International Co-operation on Theories and Concepts in Traffic Safety

Visual fixations of car drivers approaching pedestrian crossings – A naturalistic eye-tracking study

[1]*Kramm, R.M., [1]Uhlmann, J., [1]Ehlers, J. & [1]Plank-Wiedenbeck, U.
*lead presenter
[1]rebekka.maria.kramm@uni-weimar.de, Bauhaus-Universität Weimar, Germany

Introduction

The Interaction between pedestrians and drivers at pedestrian crossings relies on visual communication to determine the right-of-way situation and the safety of pedestrian passage. Therefore, it is important to analyse the visual attention processes of drivers at pedestrian crossings. Where is the focus of the vision of the drivers and how can we improve pedestrian crossings based on this?

Research design

To investigate visual attention and eye movements of drivers at pedestrian crossings, mobile eye-tracking was used to determine gaze shifts and fixations. The eye-tracking device enables binocular tracking over various distances and are adjusted by means of a calibration, which can be validated afterwards.

For the study, 20 volunteers (10 female, 10 male) with a mean age of 25 years and a standard deviation of 4 years were selected to ensure homogeneity. The participants were categorized according to their driving experience. All participants were unaware of the exact subject of the study before and during the test and were instructed to drive as they would under normal circumstances.

The 5.7 km survey drive through Weimar, Germany took place in urban and suburban areas with speed limits of 30 to 50 km/h. The route took between 12 and 21 minutes, depending on traffic and driving style. Four pedestrian crossings, two of them in both directions, were passed along the route, making a total of six crossings. The crossings were characterised by the fact that they all crossed two lanes of traffic and some had cycle lanes. The study took place on two working days in June 2021 during the peak hours of inner-city traffic.

Analysis

The eye-tracking data was analysed using "iViewETG" software. Fixations were transferred to a reference view for relevant sections, starting approximately 30 metres in front of each pedestrian crossing, so the investigation time frame is an average of 1258 milliseconds with a standard deviation of 2025 milliseconds. Five Areas of Interest (AOIs) were defined in the software, after summarizing the AOIs, due to little date in the individual AOIs: left side area, left sign, roadway, right sign, right side area. For each of the AOIs, the number of fixations of an AOI per second, the share of fixations of an AOI of all fixations of the given sequence and the average fixation time of the AOI were calculated and used as dependent variables. The data obtained from the experiments was analysed using the statistics software R. The data sets were filtered for plausibility and data integrity and an ANOVA analysis was carried out. The variables of possible influence were the crossing location, the presence of pedestrians on the

left or right side areas, the presence of cars in front of the test vehicle or in the opposite lane, years of driving experience and regularity of car use.

Results

It was found that the average number of fixations (normalised to the same time) was the highest for the AOIs of the roadway and the right area. The participants showed significant ($p < 0.05$) differences in the number of fixations on the roadway between the different pedestrian crossings.

The highest share of the fixations was found in the AOI of the roadway, which accounted for the highest share of fixations, and the right side of the crossing. The fixation share for the left side areas was much lower. The road signs left and right were rarely fixated. As with the fixations per second, a significant difference between the pedestrian crossings was found. Furthermore, it was determined, that the presence of pedestrians in the left and right side areas led to a statistically significant increase in the fixation share for both sides (+55% on the right and +44% on the left).

Analysing the average fixation lengths it was found that the right side areas had the highest average fixation time, while the roadway and the left side areas had slightly shorter fixation times. No statistically significant influence was found.

Table 1 - Averaged results (n=20) for eye-based measures with regards to the selected AOIs

Area of interest	Left side area	Left sign	Roadway	Right sign	Right side area
Fixations per second	0.27	0.00	0.54	0.03	0.50
Fixation share	15.6 %	0,0 %	48.6 %	0.7 %	28.5 %
Average fixation length	225.97 ms	--	232.26 ms	192.49 ms	247.27 ms

Discussion

The results show that the most important areas of interest at pedestrian crossings are the roadway itself and the waiting areas on the right side. While the roadway has the higher relative fixation count and fixation share, the right side areas show a higher fixation time. The differences between the right and left side areas are clearly visible. This shows that drivers mostly focus on the road ahead and on the waiting areas that provide a threat for immediate reaction for them – the ones on the right side. The significant differences between the different pedestrian crossings can be explained by the different layouts of the right-side waiting areas, which can require more attention (and thus a higher fixation share) than less complex ones. This is particularly true for crossing number 6 which has a big park square with many access paths on the right side. The presence of pedestrians in the side areas increases the fixation share, but without increasing the fixation duration or count. The traffic signs received almost no fixations, which leads to the assumption that they are mostly seen through peripheral vision.

Implications for further research and road safety practice

The high share of fixation of the right side areas highlights the importance of good visibility of the waiting areas at pedestrian crossings. The differences regarding the fixation of the side areas

between the different pedestrian crossings raise interesting questions about the influence of the design of the side areas of pedestrian crossings, which could be the subject of further naturalistic or simulator studies.