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How to Define the Passenger's Hazard Perception Level by Combining Subjective and Objective Measures?

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Abstract. With the prosperous growing of intelligent technology, the automobile industry is developing towards an unmanned and intelligent generation. However, making a car drive in a human-like way is still a great challenge to engineers, which slows the adoption of such cars in a mass scale. Considering human perception capabilities during the design process might be a solution to this problem, and hazard perception is of great important.

The aim of the study is to propose a theoretical framework for exploring the relationship between driving environment and human perceived hazards to give suggestions on designing human-like vehicle controllers. Correlating objective environmental factors with subjective hazard ratings. Human-in-the-loop experiments were carried out on a high-fidelity driving simulator. 27 driving scenarios were designed and implemented for 14 participants to acquire their subjective hazard ratings, while objective measurements were also recorded.

Specifically, by using the proposed methodology hazard perception level of passenger can be measured by using the subjective parameters adopted during the experiment, which stands for the subjective assessment of passenger's hazard perception. To find what dynamic parameters having a significant correlation with hazard perception level, a seven scale of subjective hazard perception was defined from –3 to 3, namely over dangerous, dangerous, a little dangerous, normal, a little cautious, cautious, overcautious. Objective measures of environment include the velocity and acceleration of the subjective car and the distance between the subjective car and obstacle. A 3*3*3 mixed ANOVA was carried out in our study in order to find out the correlation between the environment and subjective assessment. The finding shows us that the interaction of velocity and acceleration and distance has a strong correlation with the passenger's hazard perception. The others show no correlation be-tween hazard perception assessment.

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This research is with great potential to improve the development of Advanced Driver Assistant System (ADAS) and intelligent automobile from a human perspective. The findings can also be applied to the design of vehicle controllers to improve the passenger's comfort by knowing that on what condition or what kind of control the passenger will feel dangerous and uncomfortable.

Keywords: Passenger · Hazard perception · Subjective · Objective · Driving simulator

1 Introduction

Road safety is achieved when the 'driver-road-vehicle' system works well. Among these three elements, the driver, without any doubt, may best affect the proper functioning of the interaction [1]. However, with the increasing development of internet, the automobile is becoming more and more intelligent and driverless. Every participant in car paly a same important role in the future 'driver-road-vehicle' system.

There are many studies showed that hazard perception is a critical factor to accidents. According to Horswill and McKenna [2], among the different components of driving skill, only hazard perception has been correlated with traffic-accident involvement across a number of studies [3–5]. With the increasing attention on road accident, hazard perception is becoming an increasingly significant research hotpot.

The assessment of hazard perception is often subjective because the perception is highly individual, depending on personal experiences with accidents and potential rewards of risk-taking [6]. Therefore, it is reasonable to measure the passenger's subjective risk perception level. The objective situation can be defined as the subject car's kinematic parameters (acceleration, speed and distance between the subjective car and obstacle on the road.). Moreover, the methods only consider subjective judgments with experiences, but no specific trip. Thus there almost no such study combining the subjective rating, objective dynamic parameter together. The aim of the study is to find out the correlation between passenger's hazard perception and objective environment. Based on study, we can learn about under what kind of condition, the passenger will feel dangerous and uncomfortable. We can adjust the parameters of a car to control the driving behavior in cased of that the passenger is involved in a situation where he or she think is dangerous. It will make a big difference if we adopted this to the Advanced Driver Assistant Systems (ADAS). The aim of the experiment is to find out what is the significant objective environment factor that effect the passenger's hazard perception level based on both objective and subjective parameters. Compared with other literature studies, we retain that the proposed methodology has some advantages, the primarily advantage is that we transfer our focus on passenger's hazard perception not the driver, which could be very different from the other existed study. In addition, our proposed methodology combined both objective parameters and subjective judgment of the hazard perception level.

Numerous studies have focused on the driver's hazard perception. Few of the researches focused on the passengers and their hazard perception, even though passengers are also the car user and should be considered as the same importance as driver.

A brief review about hazard perception would be reported in the next section. After the short introduction, we proposed a literature review in the following section about the hazard perception. Then, we depict our method combing both the subjective and objective measures of hazard perception. A brief description including participants, 27 scenarios, instruments used for collecting data about the objective and subjective judgments of hazard perception will be introduced in detail. Data analysis is described later. Finally, a conclusive section is reported.

2 Literature Review

The literature search was conducted using Google Scholar, because this search engine adopts full-text search and has broad coverage [7–9]. Searches were using the following key words: hazard perception", "situation awareness", "hazard aware-ness", "risk perception".

Hazard perception (HP) has been defined differently by many researchers [10]. Wilde [11] and Mackenna [12] firstly defined hazard perception as the ability to anticipate dangerous situations on the road ahead. While Mills et al. [13] described hazard perception as the ability to read the road. Later on Horswill and McKenna [2] added that hazard perception may be regarded as situation awareness for hazardous, dangerous situations and McKenna, Horswill, and Alexander [12] appended the ability anticipating forthcoming events to the definition. David Crundall [14] said hazard perception (HP) is the process of detecting, evaluating and responding to dangerous events on the road, which have a high likelihood of leading to a collision. One increasingly common description is 'the ability to predict dangerous situations on the road [2, 15].

The literature about the hazard perception almost studied on the driver's hazard perception. Even though there are little few research studied on the passenger's hazard perception, we can still learn something useful to the hazard perception study. Research on driver's hazard perception can be divided into 3 types: (1). the relation between hazard perception and driving experience; (2). the relation between age, gender, nationality and hazard perception; (3). Hazard perception test.

The first type of research focus on whether the driver's driving experience has influence on the hazard perception or not and how the experience affects hazard perception according to references [14, 16–21] relevant to some research about experience and hazard perception. They try to figure out whether or not the driving experiences have influence on the hazard perception and how can we discriminate the driving strategy depend on the driver's experience. The other type about hazard perception is about gender, age or nationality. References [16, 20, 22, 23] study on the relationships between the age and hazard perception to find how the age plays an effects in terms of the ability of hazard perception and what's the differences between different kind of people at different age. References [24, 25] pay their attention on the nationality. That is whether the culture or environment will affect their hazard perception ability or not and how it plays. Meanwhile, there are also some researchers [19, 21, 26–28] who focused on the hazard perception test (HPT), trying to find out the importance of HPT on driver at different period of age or experiences.

Part 1 is mainly talking about what and how the researchers do with the experiment environment where can be broadly divided into four categories: (1). Using a static pictures; (2). Using a traffic clips; (3). PC-based prototype driving-simulator; (4). Real road driving.

There are three categories strategies of evaluating hazard perception ability in the study: (1). Questionnaire; (2). Using a button, which will be pressed when, the participant percept the hazard; (3). Thinking aloud (or Verbal Protocol Analysis);

Using the static pictures and traffic clips can be considered the traditional ways used in hazard perception study. There are a lot of studies based on the traditional ways [14, 16–21, 24, 26]. Recently, the simulator becomes more and more popular in the hazard perception research like reference [23] using it to fulfill the study. With the advantage of allowing researchers to evaluate a driver's ability by parameters such as angles of steering wheel, accelerator, and brake force, driving simulation tests are often used to ascertain driving skills [29–33]. Therefore, it is not only more approaching to reality than desktop neuropsychological tests, but also they are cheaper and more efficient than evaluations of on-road driving test [30]. However, there are some researchers [22, 34] trying to move their experiments to real road, which would be more dangerous and difficult. Considering the convenience, high efficiency and safety of the participant during the experiment, we decided to use a driving simulator to achieve our goal.

A questionnaire is often used to measure the driving experience and the self-assessment of hazard-perception skills [23, 24, 27, 35–38] of the participants. The questionnaire can involve some demographic question and some other question like the frequency they drive, the score to measure how dangerous some traffic scene or something else. Specially, the questionnaire is to find out where, which, what is the hazard [24]. Another way used in hazard perception study is using a press button [16, 17, 20] or using the touch screen [21, 26] or computer mouse [19, 39–41]. The participant can press button or touch the screen or click the mouse when perceive the hazard, which can be collected as response data for researchers. It is a novelty approach called 'Think aloud' (or Verbal Protocol Analysis) used in reference [22]. Participants give continual commentary when they are driving in the real road. In addition, reference [1] combined the objective (like self-assessment) and subjective (speed and acceleration) measure to define the accident risk level. These novelty approaches are very important to improve our study of hazard perception.

In the study about hazard perception, variables about response are widely used, like response time, average response time, response latency, response sensitivity, miss, false, false alarm. In addition, eye tracking is the most used assistant way in the experiment. Also, some studies use some biological indicator to describe the participants' performance, such as palmar sweating response (PSR), electrodermal activity (EDA) in Reference [23]. There are a several of methods used to analysis the experiment data. ANOVA is obvious one of the most popular method used to find out the correlation between factors and hazard perception, which can be proved in References [16, 17, 21] et al. Meanwhile, chi-square analysis is widely used, in particular, to process data in categorization task [17]. Some studies [17, 21] applied logistic regression to fulfill predictive purpose. In their study, the participants watching the clips involve different kind of hazard would have different performance. Then, logistic regression was applied to divide drivers into two groups: novice or experienced, depending on the variables the researchers defined. Moreover, there are some other methods are used, like Poisson regression [26], Paired t-tests [17], Leximancer software [22], Fisher's exact test [17], Cronbach's alpha [25, 26] and Pearson product–moment correlation coefficient [23].

Generally, in the literature, there are many subjects on hazard perception, which were divided into three types before. However, few of them combining the subjective parameters and objective parameters together, neither the study focus on passengers' hazard perception level. However, Eboli [1] defined the accident risk level by introducing a novel methodology, which combines the objective and subjective measures of driving style.

The aim of the study is to find out what parameter standing for the objective environment has a strong correlation with the passenger's hazard perception rating through the methodology, which combines both subjective and objective parameters.

By the use of the proposed methodology, the hazard perception level of the passenger can be tested by using the subjective parameters collected during the experiment. Our study defined a seven scale of passenger's subjective hazard perception (over dangerous, dangerous, a little dangerous, normal, a little cautious, cautious, overcautious), and try to find the dynamic parameters which have significant correlation with hazard perception level.

It is believed that the research can give a great contribution to improving the Advanced Driver Assistant System (ADAS) and the development of the intelligent automobile. What's more, the study can make a big difference in ADAS to improve the passenger's comfort when they are in a road trip if knowing that on what condition or what kind of control the passenger will feel dangerous and uncomfortable.

3 Method

We design a $3 \times 3 \times 3$ mixed experiment depending on three factors, velocity, acceleration and distance. The simulator will be drove in a controlled condition, where the velocity, acceleration and distance is pre-designed. The experimenter will drive at a specific speed Vs (30 km/h, 70 km/h, 110 km/h) and complete a braking task when there is an obstacle appearing in front of the road. By giving a sign to tell the driver where to start braking at the scenario, the acceleration will be controlled at a constant ($-1\ m/s^2$, $-3\ m/s^2$, $-6\ m/s^2$). The distance between the subjective car and the obstacle is settled at $d = (1 + d') \times d0$, $d0 = v2/2a$ and $d' = (5\%, 10\%, 15\%)$. Three velocities represent different speed level (low, normal, high) of the car. As the same, three accelerations standing for three kind of driving style (aggressive, normal, cautious) to stop the car. It also goes for three distance. Participants are required to give a hazard perception rating to describe the own feeling and judgement about the braking task. Each participant is required to complete a questionnaire including a rating scale, which is a subjective self-assessment questionnaire of perceived hazard. Participants express a level from –3 (extremely dangerous) to +3 (extremely cautious).

Before the experiment, a hypothesis was proposed that the interaction of velocity, acceleration and distance has a strong relation with the passenger's hazard perception.

3.1 Participants

The participant sample is made up of 14 licensed student drivers and they all are between 23 and 26 years old. Even though they are qualified to be a driver, but during the experiment they are just told to act like a passenger siting on copilot seat and no need to drive.

All of the participants were recruited among university students to be told to know very well the objectives of our research and the proposed methodologies.

To make sure the participants to be representative the age, gender and driving experience of participants should be random.

3.2 Simulator and Questionnaire

To create the virtual driving environment and conduct the experiment, a fixed-base fidelity-driving simulator is used (Fig. 1). The driving simulator is made up of a cockpit, which is equipped with all necessary control systems similar to a real car. The graphics system includes three 42″projectors displays with a front screen resolution of 1920 × 1080 dpi and the two side screens resolution of 1360 × 768 dpi. The displays are situated around the cockpit and provide a 150° horizontal and 40° vertical perspective. The scenarios are presented at a rate of 60 frames per second. Speedometer, rear- and side-view mirror information is visible on the center and side LCD screens. In addition, the driving simulator is equipped a 3D sound system, which can provide a rich audio environment with the sound of the engine, wind and tires. Vehicle vibrations are also simulated via a bass speaker under the driver seat. Steering wheel, gas pedal, brake pedal and car seats are all taken from the vehicle of Ford.

Fig. 1. Fixed-base driving simulator used in the experiment

In order to find the correlation combining the objective and subjective measures. Objective data was pre-designed and controlled by experimenter. For the objective data, we can get it through a questionnaire (Table 1). Each participant in our study is required to finish a questionnaire that includes a rating scale, which is a subjective self-assessment about perceived hazard during the experiment. Specifically, participants is asked to make a self-evaluation of the hazard perception level by expressing a level according to a numerical rating scale about a pair of adjectives representing from over-dangerous to overcautious. We decided to use a Semantic Difference Scale (SDS) to quantify the location which associated with the distance from the center to the corresponding "0" value. The extreme position (near to the adjectives) has the highest value, while the position near to the center have the lowest value. The sign (positive or negative) is associated with the values that identifying the distance from the center for indicating the direction of the distance: it is a convention that the positive sign is on the right, and the negative sign is on the left. Nevertheless, both the extreme position stands for a bad performance: the left means too dangerous under that condition; the right means too cautious which is also considered as a bad performance. There is no doubt that over-aggressive or aggressive behavior will make us feel dangerous. However, it is acknowledged now that driving too cautious also have a terrible influence on the traffic environment and make the passenger feel nervous. Participants express a level from –3 (over dangerous) to +3 (overcautious).

Table 1. Subjective hazard perception rating scale

	Hazard perception rating
Over dangerous and uncomfortable	–3
Dangerous and uncomfortable	–2
Just feel a little dangerous and uncomfortable	–1
Normal and comfortable	0
A little cautious and uncomfortable	1
Cautious and uncomfortable	2
Overcautious and uncomfortable	3

By combining the two kind of data: the objective data controlled by simulator the subjective judgment from participants.

3.3 Driving Scenarios

The survey pre-designed the experiment scenarios (Table 2).

The main task is a braking task, which there is the situation where the experimenter found out the object car and began to brake in one way until the subjective car stopped. Depending on velocity, acceleration, and distance, we created four scenarios including one training scenario and three main task scenarios to stand for different kind of situation. Each main task scenario is made up of nine trips, and in each end of a trip, there will be a van stopped still in front of the lane as an obstacle. When the subjective car driving at a giving condition, the hazard in our study was pre-created.

To make sure the car was drove at one of 27 given scenarios. At first, there will be a speed signal to mind the driver who drive the simulate car to keep the speed as the study asked (30 km/h, 70 km/h, 110 km/h). Then after driving about 200 m later, there will be a sign for driver to start braking. By means of the simulator, when the car was braking, the acceleration of the subject was pre-set at a constant value (–1 m/s^2, –3 m/s^2, –6 m/s^2). Therefore, it was actually a uniform deceleration. The braking signal was placed in front of the van at a calculated distance, which is 5%, 10% and 15%

Table 2. Pre-designed 27 experiment scenarios

	Vs	a	d'
Scenario 1	30	–1	5%
Scenario 2	30	–1	5%
Scenario 3	30	–1	5%
Scenario 4	70	–1	10%
Scenario 5	70	–1	10%
Scenario 6	70	–1	10%
Scenario 7	100	–1	15%
Scenario 8	100	–1	15%
Scenario 9	100	–1	15%
Scenario 10	30	–3	5%
Scenario 11	30	–3	5%
Scenario 12	30	–3	5%
Scenario 13	70	–3	10%
Scenario 14	70	–3	10%
Scenario 15	70	–3	10%
Scenario 16	100	–3	15%
Scenario 17	100	–3	15%
Scenario 18	100	–3	15%
Scenario 19	30	–6	5%
Scenario 20	30	–6	5%
Scenario 21	30	–6	5%
Scenario 22	70	–6	10%
Scenario 23	70	–6	10%
Scenario 24	70	–6	10%
Scenario 25	100	–6	15%
Scenario 26	100	–6	15%
Scenario 27	100	–6	15%

longer than the uniform deceleration distance of the subject car. The training scenario was built to get the participants warmed up before the main test began, which was almost like the main task scenario, with the number of obstacle and the acceleration different from main scenario. In the training scenario, the number of van is 5, and acceleration was not pre-designed and controlled exactly. However, the subject car will be brake in three way (overaggressive, normal, and overcautious) randomly to simulate our main task.

What's more, the journey on the two lane suburban way is about 15 km.

3.4 Procedure

Fifteen participants (12 men and 3 women) were tested in 27 scenarios lasting approximately 1.5 h. A consent was obtained from each participant after the study being described in detail. Our experimental procedure included a training session and main task session. Participant would be asked to finish the main task after being trained.

Before the training session participant was asked to read the instruction. Then the experimenter would guide the participant to fulfill the training session. Each time the experimenter finished one training task, the participants were required to give a score to describe the own feeling and judgement about the braking task.

Next, the participants would be asked to fulfill the 27 main tasks as a passenger. In each scenario, subject car would be drove by the same driver on the road in a given order. Once driver finished a driving scenario, the participant should give the score of the hazard perception each time. Between each session, participants can had a rest about one minute. The procedure would repeat for 27 times until the main tasks are finished (Fig. 2).

Fig. 2. Experiment scene

3.5 Data Collection

3.5.1 Variables

In our study, we aim to find the correlation between the passenger's hazard perception and objective parameters (velocity, acceleration and distance). Hazard perception rating of each session has been treated as an exogenous variable, and three factors are treated as endogenous variable. The independent variables in the experiment is velocity, acceleration, and distance, which respectively has three levels.

3.6 Design

With the specific aim of finding the correlation between hazard perception rate and objective environment factors the experiment is conducted.

A $3 \times 3 \times 3$ mixed design is used. The between groups factors are the velocity, acceleration and distance between objective car and obstacle when the braking task is finished. The groups factor are different level, such as velocity (low: 30 km/h, normal: 70 km/h, high: 110 km/h), acceleration (overcautious: –1 m/s^2, normal: –3 m/s^2, overaggressive: –6 m/s^2).

To determine whether there is any relationship between the participant's hazard perception rating and the objective environment factors (velocity, acceleration, distance), we carry out a 3 × 3 × 3 ANOVA with velocity (30 km/h, 70 km/h, 110 km/h) and acceleration (low, normal, high) and distance (5%, 10%, 15%) as independent variables, hazard perception rating as the dependent variable.

4 Data Analyze

As is shown in Table 3, we found out that the interaction of velocity, acceleration and distance shows significant influence on hazard perception score, F(8,351) = 2.324, P = 0.019 < 0.05, that is, the interaction of two independent variables has different influence on the dependent variable at different levels of the third dependent variable. Therefore, it's necessary for us to have a simple two-way interaction test to find out whether the two-factor interactions have significant effect on HP score or not.

Table 3. Test of between subjects effects

Source	df	Mean square	F	p
Velocity	2	120.495	40.703	<0.001
Acceleration	2	144.844	173.052	<0.001
Distance	2	26.963	32.214	<0.001
Velocity*Acceleration	4	68.979	82.412	<0.001
Velocity*Distance	4	1.574	1.881	.113
Acceleration*Distance	4	.852	1.018	.398
Velocity*Acceleration*Distance	8	1.945	2.324	.019

[a]R Squared = .751(Adjusted R Squared = .732)

In our study, we analyzed the impact of acceleration and distance interaction on HP score when velocity at different level. As highlighted in Table 4, when the velocity was 100 km/h, F (4,351) = 2.755, p = 0.028 < 0.05, it mean that the interaction of acceleration and distance is statistically significant, that is, the acceleration and distance interaction has impact on HP rating when velocity is 100 km/h. However, when velocity was 30 km/h, F (4,351) = 2.371, p = 0.052 > 0.05, it shows no statistically significance, which means the interaction of acceleration and distance had no influence on HP score (v = 30 km/h). In addition, the results of statistical analyses indicated that the interaction of acceleration and distance has no significant effect on dependent variable when velocity is 70 km/h, F (4,351) = 0.540, p = 0.706 > 0.05.

According to Table 4, we just need to analyze the influence when velocity is 100 km/h (p = 0.028 < 0.05). Pairwise comparisons is shown in Table 5. As is shown in Table 5, there is no statistically significance when velocity is 100 km/h and acceleration is –1 m/s^2 (p = 1.000 > 0.05). Table 66 also highlights the comparison between different level of distance, 5% and 10%, 5% and 15%, 10% and –15%, respectively. The correlation between 15% group and HP rating is significantly higher than that in 5% group, p < 0.001, and the correlation between 10% group and HP

Table 4. Simple two factor interaction test result

Velocity	source	Sum of Squares	df	Mean Square	F	p
100 km/h	Contrast	9.222	4	2.306	2.755	.028
	Error	293.786[a]	351[a]	.837		
30 km/h	Contrast	7.937	4	1.984	2.371	.052
	Error	293.786[a]	351[a]	.837		
70 km/h	Contrast	1.810	4	.452	.540	.706
	Error	293.786[a]	351[a]	.837		

rating is significantly higher than that in 5% group, $p = 0.006 < 0.05$. However, there is no significant difference between 15% group and 10% group, $p = 1.00 > 0.05$. In addition, when velocity is 100 km/h and acceleration is –2 m/s^2, the result of pairwise comparisons shows that The correlation between 15% group and HP rating is significantly higher than that in 5% group, $p < 0.001$. It also shows that there has significant difference between 10% group and 5% group, $p = 0.012 < 0.05$. However, there is no sig-indicant difference between 15% group and 10% group, $p = 0.119 > 0.05$.

Table 5. Result of Pairwise Comparisons

v	a	(I)d	(J)d	Mean difference (I–J)	Std. error	Sig[b]	95% Confidence internal for difference	
							Lower bound	Upper bound
High	High	Max	Mid	.286	.346	1.000	–.546	1.118
			Min	1.357*	.346	<0.001	.525	.546
		Mid	Max	–.286	.346	1.000	–1.118	1.290
			Min	1.071*	.346	0.006	.240	1.903
		Min	Max	–1.357*	.346	<0.001	–2.189	–.525
			Mid	–1.071	.346	.0.006	–1.903	–.240
	Mid	Max	Mid	.714	.346	.119	–.118	1.546
			Min	1.714*	.346	<0.001	.882	2.546
		Mid	Max	–.714	.346	.119	–1.546	.118
			Min	1.000*	.346	.012	.168	1.932
		Min	Max	–1.714*	.346	<0.001	–2.546	–.882
			Mid	–1.000*	.346	.012	–1.832	–.168
	Small	Max	Mid	.071	.346	1.000	–.760	.903
			Min	.214	.346	1.000	–.618	1.046
		Mid	Max	–.071	.346	1.000	–.903	.760
			Min	.143	.346	1.000	–.689	.975
		Min	Max	–.214	.346	1.000	–1.046	.618
			Mid	–.143	.346	1.000	–.975	.689

5 Conclusion and Future Work

In our simulator study, effects of the velocity, acceleration, and distance, which stand for the objective environment on the passengers' hazard perception rating, were examined.

Similar to what we expected, we initially hypothesized that the interaction of velocity, acceleration and distance has a strong correlation with participants' hazard perception rating. As is shown in the result, the interaction of the three subjective parameter shows strong correlation between hazard perception level. However, the simple two factor result demonstrate that only when the velocity is high ($v = 100$ km/h), the interaction of acceleration and distance has influence on passenger's HP assessment. However, the result shows us that the interaction of acceleration and distance is not statistically significant when acceleration is -1 m/s^2. The pairwise comparisons result also shows us that level of objective parameter (distance) has significant impact on the hazard perception assessment.

In summary, this study, which focused on passenger's hazard perception not the driver's providing a novel experiment that combines both objective measurement and subjective measure together to investigate the relation of hazard perception rating and the objective environment parameters. This study was also the first research to focus the passenger's hazard perception, proving that velocity, acceleration and distance are significantly associated with the passenger's hazard perception.

With the internet industry growing prosperous, the automobile industry is gradually developing towards the unmanned and intelligent way. The most participants when during an automobile will be the passenger not the driver. It is more and more important for us to focus on the passenger. In addition, with the rapidly developing of ADAS, it should not just focus on the driver but also the passenger.

Our study focusing on the passenger would have some disadvantages. Firstly, the simulator will lose some feeling that will be important for passenger to feel the situation. Secondly, it will be more convincible for the study if there will be more participants involved in the study. What's more, the study did not consider about the difference of participant's gender, age, weather a driver and so on.

In our future, we can move the experiment to the real road, which would be less efficient and less convenient but more real. It is possible for us to increase the number of participant, too. In addition, we can take the participants' age, gender, driver or not, novice or experienced into consideration. Furthermore, we can build up a model depending on such researcher to anticipate the passenger's hazard perception. So that the ADAS can be more humanized.

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