Spatial cueing and planned saccade tasks in the marmoset

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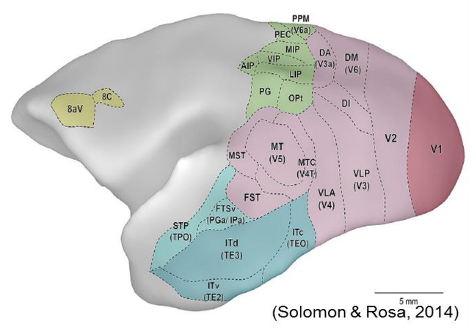
Background

The marmoset is a growing model in visual neuroscience for many reasons:

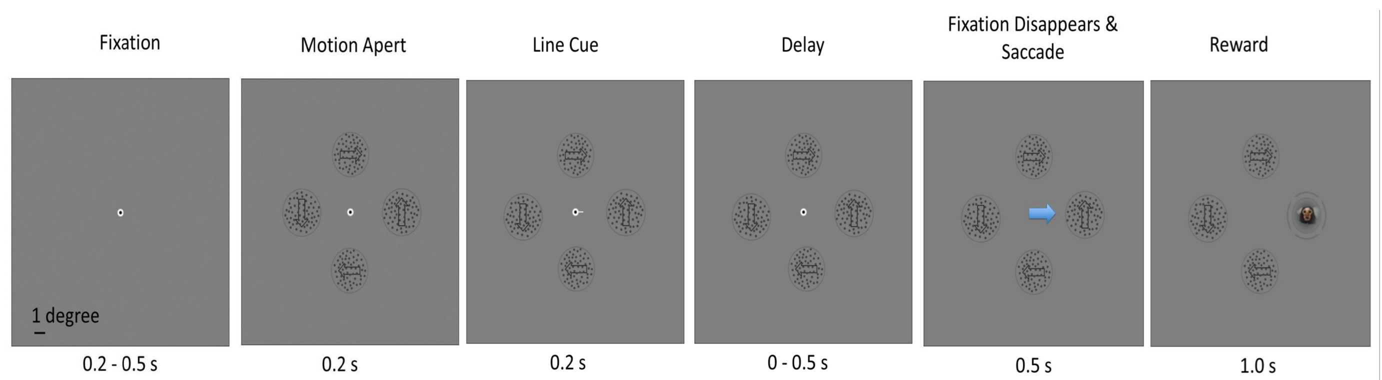
- High acuity fovea
- Anatomical similarities to other primates
- Smooth cortex with access for imaging and array recordings in visual and oculomotor areas
- Advantages for genetic manipulation

But much remains unknown about their behavior in trained tasks. Here we test their ability to use central cues at fixation to direct saccades to peripheral targets.



Spatial Cueing Task

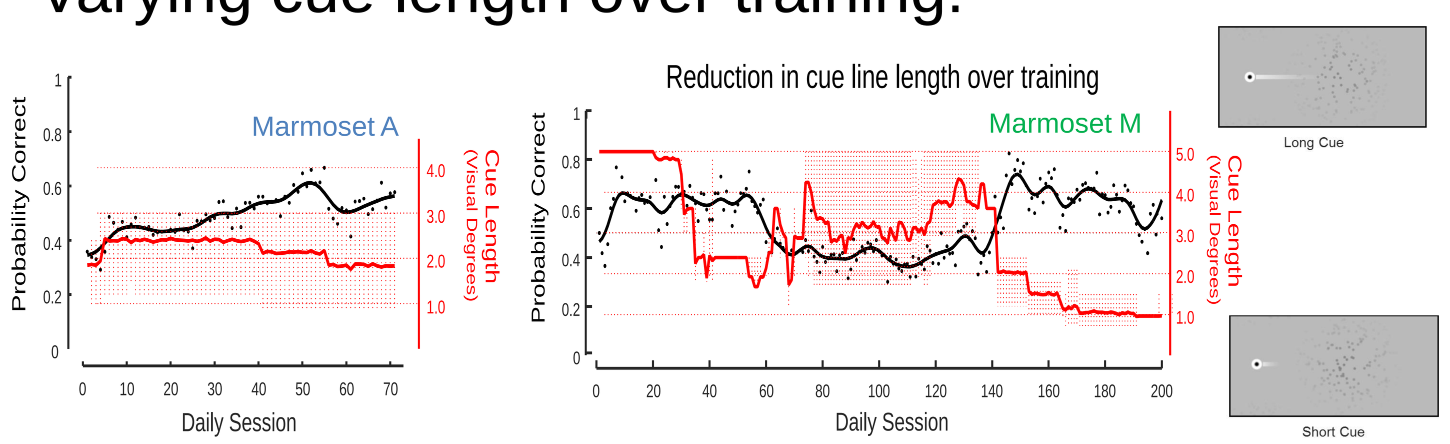
4 Alternative Choice Cueing Task:



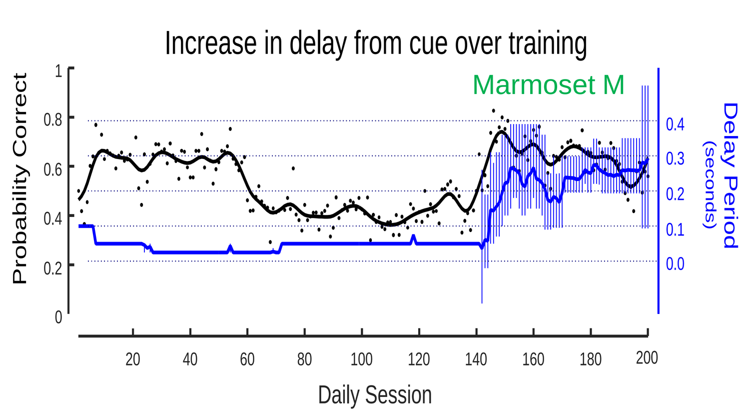
-After fixation is acquired four equally spaced apertures appear at 5 deg eccentricity.
-On alternating trials, 4 targets were shown either in ordinal or cardinal positions, covering 8 locations.
-Dot fields move within apertures (100%coherence, 50 dots, 2-3 degree diameter, 7 degs/sec).
-Motion was chosen at random between two directions that were tangent relative to fixation.
-A briefly flashed (200ms) central line cue indicated the location of a rewarded target aperture.
-After a brief delay fixation disappeared prompting a saccade to the target aperture.

Training Regimen

Varying cue length over training:

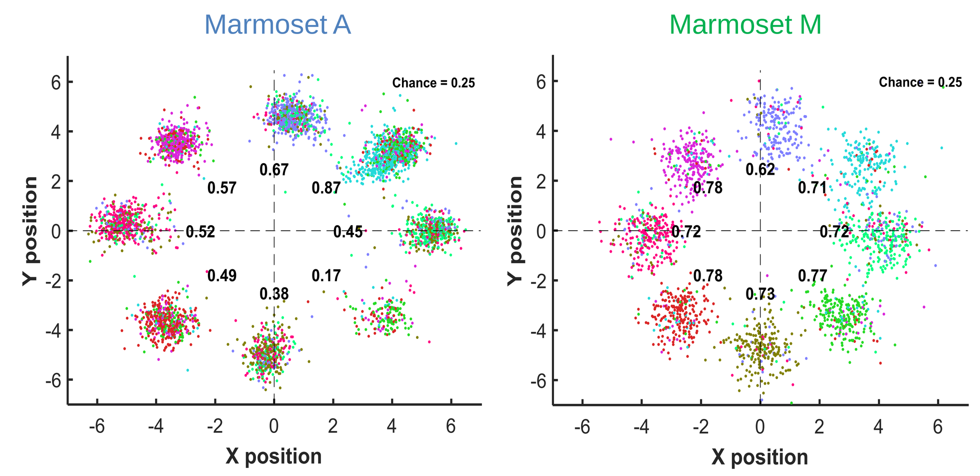


Varying delay over training:

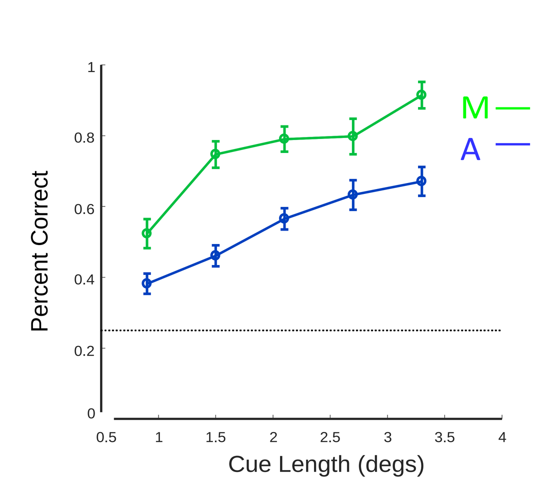


Over months of training the length of the line cue was reduced from full length, connecting fixation to the target, to a shorter length, less than 2 degrees at fixation. Later we also attempted to introduce a delay between the line cue and the offset of fixation that prompted a delayed saccade to the target in one animal.

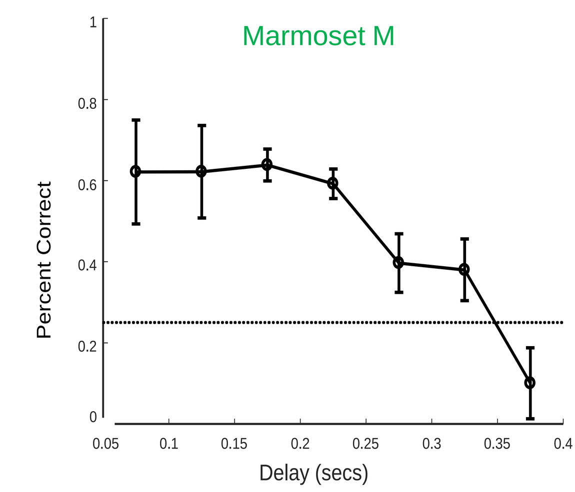
Performance



Marmosets use line cue to guide saccades with limited spatial bias.



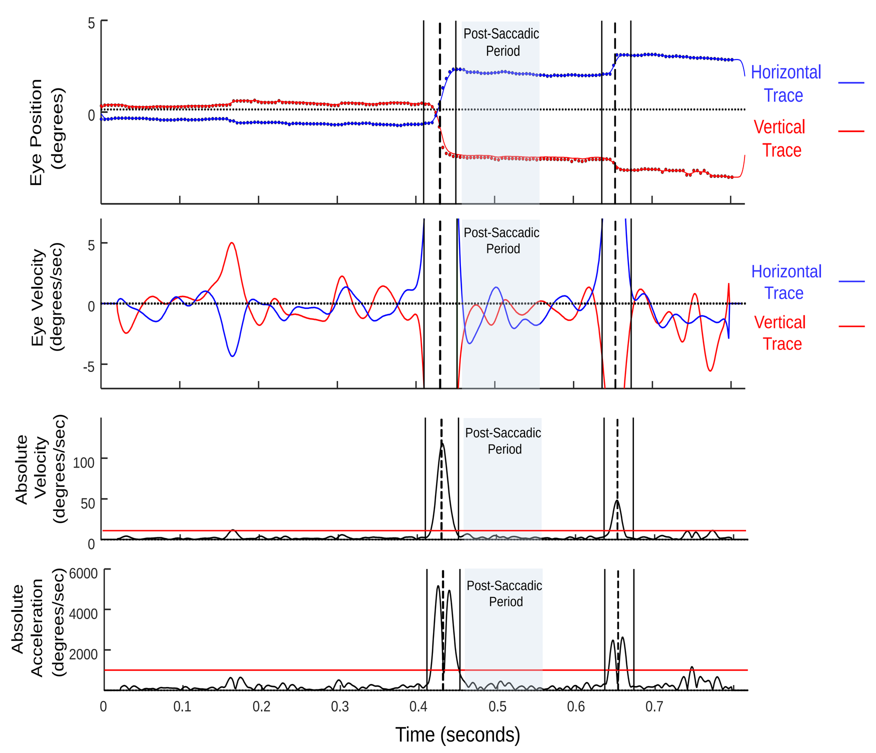
Marmosets can use shorter line cues.

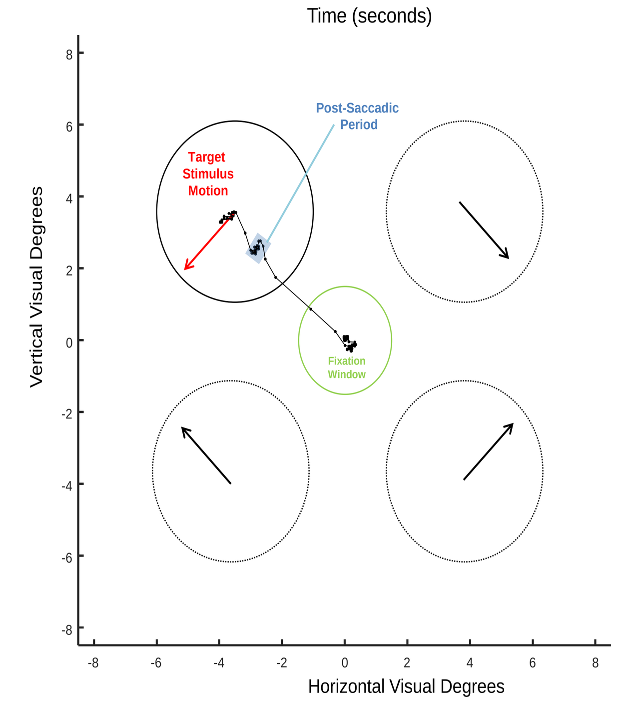


A single marmoset could not hold for delays over 300ms.

Pursuit

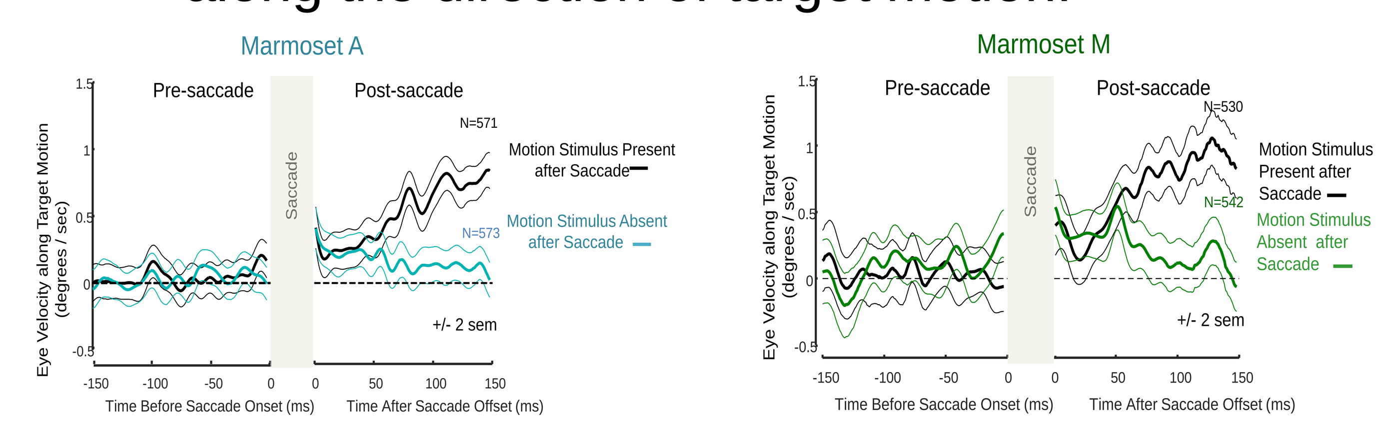
Eye movements in a single trial:





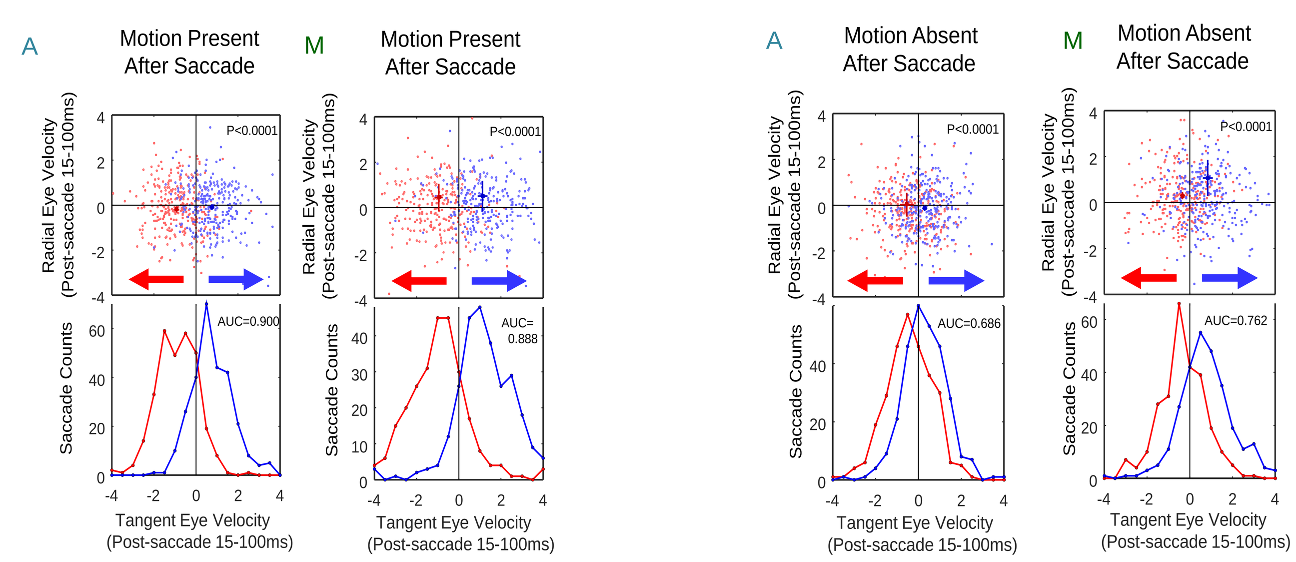
Methods: Eye movements were collected with an infra-red eye tracker (220hz, Arrington, Inc), median filtered (+/- 2 samples) and smoothed with a Gaussian kernel (10 ms half-width). Saccades were scored using both velocity and acceleration thresholds (10 degs/sec and 1000 degs/sec²). To determine if eye velocity tracked the motion in the target aperture, we projected horizontal and vertical components onto the target motion direction. Intervals between saccade onset and offset were excluded from analysis to focus on smooth pursuit.

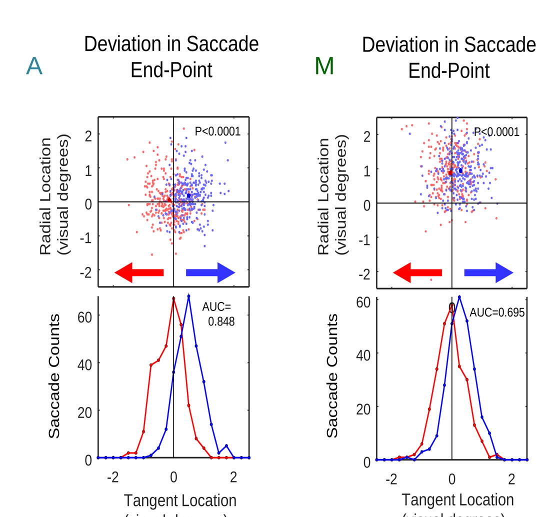
Both marmosets exhibit low gain pursuit along the direction of target motion:



The trial to trial distribution of post-saccade eye velocity (15-100ms) distinguished target motion.

Eye velocity still distinguished target motion when the stimulus was removed before saccade landing (pre-saccadic selection)



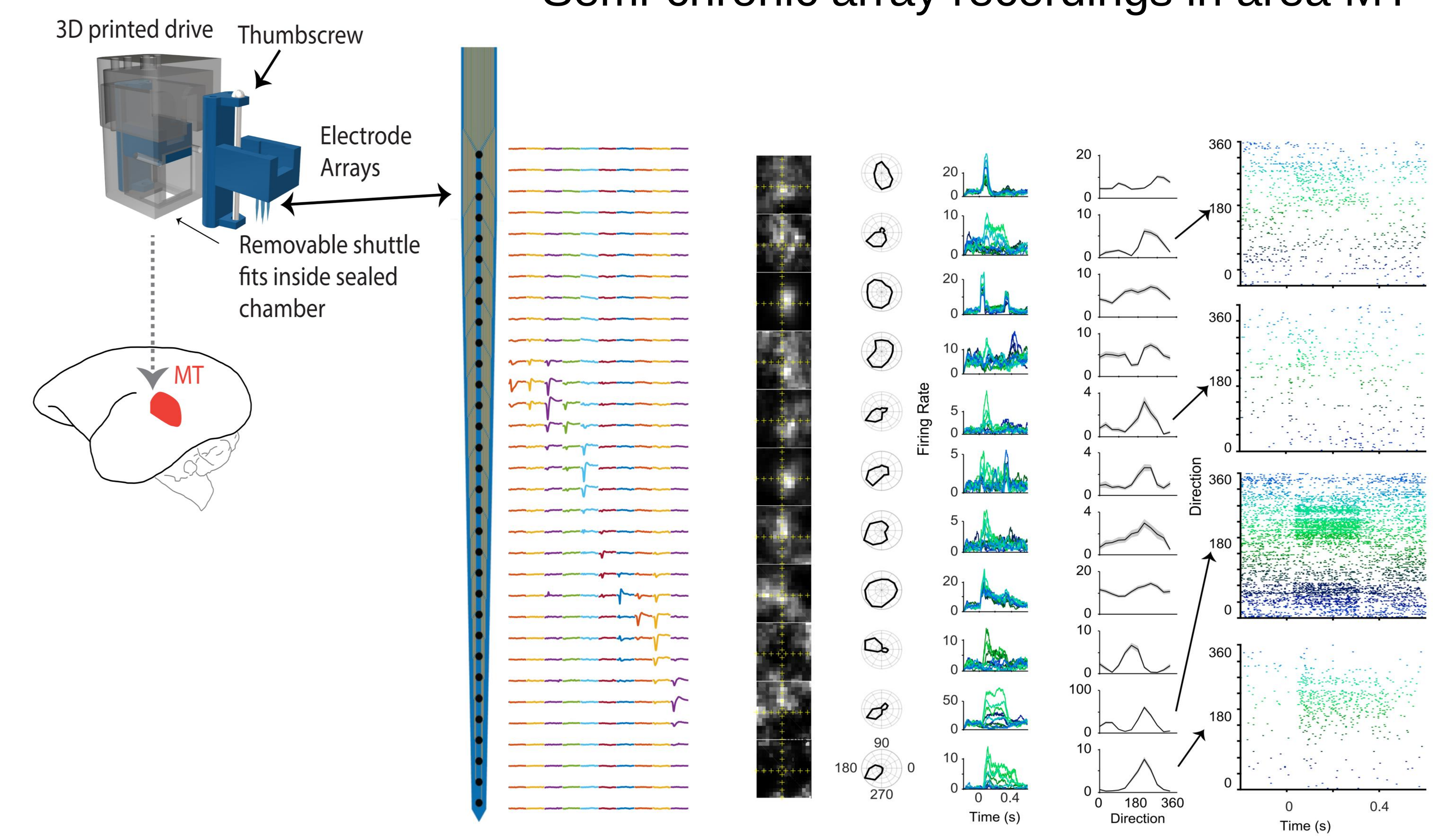


Both marmosets also show deviation in saccade endpoints along target motion

(see Kosovicheva et al, 2014).

Future directions

Semi-chronic array recordings in area MT



Current efforts in our lab are focused on using chronically placed high density silicon arrays that are movable on a screw micro-drive in order to record large scale populations and also distinguish cortical layers in area MT of marmoset.

Conclusions

- Marmosets can learn a central spatial cueing task.
- Saccades to motion apertures reveal low gain pursuit for target motion directly after saccade offset.
- Pursuit persists when the motion is removed during saccade flight, indicating pre-saccadic motion selection.
- Future studies will investigate pre-saccadic motion selection across neural populations in area MT.

Acknowledgments & References

Thanks to Jacob Yates for analysis of MT receptive field data and to Martin Rolfs and Sunwoo Kwon for helpful insights gained from companion studies with human psychophysics. This work was supported by funding from NIH grant U01-NS094330.

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