Visual response properties of neurons

A. Spatial Analysis

Analysis #1:
Map receptive fields

Analysis #2:
Determine orientation tuning selectivity

Analysis #3:
Determine direction tuning selectivity

B. Feature tuning

Analysis #1:
Map receptive fields

Analysis #2:
Determine orientation tuning selectivity

Analysis #3:
Determine direction tuning selectivity

What kind of information is encoded by mismatch responses?

A. Multiplicative novelty:
Stimulus-specific enhancement for novel / unpredicted stimuli

Analysis #1:
Compare the mismatch response in the novel vs. control conditions:

For each neuron and each mismatch stimulus, construct either
the event-triggered average (ETA; for Ca++ imaging data)
or peri-stimulus time histogram (PSTH; Neuropixel data)

Analysis #1:
Compare the mismatch response in the novel vs. control conditions:

Calculate the relative response to the four different mismatch stimuli;
Other possibilities: i) make some index that captures this relationship for individual neurons eg. layer analysis

B. Additive novelty:
A generalized "alert" signal that encodes novelty per se

Analysis #2:
Compare the mismatch response in the novel vs. control conditions:

Scatter plot of responses in the two conditions and carry out a linear fit.
Interprete slope fit and axis intersept to dissociate Multiplication/Addition

C. Subtractive novelty:
The difference between the expected vs. actual stimulus

Analysis #4:
Calculate decoding performance for mismatch stimuli vs. novelty per se:

What fraction of neurons encode significant info about novelty per se?
What fraction of neurons encode significant info about individual mismatch stimuli?

D. No effect:
Reject the hypothesis no predictive comp. involved

Mismatch responses across different types of prediction

A. Standard-Oddball vs. other sessions

Analysis #1:
Map the locations of neurons showing mismatch responses in the 2-photon imaging or neuropixels recordings

PCA,t-SNE, umap

Analysis #3:
Compare responses for the *same* neurons between sessions

oddball (session 1) and
sequence (session 3) mismatches

Analysis #5:
Temporal Mismatch Analysis (session 4).

baseline activity and/or visual
evoked responses under control conditions
vs. temporally deviant visual stimuli

B. Visuomotor Coupling vs other sessions

Analysis #2:
Compare responses for the *same* neurons between sessions

sensorimotor (session 2) and
temporal sequence (session 3) mismatches.

Analysis #4:
Analysis of recording from inhibitory interneurons.

Identify inhibitory Interneurons
waveform, optotagging
PV, SST, VIP

Analysis #6:
Test various prediction models across session types

deep learning models
information theory
experience-dep. plasticity across days

Distinguish between two categories of prediction made by neurons

A. Detailed predictions about the identity of the upcoming stimulus

Analysis #1:
Compare the response to the mismatch stimulus across conditions for sensorimotor mismatch (session 2)

closed-loop versus open loop
type of mismatch

Analysis #3:
Emergence of Prediction Signals in Single Neurons

Do individual neurons show changes in their response to the same oddball stimuli?
Do neuronsexhibit activity that depends on what the upcoming stimulus is?

B. Adaptation
Deviation from the expected stimulus ensemble

Analysis #2:
Decoding accuracy for individual mismatch stimuli vs. for novelty per se.

linear decoder (support vector machine)
mutual information

Analysis #4:
Emergence of Prediction Signals at the Population level

Do neurons populations of neurons exhibit activity during stimulus omission that depends systematically on the preceding stimulus?
Do identified latent variables exhibit systematic changes over trials?