Task- and time-dependence of population codes for motion in marmoset MT

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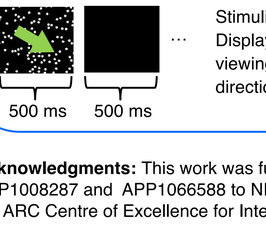
Which neurons contribute most to the population code?

In population coding schemes, ensembles of neurons collectively represent stimulus properties to which individual neurons are tuned (such as orientation in V1, or motion direction in MT).

In a linear decoder, neurons are weighted based on how their tuning relates to the given task. Within those weights, there is a lot of inter-neuron variability.



What determines whether a neuron is weighted strongly?

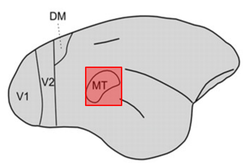
Does this vary over time?

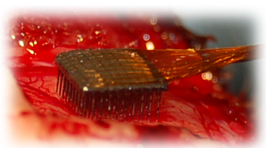
Does it vary by task?

Recording population responses to visual motion in marmoset MT

Extracellular activity was recorded from the middle temporal area (MT) in three anaesthetised marmosets (*Callithrix jacchus*) using a 96-electrode Utah array spanning 4x4 mm of cortex. Anaesthesia was maintained with sufentanil and nitrous oxide.

After spike-sorting well-isolated, direction-selective single units were recorded from a total of 136 electrodes across three animals.





Trials consisted of a sequence of motion stimuli moving in one of twelve directions (500 ms), followed by a black screen (500 ms). Simultaneous recordings were trial-shuffled within an animal, then combined across the three animals.

Stimuli were shown on ViewPixx or Display++ displays at 120 Hz and a viewing distance of 350 mm. Each direction was repeated 120 times

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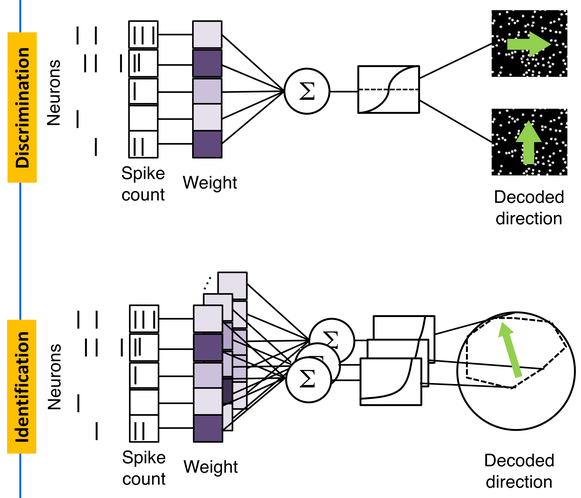
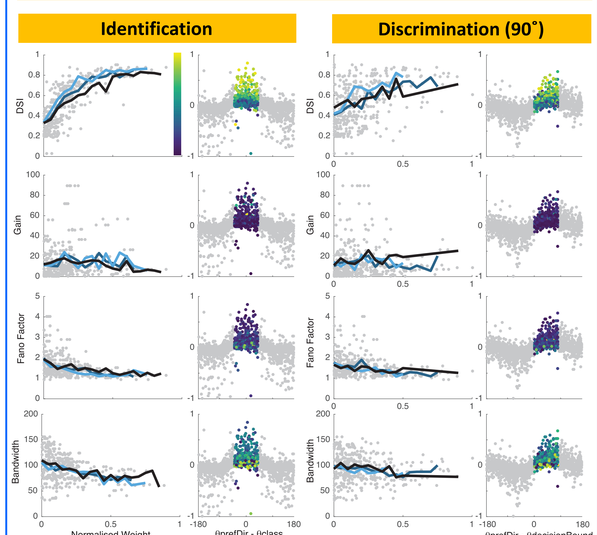
Decoding motion direction from population activity

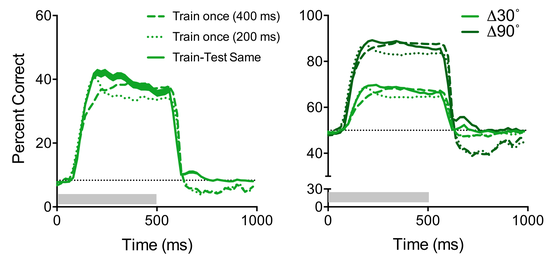


Which neurons get the highest weights?



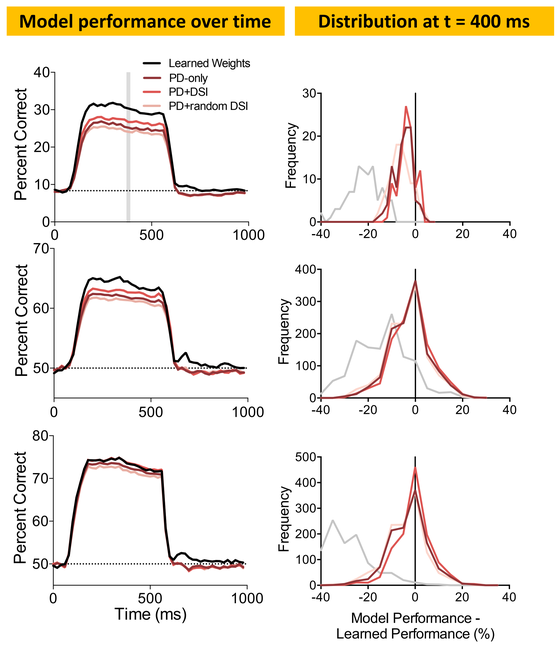
Direction selectivity, and, to a lesser extent, Fano Factor and bandwidth predict stronger weights.

How does weight vary with time?



Weights set early do not account entirely for performance after approximately 250 ms. Weights set late do not account entirely for performance at the beginning of the direction selective response.

Does scaling weights by DSI improve performance?



Setting weights by preferred direction is the most important aspect of the model. From there, performance may be slightly improved by accounting for selectivity.

Summary

- Setting weights appropriately for a neuron's preferred direction accounts for most of a model's decoding performance.
- Decoding weights vary over time.
- Scaling weights by selectivity further improves performance.
- The same factors affect whether a neuron is useful in both discrimination and identification tasks.

Coming next …