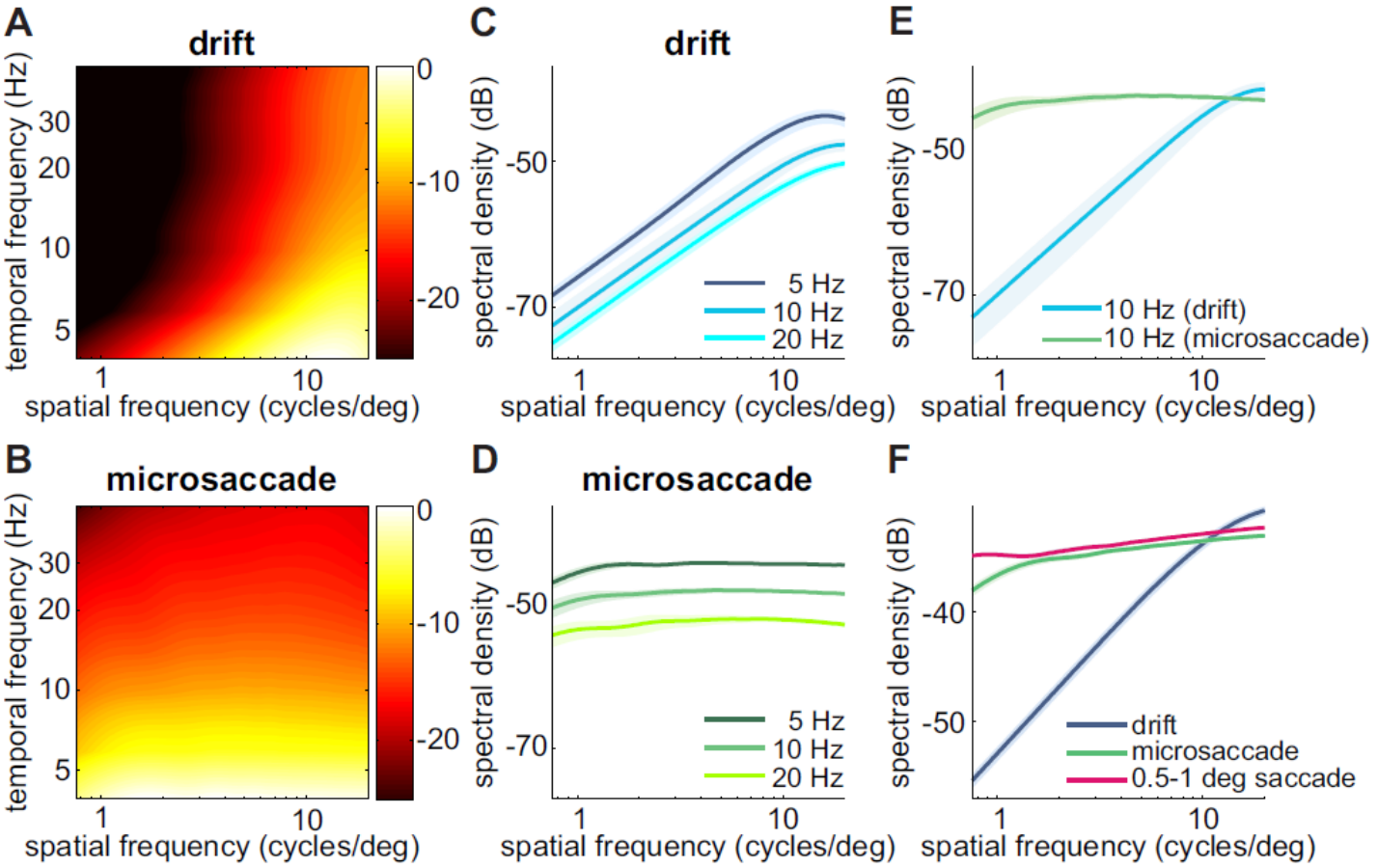
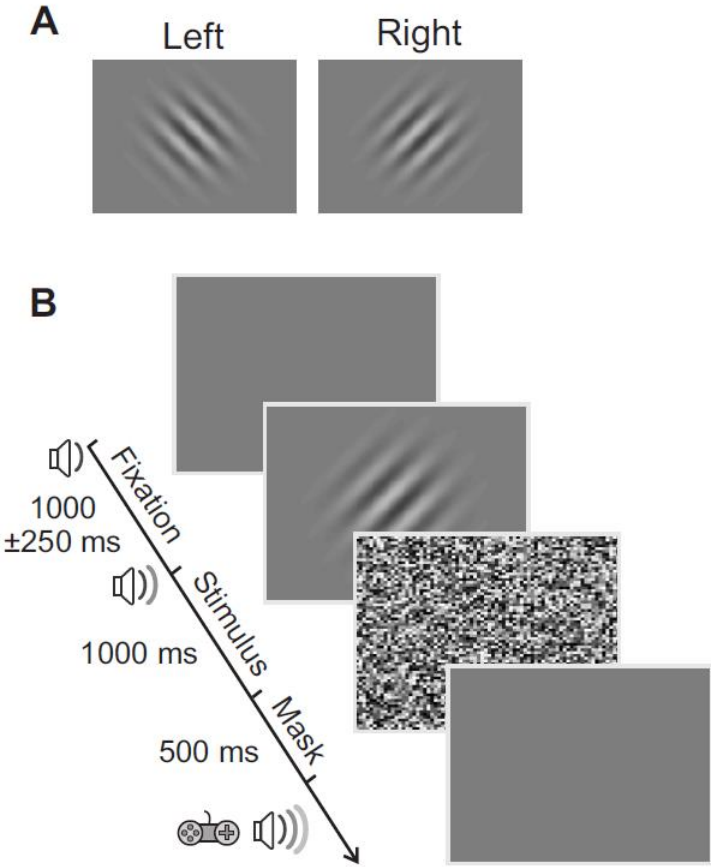
Peri-microsaccadic vision

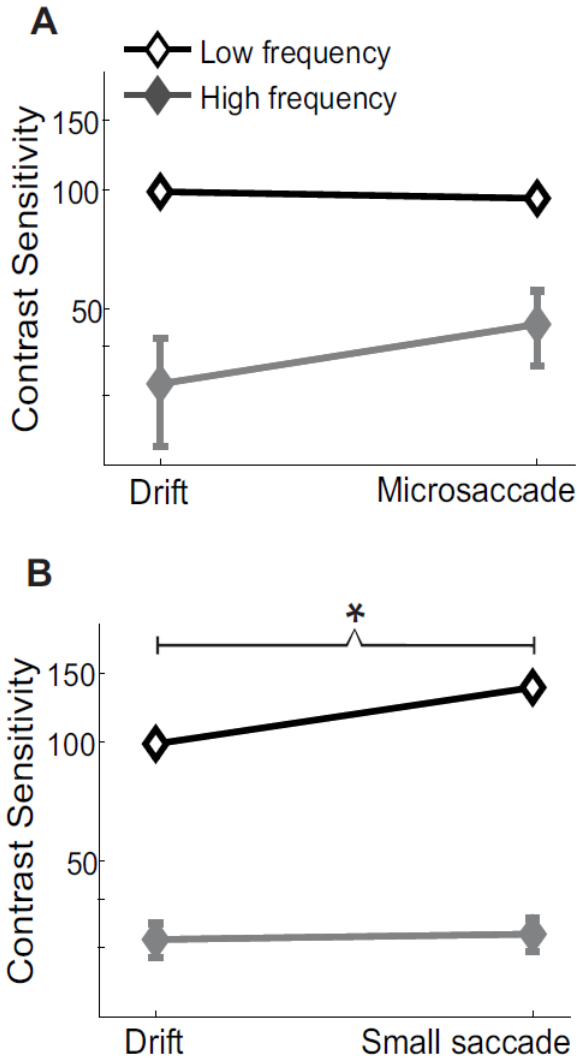
9-16-15

Microsaccades and small contain more temporal power at low frequencies compared to drift



Microsaccade transients do not contribute significantly to our contrast sensitivity





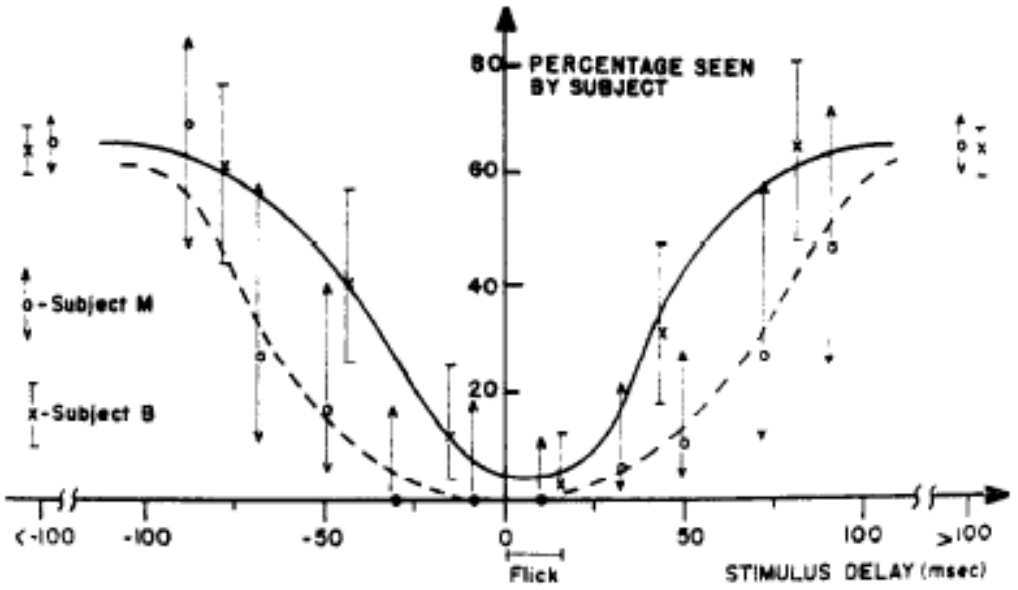
Why the increase in spectral power does not lead to a perceptual advantage?

- We assessed the perceptual over a long period and this might have concealed the effect of microsaccade transients;
  - Reduction in sensitivity during saccades *(Volkmann et al., 1978; Ross et al., 2001).*
  - Post saccadic enhancement *(Chen and Hafed, 2013).*

What is the spatiotemporal profile of contrast sensitivity relative to occurrence of microsaccades and small saccades?

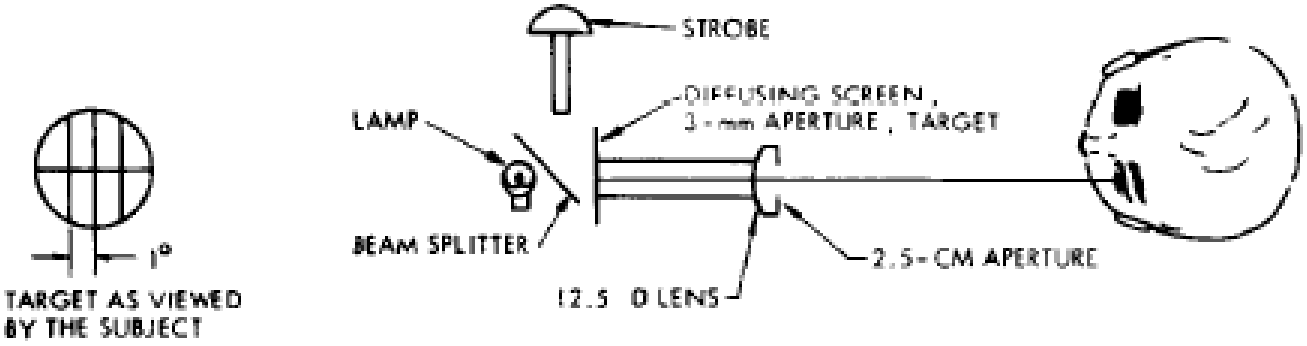
Visual threshold changes resulting from flicks

- Used a long delay random occurrence technique.
- 45% of the stimulus presentations fall within 100 ms of a flick.
- Used a single luminance level.
- the threshold changes start before the onset of the flick and extend after the completion of the eye movement.

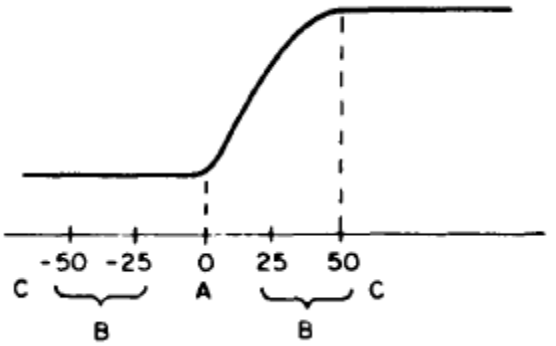


Beeler, 1967

Elevation of visual thresholds at the time of microsaccades



POSITION OF FLASH	SEEN	UNSEEN	TOTAL	% SEEN
(A) $-25 < t < 25$	0	89	89	0
(B) $25 < t < 50$ $-50 < t < -25$	1	7	8	12.5
(C) $50 < t < -50$	61	7	68	90
QUESTIONABLE	8	24	32	25

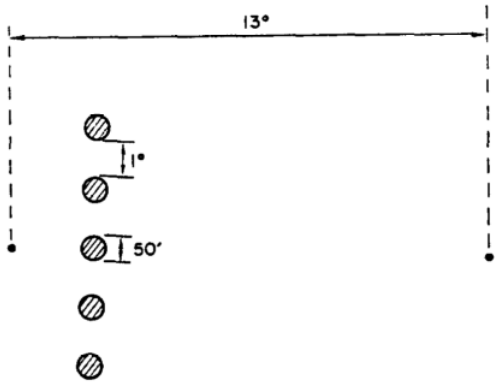


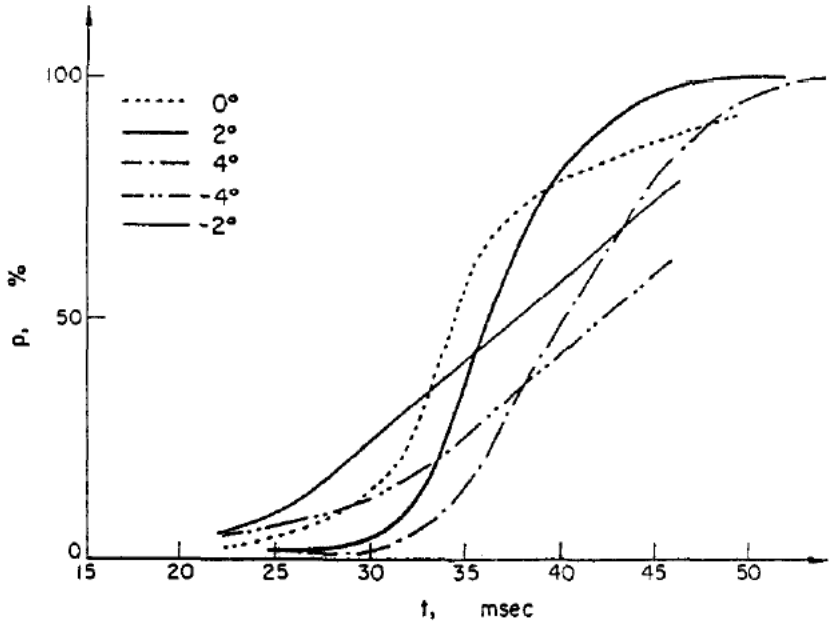
Zuber and Stark, 1966

temporal and spatial characteristics of saccadic suppression

- Saccadic suppression depends on saccade size: it increases linearly with the increase of saccade size.

- the time course of suppression varies in different retinal locations: recovery time is shorter with smaller eccentricities.



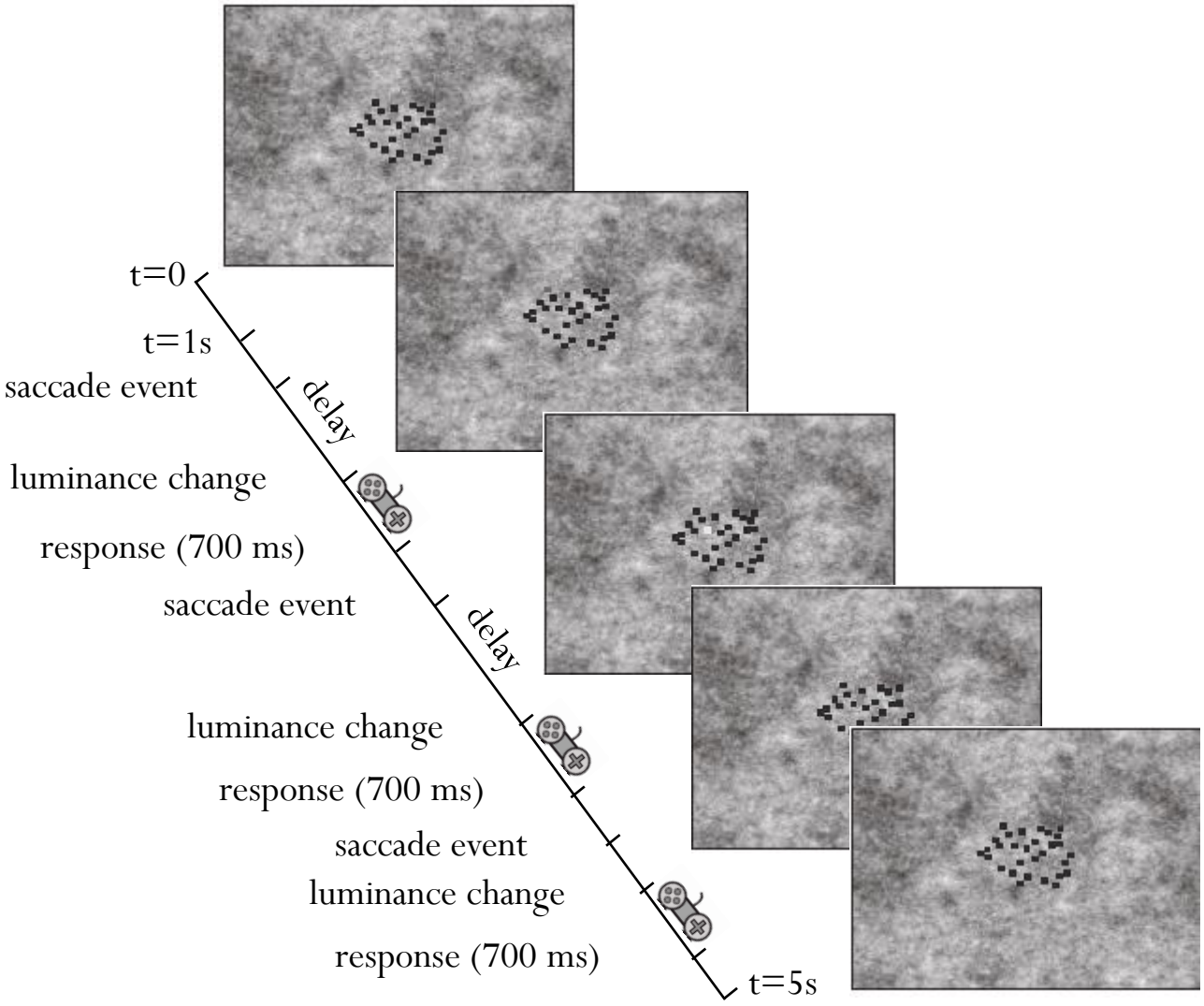


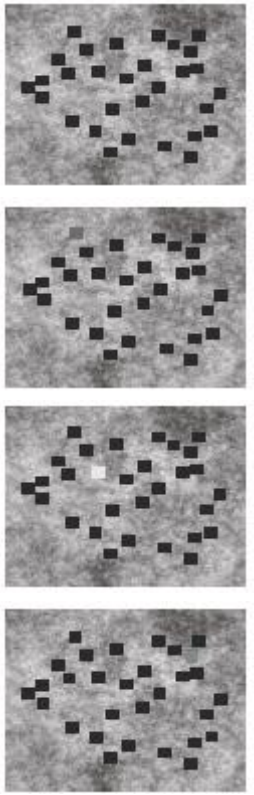
Mitrani et al., 1970

Study objectives:

- Examine the Spatiotemporal profile of peri-microsaccadic contrast sensitivity.
- Examine the homogeneity of contrast sensitivity across the fovea and perifovea.
- Study the dynamics of saccadic suppression phenomena across the fovea and perifovea.

Experimental design

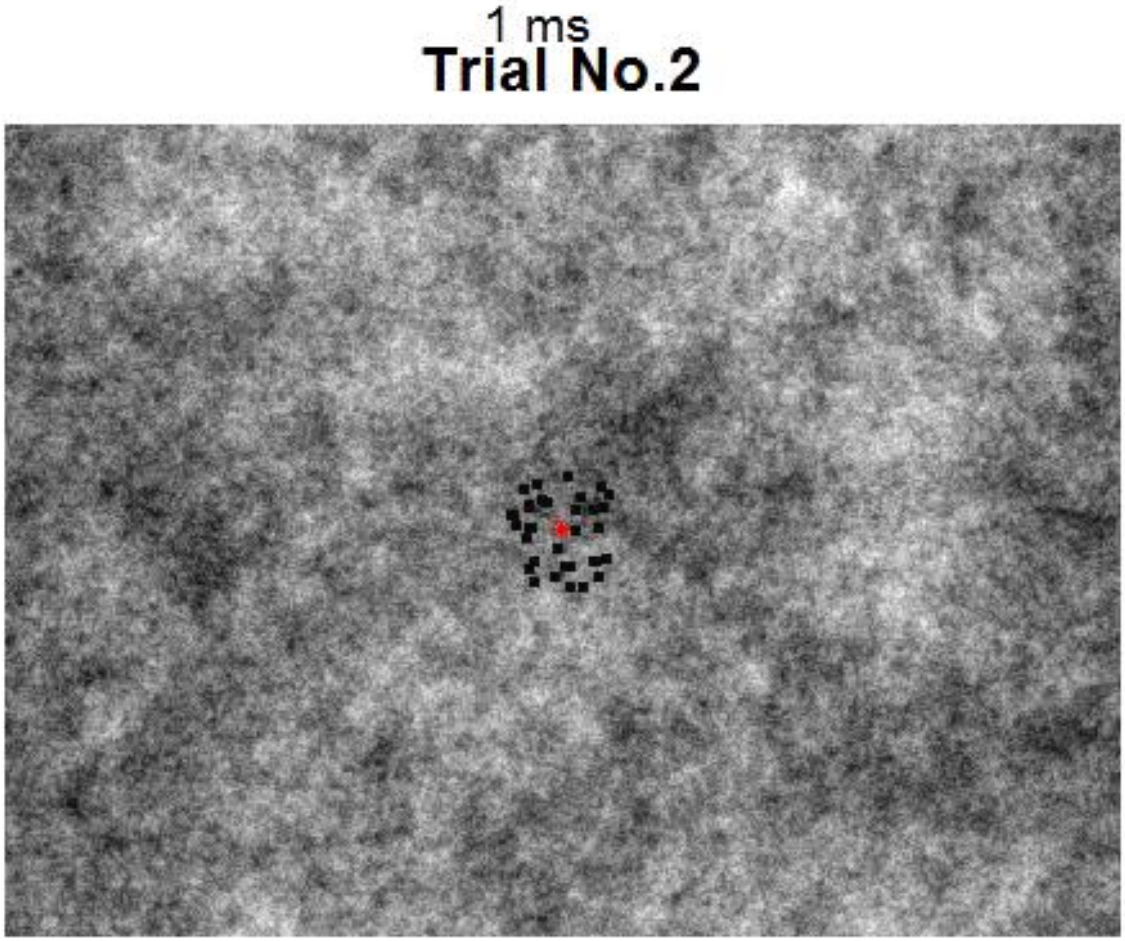




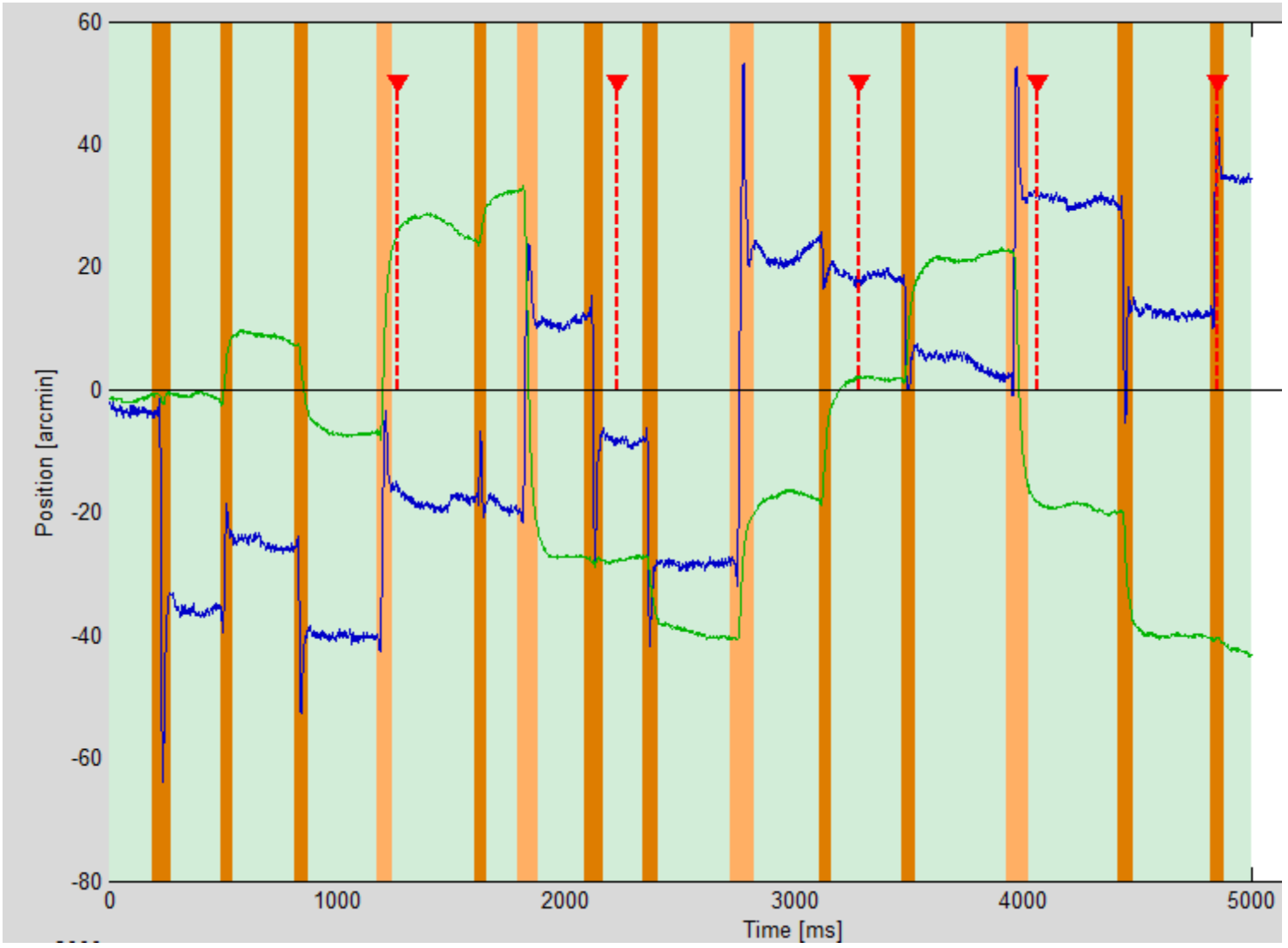
Experiment paradigm

- Each session consists of 5 blocks of 40 trials.
- Objects (squares) are uniformly distributed within 1 deg radius from the center of the screen.
- Upon occurrence of a microsaccade or small saccade (< 1 deg), a luminance change occurs after a delay.
  - The delay varies between 0-400 ms.
- The change occurs at a randomly selected location within ±15 deg from the center of gaze.
- Based on the distance from the center of gaze, the level of change is chosen randomly from 8 values varying between 60-200.
- The duration of change is 10 ms.
- The minimum distance between each two objects is 5 arcmin.
- There is a calibration trial after each trial.

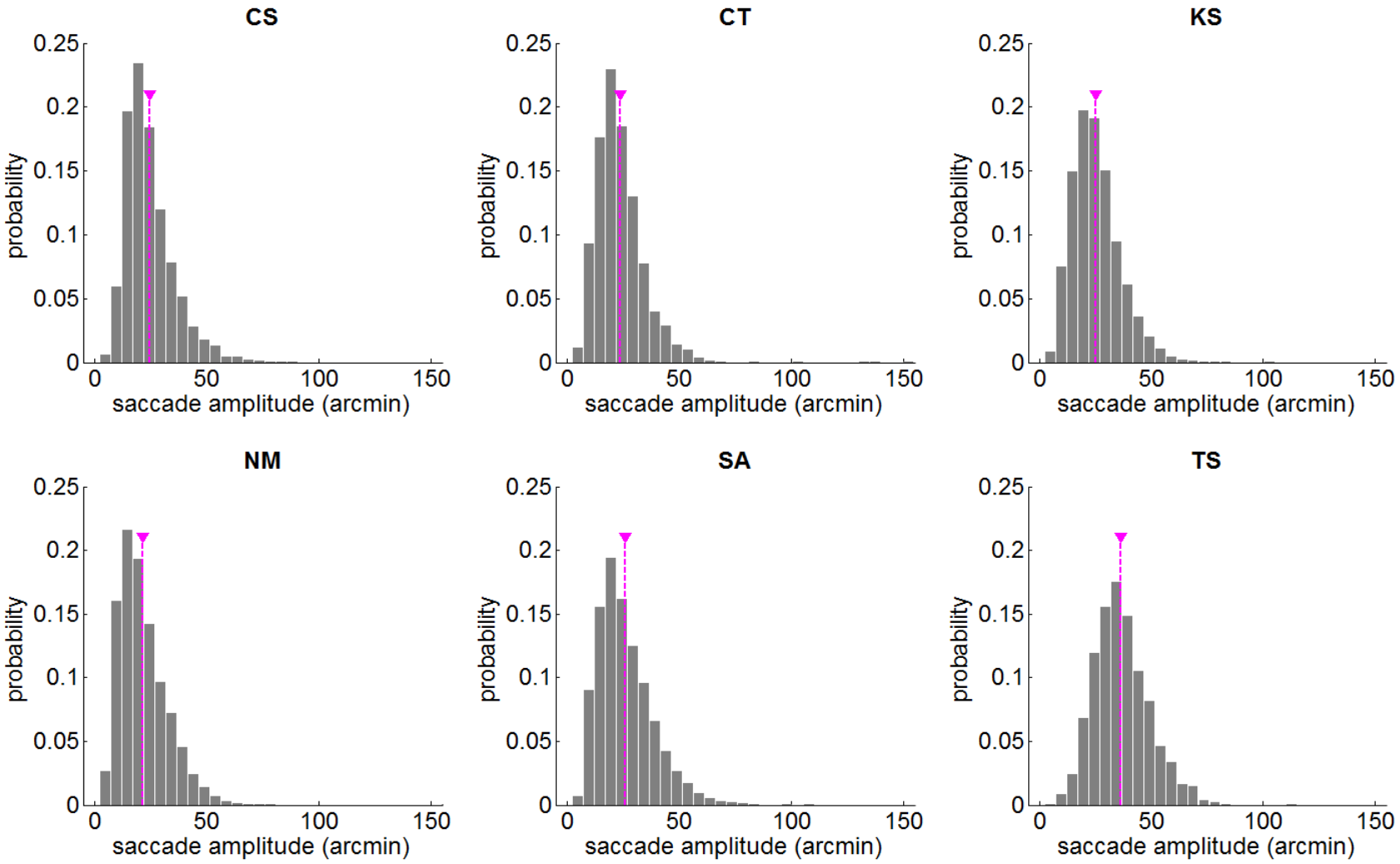
An example trial



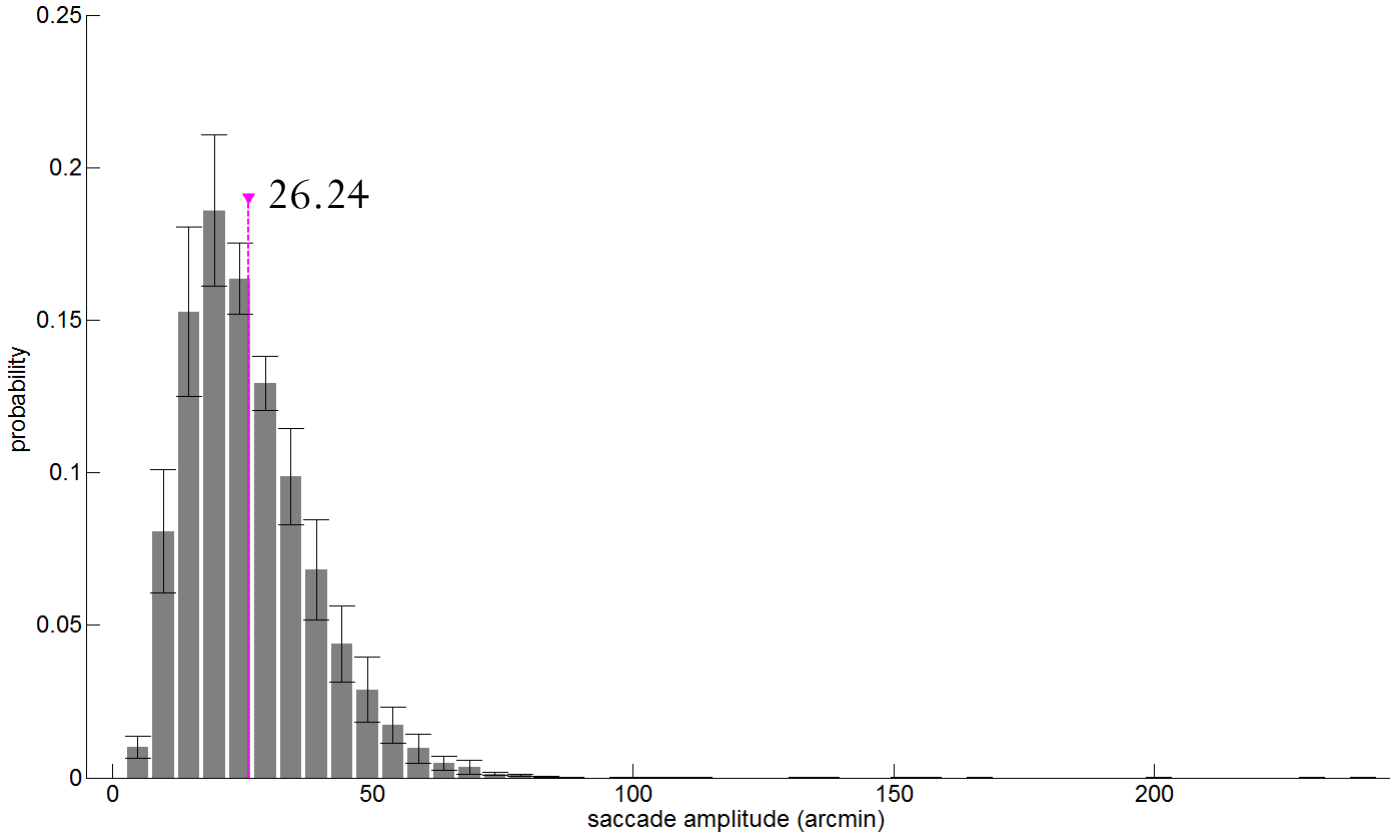
An example trial



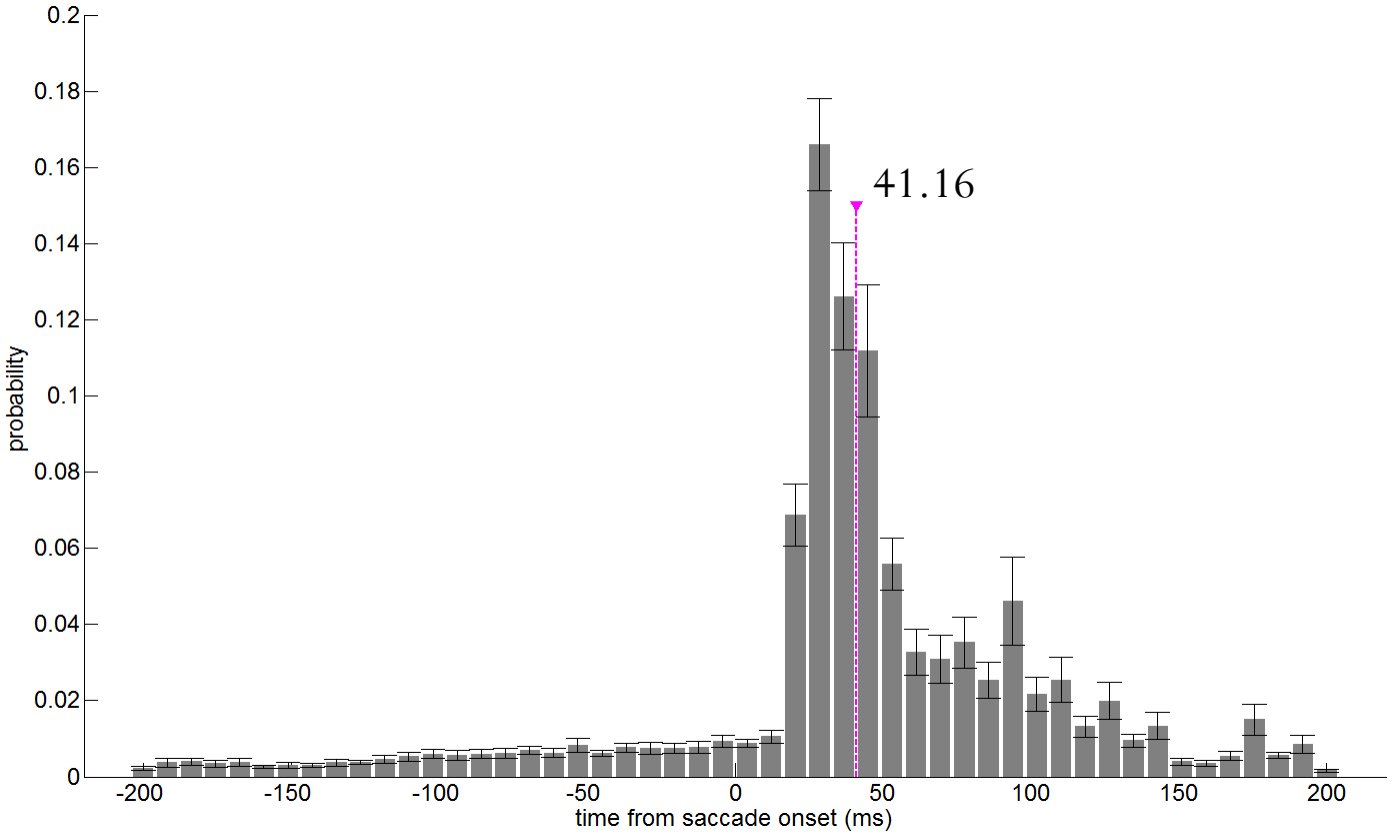
Distribution of saccade amplitudes



Distribution of saccade amplitudes



Distribution of change temporal delay from the saccade onset



Data summary

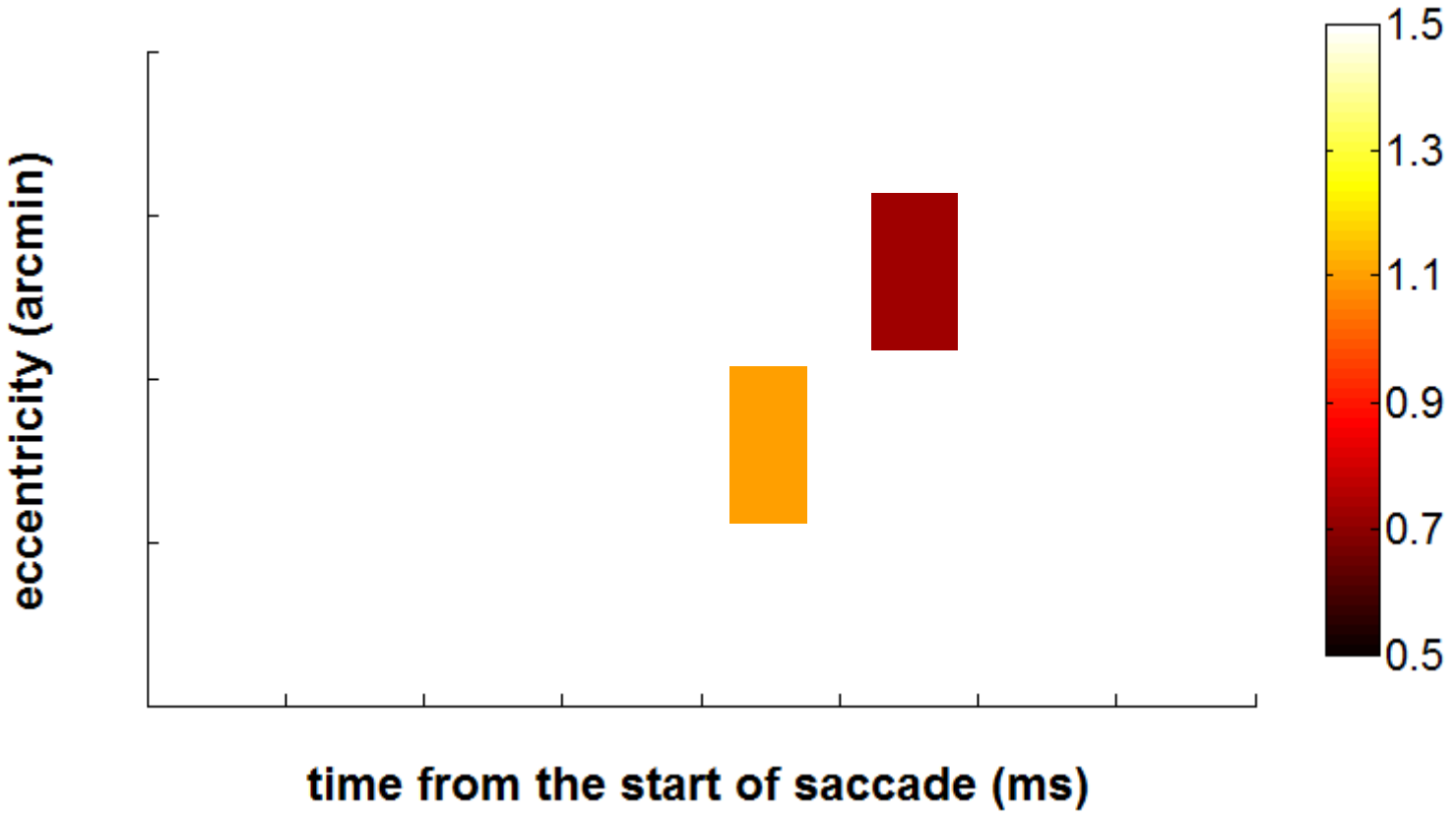
Changes within ±30 deg horizontal angel

Changes within 1 deg radius from the center of gaze, corresponding only to 1 saccade within ±200ms time window from the change.

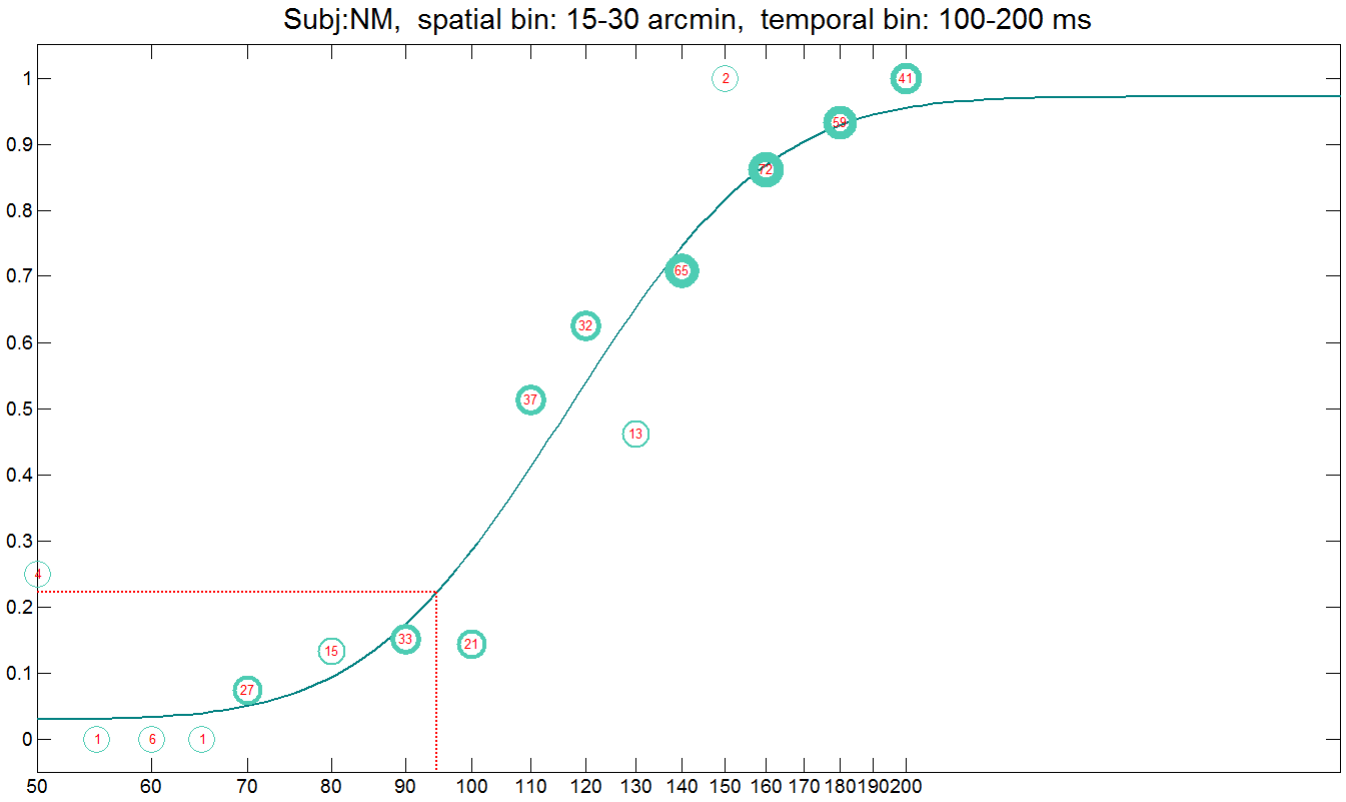
CS (7)
CT (11)
KS (18)
NM (22)
SA (15)
TS (5)

Study objectives:

Construct the map of visibility relative to saccades:

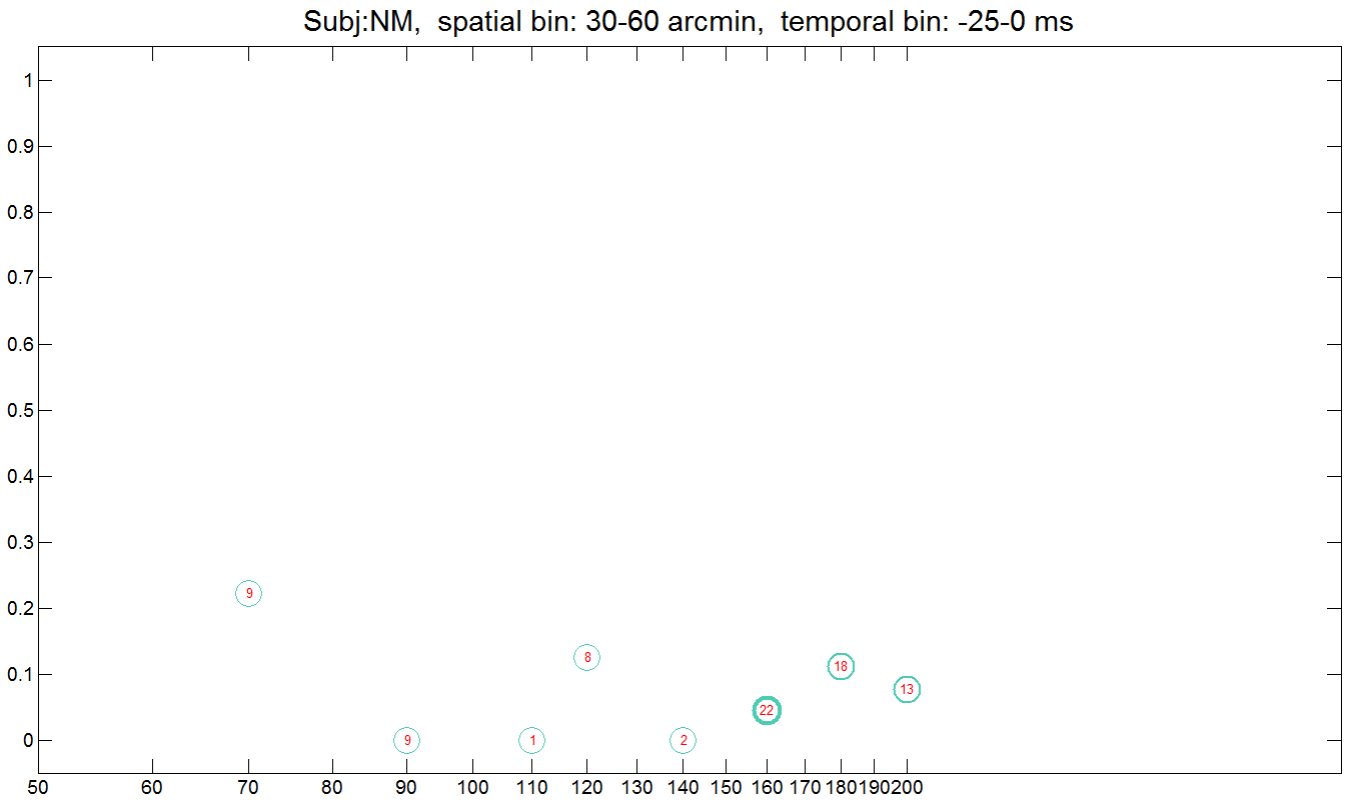


Contrast threshold estimation

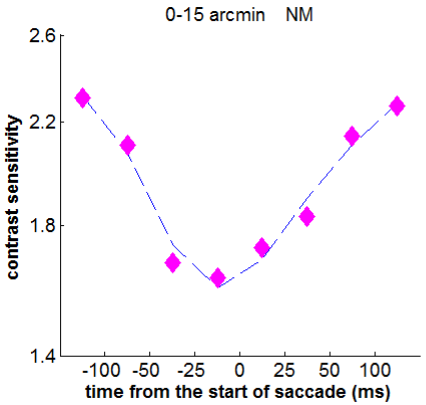


Sensitivity = contrast threshold / (contrast threshold + 100)

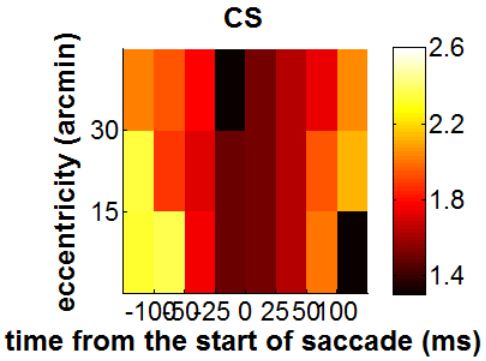
Contrast threshold estimation

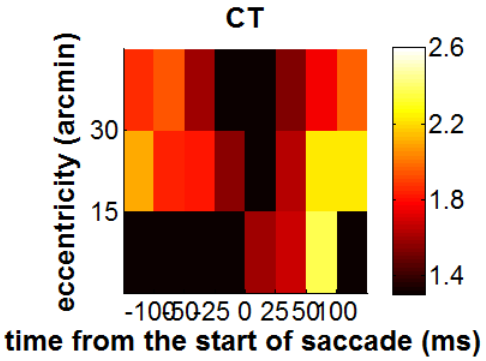


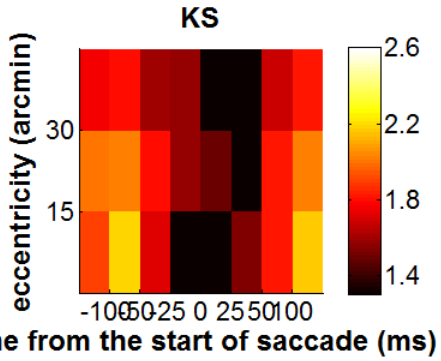
Time course of sensitivity change across the fovea and perifovea

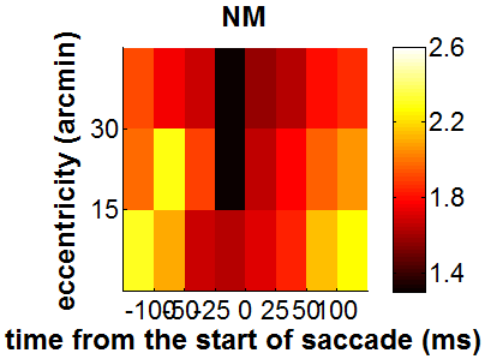


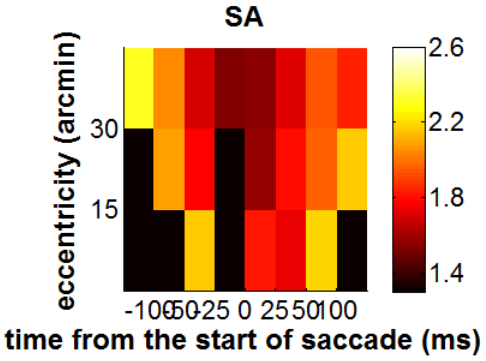
Spatiotemporal contrast sensitivity map.

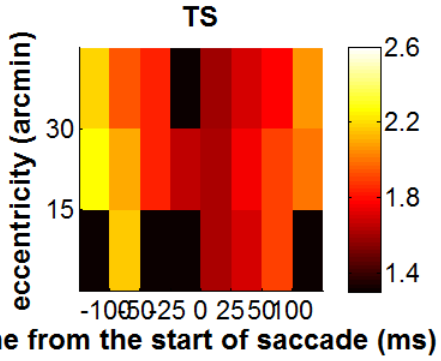




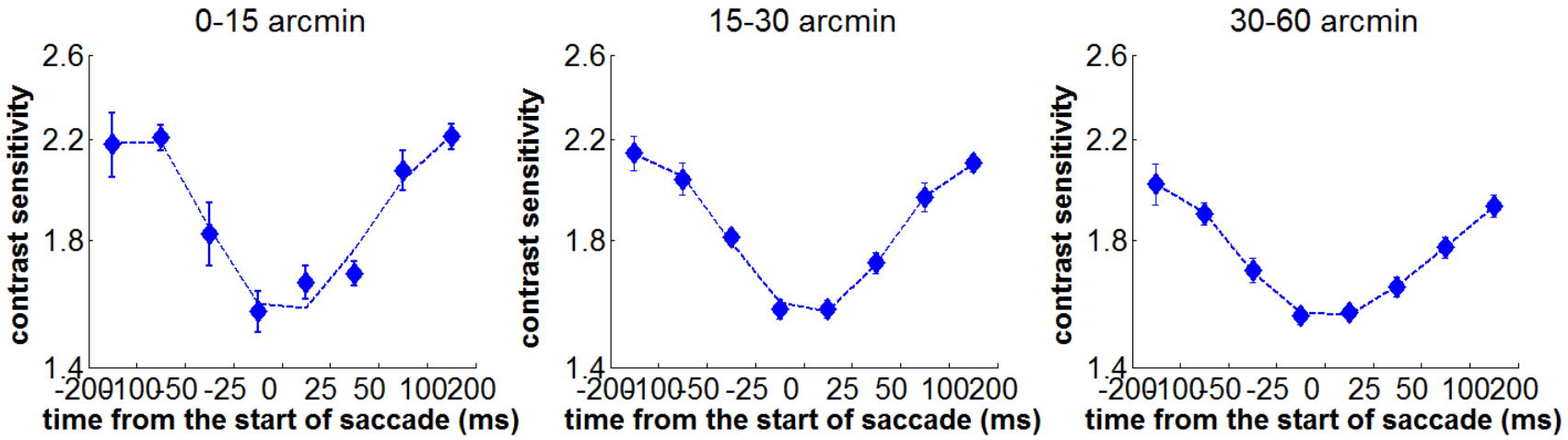




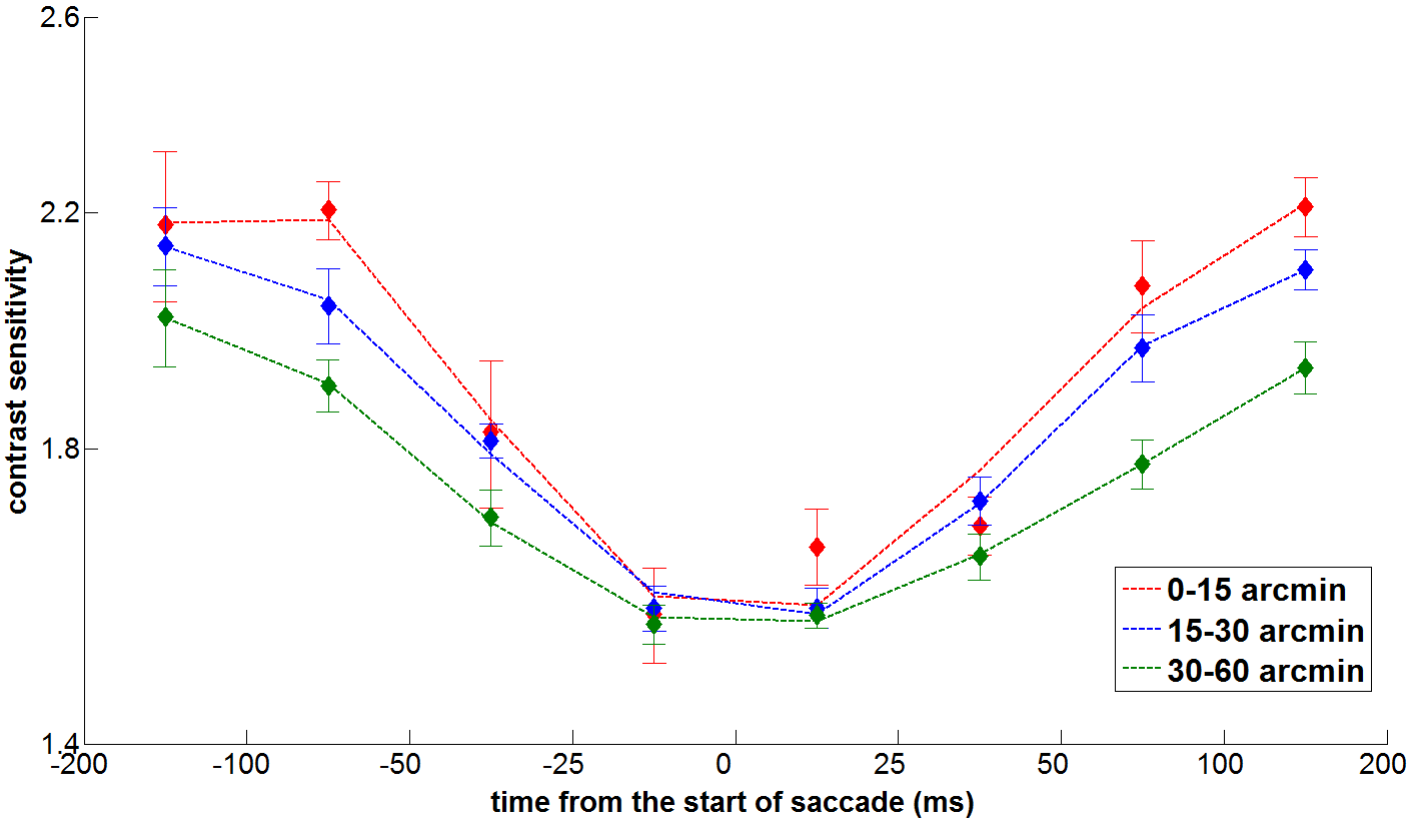




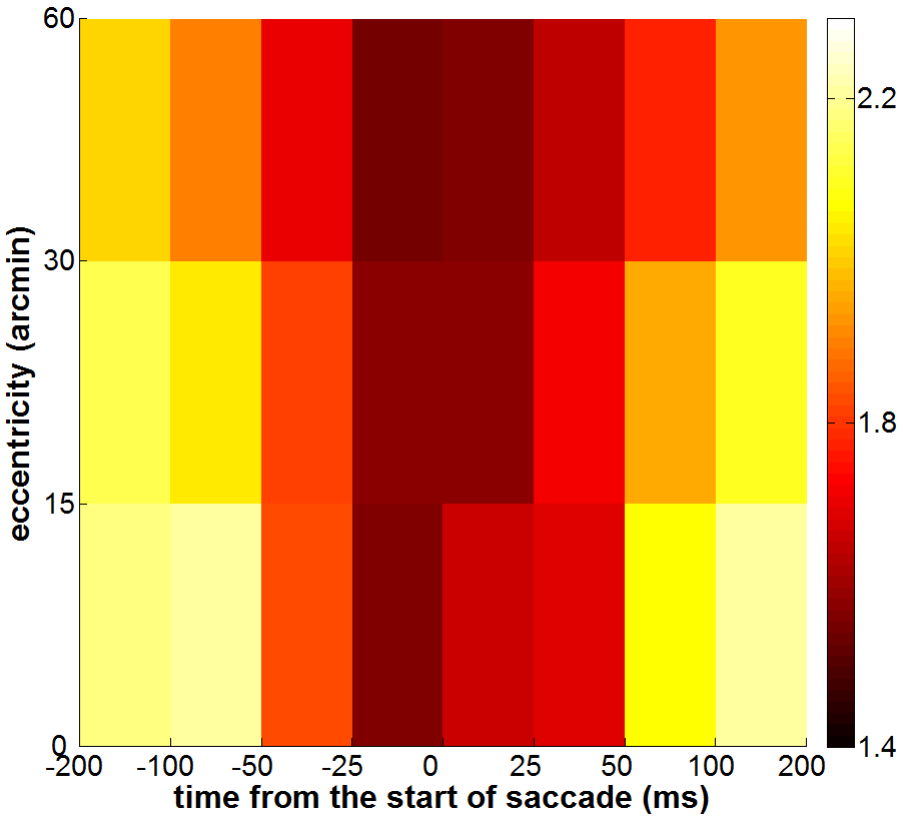
Time course of sensitivity change across the fovea and perifovea



Time course of sensitivity change across the fovea and perifovea

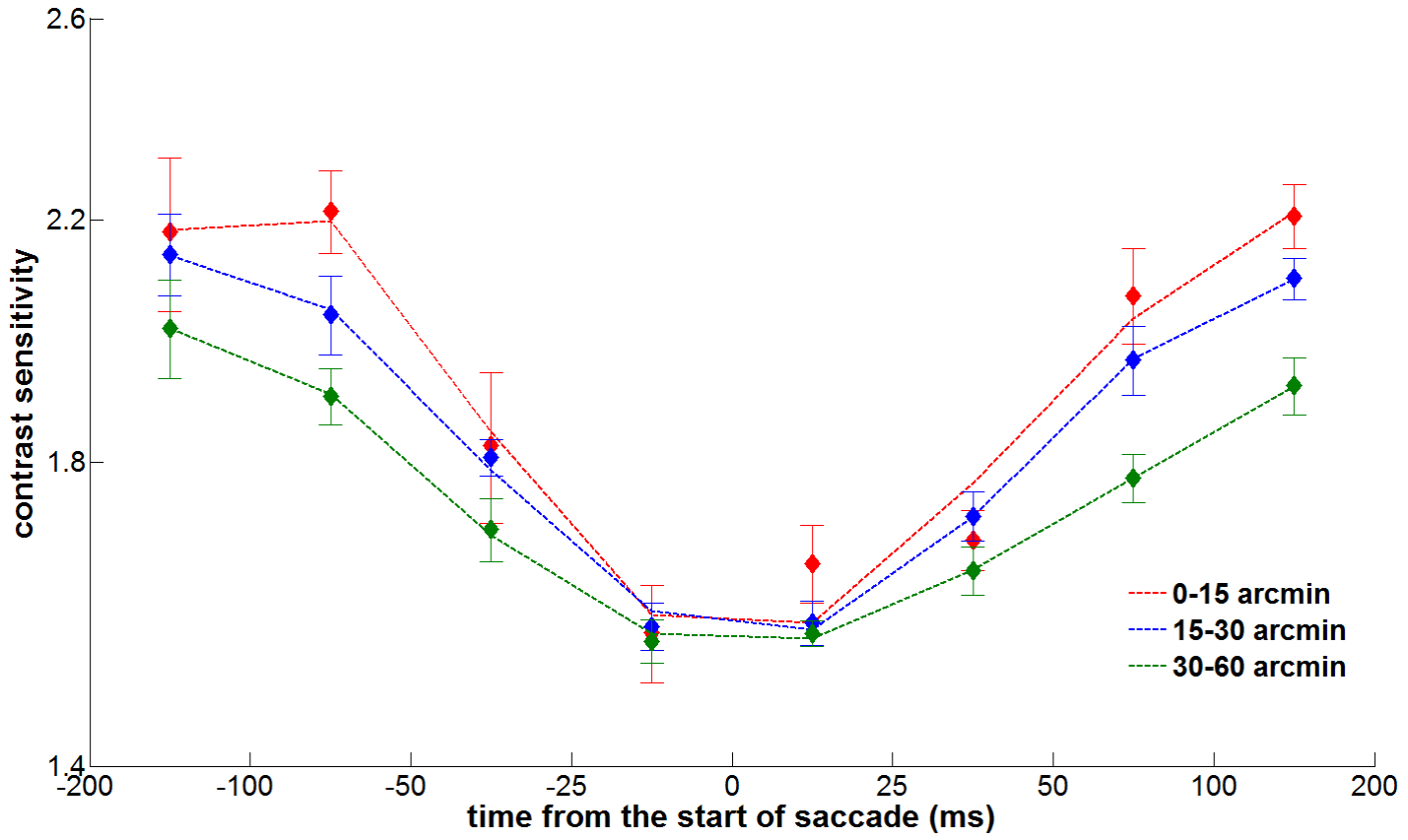


Spatiotemporal contrast sensitivity map.



Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades and small saccades



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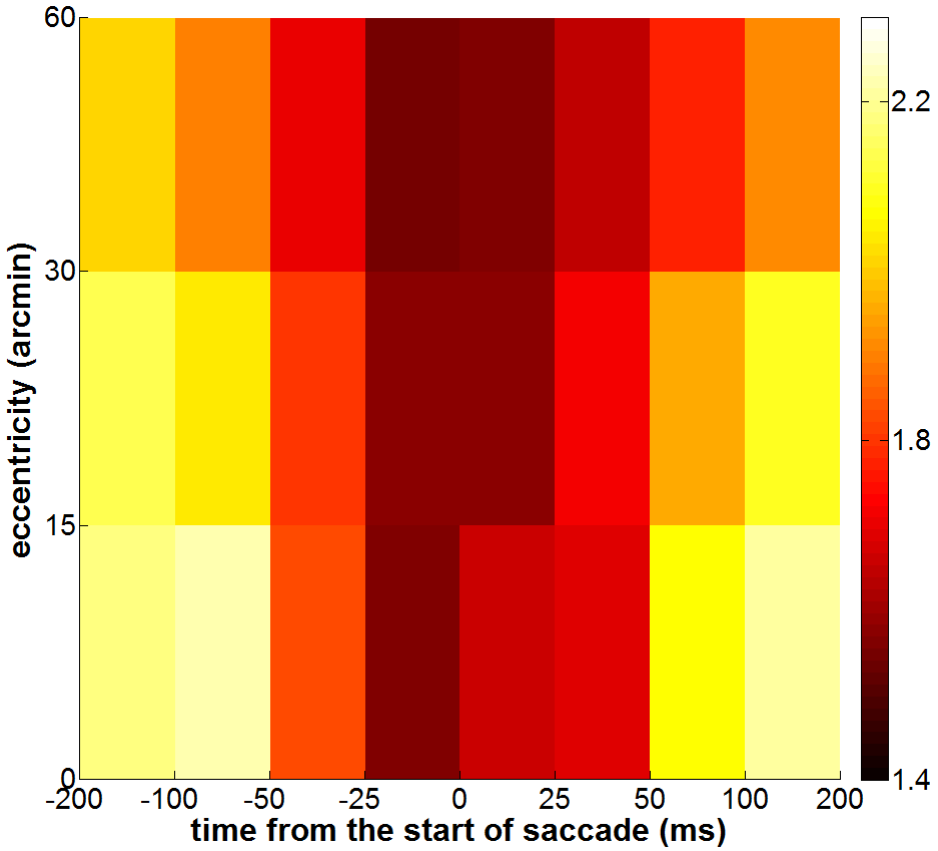
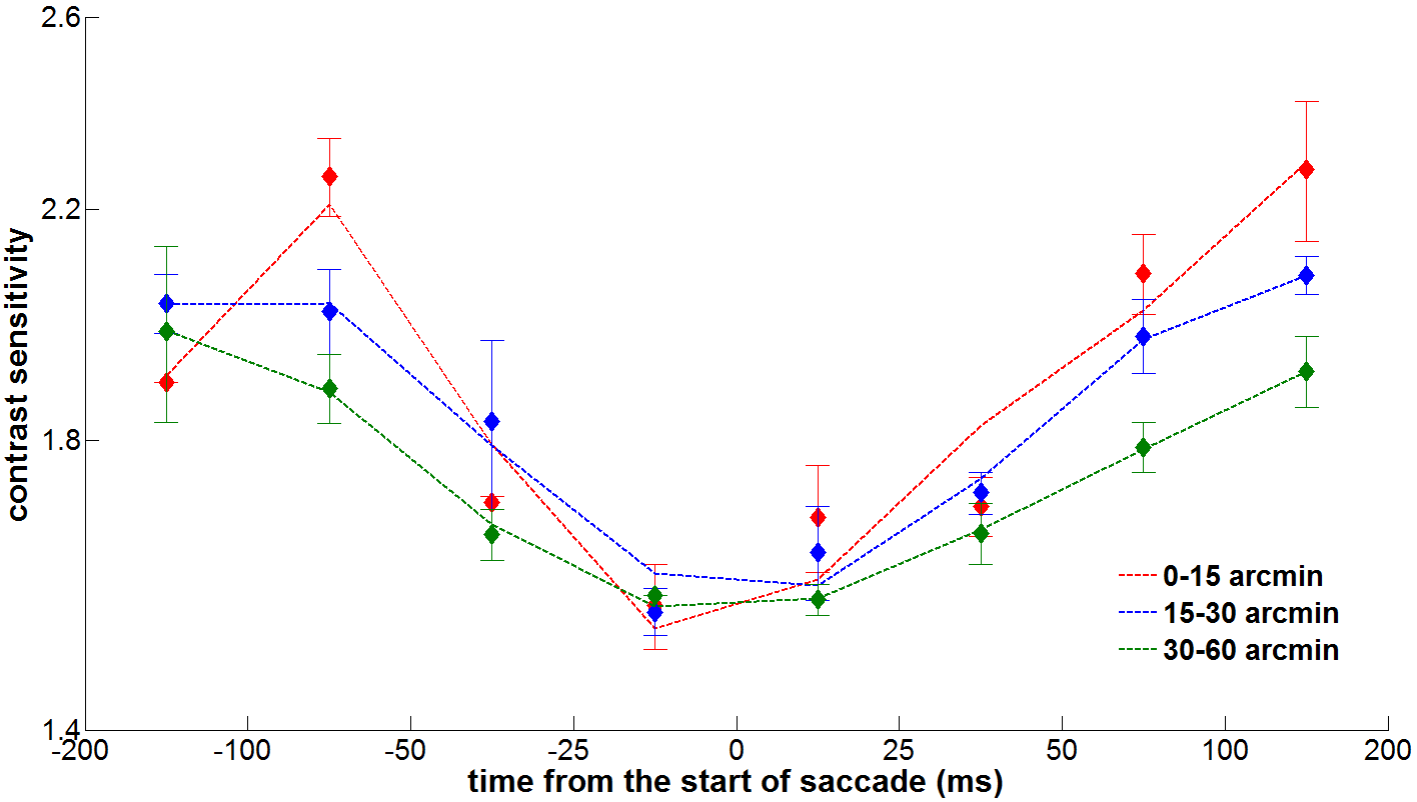
Relative to occurrence of microsaccades and small saccades



Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades



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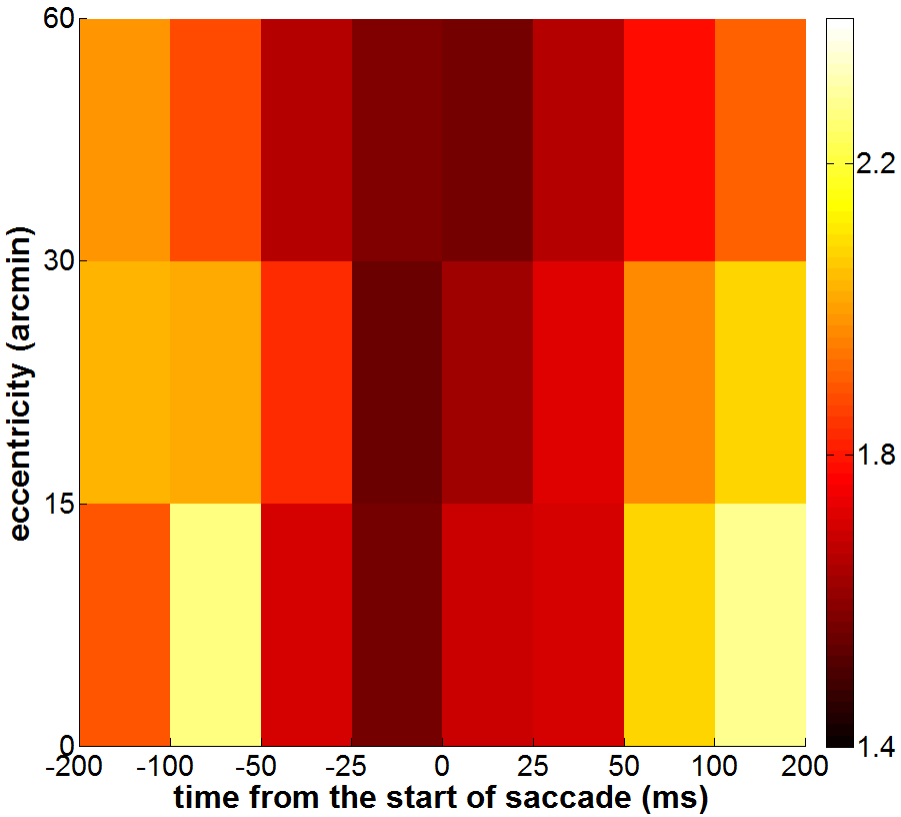
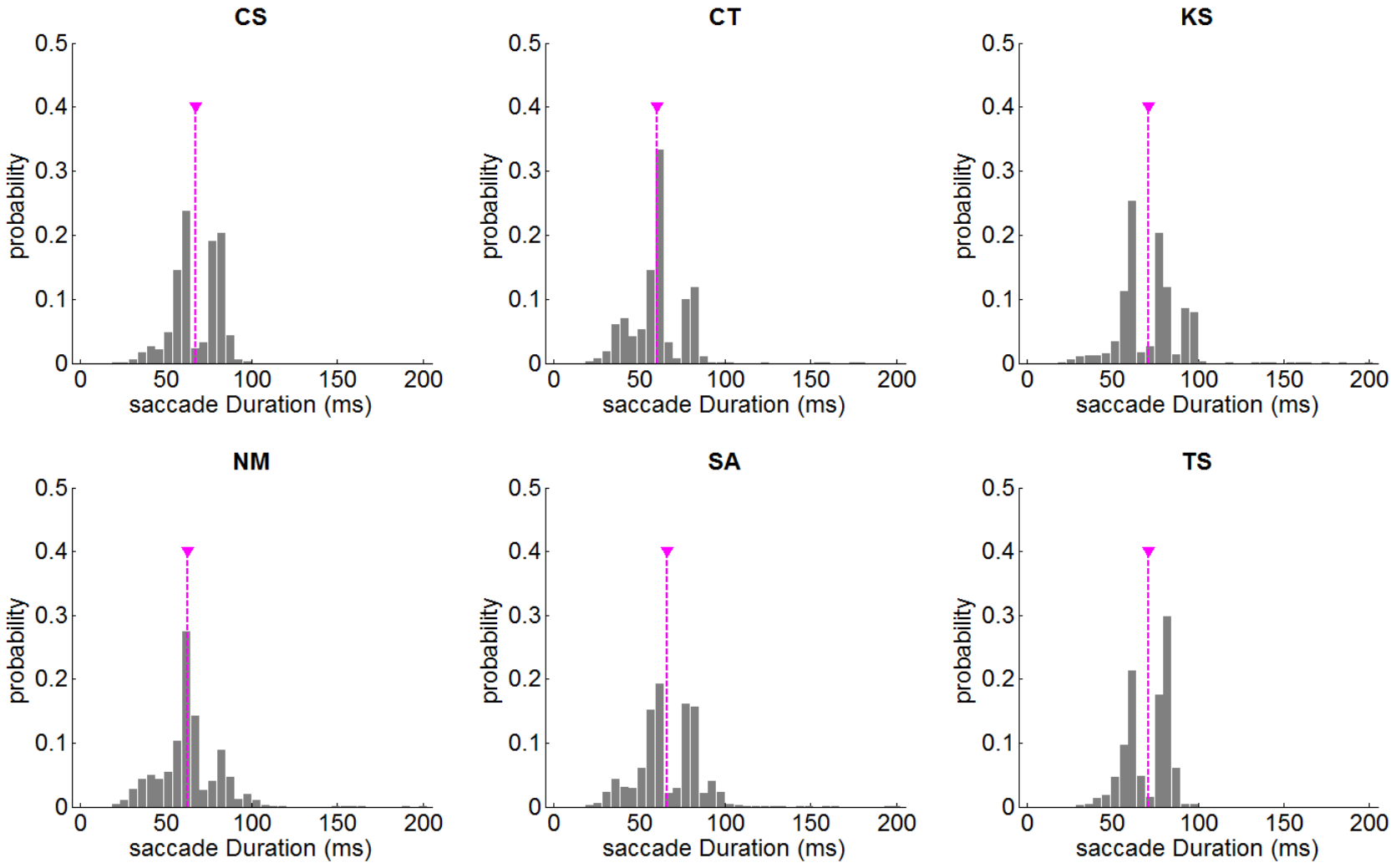
Relative to occurrence of microsaccades



Distribution of saccade duration

For microsaccades and small saccades



Distribution of saccade duration

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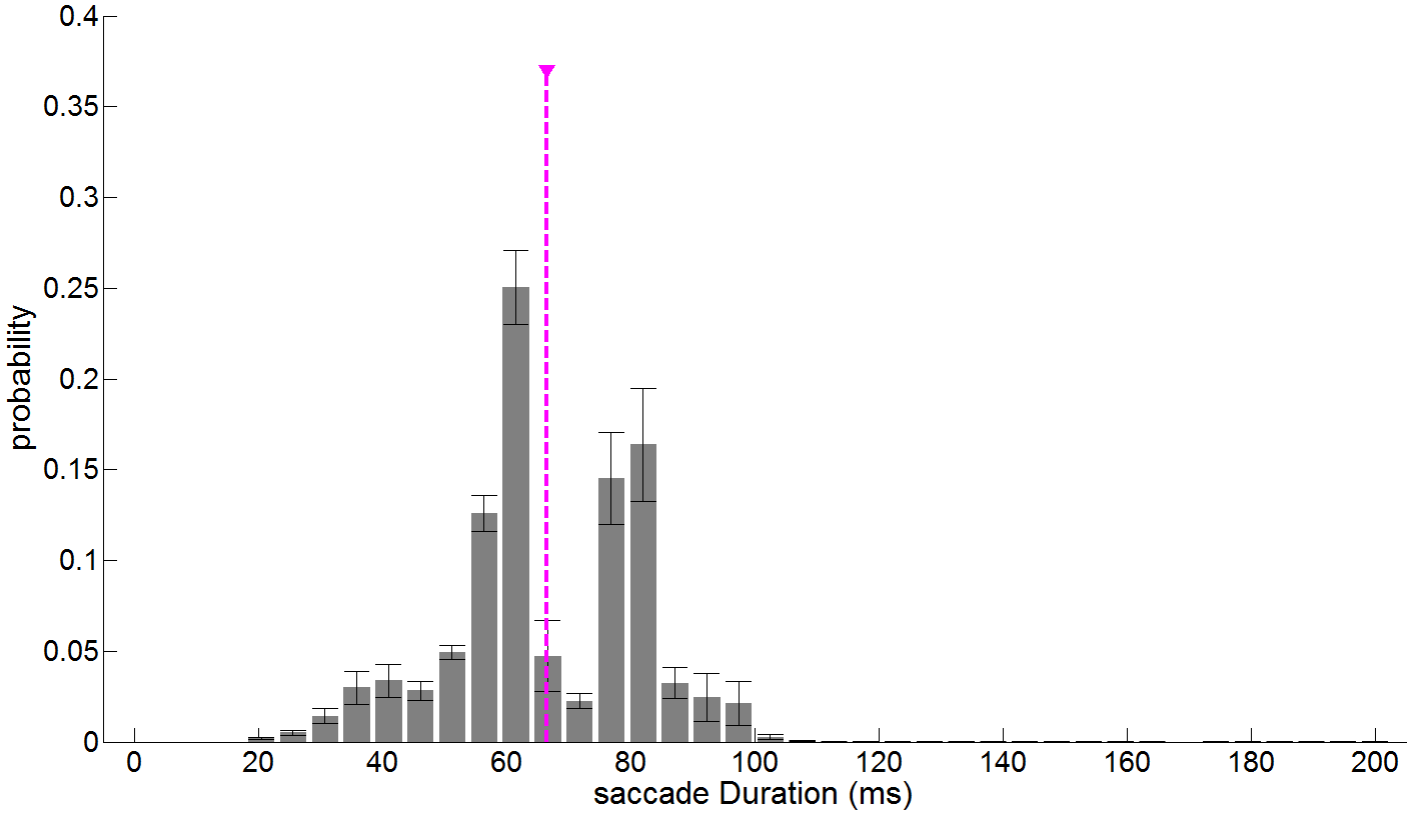
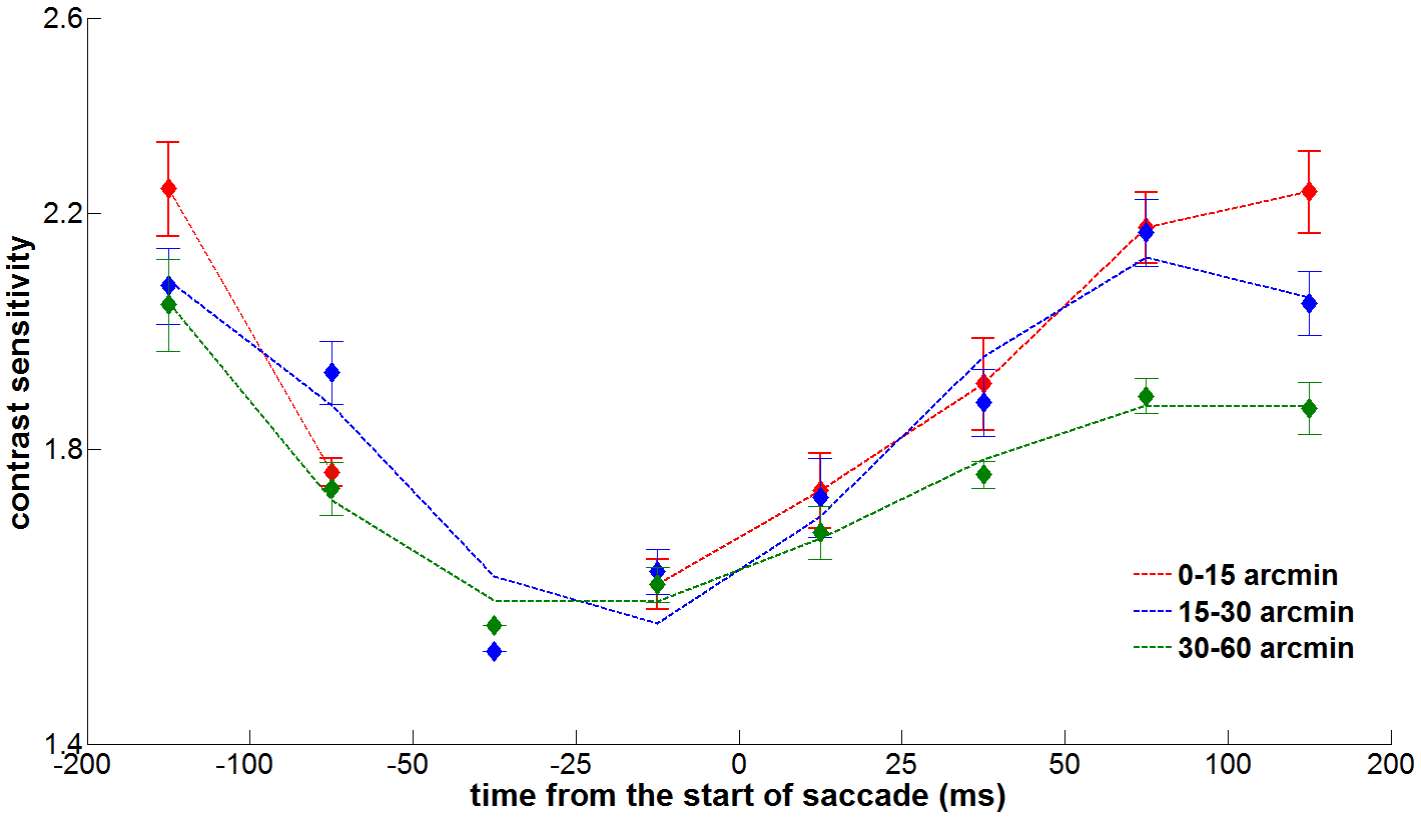


Time course of sensitivity change across the fovea and perifovea

Relative to occurrence of microsaccades and small saccades' center



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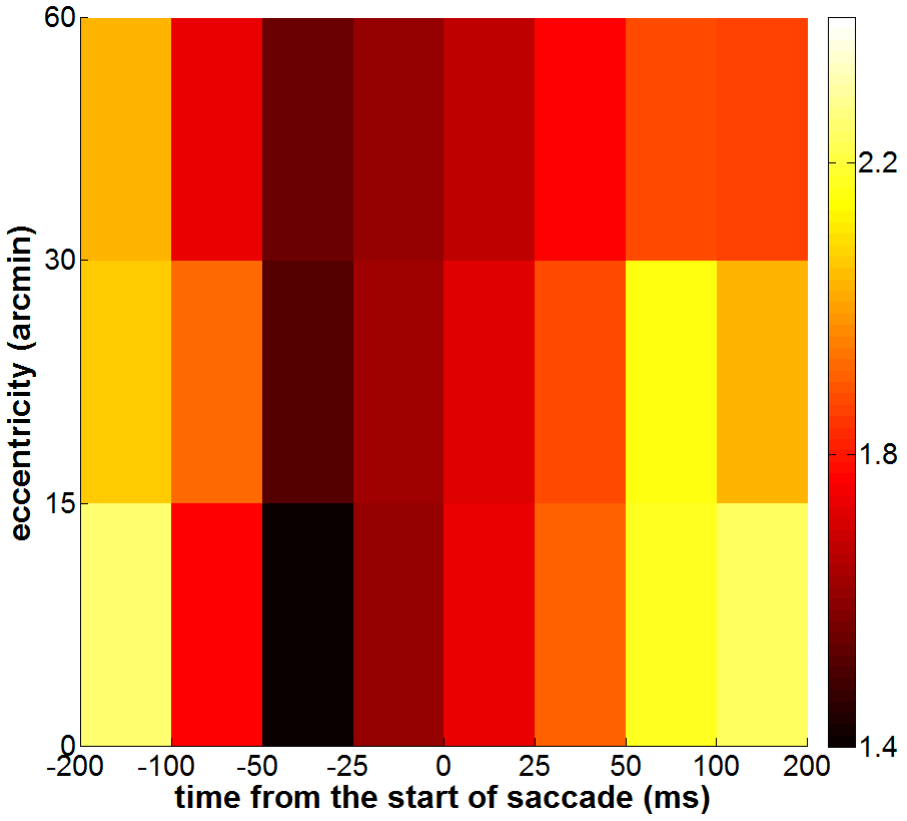
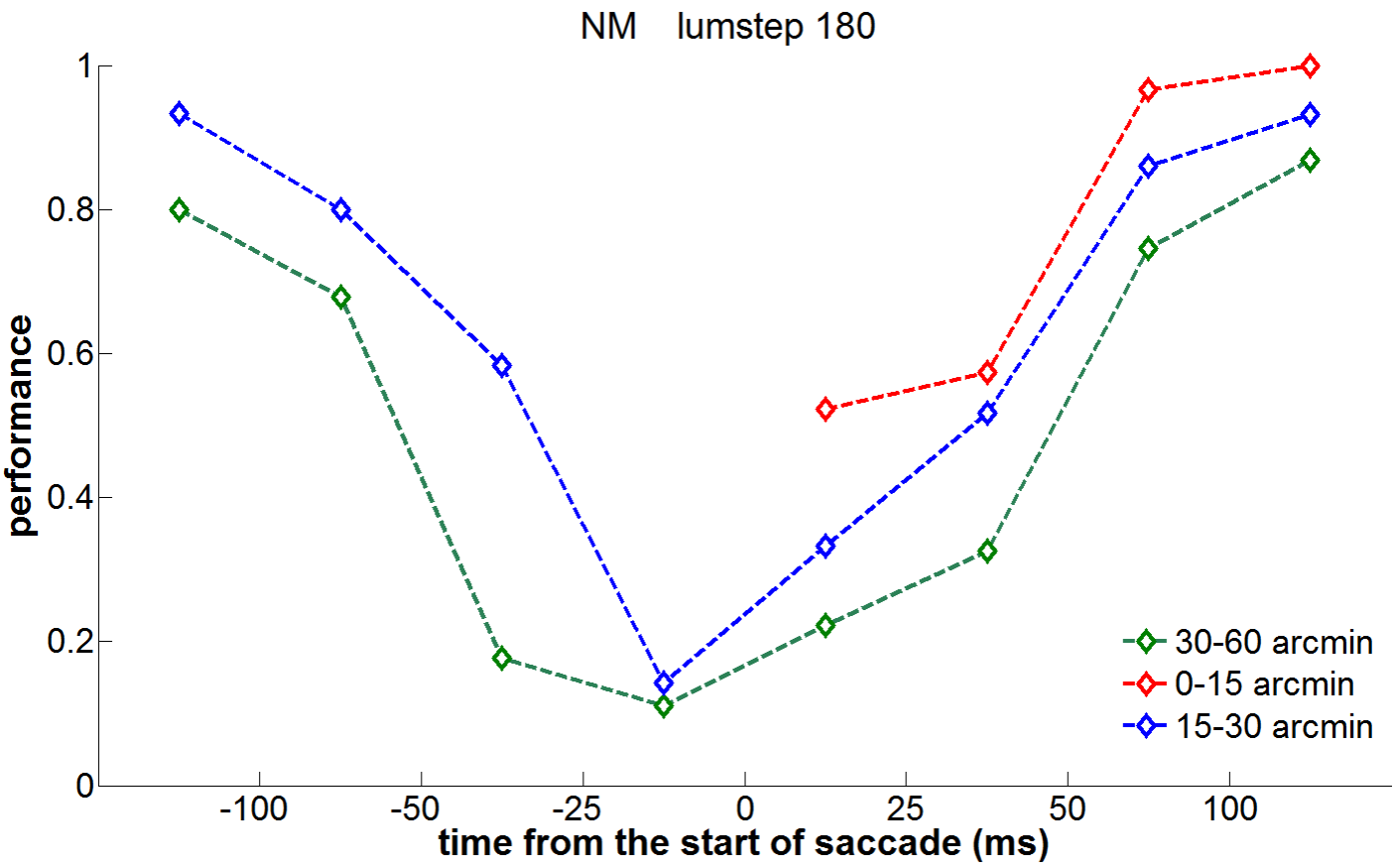
Relative to occurrence of microsaccades and small saccades' center



performance



Summary

- Construct the full spatiotemporal map of contrast sensitivity relative to occurrence of microsaccades.
- Contrast sensitivity is not homogenous within the fovea and perifovea and decreases with increasing eccentricity.
- “Microsaccadic suppression” of visual thresholds with similar time course to saccadic suppression phenomena.
- **To do:**
  - Complete the map by collecting more data with different delays.
  - Look at the effect of microsaccade/saccade amplitudes if data allows.
  - Look at sensitivity at saccade target position.
  - Come up with a cost function for making saccades.