The cEYEcling project

UNIVERSITEIT GENT

Vansteenkiste Pieter, Van Hamme David, Cardon Greet, Lenoir Matthieu

Cycling around bends
the effect of cycling speed on steering and gaze behavior

Department of Movement and Sports Sciences, Ghent University, Belgium

Corresponding author: pieter.vansteenkiste@ugent.be

Introduction

Although it is generally accepted that **visual information guides steering**, there is no consensus whether the **tangent point strategy** (the point of the inner lane boundary bearing the highest curvature in the 2D retinal image) or the **gaze sampling strategy** (looking at a points in the future path) is best suited to guide steering around bends. Unfortunately, visual behavior while negotiating curves has almost uniquely been tested in car driving situations and no effect of driving speed has been described yet. Therefore, current research investigates the **effect of cycling speed on the visual behavior while cycling curves**.
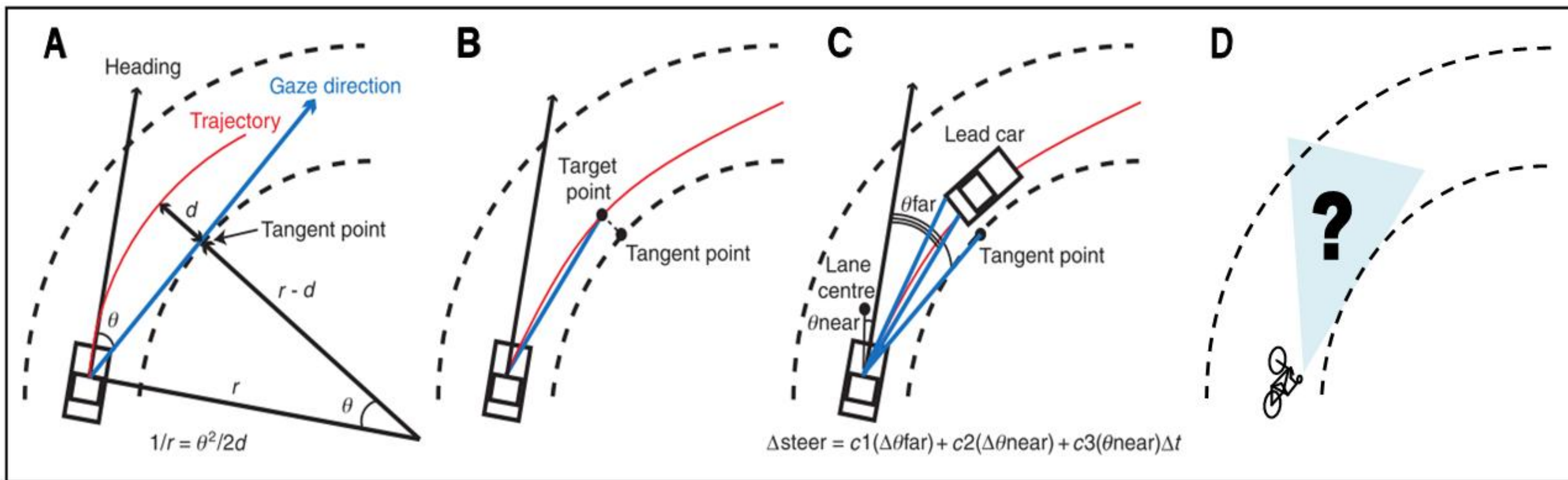

Figure 2 : Steering models for car driving (A-C) and cycling (D)
(A) Tangent point strategy according to Land and Lee (1994) **(B)** Gaze sampling strategy (Boer 1996; wilkie & wann 2008) **(C)** Salvucci and Gray (2004) : The change in direction of any salient point along the road can be used to achieve proportional control of steering. **(D)** visual behavior while cycling trough curves has never been studied. (adapted from Mars 2008)
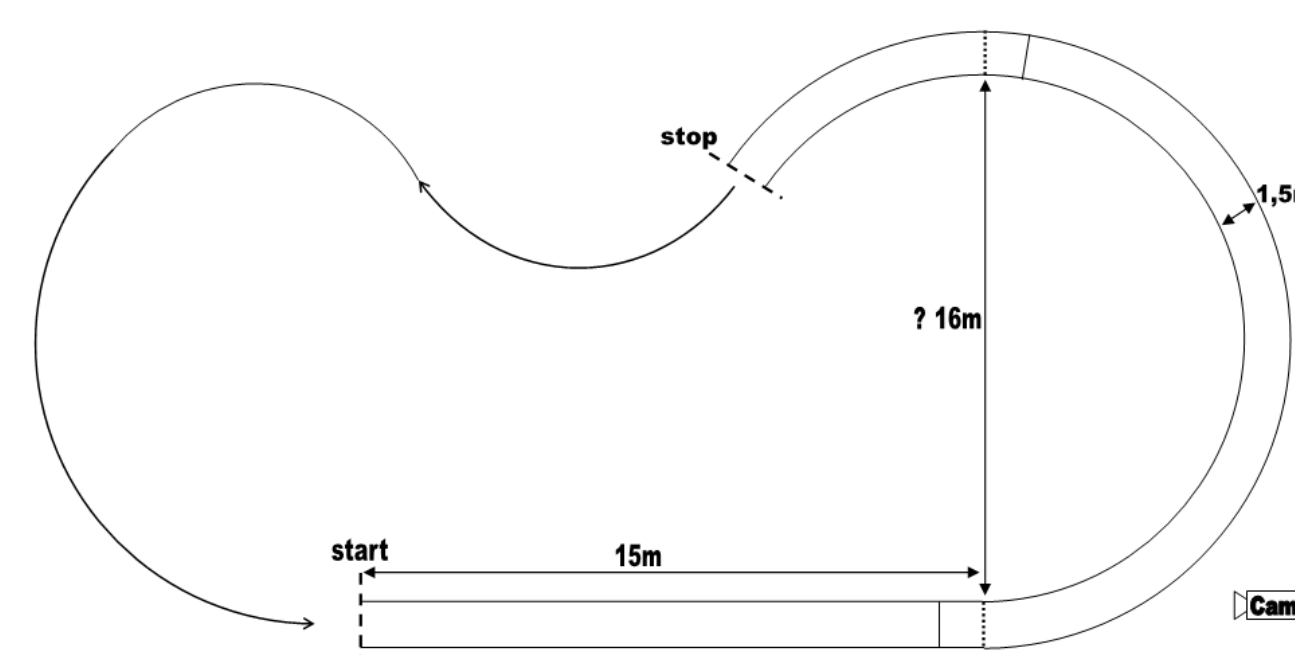
Methods

Figure 2 : Experimental set-up
Twenty-five participants (aged 21,83 ± 0,42 y; 11females) were asked to cycle three times through a semicircle at three speeds : slow, preferred and fast. Seventeen participants with a Tracking Ratio >90% were included in the analysis

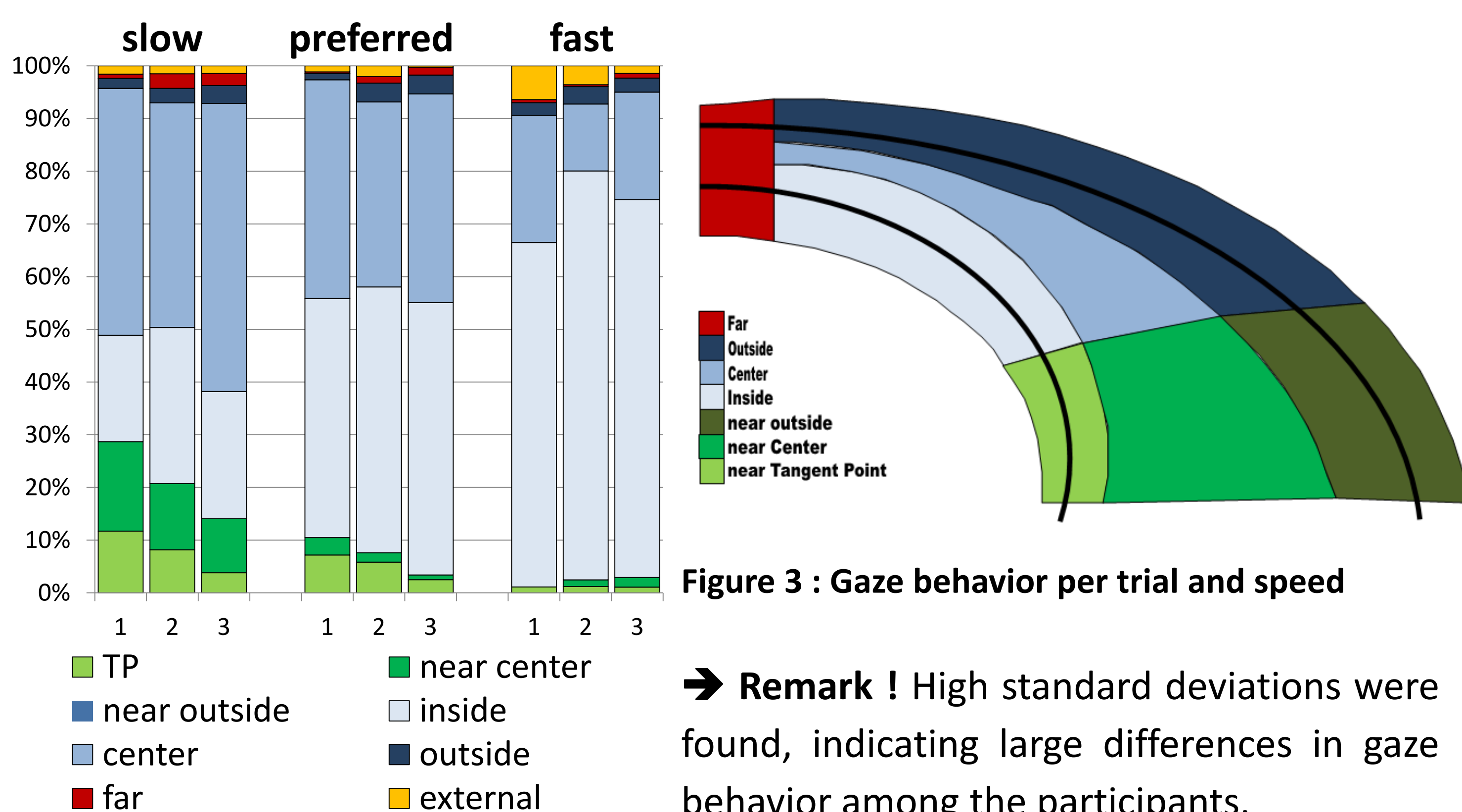**Figure 3 : Participant wearing a head mounted eye tracker**
Gaze behavior was recorded using a 50Hz Head-mounted Eye-tracking Device (SMI) which was mounted on a baseball cap and was connected to a notebook in a backpack.

Figure 4 : Instrumented bicycle
A camera was mounted at the back of the bicycle and pointed backwards. Based on these video images a trajectory was reconstructed and *distance to the middle edge*, *Standard Deviation on this distance* and *number of steering corrections* were calculated. In addition, steering behavior was analyzed per 1/5th of the semicircle.

Results

Figure 3 : Gaze behavior per trial and speed

➔ **Remark !** High standard deviations were found, indicating large differences in gaze behavior among the participants.

Effect of increase of cycling speed and difference between 3 successive trials

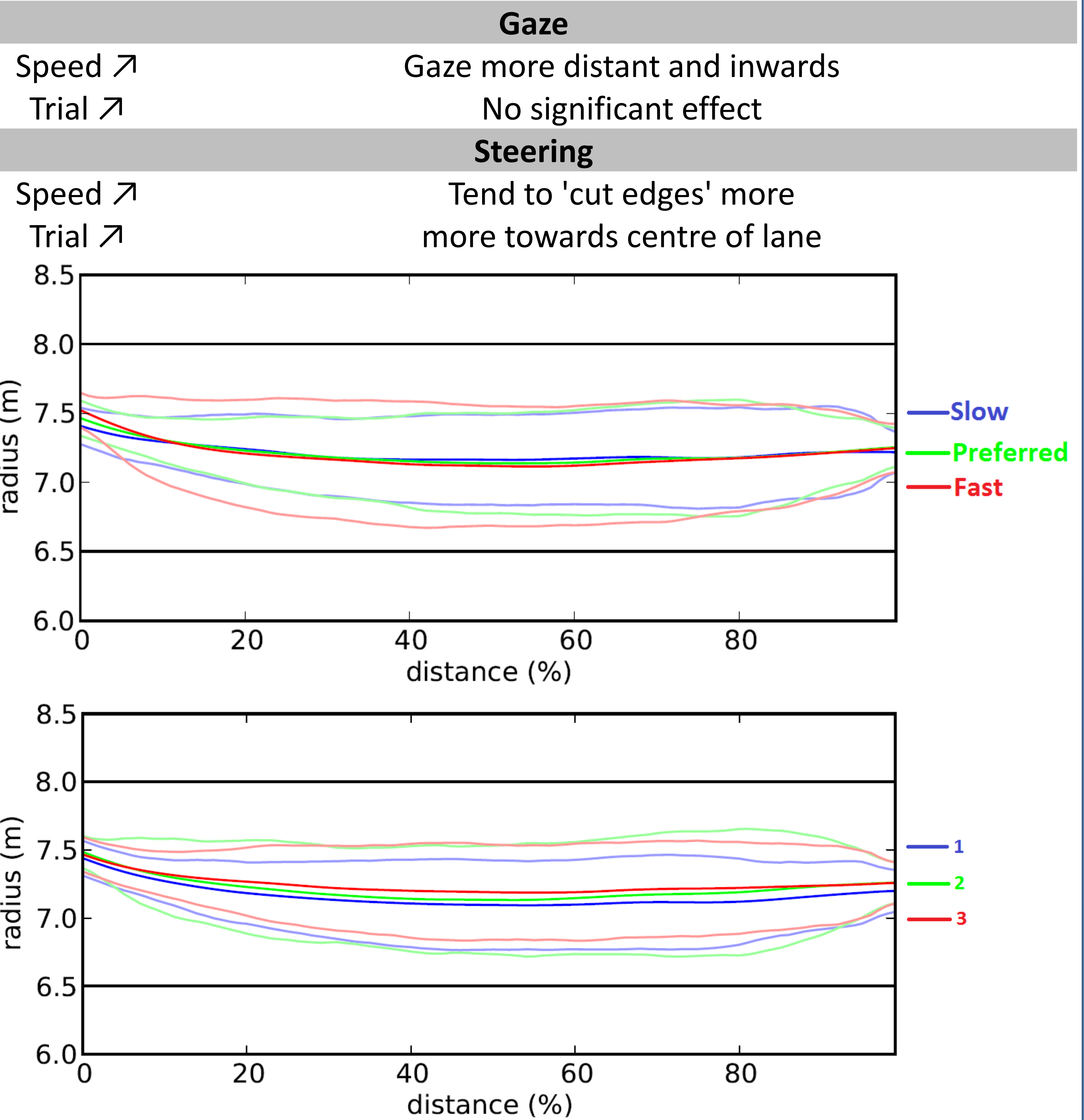| Gaze	
Speed ↗	Gaze more distant and inwards
Trial ↗	No significant effect
Steering	
Speed ↗	Tend to 'cut edges' more
Trial ↗	more towards centre of lane

Figure 6 and 7 : Average cycling trajectory and standard deviation per speed and per trial
Straight black lines represent edges of the cycling path. Light colors indicate standard deviation.

Conclusions

❌ **Tangent point strategy** was hardly used when cycling current curve

❌ No proof for **Gaze sampling strategy** since gaze was often directed to inner edge

✅ Gaze was strongly affected by cycling speed

❗Steering behavior changed over trials, gaze behavior didn't
  ➔ steering is not only guided by vision but also by working memory

❗Large variability in gaze behavior among participants
  ➔ Multiple visual strategies can be used for cycling a curve

References

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