Oculomotor inhibition: Shared or separate mechanisms for saccades and smooth pursuit?
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Introduction
How closely linked are the initiation mechanisms of saccades and smooth pursuit (SP)? With regard to the spatial (where) aspects of initiation, there is evidence of clear linkage (eg Gardner & Lieberman, 2002). With regard to the temporal (when) aspects of initiation, the latency of both behaviours is modulated in a similar manner by short duration gaps (Knox 1996; Krauzlis & Miles 1996) and by stationary distractors (Knox & Bekkers 2004). However, there are circumstances in which distinct inhibitory mechanisms operate on saccades but not SP (Knox 2005). In our current experiments SP latency was examined in circumstances in which saccades were being inhibited. Subjects were then instructed to try to inhibit SP, and saccade latency was examined. In both sets of circumstances saccade latency increases considerably, while SP latency was relatively stable.

Methods
Subjects: Different healthy adult subjects participated in the different experiments. All had normal or corrected-to-normal visual acuity. Ten subjects participated in Experiment 1, a different group of 9 subjects was recruited for Experiment 2. From this second group, 6 participated in Experiment 3, plus 4 additional naive subjects.

General Methods: Subjects were positioned with their head stabilised, 57cm from a stimulus monitor, which was driven by a VSG2/5 card. Left eye position was recorded with a Skalar Iris infrared eyetracker (the right eye was occluded). Eyetracker output was digitised with 10bit precision at 1kHz using a PClite 1401 Interface. Data were stored for analysis. Saccade tasks consisted of a randomised fixation task, after which the fixation target was extinguished and the saccade target appeared 5° to the left or right. In step-ramp centripetal SP tasks, after a randomised fixation period, the target moved 5° to either right or left, and moved back through the centre of the display at 14°/s.

Experiment 1: Saccade target was presented in the central fixation point. Target display time varied between 200ms and 1200ms in 200ms steps. Latency was calculated as the time from target offset to saccade initiation. Responses with latency <50ms were not included in the analysis.

Experiment 2: Mixed runs of saccade and SP tasks. Saccade target display time was either 200ms or 1000ms. Each subject completed two main runs and two control runs. In main runs subjects were instructed to saccade on target offset, but respond to moving targets as soon as possible. In control runs, they responded to all stimuli as soon as possible. Experiment 3: Runs were identical to Exp 1, but in main runs subjects were instructed to maintain central fixation when a moving target appeared, but respond to saccade targets as soon as they appeared.

Results
Experiment 1: The longer saccade latency observed (even considering subjects were responding to target offsets rather than onsets) suggested that subjects inhibited reflexive responses successfully. The longer latency for short display times, was consistent with saccades in these circumstances being executed against the background of high levels of oculomotor inhibition. Presumably where the offset did not occur a short delay from onset, inhibition reduced leading to a corresponding reduction in latency. Note that with a mixture of display times, onset did not reliably predict offset time, leading to consistent latencies at each display time.

Experiment 2: Two saccade target display times were used (200ms & 1000ms), but in addition SP tasks were included in runs. Saccades were again inhibited - much longer latencies in main compared to control runs, and modulation with display time. What of SP latency? While SP latency was slightly longer in main runs, this effect was much smaller compared to the difference in saccade latency between main and control runs.

Experiment 3: Now subjects responded to saccade target onsets as soon as the targets appeared and tried to suppress SP. While there was an identical rise in SP latency in main compared to control runs, saccade latency still increased considerably although to a lesser extent than in Experiment 2.

Discussion
Regardless of instructions to subjects, SP latency increased by approximately 30ms in both Experiments 2 and 3. This suggests that while it is sensitive to task context, SP latency was not influenced by the voluntary inhibitory mechanisms operating on saccades.

Even although in control runs and the main runs of Experiment 3, subjects were instructed to saccade on target onset, task context (the presence of SP tasks during which subjects were instructed not to track targets) did not affect saccade latency. In addition to this there was an additional inhibitory modulation in Experiment 2. These results are consistent with a set of distinct inhibitory mechanisms, partly under voluntary control, which influence saccade latency, but not SP latency. This implies a separability of oculomotor inhibition mechanisms between saccades and SP and confirms a degree of behavioural flexibility for saccade initiation that is not available for SP initiation.

References

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