Superior colliculus population activity during delay period of audio-visual localization task

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Introduction

- Synthesizing multisensory information is important for many complex behaviors, and such synthesis requires a judgment of causality. That is, should a set of multisensory cues be integrated as one cause or segregated as multiple causes?

- We analyzed single unit activity from a multisensory structure (the superior colliculus, or SC) while monkeys performed an audio-visual localization task requiring both integration and segregation of sensory information.

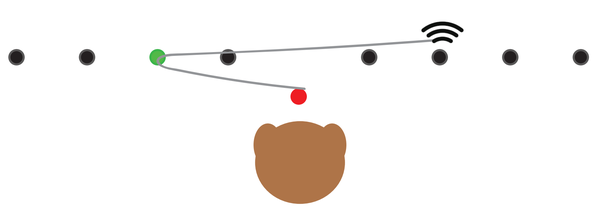
- The SC shows a diversity of combination rules across neurons, e.g. some neurons are unimodal (only respond to A or V), others are multimodal (both A and V). Multimodal neuron responses can be a sum, average, or other mixture of the unimodal responses

- Previous work found that that individual neurons do not shift from one combination rule to another in a way that matches the shift seen in behavior. This suggests that behavioral causal inference may rely on a population level interaction between neurons representing different possibilities (i.e., same or different source for a given stimulus pair).

Methods

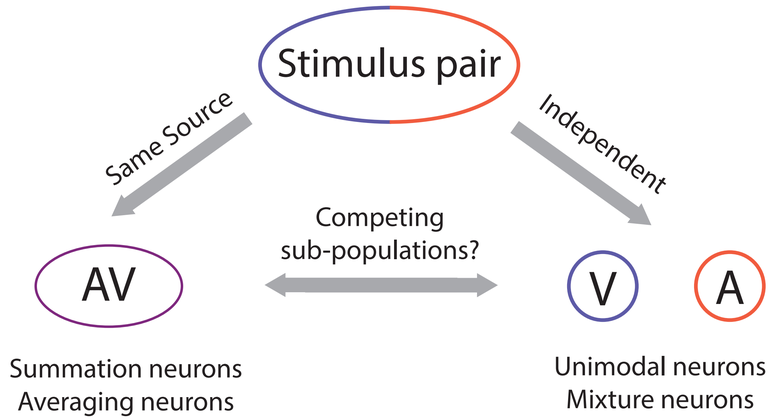
Single unit neural activity was recorded from the superior colliculus while monkeys performed a behavioral task requiring them to localize targets indicated by LEDs or white noise.

Monkeys make saccades to either one or two targets:
- Unimodal targets (either auditory or visual)
- Multi-modal targets (both auditory and visual, simultaneous)

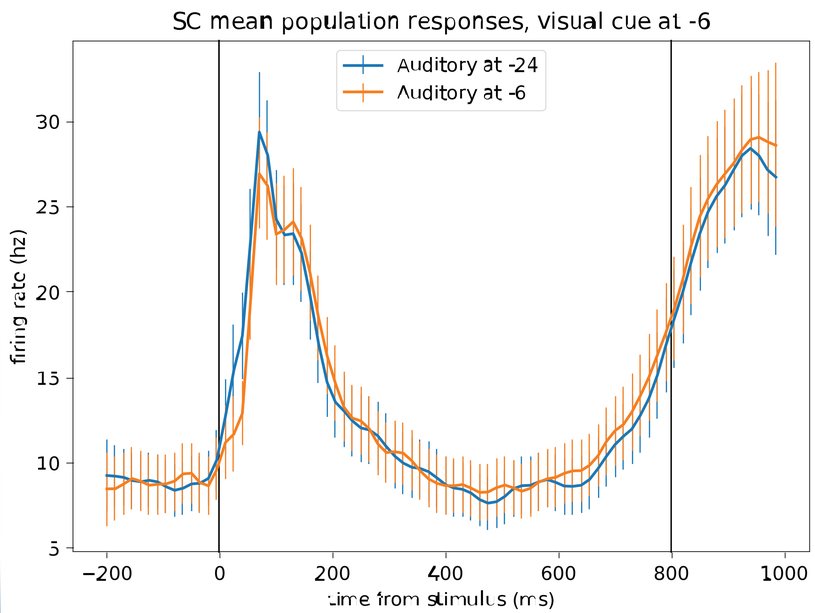


Population analyses proceeded by creating a pseudo-population of n=55 single-unit recordings.

Individual neurons do not change their combination rule based on target separation

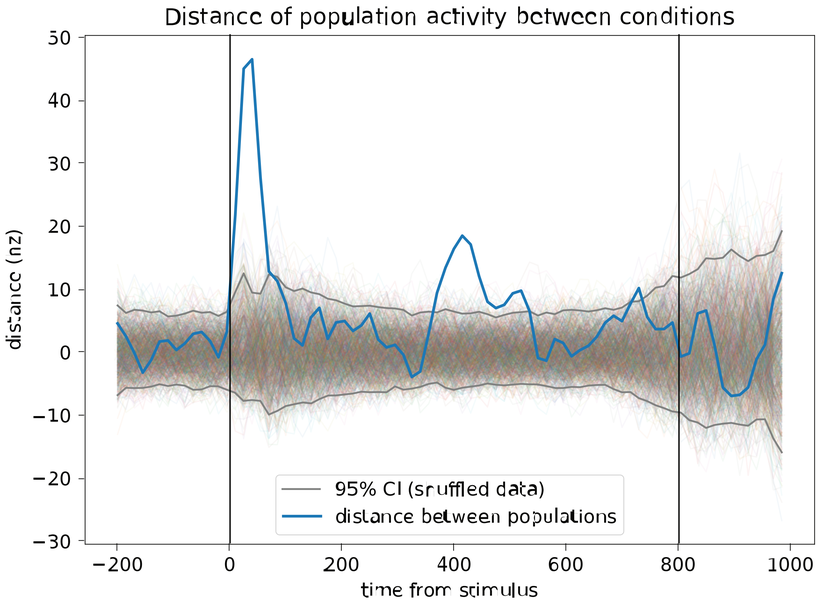


SC delay period response does not differ as function of auditory target location



- Is the population activity decreasing in the same way between conditions (i.e. between A-6 and A-24) from ~200 to 600 ms?

Multidimensional distance between conditions does not suggest differences in population structure over delay period



- Distance between populations during initial stimulus response is significantly greater than chance, but this distance is not maintained over the whole delay period
- Small blip of significant distance around 400 ms might be noise

Future Directions

- Rerun analysis with normalized firing rates
- Account for tuning by analyzing trials of same conditions but different behavioral outcomes
- Fit dynamical systems to population activity to see if dynamics can capture behavioral differences in neural data

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References
1. Stokes, M. *et al*, (2013). Dynamic Coding for Cognitive Control in

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