

Introduction

Control of motor behavior crucially depends on the ability to predict motion of visual objects in space and time. In sports, athletes are usually advised to keep their eyes on the visual object of interest, i.e. the ball, in order to hit or catch it optimally.

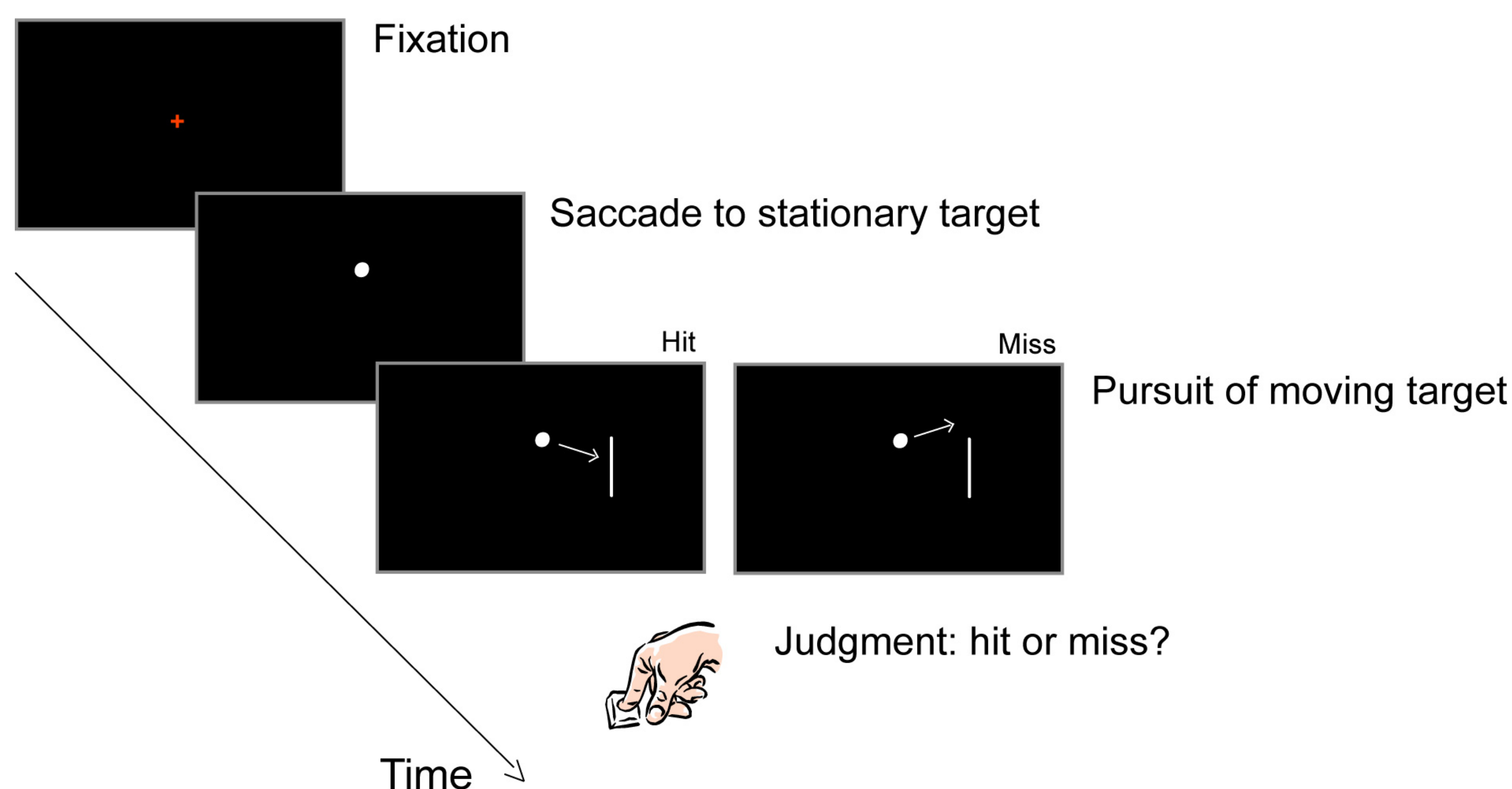
- Smooth pursuit eye movements enable better vision by stabilizing the target on the fovea (Land, 1999). Pursuit improves visual sensitivity (Schütz et al., VSS 2008, 24.15) as well as speed judgments of isoluminant stimuli (Braun et al., VSS 2007)
- At the same time, pursuit produces retinal velocity errors of target and periphery, which have to be compensated (Souman, Hooge & Wertheim, 2005).

Do smooth pursuit eye movements affect the ability to predict the trajectory of a moving visual target, and if so, do they enhance or impair predictability?

Methods

Procedure. Visual target moved towards “goal” while human observers tracked the target. Observers had to judge whether the target would hit or miss the goal. Target and goal were extinguished before the event.

Pursuit condition: target moved linearly at constant velocity (10°/s) towards stationary vertical line (goal)



Fixation condition: fixation on stationary target while goal moved towards target.

Design. From trial to trial, the following parameters were varied:

- Presentation duration of target and goal: 100, 300, 500 ms
- Distance between target and goal upon disappearance: 3, 6°
- Hit/ miss position: 1.25, 1.75° relative to end of goal line
- Angular movement direction: horizontal (90°) or diagonal (± 15°)

Eye tracking. Eyelink II (250 Hz)

Predictions

We assume that motion direction predictability is an important functional role of pursuit eye movements. Consequently, pursuit should enhance the ability to predict the direction of a moving object in two-dimensional space.

In our experiments, performance should be better

- during pursuit than during fixation
- when the “ball” disappears close to the “goal”
- when the “ball” moves for longer durations.

The presentation duration of the target should affect judgments during pursuit more than during fixation.

Conclusions

Pursuit enhances the ability to predict the trajectory of a moving target. Because the visual motion signals are the same during pursuit and fixation, the efference copy of the motor signal during pursuit could provide additional information about target motion direction.

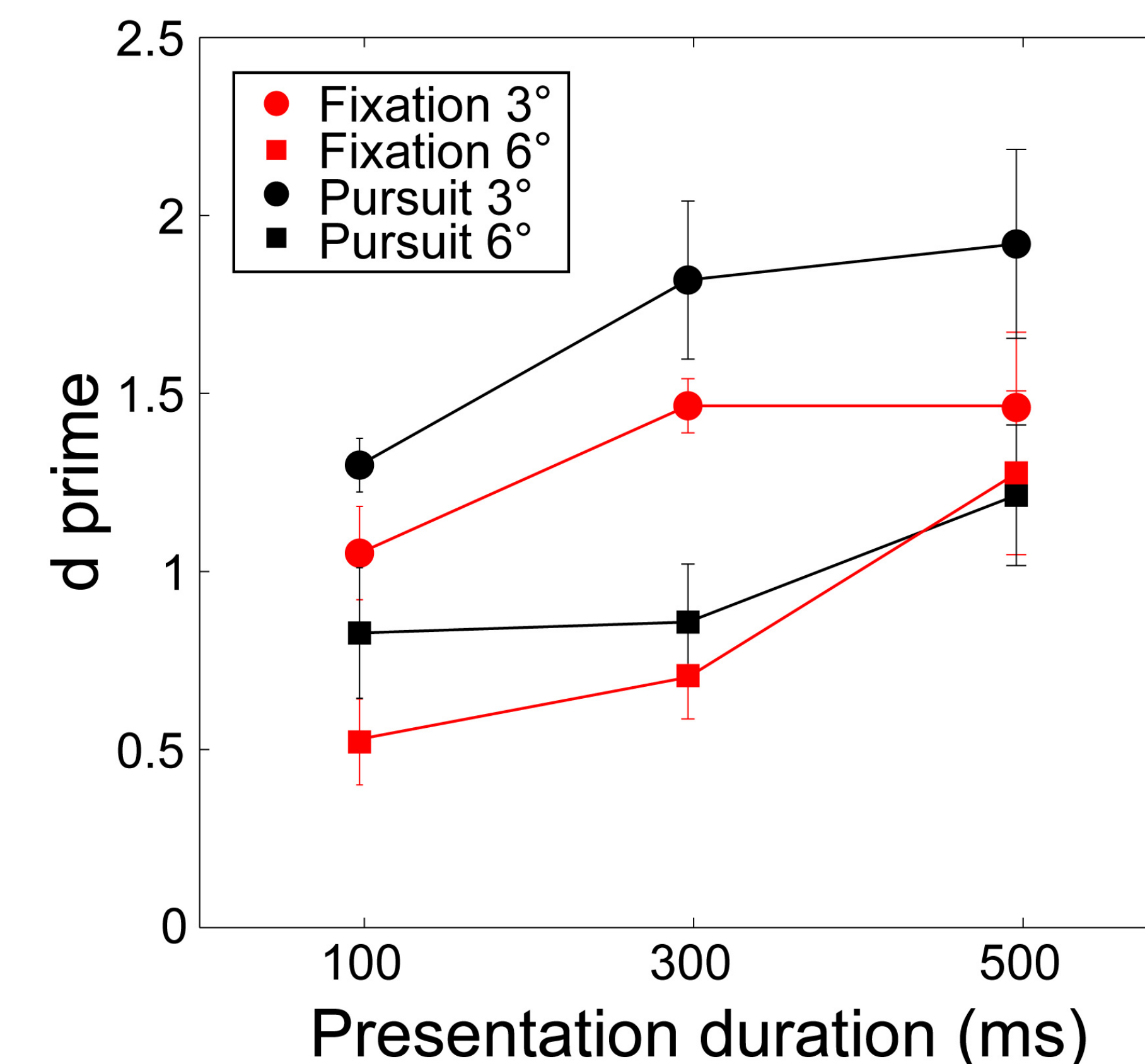
After tracking the target, observers had to make a saccade to the position where they estimated the “ball” would hit or miss the “goal”.

Perceptual judgments show the same trends as in exp. 1.

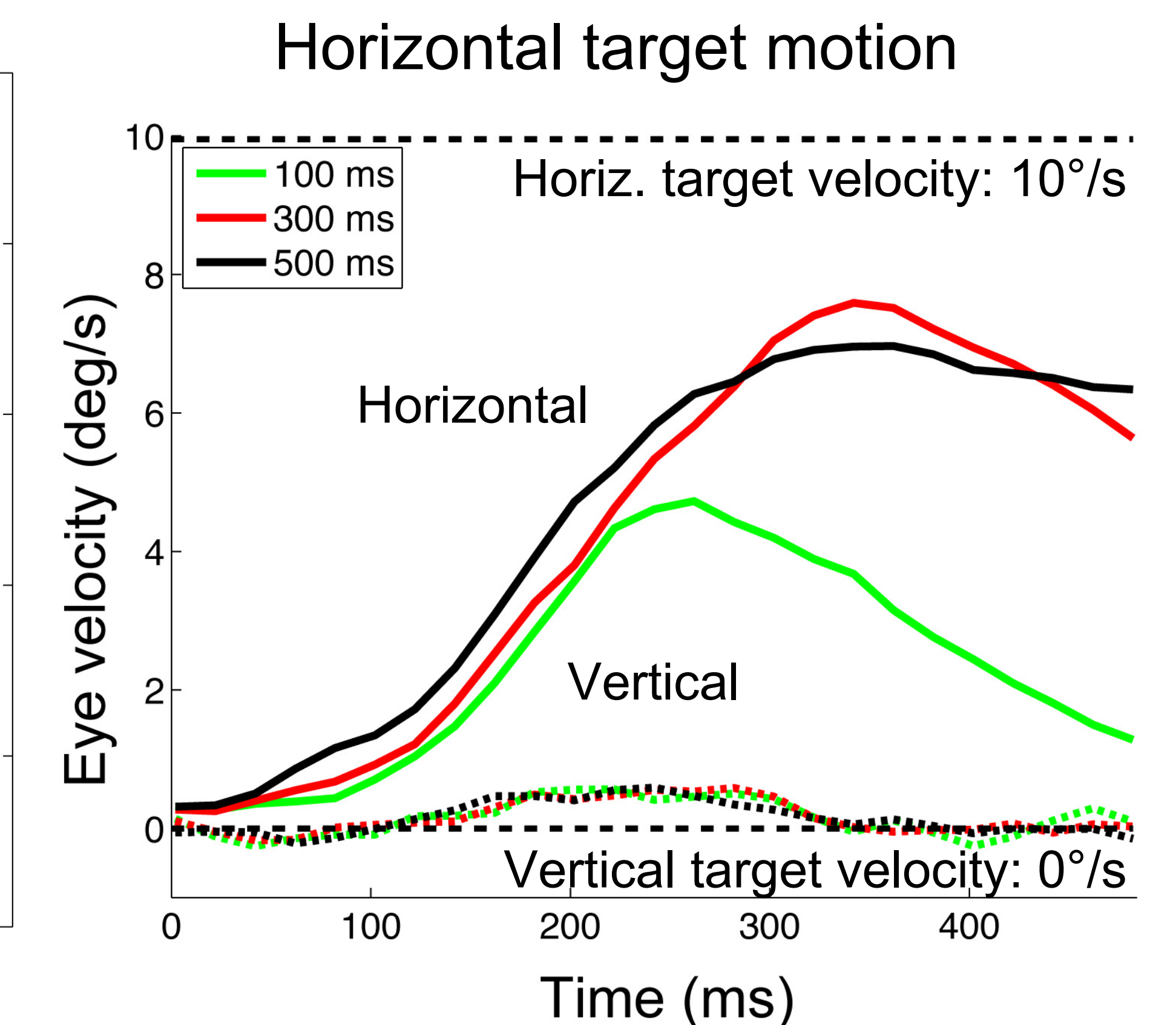
Mean two-dimensional saccadic position error is significantly lower for correct judgments (hits or correct rejections) than for errors.

Exp 1: Pursuit enhances motion predictability

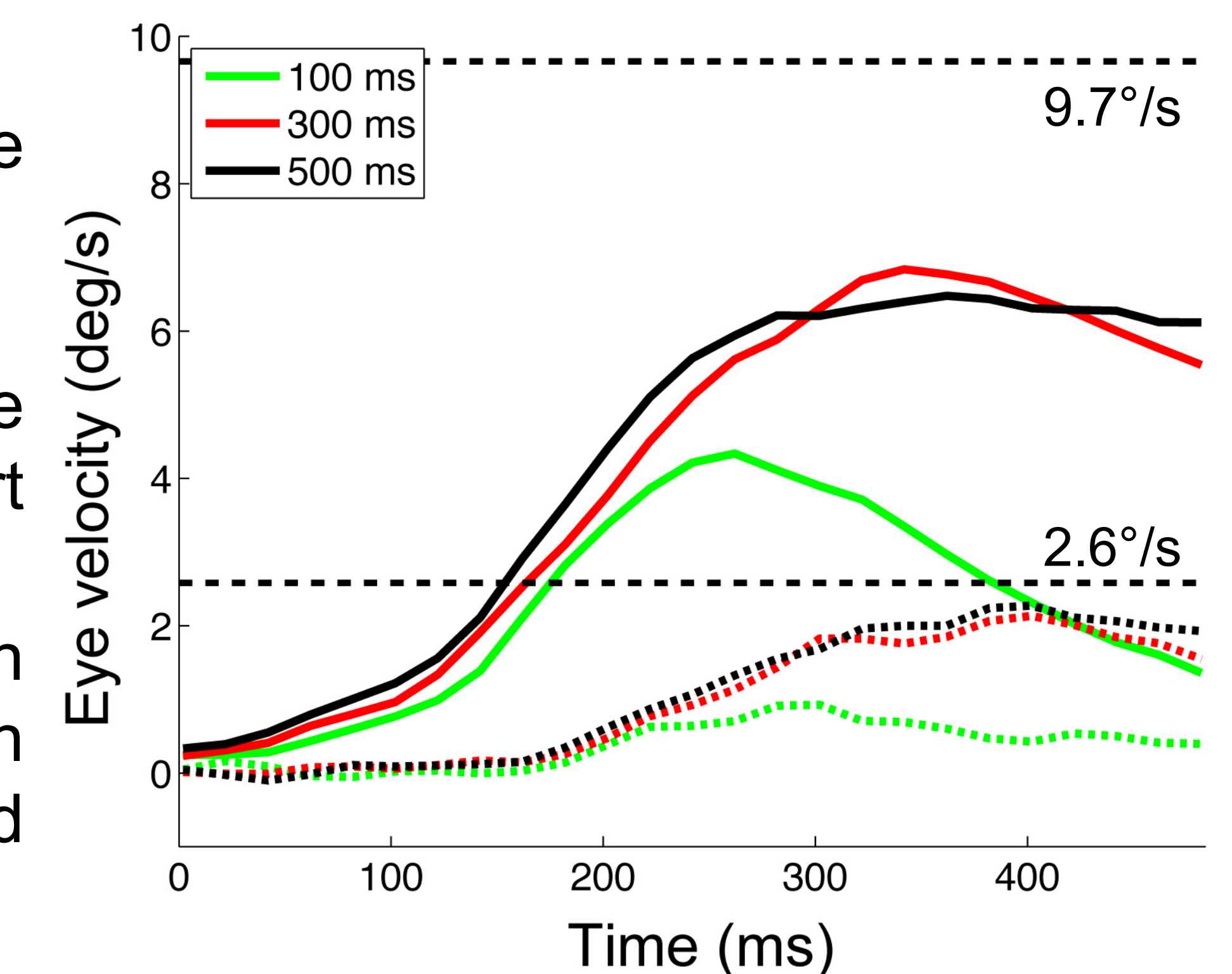
Perceptual judgments (n = 5) Three presentation durations, two distances (3°, 6°)



Horizontal and vertical eye velocity Three presentation durations



Diagonal (15°) target motion

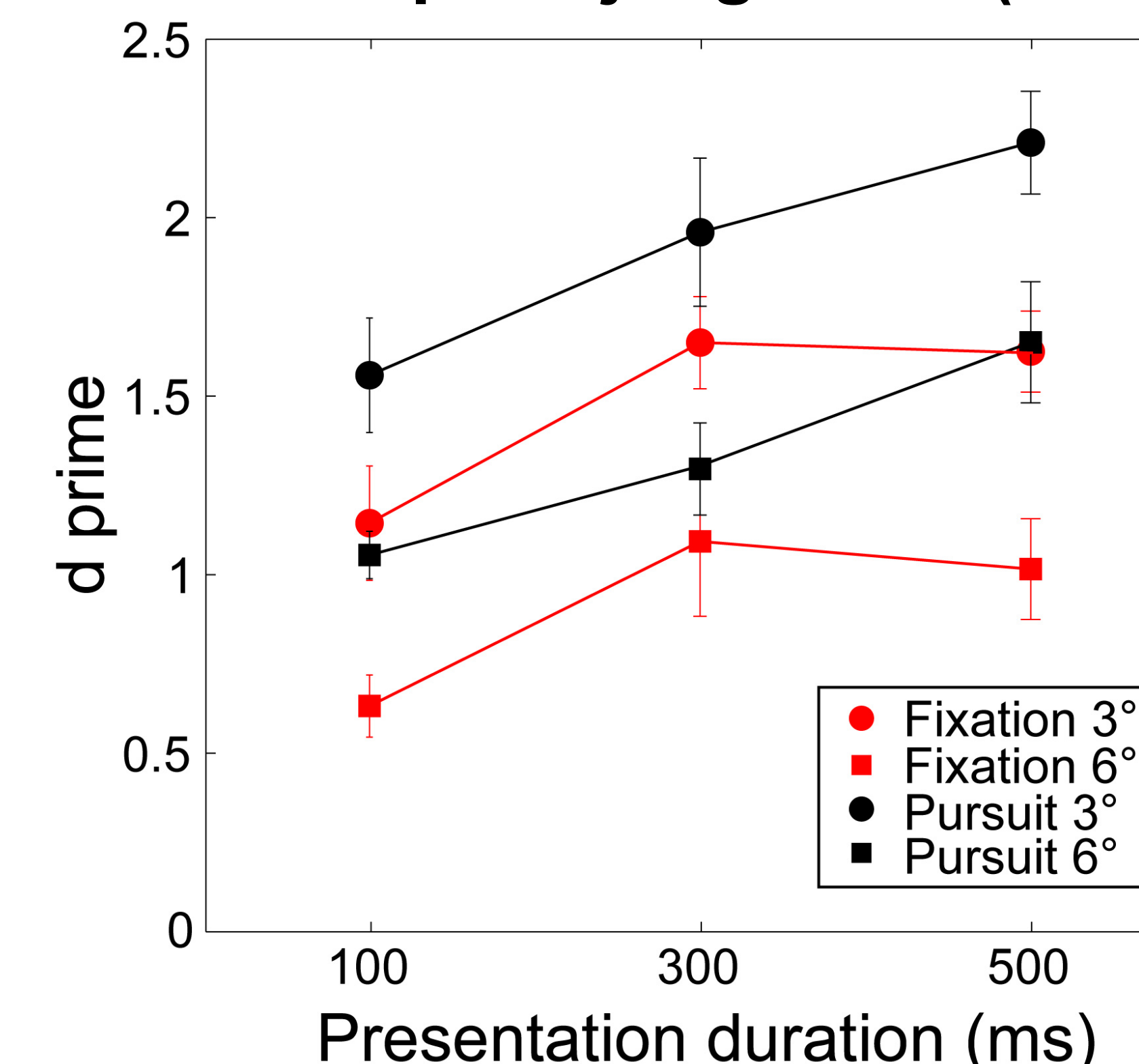


Mean traces show:

- Reliable pursuit for all three presentation durations
- A tendency for pursuit to enhance predictability, especially at short target-goal distance
- An increase in performance in pursuit and fixation with decreasing distance and increasing presentation duration

Exp 2: Saccade end position predicts judgement

Perceptual judgments (n = 5)



Saccadic position error

