

Title

An Exploratory Study of Vehicle-pedestrian Interactions based on Pedestrians' Visual Search Behaviors

Primary Researcher

Yi-Shih Chung, Department of Transportation and Logistics Management, National Yang Ming Chiao Tung University, Associate Professor

Summary

Permissive signal phasing is a common design in intersections in Taiwan where turning vehicles share the same green-time periods with pedestrians for occupying crosswalks. Despite that traffic laws and regulations give pedestrians rights of way on crosswalks, the accident risk inevitably rises, and pedestrians have to maintain alert during crossing the road. The present study aims to explore the visual search behaviors of pedestrians, including their head-turning and eye fixation behaviors while crossing an intersection with permissive signal phasing. A field experiment is developed by asking twenty young adults to walk on a designated path twice where the participants may encounter conflicting turning vehicles from different directions. Each participant receives a situational awareness test before the walking experiments, and an intervention is made between the first- and second-round experiments by informing the participants of a higher chance of encountering conflicting turning vehicles from back. The head-turning and visual search behaviors are collected with a mobile eye tracker; surrounding traffic conditions are recorded by research assistants following the participants. The analysis results showed that participants with a high level of situational awareness ability exhibited more head-turning but not necessarily more eye fixations. When walking through a crosswalk segment protected by a refuge island, the participants demonstrated a lower frequency of eye fixations, suggesting a lower attention burden because of refuge island. The behavioral change because of the intervention includes more head-turning and better performance of fixating eyes on turning vehicles. The study highlights the effectiveness of roadside safety education when the provided information is specific. Pedestrians mostly pay more attention before entering an intersection; yet, maintaining a certain level of situational awareness is preferred when walking across an intersection with permissive signal phasing.

Aim of Research

The study has two purposes. The first purpose is to explore pedestrian eye searching behaviors during crossing; in particular, we focus on signalized intersections with permissive signal phases. Seeing the high frequency of vehicle-pedestrian collisions that vehicles were running from the back of the pedestrians, the study designs an experiment that aims to raise the situational awareness of pedestrians for such potential threats. In particular, we tell the participants about the relatively high frequency of vehicle-pedestrian collisions that vehicles are coming from back of the pedestrians, and

compare the participants' eye searching behaviors before and after knowing the safety fact.

Method of Research & Progression

The experiment consists of three steps including an interview for the participants' background information, followed by a pretest of their situational awareness ability, and finally a walking experiment in a selected field. The research team recruits 20 participants aged between 20 and 30 on the campus of National Yang Ming Chiao Tung University, Taiwan. We limit the participants to be young adults without any disability in walking and had an equal number of male and female participants. Each participant receives NT\$600 in cash as a reward for the experiment. The experiment is approved by the Research Ethics Committee for Human Subject Protection, National Yang Ming Chiao Tung University (NYCU-REC-110-092E). The details of the experiment are described below.

The study uses the Pupil Invisible of the Pupil Labs (<https://pupil-labs.com/>). Pupil lab's Eye tracking glasses work like a pair of glasses. It is a device with two cameras that captures participant's every eye's movement and one world camera attached to the frame of the glasses. The hardware and the Pupil Lab Mobile Bundle are flexible and carefully designed to be lightweight and unobtrusive. A mobile phone will be connected to the eye tracker and carried by the participants to record the detected eye movement and video data.

The experimental field was on Chunghua Road, Taipei. Each participant started his or her experiment at the southeastern corner of the Zhonghua-Wuchang intersection (the bottom-left corner of Figure 1; also see Figure 2(a)). Each participant walked through a selected path twice. In the first round, the participant walked clockwise from the starting point (the bottom-left corner) to the turning point (the bottom-right corner) along the path indicated in Figure 1, including walking across the Zhonghua road with protection from a refuge island, turning left, walking straight across the Zhonghua-Wuchang and Zhonghua-Hankou intersections, turning right at Zhonghua-Kaifeng intersection (Figure 2(b)), walking across the Zhonghua road, and finally arriving at the turning point, i.e., the southeastern corner. The participant followed the same path back to the starting point.

After the participant arrived at the starting point, the research team briefed the participant again, telling the participant that the most frequently occurring vehicle-pedestrian collision type at signalized intersections in Taipei was vehicles running from back at an odds ratio greater than two. Then, the participant went through the same path to the turning point and came back to the starting point. For each round of walking, a participant would encounter vehicles running from the right rear (RB) twice, from the left rear (LB) once, from the right front once (RF), and from the left front (LF) twice. The participant would also walk through three junctions without any conflicts of turning vehicles.

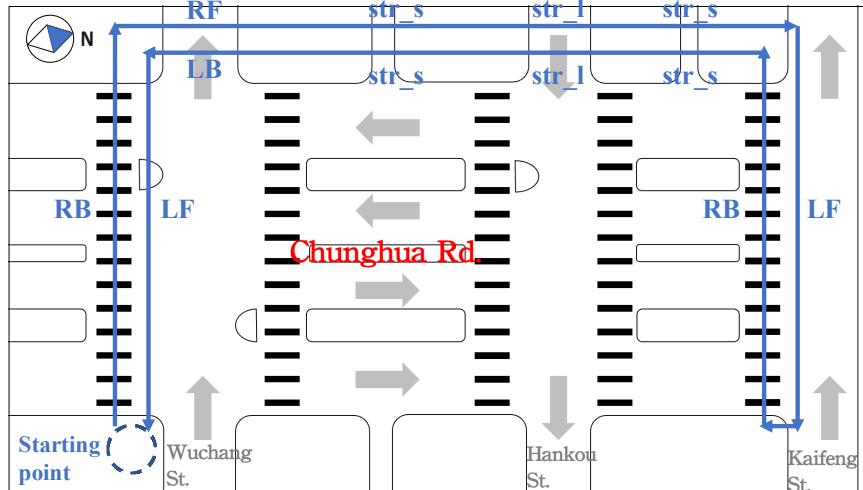


Figure 1 Experimental site: the blue path indicates the walking path selected by the research team



(a) Zhonghua-Wuchang intersection



(b) Zhonghua-Kaifeng intersection

Figure 2 Snapshot of the three main intersections in the field experiment

Results of Research

The analysis results showed that both head-turning and eye fixation frequencies were significantly positively associated with walking time. The result is consistent with our expectations as walking time was an exposure variable. In the model development process, we tested both linear and quadratic effects of the walking time variable, and only the model of eye fixation on turning vehicles exhibited significant estimates for both the linear and quadratic walking time variables. The linear effect maintained positive as the models reported in the previous section, and the quadratic effect was negative, meaning that the rate of eye fixation on turning vehicles was rising first and then declining when the walking time was long enough.

Refuge island has been considered as having safety benefits by providing pedestrians a place to rest during crossing, especially a wide street. A two-stage crossing allows pedestrians to focus on oncoming traffic from one direction only, which reduces pedestrians' burden on attention allocation. The analysis result of the present study is consistent with the literature. We showed that the participants exhibited fewer eye fixations, including total frequency, and the frequency of turning vehicles when walking across a crosswalk segment protected by a refuge island than without being

protected by a refuge island.

On the other hand, the study did not find any significant difference in head-turning rates between road segments with and without a refuge island. Head-turning is usually required when turning vehicles are coming from the back of the pedestrians. The statistically insignificant result may be due to insufficient sample size. However, it is also possible that the participants still felt threatened by turning vehicles even with a refuge island on the road. Further studies would be needed to shed light on this issue.

The study designed an intervention that informed the relatively high risk of vehicle-pedestrian collision where vehicles were running from the back toward pedestrians. The result showed that the intervention was effective; the head-turning rate and the rate of eye fixation on turning vehicles both enhanced after the intervention. Therefore, we could conclude that the designed intervention is effective in raising pedestrians' situational awareness, at least shortly. This result is consistent with the meta-analysis findings indicated by previous studies that personal communication or roadside media was beneficial to traffic accident (including vehicle-pedestrian) reduction.

Future Areas to Take Note of, and Going Forward

The study is limited to a small group of young adults aged between 20 and 30. Further studies are thus clearly needed to identify the effects of safety education on the general public. Traffic safety education has been a recent focus in Taiwan. The findings of the present study support the continual implementation of these safety campaigns. On the other hand, present safety campaigns in Taiwan focused on telling pedestrians what to do but not why to do (or not to do). The idea is to keep the campaign materials as simple as possible. However, adding information such as safety facts relevant to target behavior change could also be beneficial, as demonstrated in the present study. Most theories in social and health psychology assume that intentions cause behaviors though the intention-behavior consistency may be moderated by factors such as intervention characteristics. Accordingly, the study recommends adding such "why" information in the safety campaign materials.

Means of Official Announcement of Research Results

The research results are summarized as an academic paper, "Head-turning and Visual Search Behaviors at Intersections with Permissive Signal Phasing: An Eye-Tracker Experiment", accepted for presentation at the coming Road Safety and Simulation International Conference held in Athens, Greece.