Yellow Light Decision Based On Driving Style: Day Or Night

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Abstract

Drivers’ driving decisions at yellow lights are an important cause of accidents at intersections. According to previous studies, driving style is an important basis for deciding whether a driver passes a yellow light or not. This study therefore aims to investigate the effect of different driving styles on driving decisions at yellow lights under different lighting conditions. In this paper, 64 licensed drivers were recruited to study the effect of different driving styles on the decision to drive through yellow lights under both daytime and nighttime lighting conditions using a driving simulator and a VR device. The results showed that maladjusted drivers were faster and more likely to pass the yellow light than adapted drivers (81.25% > 43.75%) in both day and night. Male drivers had higher overall driving style scores than female drivers, and male drivers were faster and more likely to pass a yellow light than female drivers (56.25% > 31.25%). The study also found that inexperienced drivers were faster and more likely to pass a yellow light than experienced drivers (50% > 37.5%). Overall, maladjusted drivers are more likely to pass yellow lights, and we can improve this situation by enhancing driving learning for maladjusted drivers.

Introduction

Road traffic safety is a major concern today. 56% of fatal road traffic accidents are usually caused by unsafe driving behavior, which is often associated with aggressive driving styles. Due to the close relationship with road safety, the study of driving styles has become crucial. Driving style is a decisive factor in driving decisions. It is therefore relevant to study the influence of driving style on driving decisions.

Driving style has an important influence on driver decision making. Driving style is also considered to be important in reflecting the internal state of driving and predicting driving behavior. Driving style refers to the driver’s habits regarding choice of speed, distance from the vehicle in front, tendency to overtake other vehicles and violate traffic rules. As a result, many tools such as the Multidimensional Driving Style Inventory (MDSI) have been developed to measure driving style. The MDSI has proven to be a valid and reliable measure for assessing driver style. The MDSI is divided into four driving styles through eight factors: danger, anger, anxiety, and caution. A dangerous driving style is one in which the driver deliberately violates driving regulations and is driving in pursuit of excitement, speeding or illegal overtaking. Anxious driving is driving in a manner where the driver develops feelings and emotions of alertness and nervousness, accompanied by distracting behavior. An angry driving style is one in which the driver displays irritating, angry, and hostile attitudes and behaviors. Cautious driving style refers to safe and cautious driving behavior. The four driving styles are divided into two main categories: maladaptive driving styles and adaptive driving styles. Maladaptive driving styles include dangerous, anxious, and angry driving styles, while cautious driving styles are adaptive driving styles. Drivers with different driving styles make different decisions at signal crossings. The maladjusted driver usually exhibits aggressive driving. That is, they decide to cross the intersection and try to run the red light, even though they are away from the stop line. Adaptive drivers, on the other hand, usually drive conservatively.
This means that they are close to the stop line and decide to stop, even though they can safely cross the intersection\textsuperscript{1,10}. Although there have been many studies on driving styles, there are fewer studies on drivers’ driving styles in different lighting conditions.

Light conditions also have an important influence on driver decisions. Driver perception of hazards differs across lighting conditions. There was no significant difference in driver perception of hazards in the daytime scenario\textsuperscript{4,11}. The hazard perception sensitivity indices of drivers in the night scenario all decreased, and there were even cases where they were not aware of the hazard at all\textsuperscript{4,11}. And the psychological needs of drivers are higher in the night scenario than in the day scenario\textsuperscript{4}. So, it is relevant to study the driving behavior of drivers with different driving styles. Although there have been extensive studies on driving performance under different light conditions such as distracted driving\textsuperscript{12,45}, sleep driving\textsuperscript{6,46}, driving risk\textsuperscript{23,39}, visibility\textsuperscript{27,35} etc., but for drivers with different driving styles under different lighting conditions at signal intersections, driving decisions of drivers with different driving styles under different lighting conditions are not clearly studied.

Traffic signals at intersections have the same impact on drivers’ driving decisions. Intersections are high-risk locations where traffic accidents occur frequently. Approximately 30\% of road accidents in China occur at intersections\textsuperscript{44}. In particular, the decisions made by drivers at the start of yellow traffic lights are often critical, as inaccurate decisions can lead to traffic conflicts and collisions\textsuperscript{33}. Depending on the distance of the vehicle from the stop line, the driver is faced with two different scenarios. In the first case, the driver is in the indecision zone, while in the second case, the driver is in the possible stopping zone\textsuperscript{16}. At the onset of the yellow light signal, drivers need to decide immediately whether to stop or cross the intersection\textsuperscript{10,36}. However, immediate decision making by drivers is a challenge, especially in yellow light zones where drivers can neither stop safely nor cross the intersection\textsuperscript{14}. Therefore it is of relevance to study drivers’ decision making at yellow signals. Although there have been many studies on signalized intersections, less research has been conducted on the decision-making behavior of drivers with different driving styles for yellow signals under different lighting conditions.

Driving simulators have been shown to be effective in assessing the human factors of road safety\textsuperscript{17,28,31}. However, there are still limitations in the fidelity of driving simulators\textsuperscript{24,27}. So virtual reality (VR) technology based immersive virtual environments (IVEs) provide an alternative for crowd evacuation studies. Virtual reality is "a real or simulated environment in which the perceiver experiences a sense of remoteness"\textsuperscript{40}. Evacuation behavior observed in virtual reality environments is qualitatively comparable to real-world behavior\textsuperscript{26}.

IVE is an effective research tool with reasonable ecological validity to evoke realistic human contingency behaviors. It can control and manipulate key variables according to an experimental design and collect reliable qualitative and quantitative behavioral data\textsuperscript{25,29}. In this paper, we use a driving simulator and an IVE approach to address two questions in this study. First, what driving decisions do drivers with different driving styles make when driving when the traffic signal is yellow? Second, what driving decisions do
drivers with different driving styles make when the traffic signal is yellow under different lighting conditions?

**Methods**

**Participants**

In this paper, 64 participants aged 19-23 years (mean age 20.4 years (SD: 1.57 years)) were recruited for this experiment. Of these, 32 were male and 32 were female, randomly divided into four groups of 16 participants each, with equal proportions of males and females. They had to have a valid driver’s license with at least one year of driving experience and 10,000 km of driving history per year. Participants had normal or corrected to normal vision and hearing. Participants were required to sign an informed consent form prior to the start of the experiment, complete a pre-driving questionnaire that included questions related to demographics, driving history, and driving behavior, and perform a familiarization drive that included interaction with traffic signal changes. Participants in the experiment were asked to obey the speed limit of the signs and drive as close to the speed limit as possible. In this paper, participants were evaluated for motion sickness using an adaptation of a standard motion sickness assessment tool and was assessed after each drive using the NASATLX questionnaire. Upon completion of the experiment, each participant was paid 50 RMB. The study was approved by the Ethics Committee of Sichuan Normal University. All experimental procedures were carried out in accordance with the Declaration of Helsinki.

**Experimental equipment**

**Driving simulator**

The experiment was conducted using a driving simulator. The simulator consists of a fully functional real car and is equipped with three projectors capable of displaying 180-degree scenes. The simulator can simulate realistic driving characteristics such as acceleration, deceleration, braking, and cornering. In addition, the driving simulator car can simulate engine noise, vehicle-road interaction noise and other traffic interaction sounds. The simulator uses software with computers connected to control the dynamics of the simulator car and the virtual environment, and records basic operating variables (speed, acceleration, position, etc.).

**VR**

This experiment was also experimentally certified using a VR system. the VR system has a combined resolution of (1080 (horizontal) × 1200 (vertical)) pixels for the binocular display. We used 3D Studio Max software to model and render the IVE (Immersive Virtual Environment) and then imported it into the platform of the Unity3D game engine. A Unity3D particle system was also used to visualize the scene and headphones were utilized to provide realistic driving sounds.

During the experiment, participants remained seated and used the steering wheel to interact with the IVE. Specifically, they manipulated the steering wheel and moved through the IVE, moving forward, backward,
Experimental design and procedures

Experimental scenarios

The experimental design simulates the route based on the road layout and surrounding environment of Cheng Long Avenue in Chengdu. A total of one virtual intersection was included in this driving scenario (see Figure 1). To maximize the realism of the driving experience in the simulator, the road environment was simulated as natural and detailed as possible. The scenario was consistent in the driving simulator and the VR system.

To meet the needs of the study, traffic signs and road markings were designed according to Chinese road standards. Traffic signals are distinctly placed in an intersection on an urban route. Before meeting the traffic signal, drivers drove in a simulated urban environment to familiarize themselves with the environment. When approaching an intersection with a signal, the driver must respond to the change in the traffic signal from green to yellow. The driver interacts with the traffic signal in such a way that the traffic light changes from green to yellow when the driver is 5 seconds away from the stop line. Since the yellow interval between the red and green lights was set to 3 seconds (see Figure 1), this meant that participants had 2 seconds to read and interpret the information.

Experimental procedure

The experiment recruited 64 subjects and each subject was given two opportunities to experiment. The flow of the experiment was as follows (as shown in Figure 2).

1. Participants arrived at the laboratory to sign an informed consent form for the experiment and fill out relevant personal information (age, gender, driving experience, driving history, and questions related to driving behavior) and perform a familiarization drive that included interaction with traffic signal changes.

2. The drivers were differentiated using the MDSI questionnaire, and the subjects were divided into 4 groups, and the subjects were assigned separate tasks. First, training in the operation of the driving simulator was conducted; second, after the training was completed, a formal driving simulation was conducted through the driving simulator.

3. After informing, subjects were placed on the driving simulator for training and performed a familiarization drive, including interaction with traffic signal changes, and 15 minutes later began a formal driving simulation.

4. Before starting the experimental driving, participants received the following instructions: "Drive as usual until you pass the intersection. You have the option to withdraw from the experiment at any time for any reason." For the formal driving, the average participant was required to react to the traffic light ahead...
changing from green to yellow in a daytime scenario. The other half of the participants performed the same experiment in a nighttime scenario.

5 After the simulated driving is completed an equal number of participants will be randomly selected from each of the 4 groups to be certified for the VR experiment.

6 After completing the test, each participant was asked to answer a post-test questionnaire. The questionnaire included feedback/thoughts on the driving experience and the driving simulator itself, as well as an assessment of the effect of the tool on the participant’s motion sickness using the NASATLX questionnaire.

**Data processing**

Driver decisions were derived from driving simulator data. The explanatory variables are divided into traffic operation variables, driver demographics, and driving conditions.

| Table 1 | Summary statistics of operation and response data for each driving scenario |
|---------|------------------------------------------------------------------------------------------------|
| variable | Variable Description                                                                 | Average (SD)         | Count (percentage) |
|          |                                                                                       | Day Night            | Day Night         |
| Driving conditions |                                                                                       |                        |                   |
| Day      | Driving in daytime scenarios                                                          | - -                   | 32 100            |
| Night    | Driving at night scenario                                                             | - -                   | 32 100            |
| Traffic operation variables |                                                                                        |                        |                   |
| speed    | Speed of driver at start of yellow light (m/s)                                         | 11.97(2.26)10.69(2.16) | - -               |
| Acceleration noise (or variation) | Standard deviation of driver's acceleration and deceleration before the start of the red light (m/s^2) | 0.38(0.04) 0.37(0.04) | - -               |
| length   | Distance from the stop line at the start of the yellow light                          | 37.66(4.29)36.75(4.20) | - -               |
| Response Variables |                                                                                        |                        |                   |
| decision-making | The driver decided to proceed through a yellow light                                       | 10(43.75)18           |                   |
Table 2
Driving style scores according to gender

| Driving styles       | MDSI factors            | Men   | Women  |
|----------------------|-------------------------|-------|--------|
| Non-adaptive         | Dissociative and Anxious|       |        |
|                      | Mean                    | 2.31  | 2.23   |
|                      | S.D.                    | 0.77  | 0.75   |
|                      | Risky and Angry         |       |        |
|                      | Mean                    | 2.04  | 2.05   |
|                      | S.D.                    | 0.77  | 0.74   |
|                      | High-velocity and Distress reduction |       |        |
|                      | Mean                    | 2.67  | 2.43   |
|                      | S.D.                    | 1.01  | 0.89   |
| Adaptive             | Patient and Careful     |       |        |
|                      | Mean                    | 4.65  | 4.57   |
|                      | S.D.                    | 0.78  | 0.69   |

Traffic operation variables included driving speed, distance to the stop line at the start of the yellow light, acceleration noise (or change) before the start of the yellow light, time, and minimum speed. Driver demographics included age, gender, driving experience, license type, and education. Driving condition variables had two categories, daytime, and nighttime.

Sixty-four participants drove twice, resulting in 128 decisions at the start of the yellow interval at signalized intersections. Each driver interacted with the traffic signal twice in repeated driving, resulting in a data set. Summary statistics for the explanatory and response variables (Table 1). Of the 128 encounters with the yellow light, 18 drivers decided to cross the intersection in the daytime scenario and 38 drivers crossed the intersection in the nighttime scenario. The average driving speeds for the daytime and nighttime light conditions were 11.97 m/s (SD: 2.26 m/s) and 10.69 m/s (SD: 2.16 m/s), respectively. Acceleration noise, as the standard deviation of roadway acceleration before the onset of yellow light, is considered an indicator of reckless driving, with values of 0.38 m/s² (SD: 0.04 m/s²) and 0.37 m/s² (SD: 0.04 m/s²) for daytime and nighttime ambient driving conditions, respectively.

**Results**

**Decision Trees**
A decision tree is constructed from the available data to classify the discrete outcomes of drivers stopping/passing at the start of a yellow indication at a signalized intersection. The dependent variable is the binary outcome in the decision tree (i.e., driver's decision to stop at a traffic signal intersection), and the input variables are driving conditions, driver's gender, traffic operation variables, and driver demographics provided as possible explanatory variables in the decision tree. Figure 3 shows the decision tree diagram for the stop/pass decision model. Nodes are identified to select the option that provides the highest information gain. The decision tree classifies driver decisions by dividing the data into 52 smaller homogeneous groups, and their corresponding statistics are given within each node. The total number of nodes reached (N) and the number of stops or passes at the intersection for that node are presented in the figure. For example, terminal node 3 indicates that about 12.5% of drivers choose to pass the yellow light at a speed of 11.53m/s and an acceleration of 0.37m/s for the adapted drivers. Similarly, terminal node 15 implies that drivers with distances greater than 38m are likely to stop in the daytime scenario. Terminal node 19 shows that 57.14% of male drivers with an acceleration noise of 0.37m/s^2, and a speed greater than 10.44m/s will choose to pass the yellow light in the night scenario.

**Driving style**

In this paper, driving styles are scored by the MDSI driving questionnaire, and the results of the MDSI questionnaire are divided according to gender. This paper examines the differences between driving styles and gender by means of t-tests. The mean and SD scores are shown in Table 2. The results show that there is a significant difference between driving style and gender. This result shows that adaptive driving style scores are overall higher than non-adaptive driving scores and males score higher than females score. And the results also showed that males scored higher than females on anxious and cautious driving styles. Females scored higher than males on dangerous and angry driving styles.

**Different light conditions**

In this paper, a 2 (driving style: maladaptive, adaptive) X 2 (light conditions: day, night) simulation experiment was conducted on drivers' driving decisions. Analysis of variance (ANOVA) was conducted for the results collected from the experiments. The results showed that light conditions had a significant effect on driving decisions (F (1,62) = 10.33, p < 0.05). Drivers in the daytime scenario were slower than drivers in the night scenario (11.97m/s > 10.69m/s). The results also revealed that drivers in the night scenario had a higher probability of continuing through a yellow light than drivers in the day scenario (59.375% > 28.125%).

**Discussions**

**Driving decisions under different light conditions**

The speed and acceleration of passing the yellow light under the interaction are shown in Figure 5. The probability of the driver passing the yellow light under the interaction is shown in Figure 6. The results showed that different lighting conditions had a significant effect on the driver's decision to choose to...
pass the yellow light ($F(1,62) = 10.33, p < 0.05$). According to Figure 6, the probability of drivers choosing to pass the yellow light in the daytime scenario is lower than the probability of drivers choosing to pass the yellow light in the nighttime scenario (31.25% < 56.25%). This reduction in probability can be attributed to the fact that drivers have different visibility of the road under different lighting conditions. Under low visibility, accidents are more likely to occur due to difficulties in recognizing the conditions on the road, especially in encounter scenarios with pedestrians. In contrast, with high visibility, drivers can make the right decisions in time to avoid accidents when encountering road conditions. Figure 5 shows that the speed of drivers in the daytime scenario is lower than the speed of drivers in the night scenario. This result can be explained by the fact that drivers are more likely to control their emotions in the daytime scenario and tend to choose to comply with driving safety traffic norms, and therefore choose to reduce their speed in the yellow light scenario with encounter. Whereas, in the night scenario, drivers tend to choose to ignore the driving safety norms due to environmental changes and visibility changes and believe that high speed is safer, hence drivers choose to pass at high speed in the yellow light scenario. Figure 5 also shows that the driver’s driving acceleration at night is greater than the driver’s acceleration during the day, which is because of different light conditions on the driver’s speed choice. In particular, the difference between the acceleration chosen by the maladjusted driver at night and during the day varies more, which may be related to changes in the driver’s mood. From Figure 8, the driver’s distance from the stop line in the night scenario is smaller than the distance from the stop line in the daytime scenario. This result can be explained by the fact that the shorter the driver’s distance from the stop line, the easier it is for the driver to make the decision to pass the yellow light. And the night environment drivers tend to increase their speed, so the shorter the distance from the stop line, the higher the probability of passing the yellow light.

**Driving decisions under different driving styles**

The speed and acceleration of passing the yellow light under the interaction are shown in Figure 5. The probability of the driver passing the yellow light under the interaction is shown in Figure 6. The results showed that driving style had a significant effect on the driver’s driving decision to choose to pass the yellow light ($F(1,62) = 6.83, p < 0.05$). This result suggests that driving style has an important basis for drivers to make driving decisions. The driving decision can predict the driver’s road behavior. According to Figure 6 it can be concluded that the probability of choosing to pass the yellow light is higher for the non-adaptive drivers than for the adaptive drivers (59.375% > 28.125%). This can be attributed to the fact that maladaptive drivers are more likely to make dangerous decisions and tend to violate safe driving norms by passing the yellow light quickly. Adaptive drivers, due to their emotional stability, make more rational decisions and tend to follow safe driving norms and stop and wait at the stop line. Figure 5 shows that drivers with different driving styles choose to drive at different speeds. The non-adaptive drivers chose to drive significantly faster than the adaptive drivers’ speed. This result can be explained by the fact that the non-adapted drivers tend to consider themselves skilled drivers and that higher speeds produce a sensation of excitement, which makes the non-adapted drivers feel happy emotions. In contrast, the adaptive drivers were mainly dominated by cautious and careful emotions of driving and tended to drive within the prescribed speed limit. Therefore, the speed of the non-adapted driver is significantly higher.
than that of the adapted driver \((11.53\text{m/s} > 10.13\text{m/s})\). Figure 5 also shows that drivers with different driving styles will have different accelerations. Higher acceleration indicates greater speed variation, and from Figure 5 the acceleration of unadopted drivers is higher than the acceleration of adapted drivers, and this result can be interpreted that the driver's style significantly affects the variation of acceleration with a positive correlation \((F=0.27, p<0.05)\). Figure 8 shows the relationship between driving style and distance. The graph shows that the non-adaptive drivers had shorter distances than the adaptive drivers. Since distance has a negative correlation with passing decision, the results show that the maladjusted drivers are more inclined to make the decision to pass the yellow light.

**Impact of interactions on driving decisions**

The probability of a driver passing a yellow light under the interaction is shown in Figure 6. The results indicated that the interaction of driving style and light conditions had a significant effect on the driver's driving decision to choose to pass the yellow light.

\[ F (1,1) = 0.01, p < 0.05 \]

This result shows that in the daytime scenario, adaptive drivers are less likely to choose to pass the yellow light than non-adaptive drivers \((12.5\% < 43.75\%)\); in the nighttime scenario, non-adaptive drivers are much more likely to pass the yellow light than in the daytime scenario \((81.25\% > 43.75\%)\) and are still more likely to pass the yellow light than adaptive drivers \((81.25\% > 37.5\%)\). The results suggest that the interaction between light conditions and driving style has a negative effect on driving decisions. For drivers with different driving styles, the effects of different light conditions differed. Firstly, for non-adaptive drivers, sufficient light mitigates the behavior of passing yellow lights and reduces the probability of injury or death \((43.75\% < 81.25\%)\). Second, for adaptive drivers, the effect of light conditions on passing yellow lights was significant, suggesting that drivers were more likely to choose to pass yellow lights in nighttime scenarios \((12.5\% < 32.5\%)\).

**Impact of driver demographics on the probability of running yellow lights**

(Table 3 Effect of driver demographics on the probability of running yellow lights)

| Driving demographics | Variable Description | Driving Speed (m/s) | Count (percentage) |
|----------------------|----------------------|---------------------|--------------------|
|                      |                      | Day Night           |                    |
| Driving gender       | Male                 | 11.50               | 6(56.25)12         |
|                      | Female               | 11.16               | 3(31.25)7          |
| Driving experience   | lack                 | 11.68               | 5(50.00)11         |
|                      | plentiful            | 11.00               | 4(37.50)8          |

Gender of drivers

\( F (1,1) = 0.01, p < 0.05 \)
The speed and acceleration of driving through yellow is shown in Figure 4. Figure 7 shows the probability of passing the yellow light among drivers. It can be observed that in both cases, the probability of passing the yellow light increases for all drivers as the speed increases, and the probability of passing the yellow light is higher in the night driving condition. For example, the probability of running a yellow light for male drivers in daytime driving conditions is (37.5%), while the probability of passing a yellow light for male drivers in nighttime conditions at the same speed is (75%), which indicates that the probability of passing a yellow light is reduced by half. This reduction in probability can be attributed to the higher driver visibility in daytime scenarios, which is in line with studies that have found that women are more hesitant than men to run red lights when drivers decide to do so. And the study found that the night environment provides better environmental conditions for male drivers to pass compared to female drivers. This is because males have more risk-taking behaviors than females and have more risk in car accidents, more likely to violate traffic rules. For example, compared to the daytime scenario, the probability of passing for female drivers is about (18.75%), while the probability of passing for male drivers is about (37.5%), which means that male drivers seem to prefer to pass the yellow light, while female drivers prefer to wait at the stop line at night. This is because males are more likely to make dangerous decisions than females and believe that they are less likely to meet a car accident. Whereas females are conservative and tend to follow safe driving norms.

**Driver experience**

The speed and acceleration of driving through yellow is shown in Figure 4. Figure 7 shows the probability of passing the yellow light among drivers. It can be observed that in both cases, the probability of passing the yellow light increases for all drivers as the speed increases, while the probability of passing the yellow light is higher in the night scenario driving condition. For example, the probability of passing the yellow light for inexperienced drivers in the daytime scenario condition is (31.25%), while the probability of passing the yellow light for experienced drivers in the same speed condition is (25%), which indicates a decrease in the probability of passing the yellow light. This decrease in probability can be attributed to the slower driving speed of inexperienced drivers in the daytime scenario. Inexperienced drivers are considered dangerous drivers many times because they tend to cross the intersection at the beginning of the yellow light by increasing their speed or running the red-light violation, while drivers with more driving experience have more experience in processing information, deciding, and taking safe actions to avoid potentially dangerous events. Whereas, in the night scenario, the probability of passing the yellow light for inexperienced drivers is (50%), while the probability of passing the yellow light for experienced drivers under the same speed condition is (68.75%), which indicates an increase in the probability of passing the yellow light. This increase in probability can be attributed to the fact that experienced drivers choose to drive faster in the nighttime environment. More specifically, experienced drivers are more likely to choose to drive at high speeds compared to the speed of the daytime scenario. This is because experienced drivers believe that they are proficient in driving operations, they have good road perception, they can make correct decisions, and they trust their skills and believe that no dangerous accidents will occur.
Conclusions And Limitations

In this paper, a study was conducted under different lighting conditions to investigate the effect of driving decisions of drivers with different driving styles with respect to traffic signal transitions. Based on the results obtained, we conclude that:

1. The probability of a driver deciding to wait at the stop line in the daytime scenario is greater than the probability of waiting in the nighttime scenario. (71.875% > 40.625%)

2. Non-adaptive drivers are more likely to choose to pass a yellow light rather than wait at the stop line. (62.5%)

3. In the daytime scenario, adaptive drivers tended to choose to wait at the stop line, while non-adaptive drivers tended to pass the yellow light; in the nighttime scenario, the probability of passing the yellow light was much higher for non-adaptive drivers than for the daytime scenario, and the probability of passing the yellow light increased for adaptive drivers.

The purpose of this study is to make recommendations by comparing daytime and nighttime drivers' decisions to pass the yellow light. Since the probability of passing a yellow light at night is significantly higher than the probability of passing a yellow light during the day, it is recommended that:

1. Add education on traffic lights to your driving test, especially the 3-second yellow light, so that you do not jump the yellow light.

2. It is possible to rationalize the length of traffic signals during the day and night, and to increase the duration of traffic signals at night as appropriate.

3. For maladjusted drivers, they can learn about traffic signals and watch videos of accidents related to yellow light jumping online, so that they can realize the seriousness of the incident and achieve a reduction in yellow light jumping; for adapted drivers, they can learn to prevent yellow light jumping through videos.

Although this paper investigates the driving decisions of drivers with different driving styles under yellow lights based on different lighting conditions, there are limitations:

1. The sample for this paper lies primarily with private drivers, and it is unclear whether professionally trained drivers such as taxi drivers, bus drivers, and bus drivers can reach the consistent conclusions of this paper.

2. This paper is more general about the division of driving styles, there are three different driving styles under the maladaptive driving style, whether these three driving styles are still used with the conclusions of this paper is worthy of future research.
This paper only considers the yellow light decision in daytime and nighttime scenarios, and it is unclear whether it is used with scenarios, especially in bad weather.

The yellow interval studied in this paper is 3 seconds, but a 3-second yellow interval is not sufficient. Future studies can be conducted for different yellow light intervals and different intersection types.

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## Figures

**Figure 1**

Experimental scenario
Figure 2

Experimental procedures

Figure 3
Schematic diagram of the decision tree for the stop/pass decision model. Note that the numbers in the circles denote interaction terms; Distance, AN, and Speed denote the distance to the stop line at the start of the yellow light, acceleration noise (m/s²), and the speed at the start of the yellow light (m/s), respectively.

Figure 4

Effect of driving demographics on speed and acceleration
Figure 5

Speed and acceleration of driver through yellow light under interaction

Figure 6

Probability of driver passing yellow light under interaction
Figure 7

Effect of driving demographics on the probability of passing a yellow light

Figure 8

Distance