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

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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 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.

Methods

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)

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 5: 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

<table>
<thead>
<tr>
<th>Speed</th>
<th>Gaze</th>
<th>Steering</th>
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<tbody>
<tr>
<td>Trial</td>
<td></td>
<td></td>
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<tr>
<td>↑</td>
<td>more distant and inwards</td>
<td>tend to 'cut edges' more</td>
</tr>
<tr>
<td>No significant effect</td>
<td>more towards centre of lane</td>
<td></td>
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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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