

Neuronal mechanisms of pre-saccadic attention in middle temporal (MT) area of the marmoset monkey

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<http://marmolab.bcs.rochester.edu>

Background



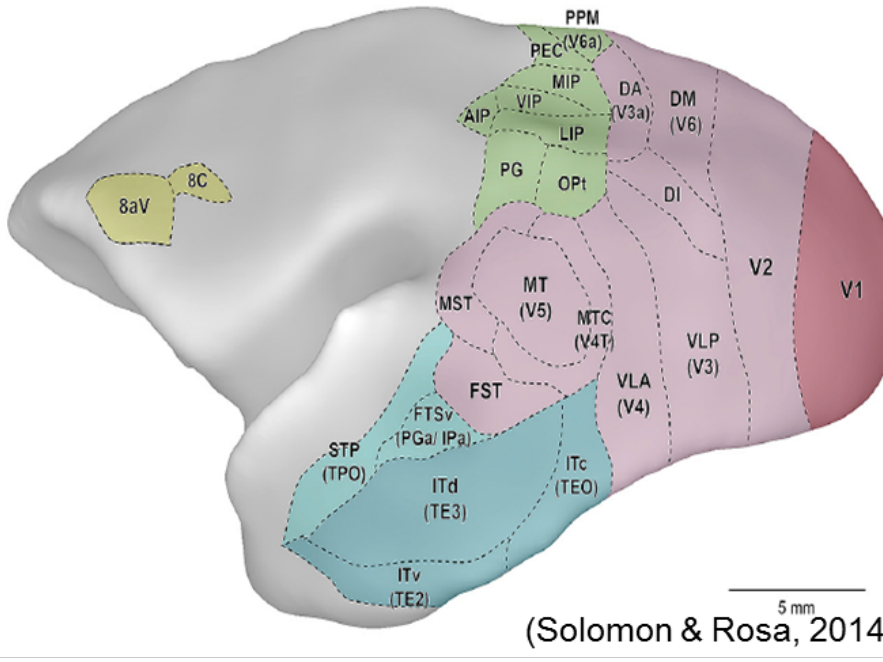
The marmoset has drawn recent interest as a model for visual neuroscience for several reasons:

- High acuity fovea
- Anatomical similarities to other primates
- Smooth cortex with access for imaging and array recordings in visual and oculomotor areas
- Advantages for genetic manipulation

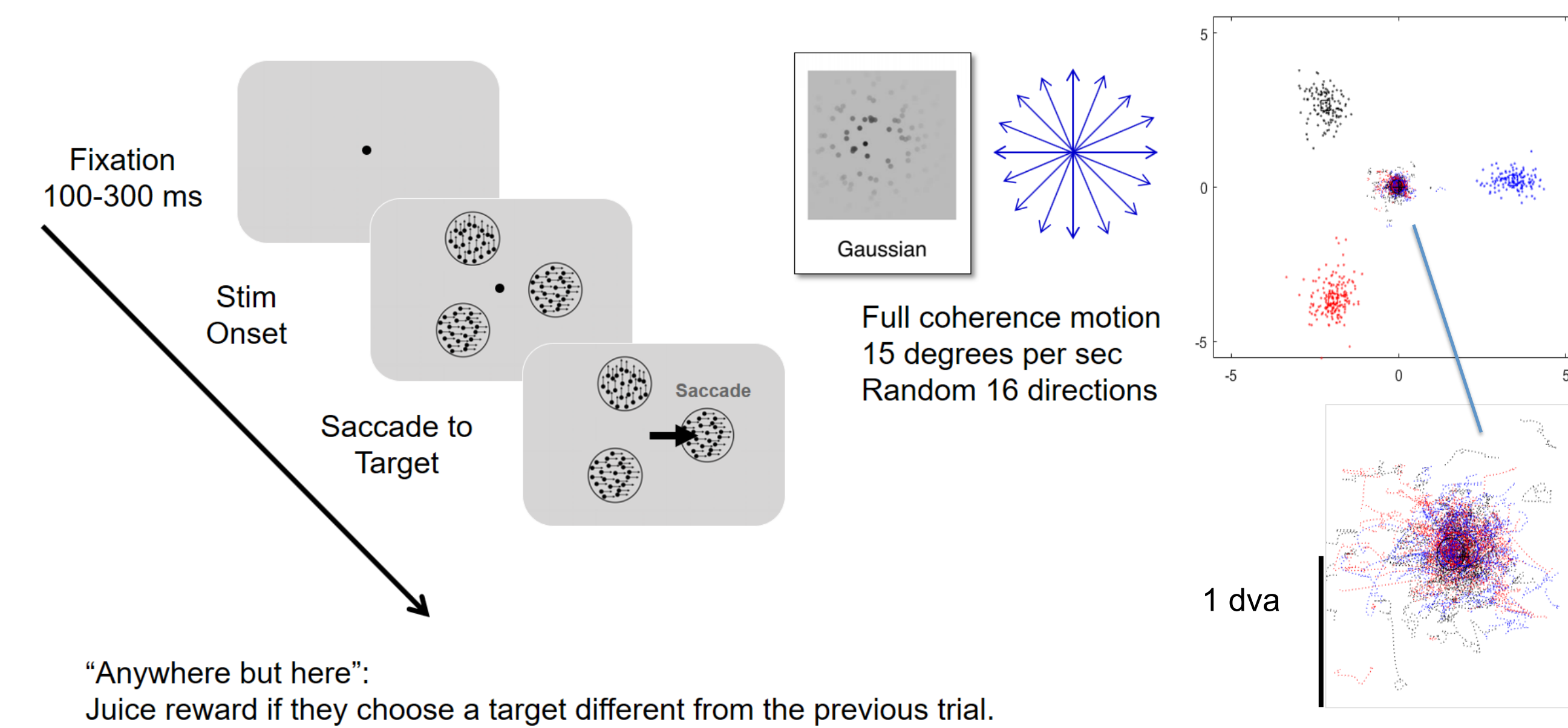
We examined the neural mechanisms of pre-saccadic attention in cortical area MT using a simple saccade task that exploited their natural foraging behaviors.

Is pre-saccadic attention in marmoset comparable to the macaque with increased stimulus sensitivity?

Does pre-saccadic attention differ from covert attention in modulation of neuronal tuning curves?



Spatial Cueing Task



Right: The subject maintained fixation for 100-300ms, then three motion dots fields appeared and a saccade was made to one of the targets. We rewarded saccades to any location as long as it differed from the previous trial to encourage foraging. We analyzed neuronal responses to motion stimuli based on when saccades were made towards or away from the receptive field (RF). Left: Saccade end-points across a behavioral session are shown with the eye position traces at fixation 100 ms prior to the saccade. Marmosets acquired fixation accurately within a 1.5 degree window without any systematic bias in position towards the target they would choose.

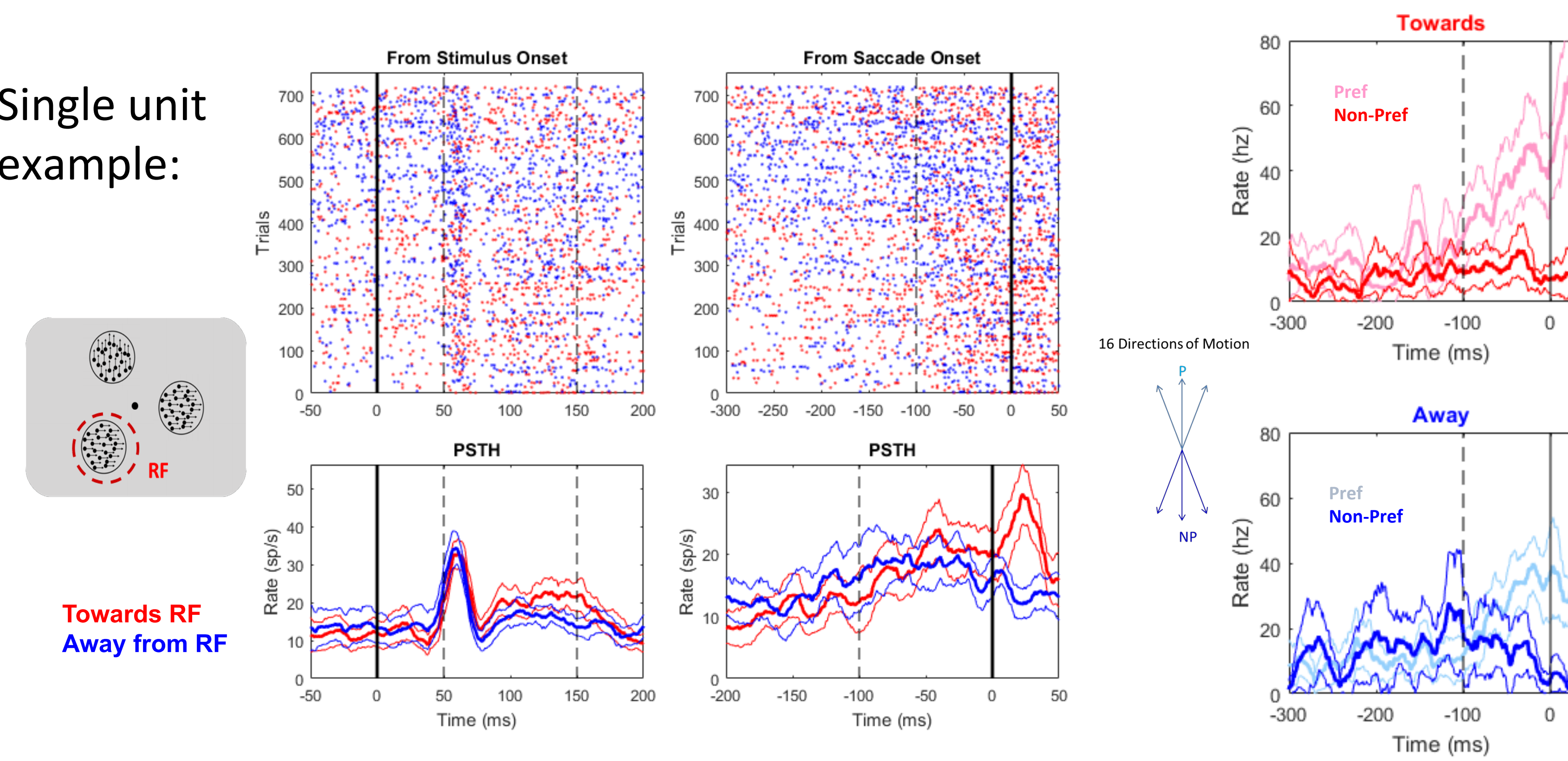
Funding and References

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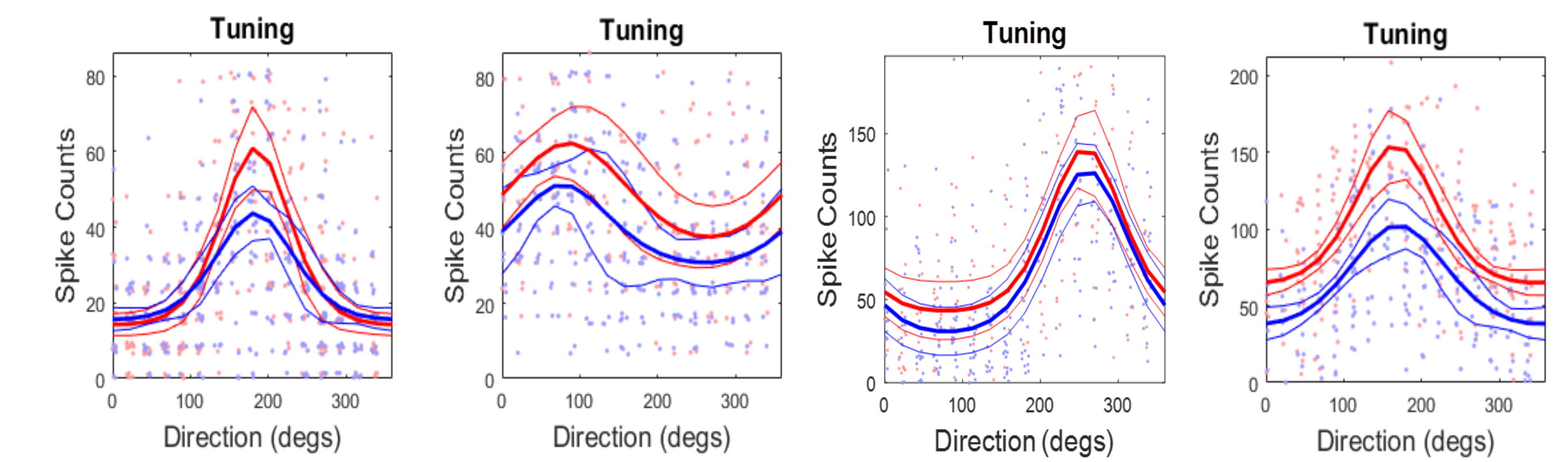
Pre-saccadic Attention Increases Neural Sensitivity

Single unit example:

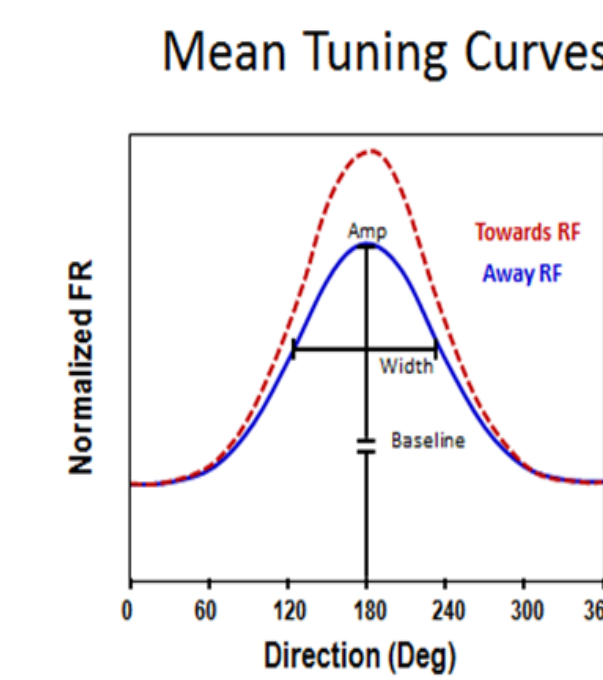


Do Tuning Curves Narrow in Pre-saccadic Attention?

Individual unit examples:



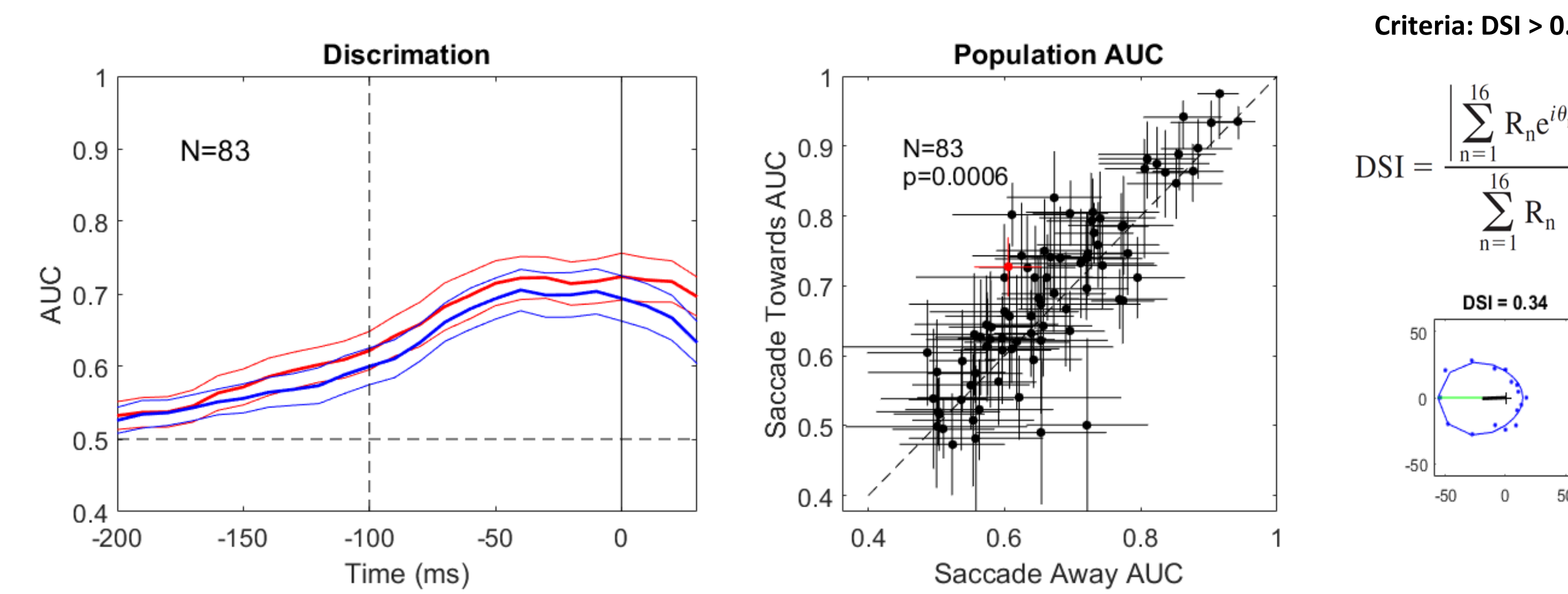
Von Mises Curve Fit:



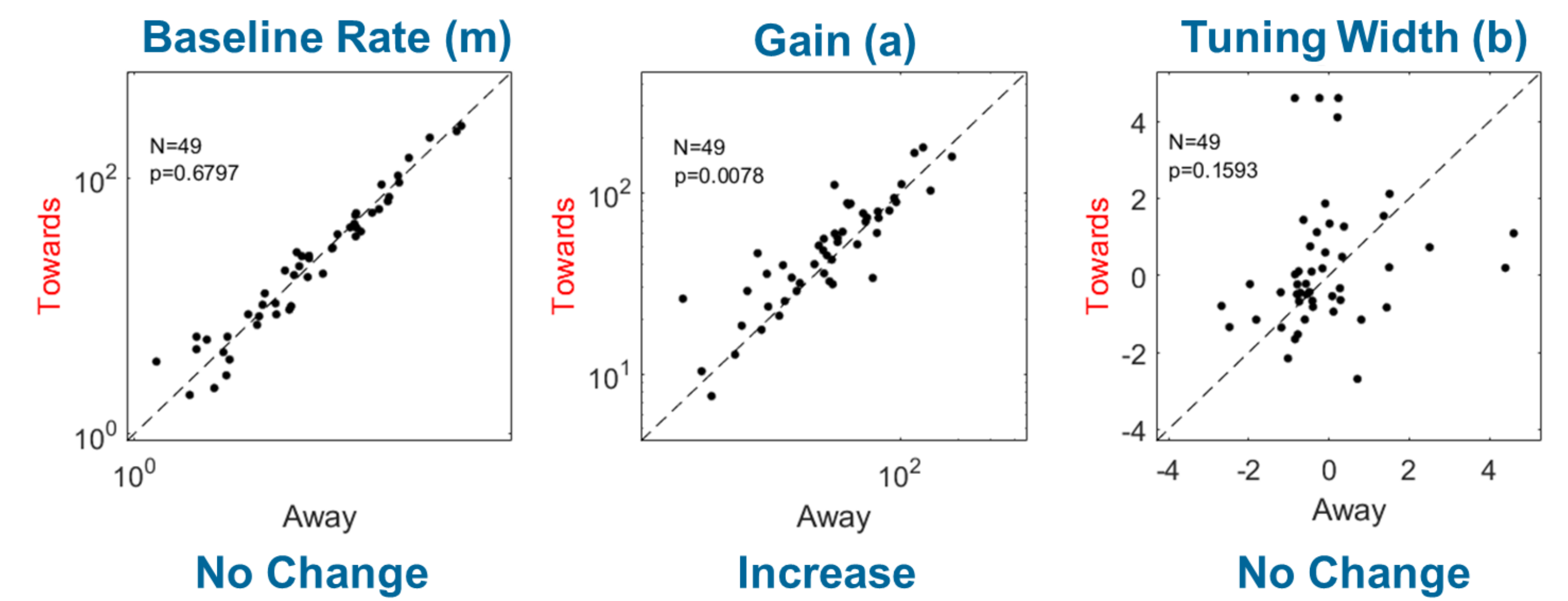
$$r_p = m + ae^{b[\cos(\theta - \theta_{pref}) - 1]}$$

Patterson et al. 2013

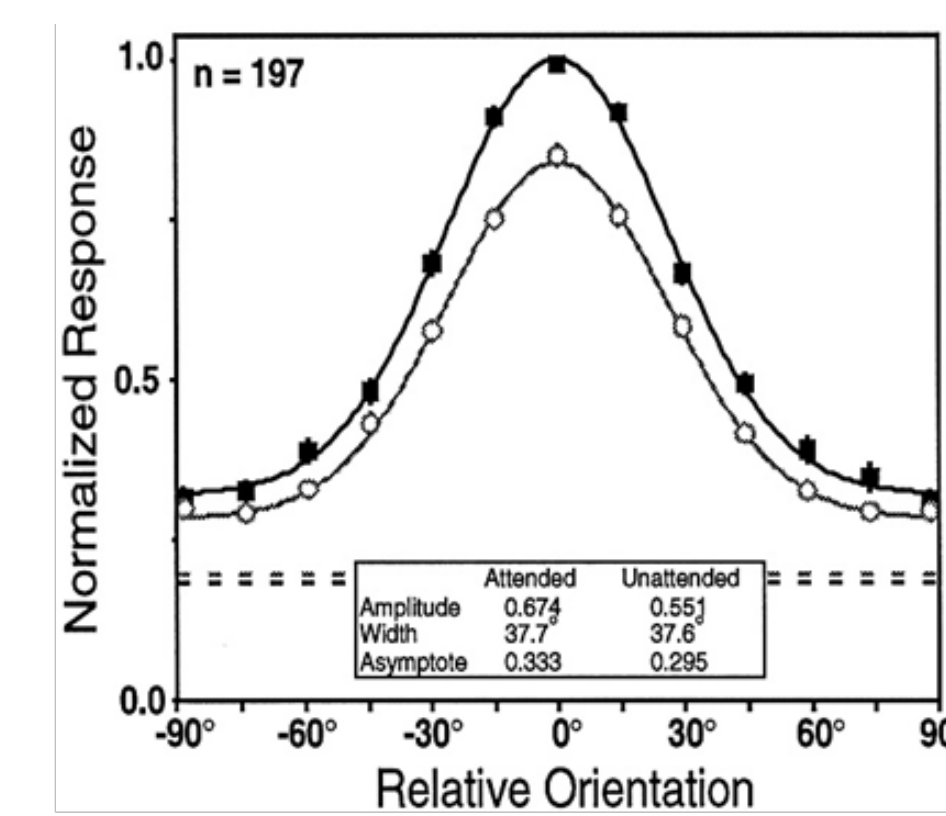
Population Sensitivity:



Changes across population:

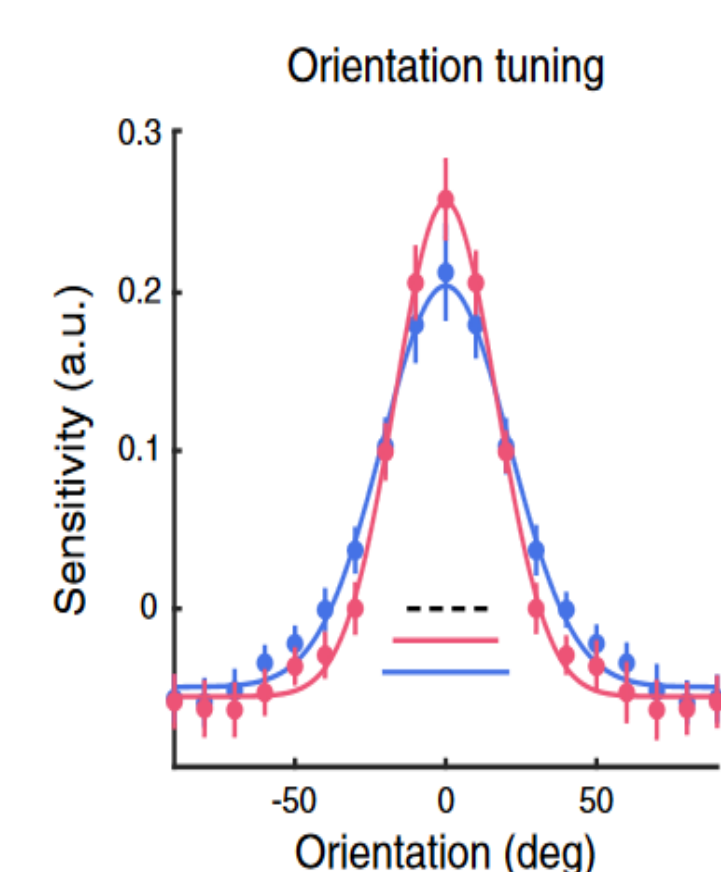


Covert vs. Pre-saccadic Attention



(McAdams & Maunsell, 1999)

Pre-saccadic attention has been thought to be highly similar to covert attention at the neural level in macaques (Moore & Chang, 2009), but tuning curves in pre-saccadic attention have not been measured.

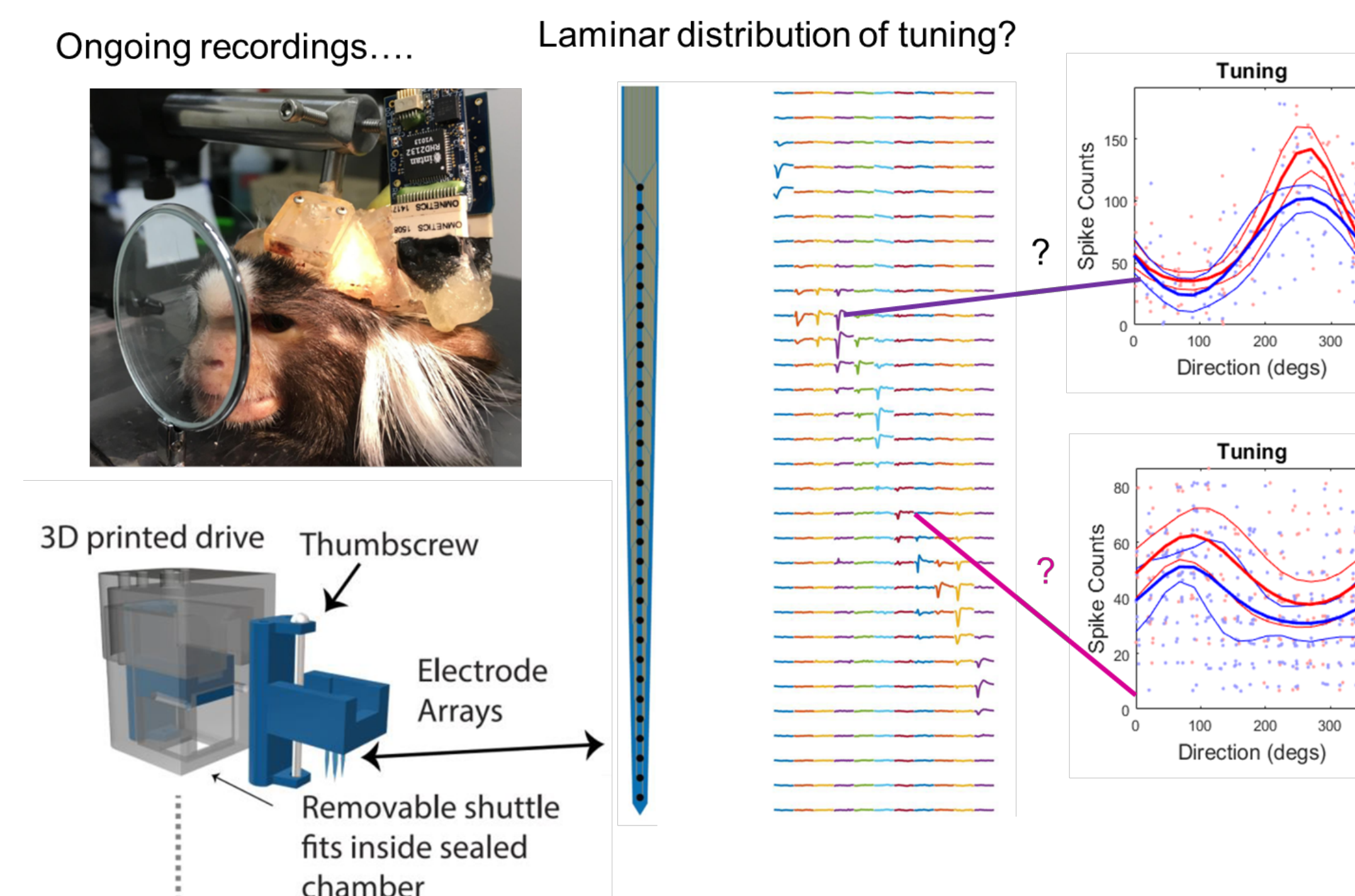


Recent human psychophysics studies suggest the target feature is enhanced prior to saccades and predicts a **Narrowing of Feature Tuning**

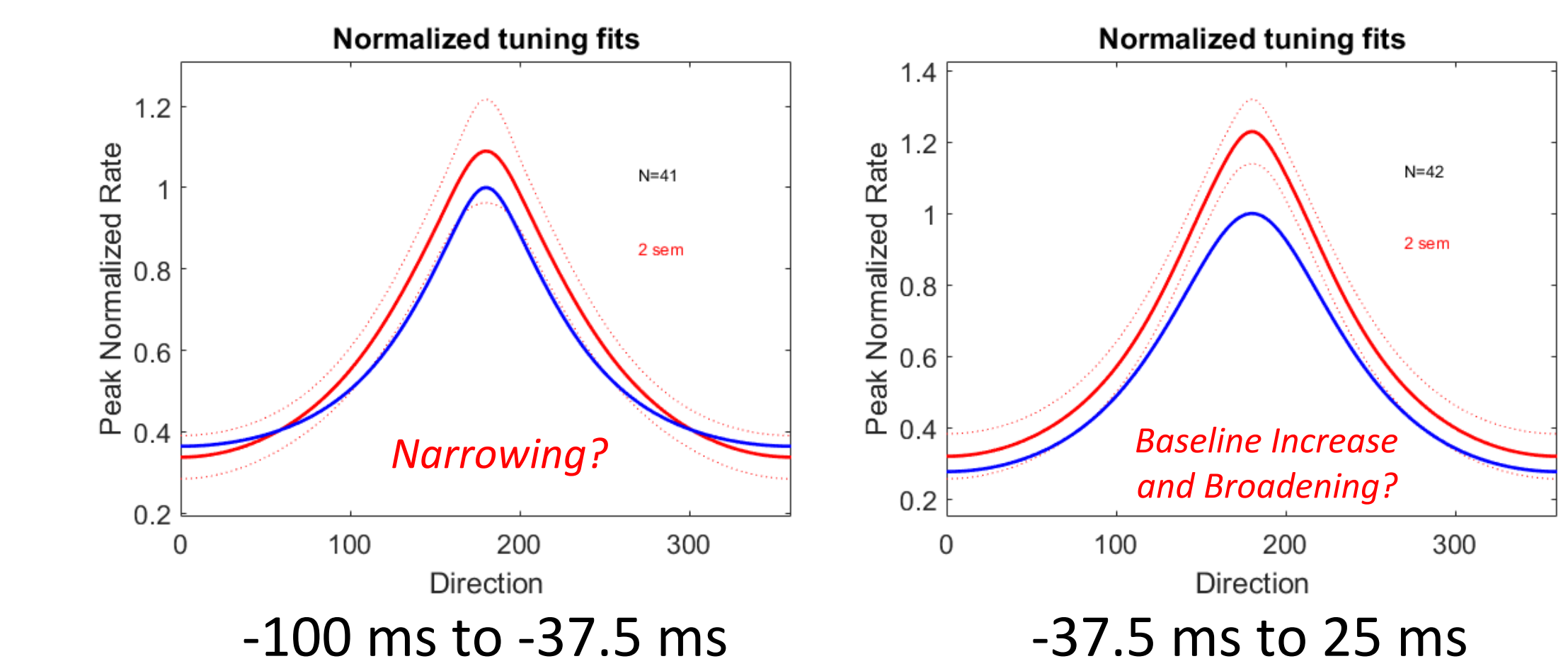
(Li, Barbot, & Carrasco, 2016)

Future directions

Semi-chronic laminar arrays in area MT



Preliminary: modulation may change across pre-saccadic epochs



Conclusions

- Neurons in marmoset MT show pre-saccadic increases in sensitivity for saccade targets similar to that found in macaque area V4.
- Tuning curves in MT are modulated in diverse ways, including narrowing of tuning, but only among subsets of neurons.
- Overall, the most consistent effect of pre-saccadic attention on neural tuning is an increases in gain similar to covert attention.