Supplementary Figure and Movie Legends

Supplementary Figure 1 Can saccade changes conceptually explain our observed eye position offsets during extrafoveal tracking? We created 'simulated' sinusoidal eye position traces before and after inactivation. For baseline traces, we first defined a sinusoidal trajectory, and then we introduced step discontinuities in this trajectory at four time points of 'simulated saccade' onset times (these 'simulated saccades' had amplitudes and onset times that were normally distributed with a given mean and s.d.). To investigate the potential effects of inactivation-induced saccade changes, we then took the same simulated traces but increased the mean latency and s.d. of contralesional 'simulated saccades' by 200 ms and 20 ms (respectively). We also decreased the mean 'amplitude' of these 'simulated contralesional saccades' by 10%, and we completely eliminated 33% of the initiation contralesional 'saccades' at the beginning of the trials. Even with such an extreme scenario (which assumes no other corrections by the oculomotor system), the differences between simulated 'baseline' and simulated 'inactivation' traces are not like those we observed experimentally - compare to Figure 3B of the main text. Most strikingly, the bottom histogram of 'saccade' onset times shows clear shifts between baseline and inactivation for 'simulated contralesional saccades' that were not seen experimentally in Figure 3B (bottom). These simulated traces are a simple schematic illustration of how changes to saccades are not sufficient to explain our eye position offsets.

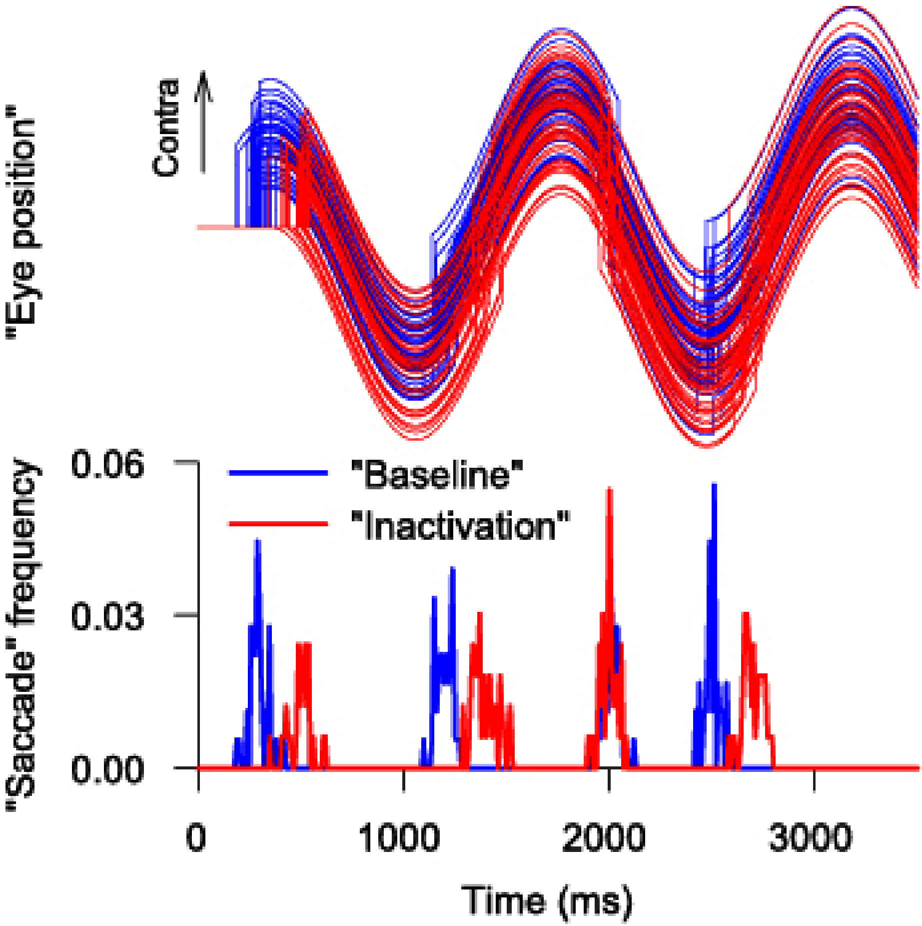
Supplementary Figure 2 A sample experiment showing how SC inactivation did not affect (open-loop) smooth pursuit initiation during the extrafoveal tracking condition. The blue curves show average s.e.m. de-saccaded radial eye velocity traces for contraversive initial stimulus motion in the baseline condition. The red curves show the same eye velocity parameters but after SC inactivation. In both baseline and inactivation, the monkey initiated pursuit (in the direction of stimulus motion - which was towards the affected region in inactivation) before quickly reversing to anticipate the predictable reversal in stimulus trajectory. This behavior was not affected by SC inactivation. We confirmed this observation statistically by measuring eye velocity in the open-loop interval (within the first 100 ms of movement onset) of smooth pursuit. See Results in the main text and Supplementary Figure 5 for summaries of the statistical tests across experiments and conditions.

Supplementary Figure 3 Our observed offsets for all target sizes could not be explained by a systematic inability to generate catch-up saccades. Each panel plots the frequency of contralesional catch-up saccades before and after inactivation. Because the tracking axis crossed the inactivated site, and because catch-up saccades were along this tracking axis, this analysis checked whether saccades towards the inactivated region were eliminated or not. They were not for the great majority of our experiments. Filled symbols indicate experiments for which inactivation results were different from baseline ($p<0.05$, binomial distribution). Error bars denote 95% confidence intervals, and the red symbols indicate saline control injections. The extrafoveal tracking panel is like that shown in Figure 5A of the main text and is included here for clarity.

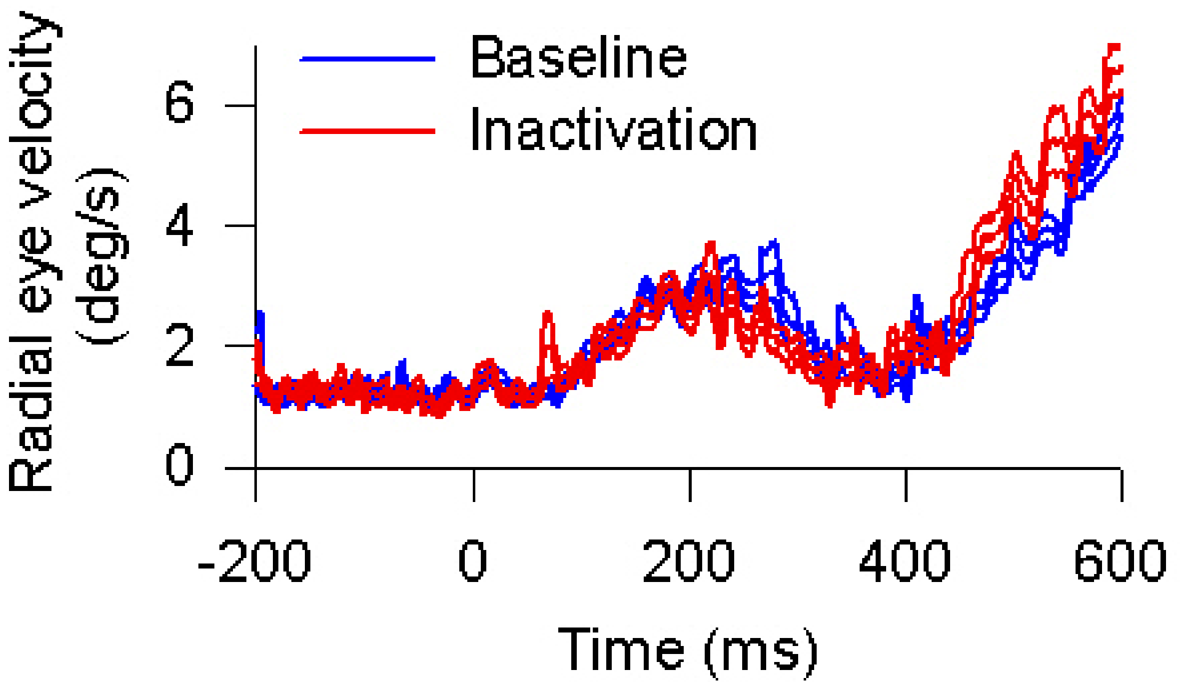
Supplementary Figure 4 The first contralesional initiation saccade in a trial often exhibited increased latency after muscimol injection. This is consistent with the known effects of SC inactivation. Each panel plots the latency of the first saccade before and after inactivation. For all target sizes, we often saw an increase in first saccade latency from trial onset. However, this increase was not sufficient to explain our observed eye position offsets (see Results in the main text). Error bars denote s.e.m., and the red symbols describe the results of our saline control injections, which did not cause any increases in saccade latency. The extrafoveal tracking panel is like that shown in Figure 5C of the main text and is included here for clarity. It should be noted that not all experiments caused an increase in saccade latency (evident in each of the panels). This is expected because some of our injections affected sites that did not contribute to saccades of the sizes that were typical of our first initiation saccades.

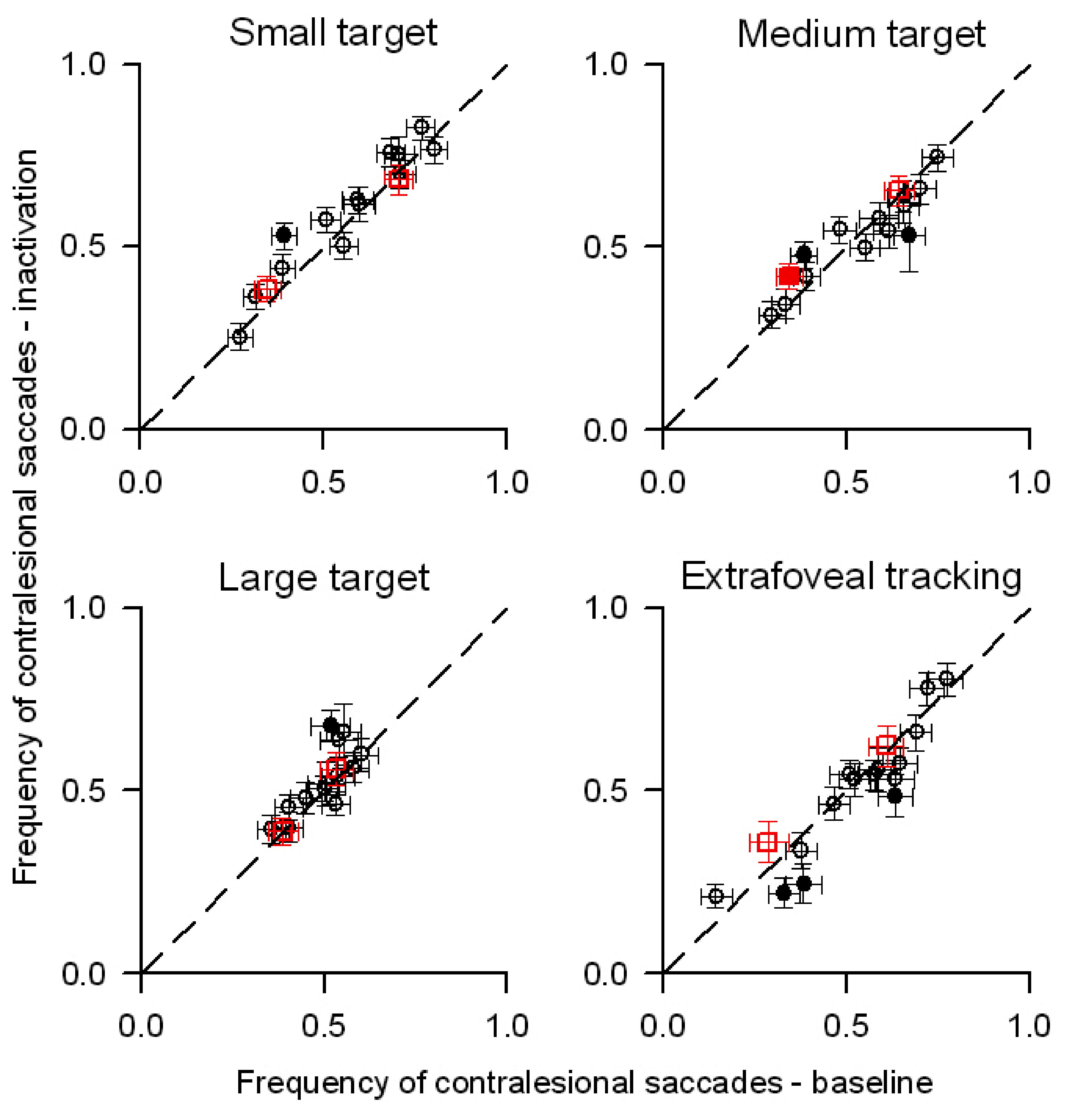
Supplementary Figure 5 Inactivation did not systematically affect open-loop or steady-state smooth pursuit gain. In the top panel, the bar graph describes the average change in initial eye velocity (inactivation minus baseline) for contraversive pursuit initiation (i.e. initiation towards the affected region) across experiments. The error bars denote s.d. across experiments. For each target size, the individual symbols superimposed on the bars denote the changes observed for each experiment individually. Extrafoveal tracking, which had the largest eye position offsets, exhibited the smallest changes in initial eye velocity. The middle panel is identical to the top panel but shows data for ipsiversive pursuit initiation (i.e. away from the affected region). This panel shows that there was often a reduction in ipsiversive pursuit, which cannot account for an ipsilesional eye position offset. The bottom panel is similar to the two above it but shows the change in steady-state smooth pursuit gain, as opposed to the change in initial eye velocity. Across experiments, there were no changes in such gain after SC inactivation in our tasks.

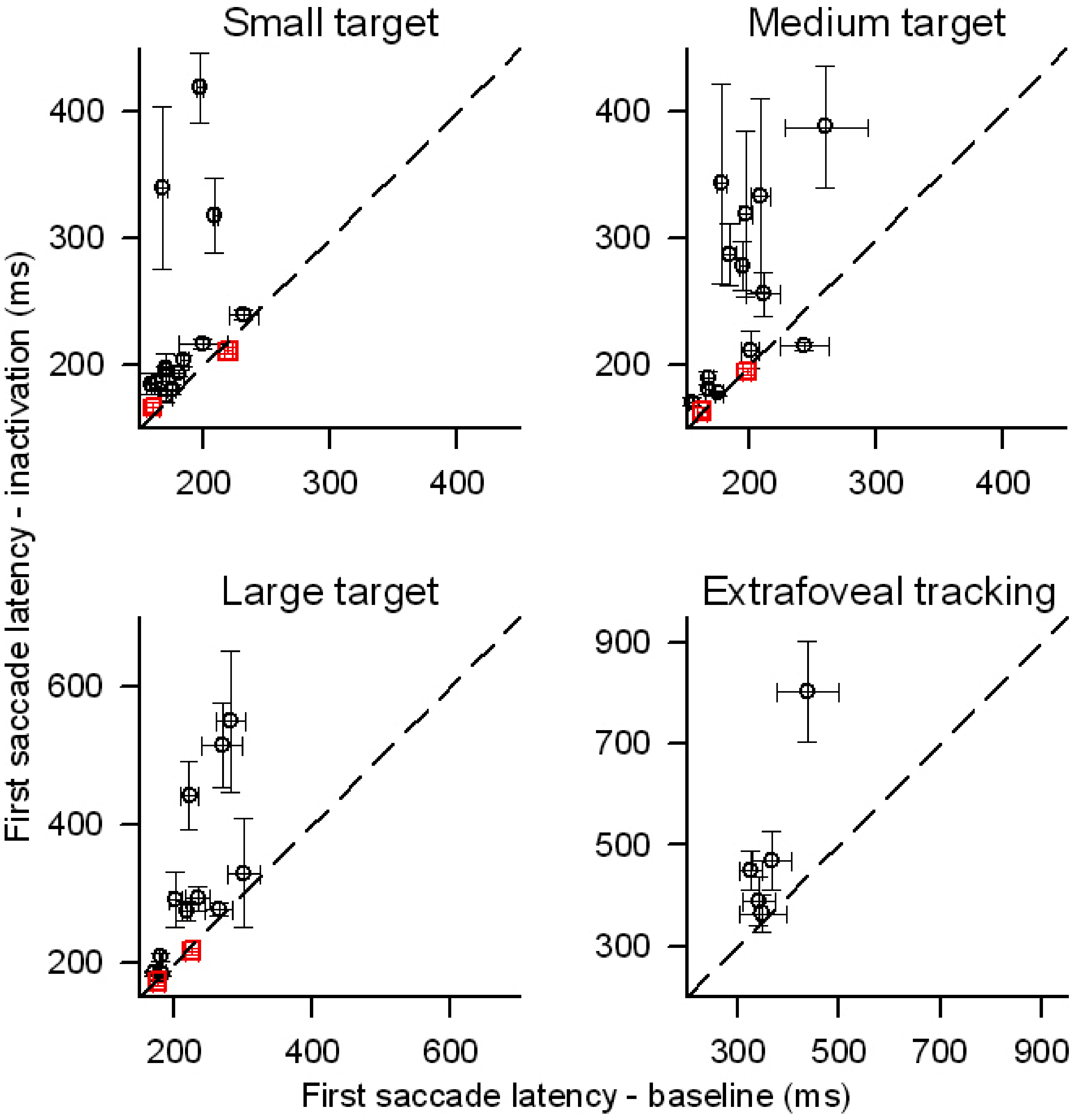
Supplementary Movie 1 Extrafoveal tracking with and without rostral SC inactivation. The white crosshair shows the monkey□s average eye position from a baseline data set. The yellow crosshair shows this position after locations in the SC encoding the lower left quadrant (in retinotopic coordinates) were inactivated. The monkey tracked as in the baseline condition but with a constant offset (relative to baseline) to the upper right quadrant. This movie is running at half the actual speed in the experiments.



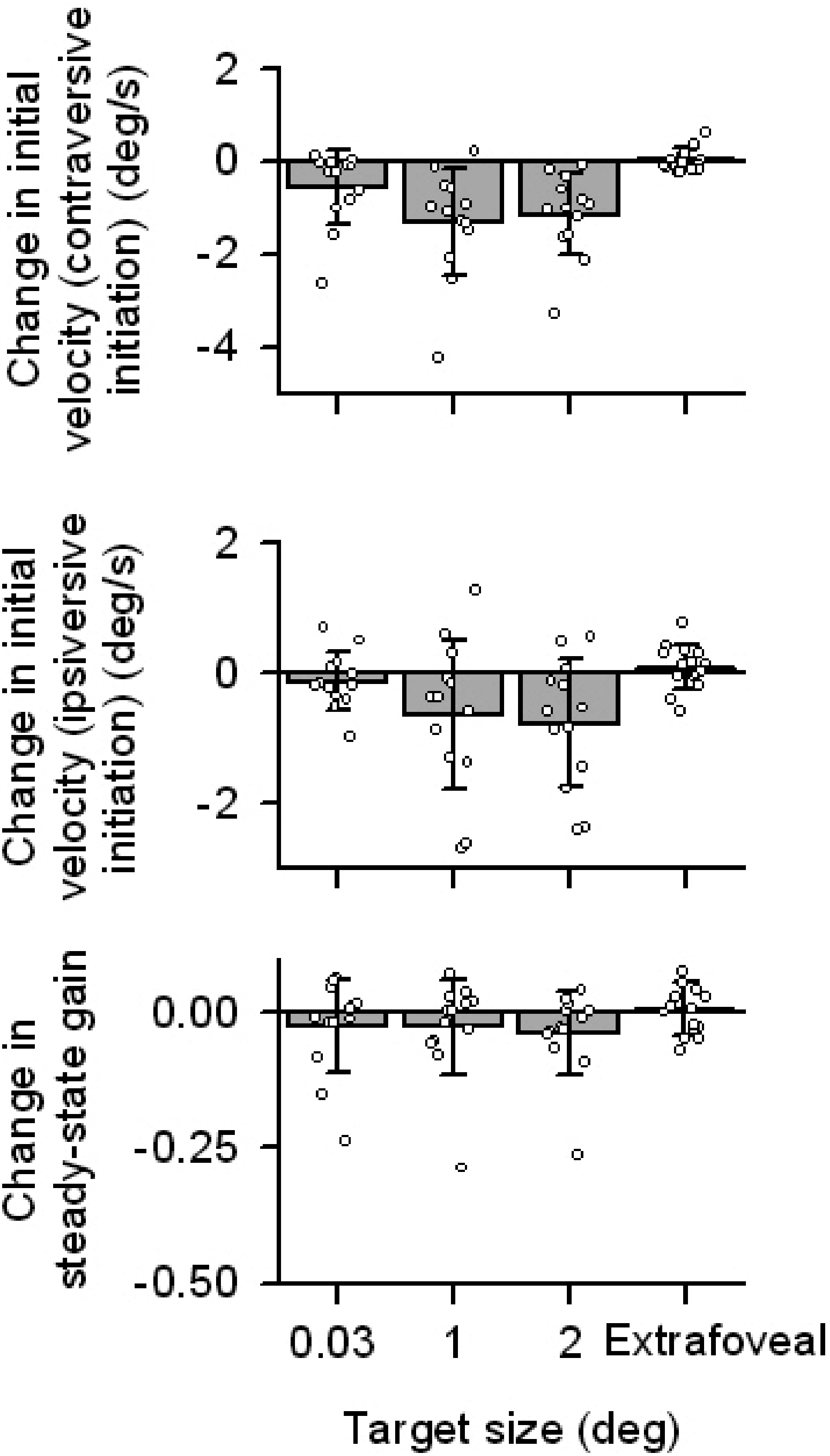
"Eye position"
Contra
"Saccade" frequency
0.06
0.03
0.00
"Baseline"
"Inactivation"
0
1000
2000
3000
Time (ms)


Baseline
Inactivation
Radial eye velocity (deg/s)
0
2
4
6
-200
0
200
400
600
Time (ms)


Small target
Medium target
Large target
Extrafoveal tracking
1.0
0.5
0.0
Frequency of contralesional saccades - inactivation
Frequency of contralesional saccades - baseline



Small target
Medium target
Large target
Extrafoveal tracking
First saccade latency - inactivation (ms)
First saccade latency - baseline (ms)
400
300
200
200
300
400
600
400
200
200
400
600
900
700
500
300
300
500
700
900



Change in initial velocity (contraversive initiation) (deg/s)
2
0
-2
-4
Change in initial velocity (ipsiversive initiation) (deg/s)
2
0
-2
Change in steady-state gain
0.00
-0.25
-0.50
0.03
1
2
Extrafoveal
Target size (deg)