



# Attentive tracking of multiple objects by humans and monkeys

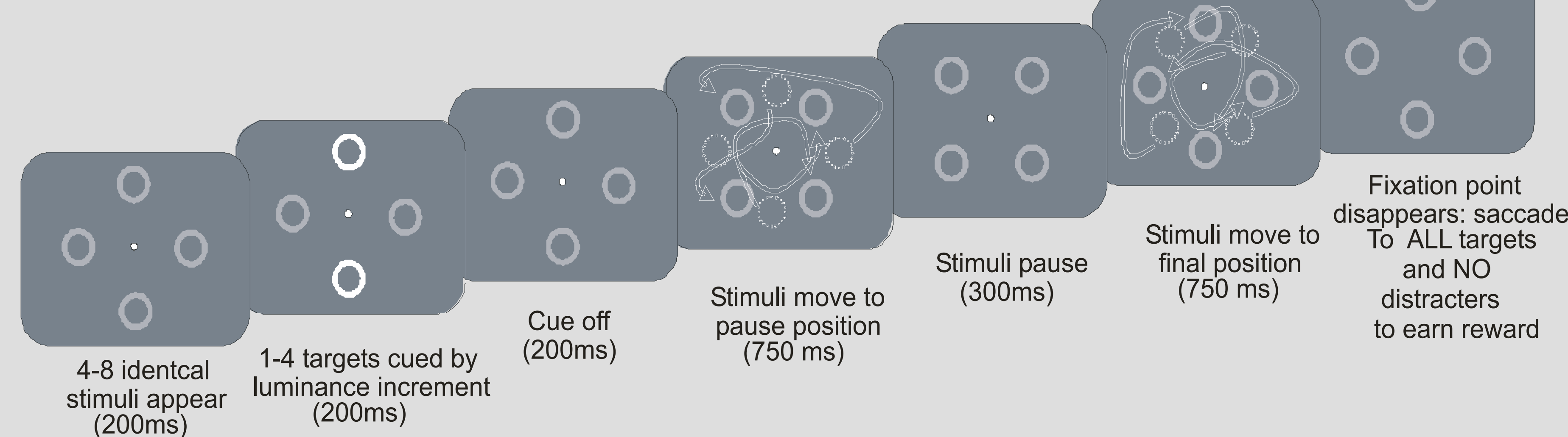
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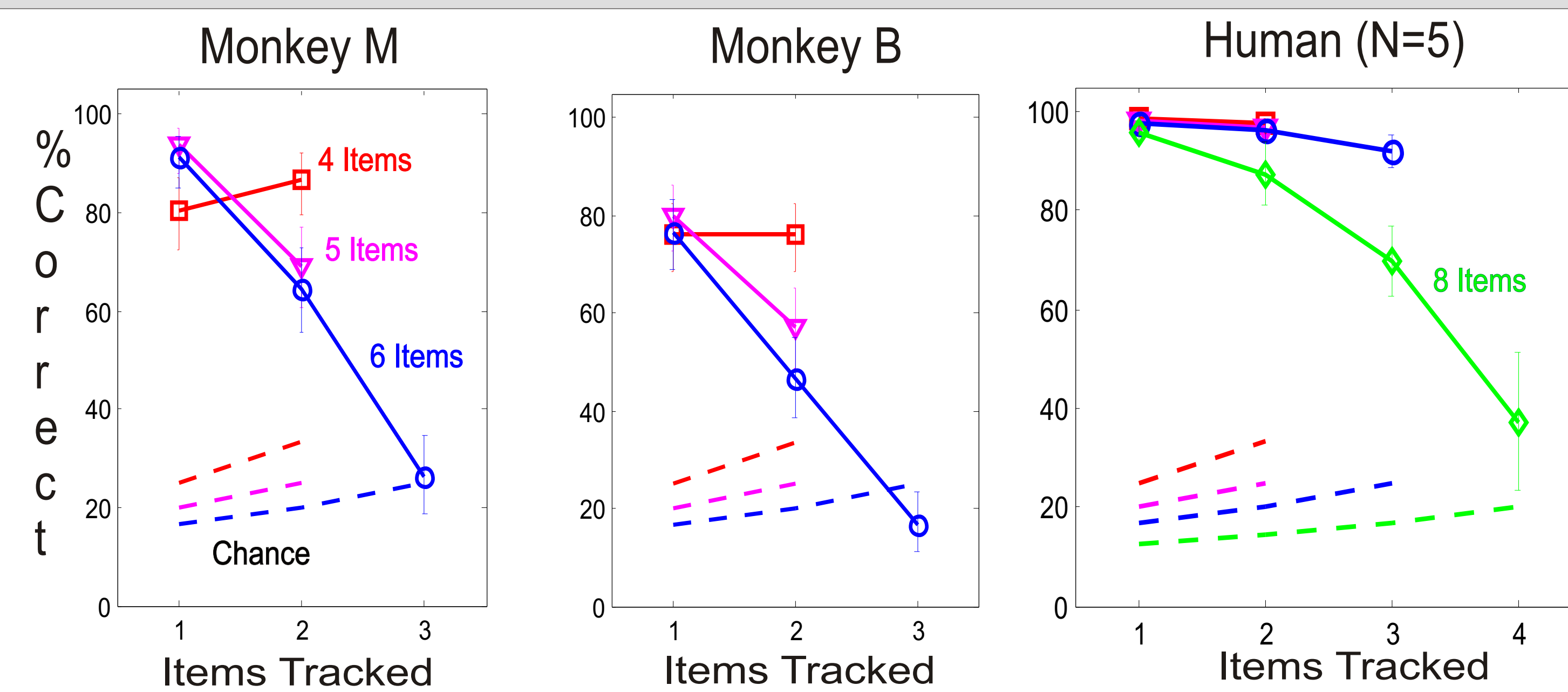


## Can Monkeys Mentally Track Multiple Stimuli?

Task: while maintaining fixation, track all cued stimuli.



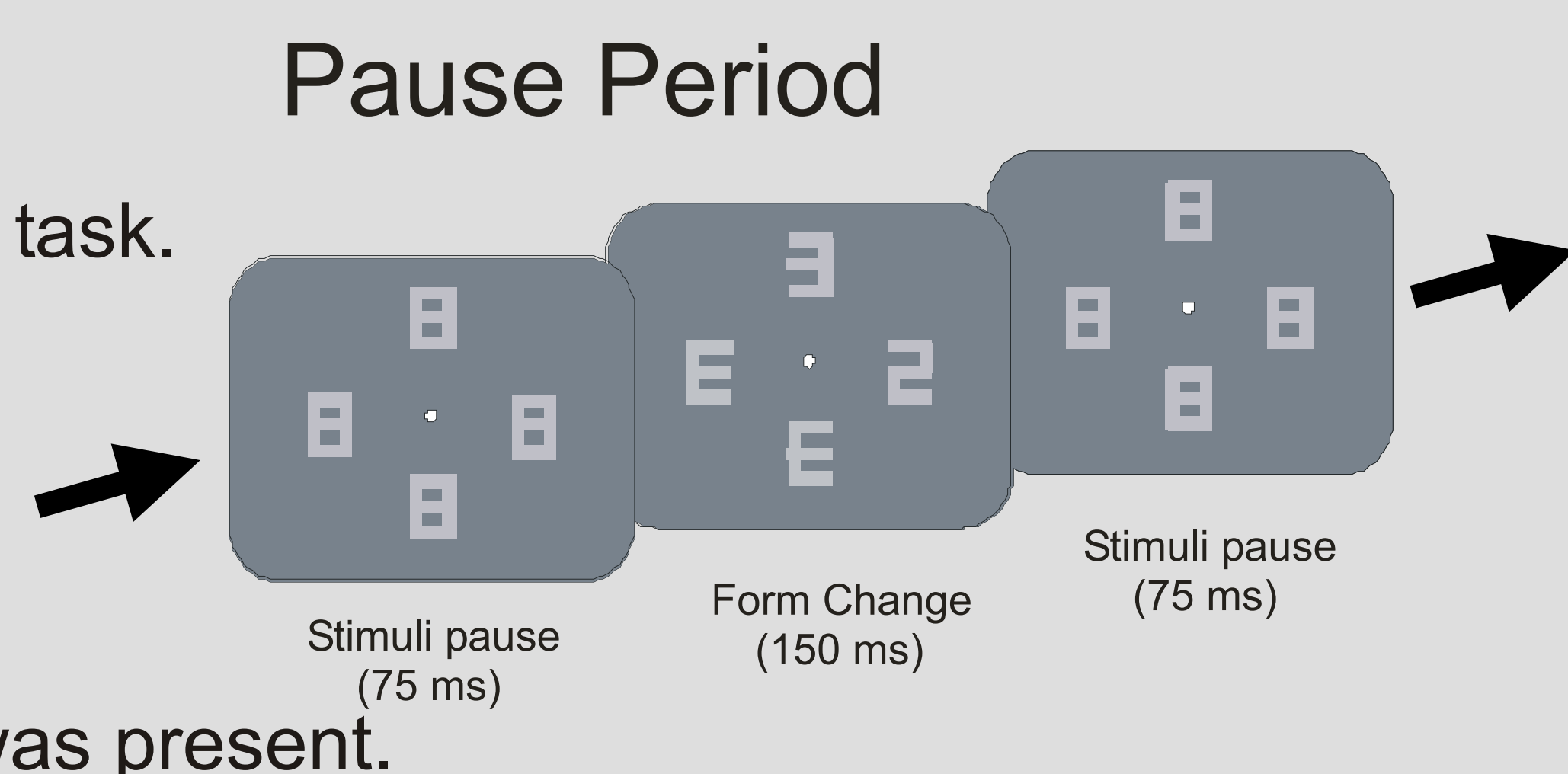
Yes. Monkeys can track at least 2 stimuli



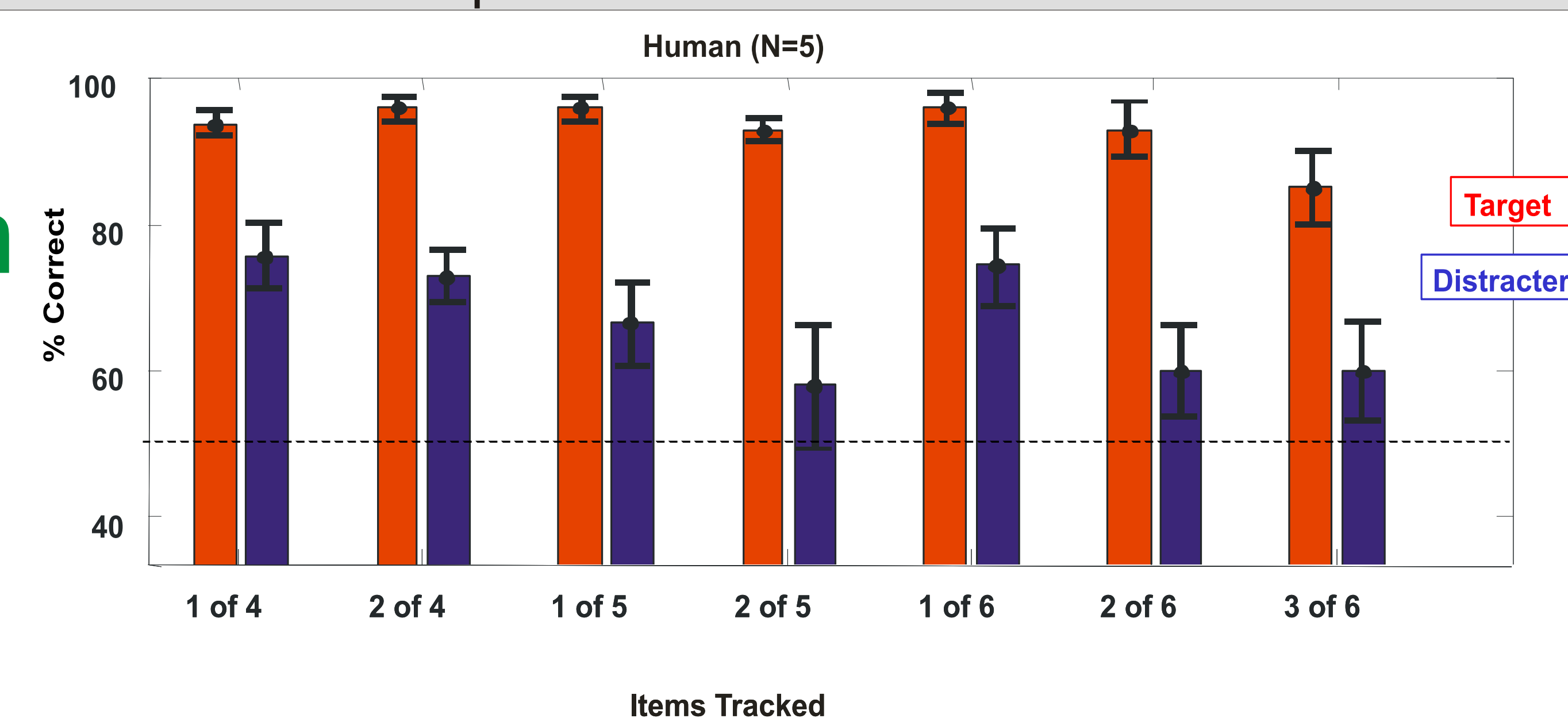
## Are tracked stimuli attended?

Attention Task:

- \* Trajectories were identical to the monkey task.
- \* Rings were replaced with figure 8's.
- \* At the motion pause, all items changed from 8's to E's or 3's, except one that changed to either a 2 or 5.
- \* Subjects tracked the targets and also reported by key-press whether a 2 or 5 was present.



Yes. Discrimination is better for tracked stimuli.

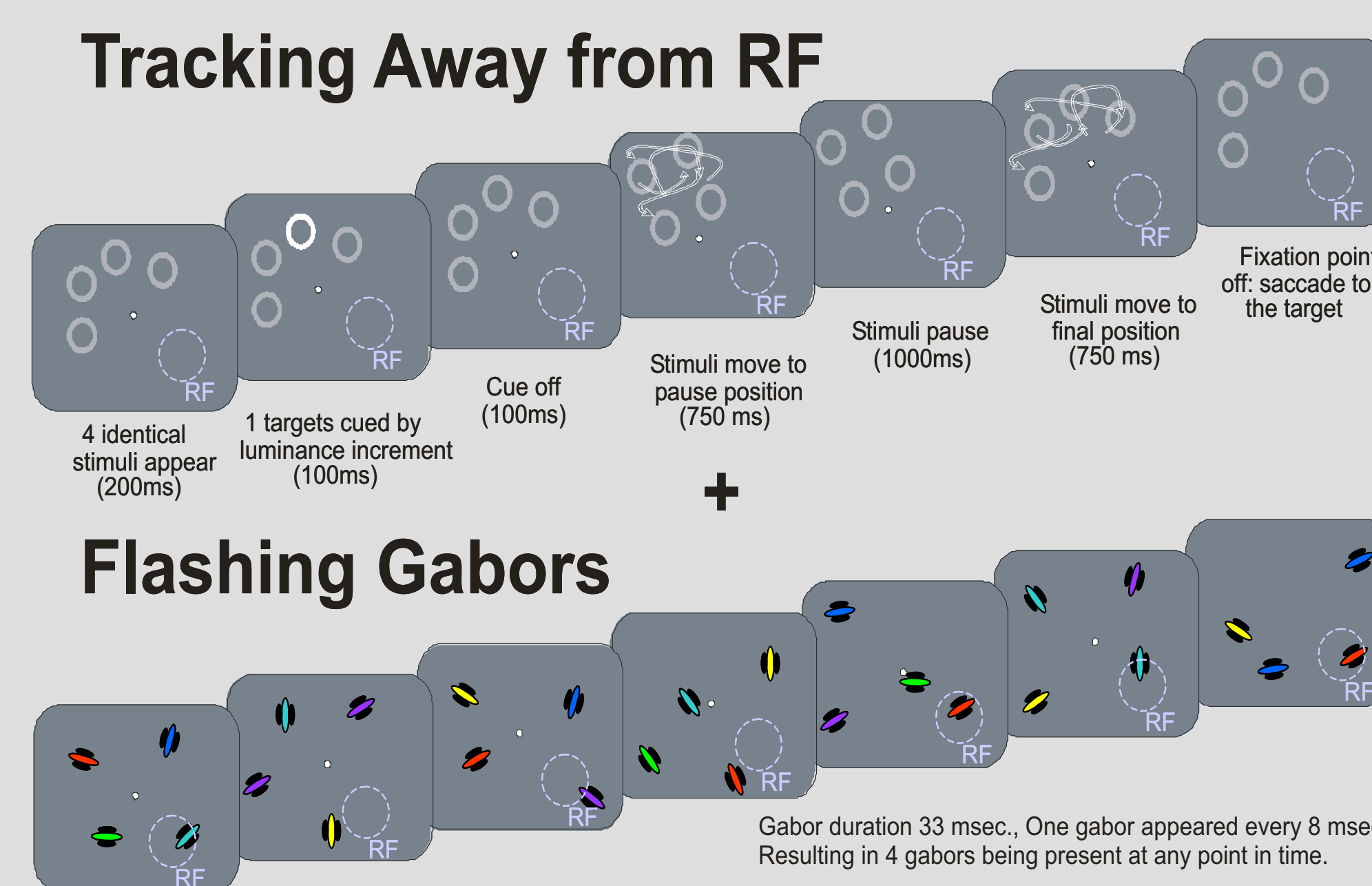


## Are V4 Neurons Modulated?

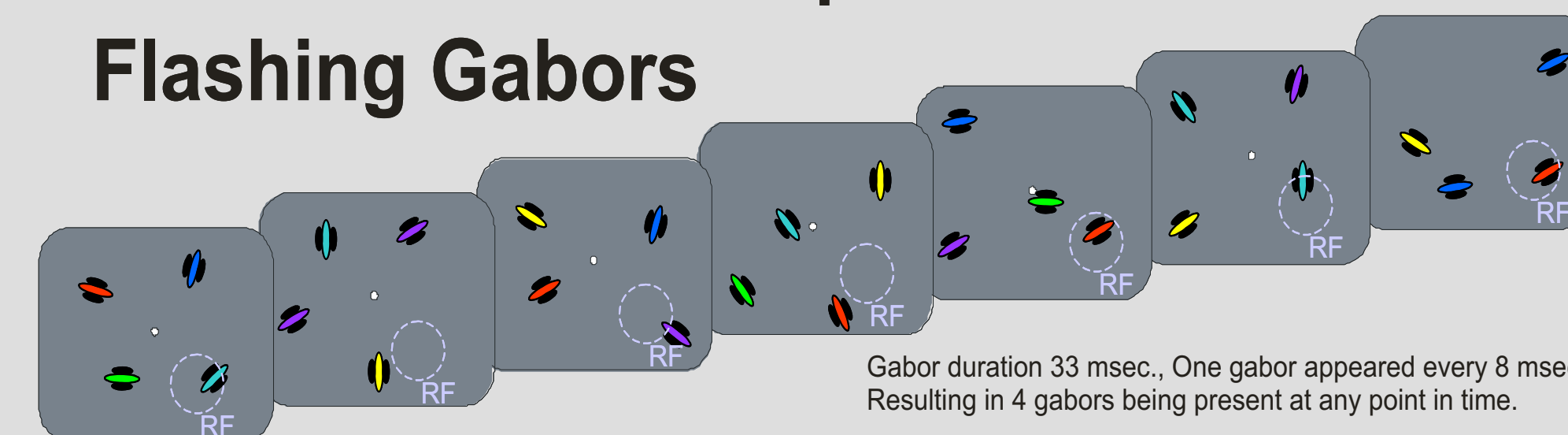
### Step 1) Mapping a V4 Unit's Receptive Field

\* The monkey attentively tracked targets far from the receptive field while oriented, colored gabors appeared throughout the visual field. The neuron's spatial receptive field, color, and orientation tuning were computed on the basis of responses to the gabors.

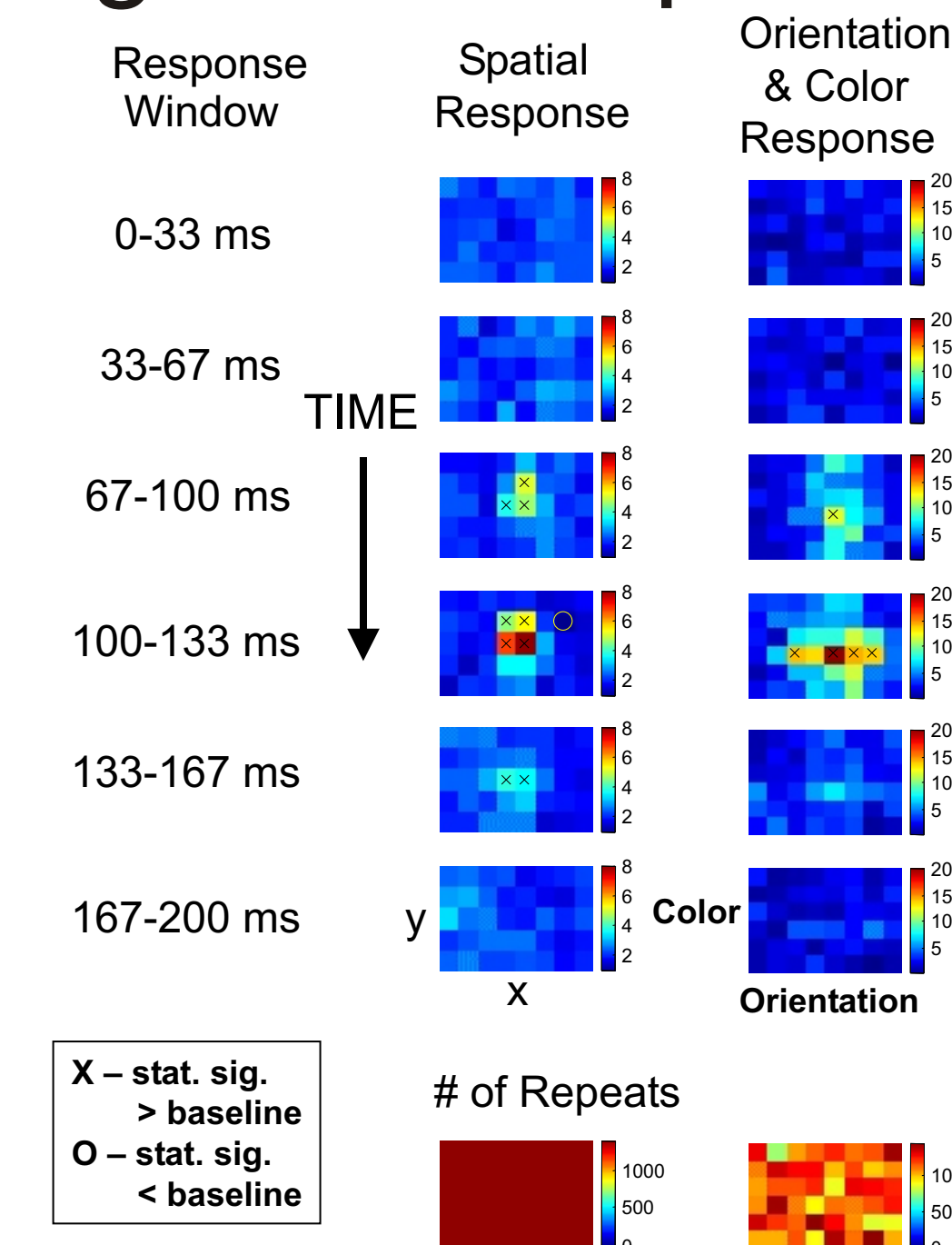
Tracking Away from RF



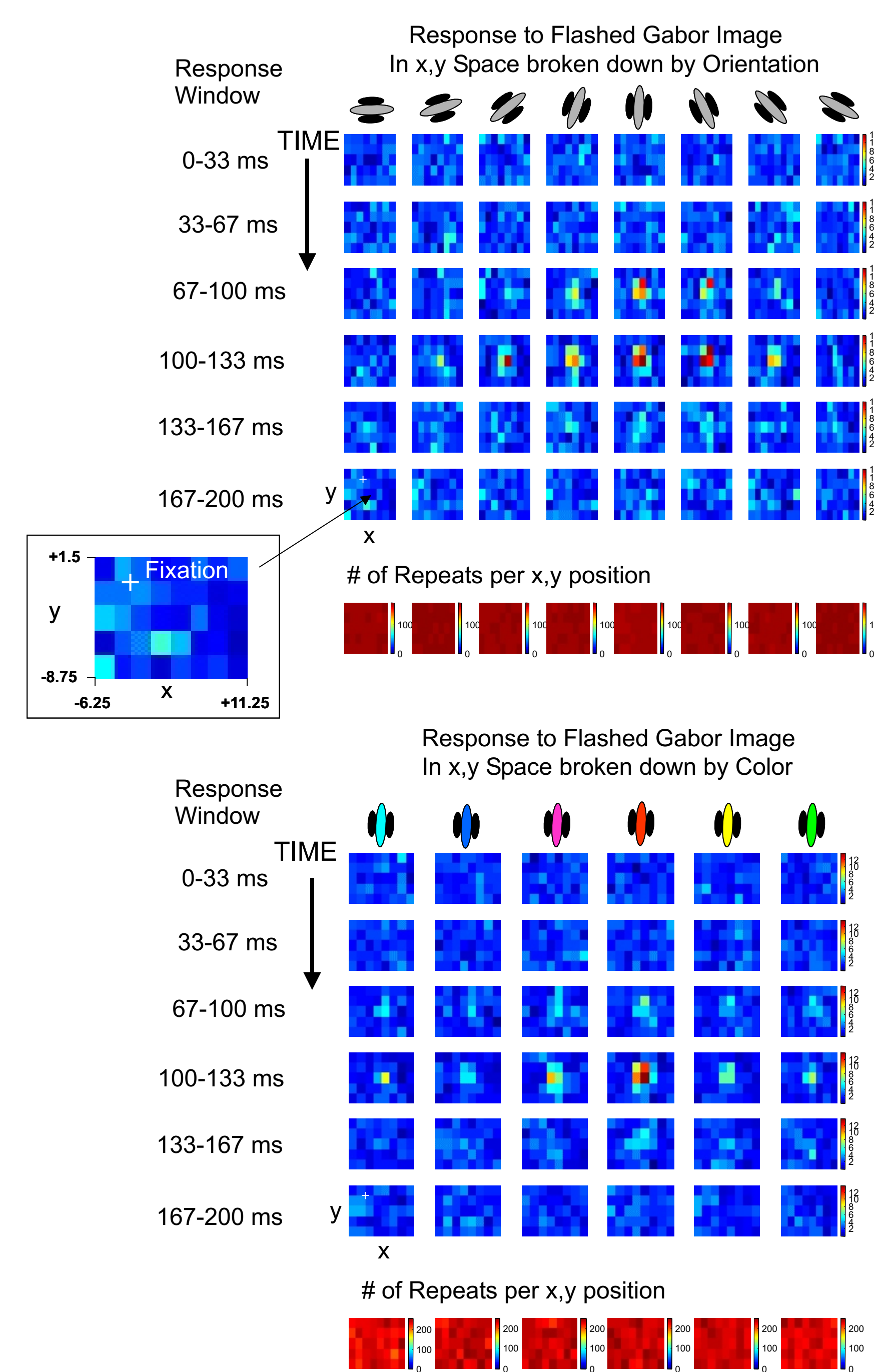
Flashing Gabors



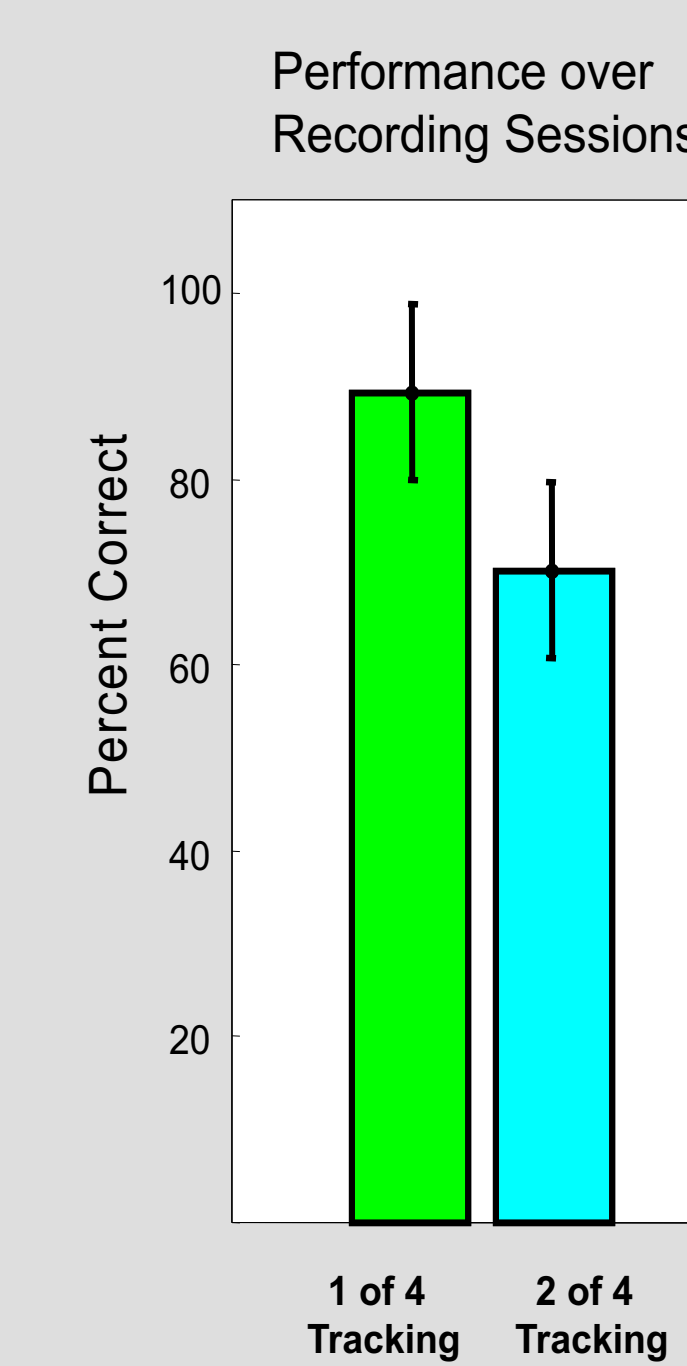
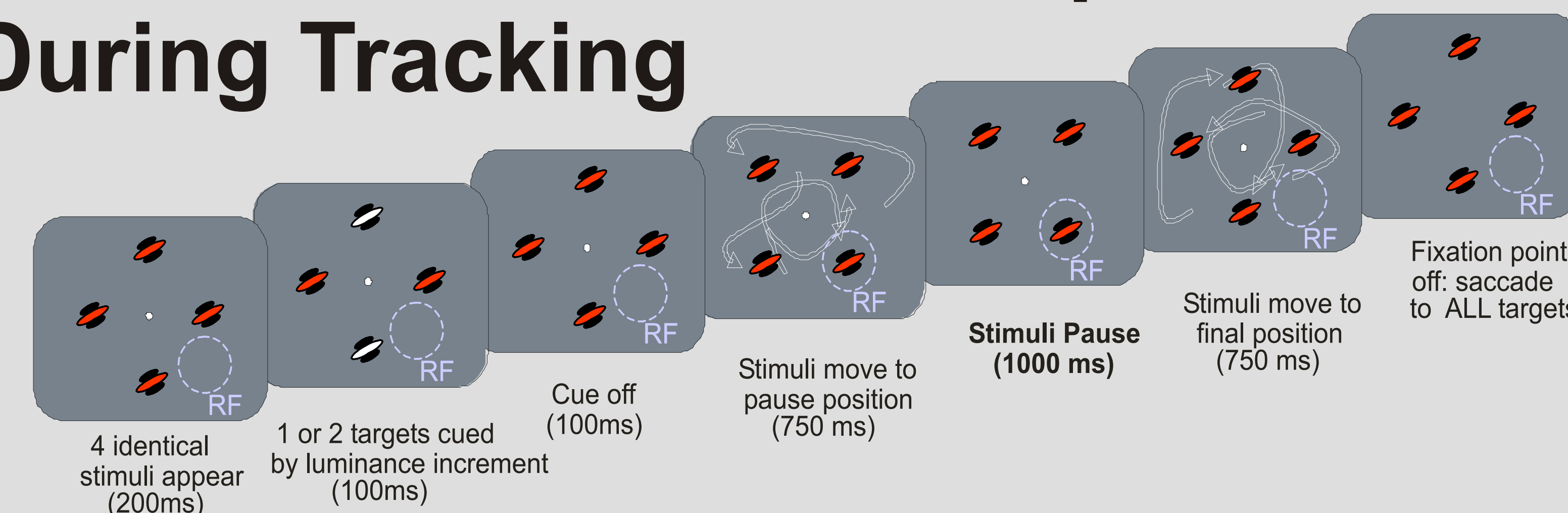
Joint Color/Orientation Tuning for Example Cell:



Example Neuron:



### Step 2) Preferred Stimuli Enter and Pause in the Unit's Receptive Field During Tracking

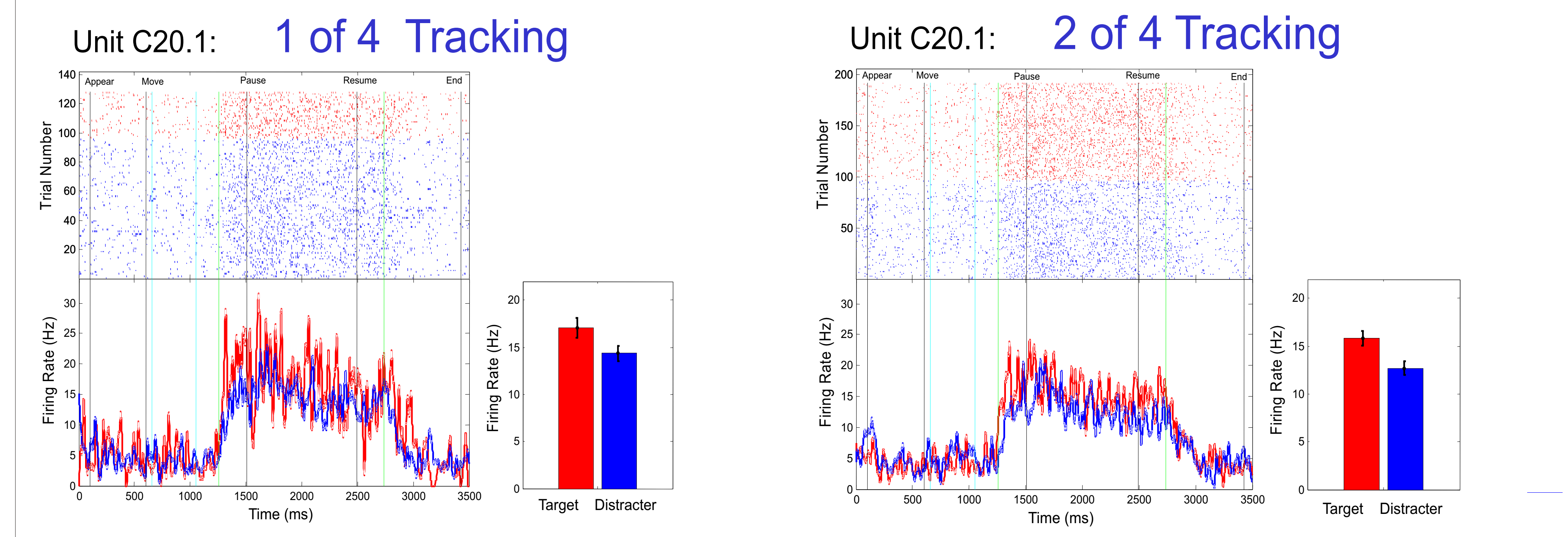


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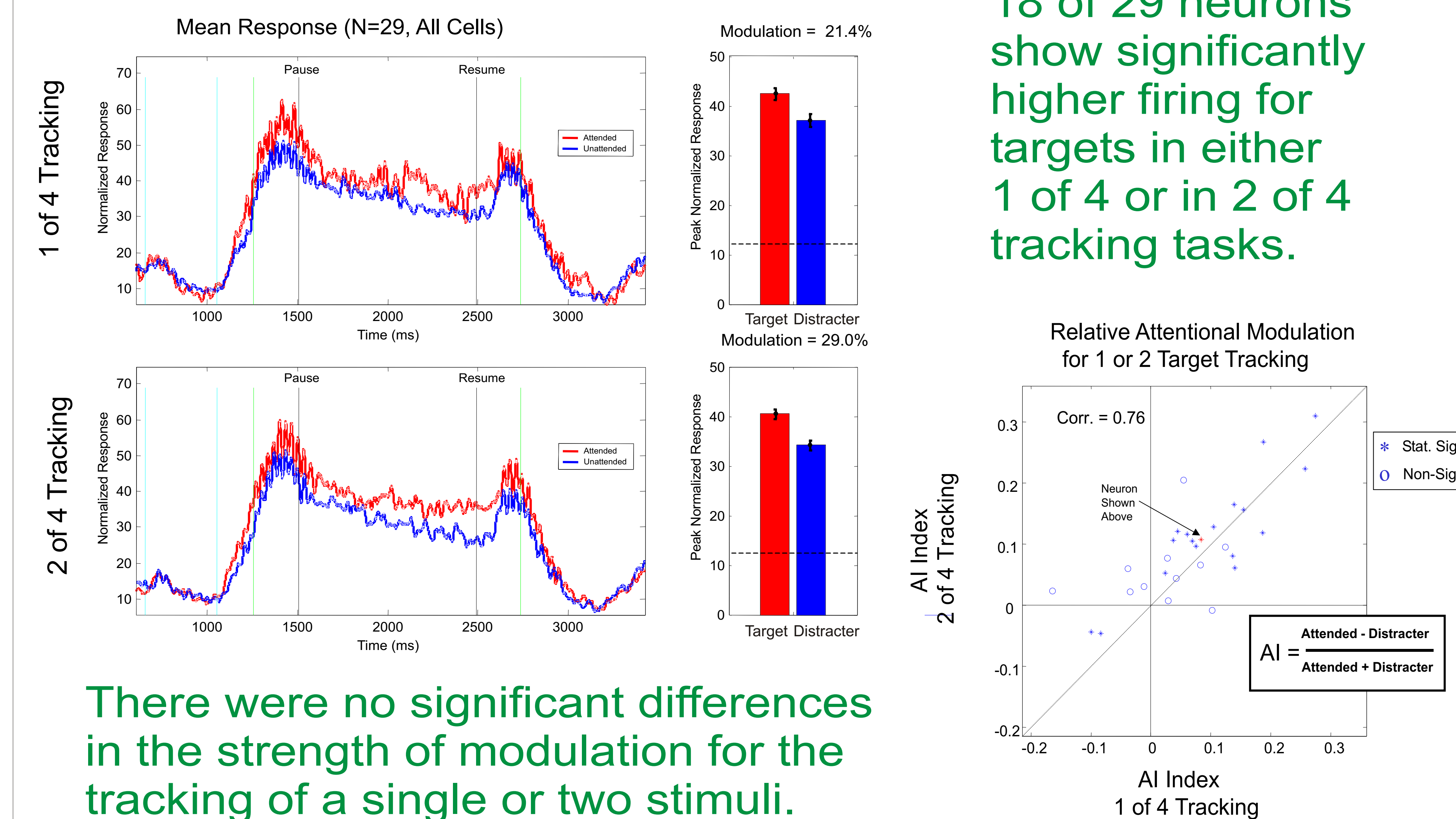
Funding provided by NIH Training Grant in Cognitive Neuroscience (J.M.), NSF Graduate Research Fellowship (K.S.), and NEI grant 1R01EY13802 (J.R.).

V4 responses are enhanced for tracked items. The strength of modulation is similar for tracking 1 or 2 targets.

Example Cell:



We recorded 29 cells from Monkey M:



There were no significant differences in the strength of modulation for the tracking of a single or two stimuli.

## Summary

- 1) Monkeys can track 2 and humans can track 3-4 items.
- 2) Humans discriminate form changes better on targets.
- 3) In V4 tracked stimuli elicit higher firing rates.
- 4) This response increase is not measurably diminished when a second stimulus is tracked.

References

1. Pylyshyn ZW and Storm RW (1988) Tracking multiple independent targets: evidence for a parallel tracking mechanism. Spat Vis. 3(3):179-97.
2. Sears CR and Pylyshyn ZW (2000) Multiple object tracking and attentional processing. Can J Exp Psychol. 54(1):1-14.