Submission ID: 56

Lund, Sweden 10-12 November 2021 ICSC International Cycling Safety Conference

A VR cycling study on visual attention allocation and subjective risk perception at intersections

Rul von Stülpnagel

Keywords: virtual reality, subjective risk perception, visual attention, gaze behaviour

[Abstract as included in the submitted paper]
Cyclists need to constantly scan their surroundings for potential hazards. Our knowledge about how cyclists allocate their visual attention towards certain directions (or not) is so far limited. We designed a virtual intersection that participants crossed in several variations on a virtual bike while wearing a head mounted display. We hypothesized that both visually accessible and visually inaccessible branches of the intersection (as seen from the cyclist's position) are perceived as less dangerous than areas of medium visual accessibility. Although the participants' behavior revealed general plausible effects, we found no support for this hypothesis. The spatial position and the visual accessibility of an intersection branch were not relevant for the associated level of risk. However, we conclude that the general gaze direction extracted from the orientation of the head mounted display provides relevant information about the allocation of visual attention. This underlines the potential of cycling simulators and virtual environments for understanding and studying cyclists' behavior and perceptions.

[Old Abstract]
Background
Cyclists need to constantly scan their surroundings for potential hazards. Several studies used video clips to investigate how factors such as cycling experience affect hazard detection rates and subjective risk perception. This approach is thus bound to a specific point of view for presenting the scene. Virtual reality experienced through head-mounted displays provides a tool enhancing the possibilities in this regard: In a VR cycling simulation, participants are free to look into the directions they perceive as potentially dangerous. Furthermore, this approach also allows studying which directions they neglect. Arguably, the limited visual attention allocated to those directions may lead to less subjective risk, but to an increased probability to overlook a potential hazard.
Aim
We aim at linking the visual accessibility of the different branches of an intersection to the associated subjective risk. We postulate an inversed U-function. More specifically, we expect that an intersection branch in front of a cyclist is visually accessible and thus perceived as manageable and less dangerous. Intersection branches located more to the left and right to the cyclist's travel direction are visually less accessible, and are thus perceived as less controllable and more dangerous. However, intersection branches beyond the normal field of vision (i.e., diagonally behind the cyclist) receive little, if any, attention. Consequently, the subjective risk attributed to these intersection branches is low, and the risk of collision partners coming from these directions is likely to be underestimated.
Method or methodological issues
We created a virtual model inspired by a real-world intersection, featuring simulated pedestrians, cars, and motorcycles. Three intersection branches were streets accessible for motorized vehicles and cyclists; one intersection branch was a path shared by cyclists and pedestrians only. We are currently collecting data of about 20-25 participants. During the study, participants wear an Oculus Rift headset enabling an immersive and natural viewing experience. Participants sit on a chair, but accelerate, decelerate, and steer a simulated bike with the Oculus touch controllers. In twelve consecutive, randomized trials, they travel from all four different intersection branches into each of the other three possible directions. After each trial, they rate the experienced hazard level of each intersection branch (except the one they started from) on 7-point scales. In addition to these ratings, we extract the general gaze direction as well as the intersections branches' position in relation to the travelling trajectory, and categorize these information into a six-field schemata (i.e., front, back, front right, front left, back right, back left).
Results obtained or expected
We will run linear mixed models to investigate to which extent the visual accessibility of an intersection branch affects visual attention allocation. Then, we will analyze the relation of visual attention allocation and the perception of subjective risk emanating from this direction. We will also account for effects of cycling experience and frequency.
Conclusions
This study promises insights into how specific spatial configurations of an intersection can affect cyclists' attention, leading to potential and systematic underestimations of the risk associated with certain directions. This may help to design proper solutions to raise cyclists' attention accordingly.