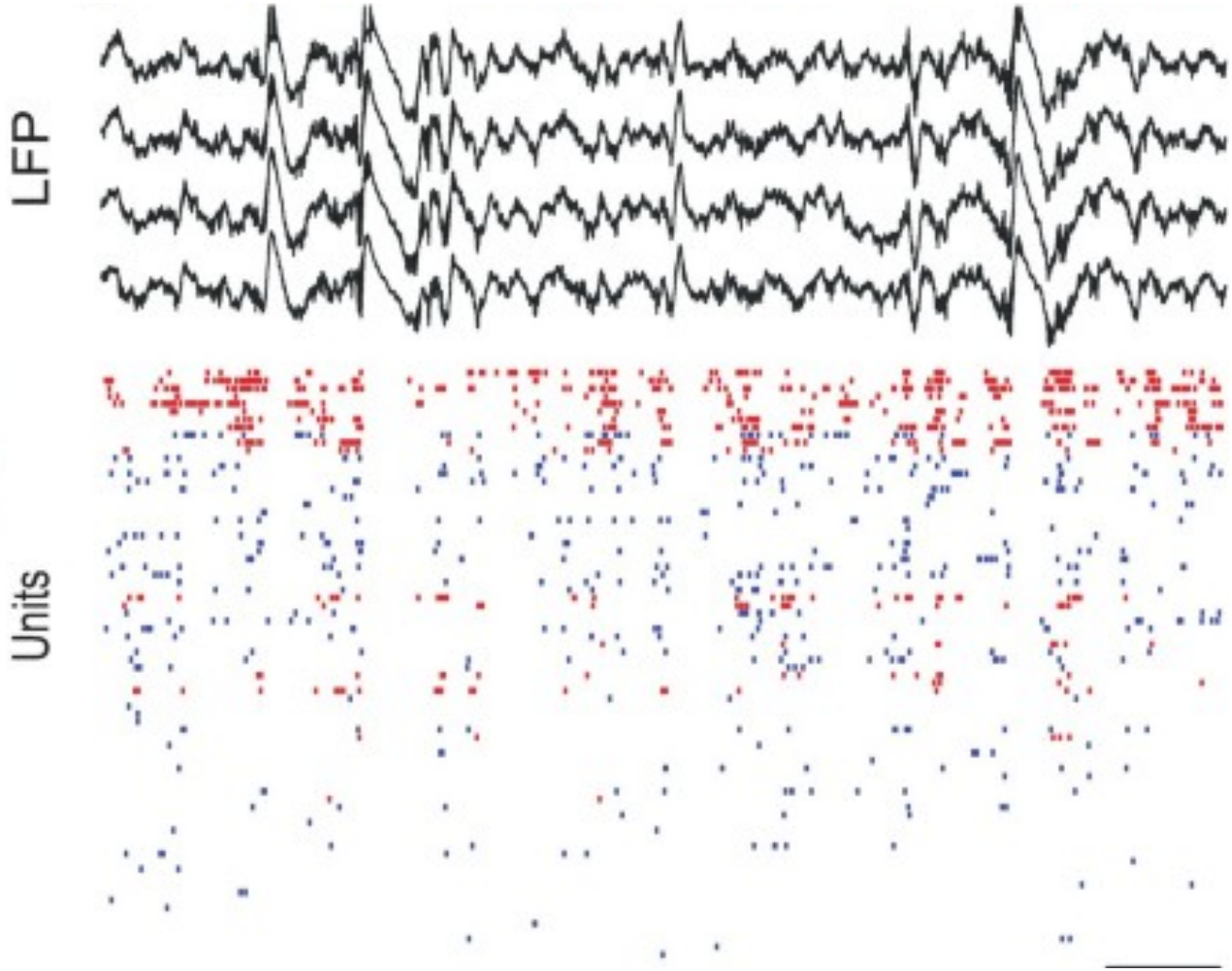
This electrodes are able to record **Local Field Potentials (LFP)**, but also **single spike activity**.



102 recording sites!



LFP vs. single spike activity



Experimental procedure

1. Macaque monkeys were anesthetized.
2. **A craniotomy was performed**, and electrode arrays were inserted to record from **V1 and V2** (102 recording sites).
3. **Stimulus images were presented** in short bursts of **300 ms.**
4. **Neural activity was recorded** while monkeys viewed **naturalistic textures or spectrally-matched noise**.
5. **Presentations** were repeated several times

Key Question: How do V1 and V2 respond differently to naturalistic textures?

The Dataset

Data by Freeman & Ziemba et al. 2013, packaged into the Brain-Score platform.

300 ms of time

102 neural recording sites

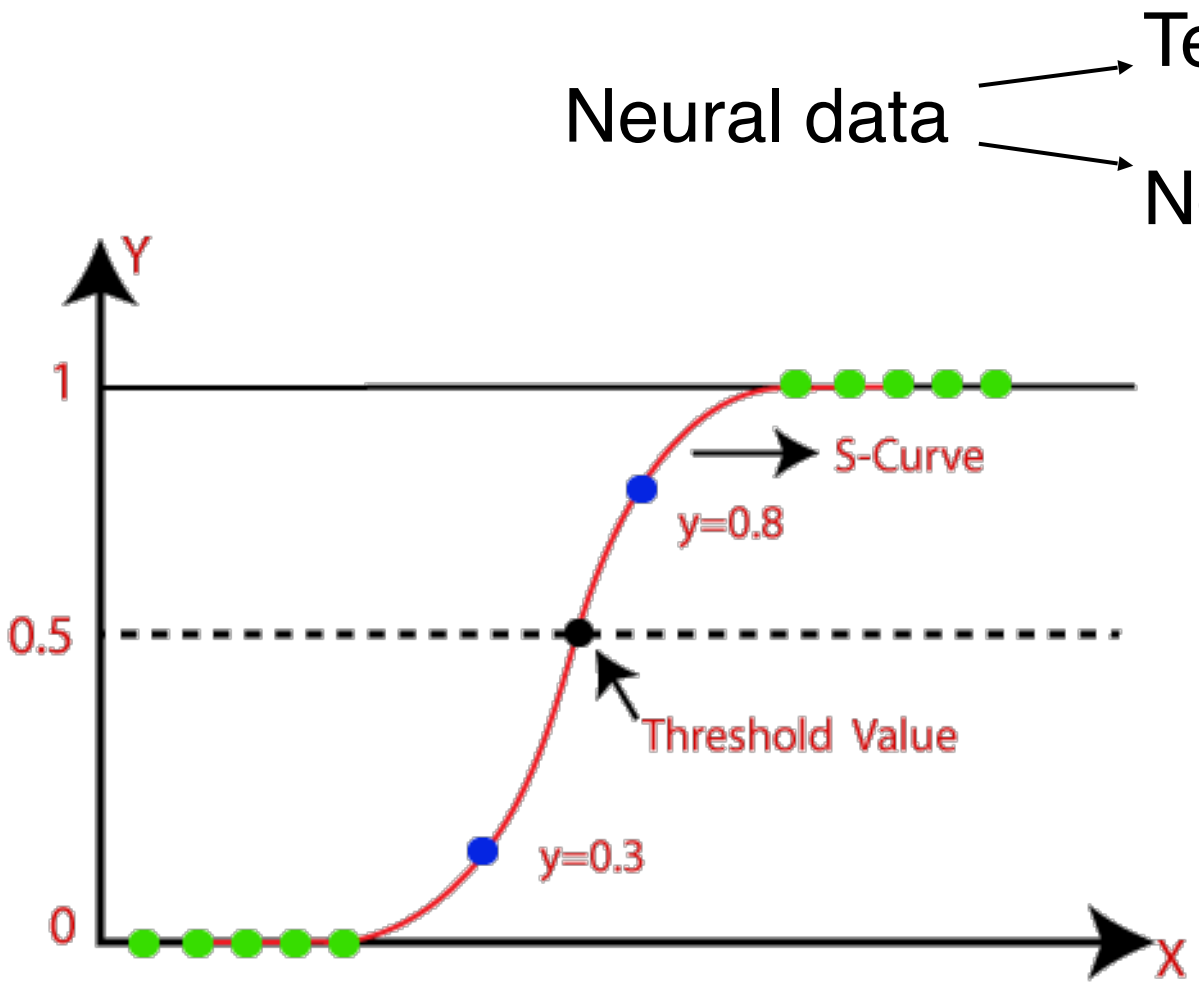
2700

Repetitions of the experiment (Presentations)

Objectives

- Download the dataset
- Access and visualize the different stimulus
- Access and visualize the neural data
- **Apply Linear readout / linear probing to sort the data**

Linear readout / linear probing



A **Logistic Regression** model is used as the classifier. It tries to learn the relationship between the neural data (train_x) and the texture type (train_y).

Questions?