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Effect on cycling behavior at a signalized intersection by fixed-point camera observation

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1 INTRODUCTION

In 2016, there were 509 traffic accident fatalities of cyclists in Japan. The main cause of traffic accidents involving bicycles in the last 10 years is traffic violations, and unsafe cycling is the most common traffic violation.

It is necessary to better understand the current situations regarding cycling to take measures preventing bicycle traffic accidents [1]. This study analyzed the cycling behaviors, focusing on the velocity and obeying traffic lights at intersections. The purpose of this study is to investigate the timing of braking by cyclists at the dilemma zone, where they have to choose whether stopping before the intersection or traveling through the intersection at the risk of changing to a red light when the traffic light changes green to yellow, and the effects of weather and road width conditions on bicycle velocities.

2 METHOD OF INVESTIGATION

This investigation focused on a signalized intersection in a city A, Tokyo, Japan. This particular intersection was selected because a number of traffic accidents had previously occurred there in city A. Video cameras were set up at the intersection and recorded the traffic scene at and around the intersection. The cycling situation at this intersection was analyzed using data collected from video recordings. Two video cameras were angled pointing the west (a wide road) and the south (a narrow road), as the majority of bicycles traveled from those directions. The video recordings covered the morning commute (7–9 a.m.), the time period when accidents were more likely to occur. Recordings were conducted on two days, the sunny and rainy days. Permission to record was obtained from the Tokyo Metropolitan Police Department and city A's police station.

3 METHOD OF ANALYSIS

The analysis in this study was conducted using data collected from video recordings. Velocity and position were calculated using coordinate data, that is, data regarding the bicycles' positions in the video data. Moreover, the footage was used to determine the sex of the cyclists, color of traffic lights and cyclists wearing a raincoat or holding an umbrella. The effects on cycling behavior were investigated using these data. The number of bicycles investigated in this study was 881.

3.1 Method of calculating velocity

This study calculated the velocity of bicycles at the moment the bicycle passed the stop line at the intersection. In the analyses, the oblique views of the bicycles' movements captured by the video camera installed on a traffic sign pole were converted into two-dimensional Cartesian coordinates (e.g., the view from the top) using Dipp-Motion software (DITECT 2014) to determine the velocity.

3.2 Method of calculating dilemma zone

The targets of the dilemma zone were bicycles that rode within 40 m from the crosswalk at the intersection. This study calculated the position, velocity and Time To Intersection (TTI) of target bicycles as they entered the intersection.

4 RESULTS

4.1 Dilemma zone

Figure 1 shows the relationship between the velocity and the TTI of bicycles when cyclists rode into the dilemma zone. Regardless of weather, cyclists tended to go into the intersection if the TTI was under 4 s. This result shows that cyclists decided to enter the intersection or to stop when the green light changed to yellow when the TTI was around 4 s. Moreover, on the sunny day, cyclists with a velocity over 4 m/s did not stop before the intersection. On the rainy day, cyclists with a velocity over 3 m/s did not stop. Thus, the velocity at which cyclists would not stop before the intersection on the sunny day tended to be faster than that on the rainy day.

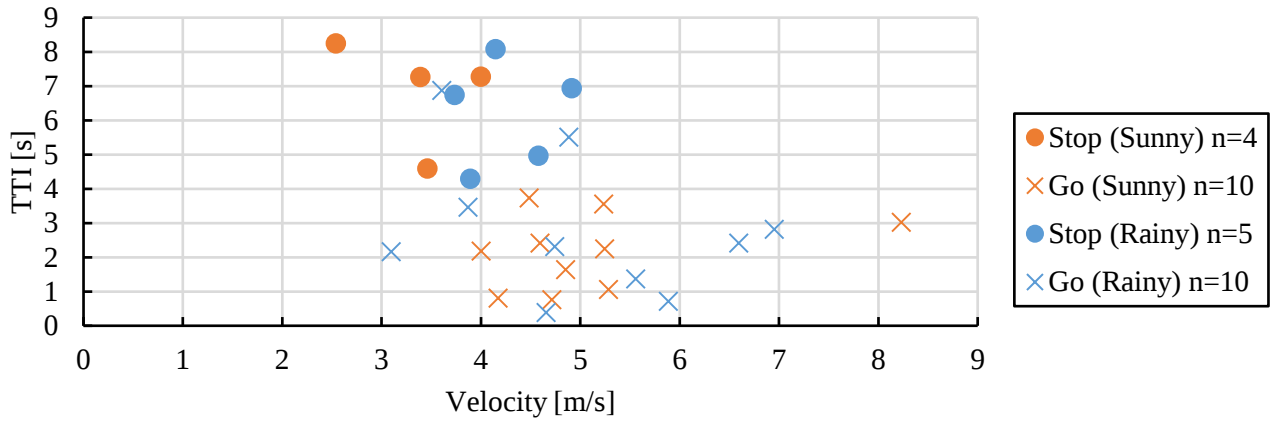


Figure 1: Action of cyclists in the dilemma zone

4.2 Effects of weather and road width

Rainy day conditions were investigated using data showing bicycles approaching from the wide and narrow roads. Figure 2 shows the rate of cyclists wearing a raincoat and those holding an umbrella on the rainy day. In total, 37% of cyclists held umbrellas, and this is a traffic violation. Furthermore, looking at the sex of cyclists, more males rode with open umbrellas than females, denoting unsafe cycling practices.

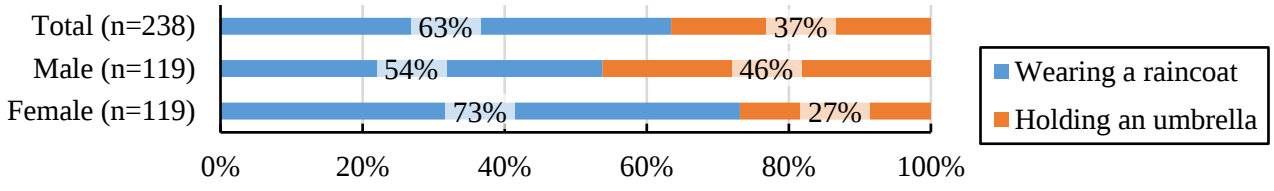
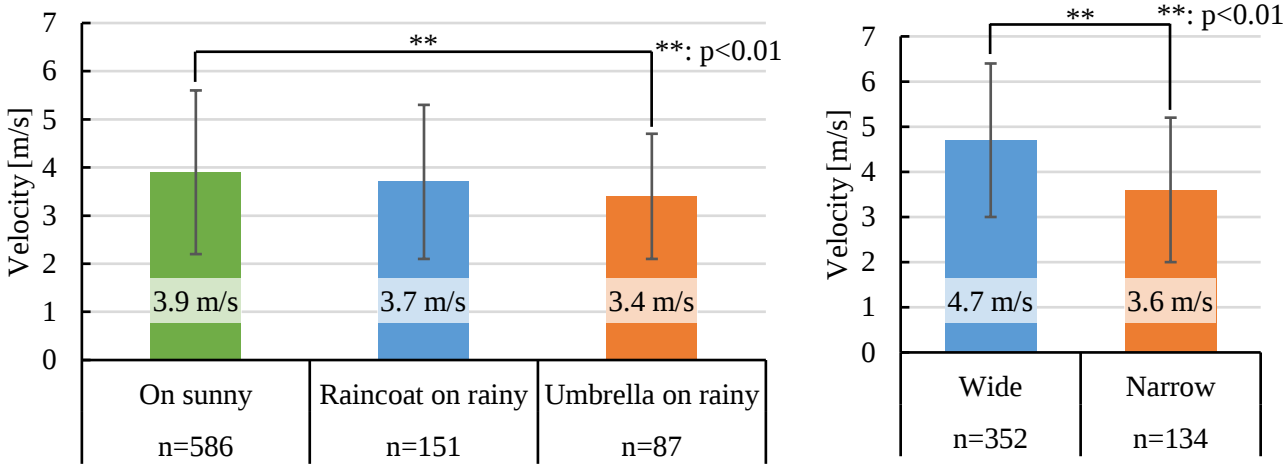


Figure 2: Ratio of wearing a raincoat and holding an umbrella

Figure 3(a) shows the average velocity and the standard deviation for the sunny and rainy days (wearing a raincoat and holding an umbrella). There was no significant difference ($p < 0.01$) between average velocities when wearing a raincoat (3.7 m/s) and when holding an umbrella (3.4 m/s). However, it is dangerous for cyclists to ride with an open umbrella as they have to ride with one hand, making the bicycle unstable. Furthermore, there was no significant difference between the average velocity on the sunny (3.9 m/s) and rainy (3.7 m/s) days. This study proves that the speed does not change, even under slippery conditions.

In addition, this study investigated the effect of road width on bicycle velocities when the traffic light was green. The wide road had a center line and was 5.0 m wide, with a green light lasting 37 s. And, the narrow road had no center line and was 4.1 m wide with a green light of 18 s. Figure 3(b) shows the average velocity and the standard deviation for the wide and narrow roads. There was a significant difference ($p<0.01$) between the average velocity cyclists when approaching from wide (4.7 m/s) and narrow (3.6m/s) roads. Thus, road width and green light intervals influence velocity.



(a) Case on sunny and rainy days *(b) Case of wide and narrow roads*

Figure 3: Average velocity and standard deviation

5 CONCLUTIONS

This study investigated the timing of braking by cyclists at the dilemma zone, and the effects of weather and road width conditions on bicycle velocities. This investigation focused on a signalized intersection in a city A, Tokyo, Japan, and video cameras were set up at the intersection and recorded the traffic scene at and around the intersection.

Dilemma zone: The Time To Intersection (TTI) of bicycles was around 4 s when the green light changed yellow. **Rainy day conditions**: About 30% of cyclists held umbrellas, and this is a traffic violation. Furthermore, regarding sex differences, more males held umbrellas than females. There was no significant difference between the average velocities when wearing a raincoat and holding an umbrella, even though cyclists holding umbrellas had to ride with one hand. **Velocity and road width**: The velocity of bicycles that rode on the wider road was faster.

REFERENCES

[1] Shoko Oikawa, Toshiya Hirose, Shigeru Aomura and Yasuhiro Matsui, “Traffic accidents involving cyclists identifying causal factors using questionnaire survey, traffic accident data, and real-world observation”, *Stapp Car Crash Journal*, Vol. 60 (2016), pp. 183-198.