Effects of Driving Experience and Hazard Type on Young Drivers' Hazard Perception

Long Sun, Ruosong Chang and Shuang Li

Abstract Young novice drivers are found to be poor at detecting and responding to hazards on the road. In this study, three groups of young drivers with 6, 12 and 18 month driving experience were asked to complete a hazard perception task and their eye movements were recorded using Tobbi T120 eye tracker. The task contained 20 video clips, and hazards in the clips were classified into overt hazard (continuous visibility) and covert hazard (interrupted visibility) according to their visibility of materialization. Results revealed that drivers reacted to overt hazards faster than covert hazards. The experience-related differences in reaction time of the three driver groups were due to the faster processing after the initial fixation. Drivers' mean fixation duration was influenced by hazard type, but not by driving experience. These findings suggested that hazard type was a key factor when it comes to hazard perception testing and training for young drivers.

Keywords Hazard perception · Driving experience · Hazard type · Young driver

1 Introduction

Crash rates are particularly higher during the first month of licensure and decline rapidly for about six months and then much more slowly for at least two years [1]. Among the factors that accounted for young drivers' crash involvement, hazard perception (HP) skill was a key factor. For example, young novice drivers' scores on a video-based HP test could predict their crash involvement in the next year following the test [2].

L. Sun (✉) · R. Chang · S. Li
School of Psychology, Liaoning Normal University,
Huanghe Road. 850 Shahekou District, Dalian 116029, China
e-mail: sunlong510@yeah.net

S. Long and B.S. Dhillon (eds.), *Man–Machine–Environment System Engineering*,
Lecture Notes in Electrical Engineering 456, DOI 10.1007/978-981-10-6232-2_2

When facing a specific hazardous situation, drivers are expected to detect the potential hazard earlier, and then, they evaluate the hazardous level of the hazard and decide whether a response is needed to avoid a collision [3]. This skill, naming hazard perception, was a multi-component driving skill that can be improved through training. However, some studies failed to find the differences of HP performance between young novice drivers and young experienced drivers [4, 5]. This may partially due to the hazard type used in the HP studies. Another reason was the experience-related differences in HP reaction time may derive from later detection of hazard or/and the longer processing time after the initial fixation [6].

Although many studies demonstrated that experienced drivers reacted to hazards faster than novice drivers, little was known about the influencing mechanism of hazard type on young drivers' different HP processes. Thus, in this study, three groups of young drivers with 6, 12 and 18 month driving experience were recruited. And their HP performance under two types of hazard was examined using a video-based HP task.

2 Methods

2.1 Participants

Forty-five young drivers agreed to participate in this study. Participants' ages ranged from 18 to 27 (mean = 23.20, SD = 2.18), and they have 6-, 12- and 18-month driving experience, respectively. Participants were classified into three groups (labeled as 6-month, 12-month and 18-month drivers) according to their driving experience since they obtained a valid driving license (see Table 1).

The three groups of drivers were significantly different in their total driving mileage. They were not significantly different in their male-to-female ratio, age and years of education. Participants had normal or corrected-to-normal vision. Each participant received ¥50 after he/she completed the HP task.

Table 1 Demographic and test scores

Demographic factors	Driver group			*p*-value
	6-month mean (SD)	12-month mean (SD)	18-month mean (SD)	
Gender ratio (M/F)	3/12	6/9	4/11	>0.05
Age (year)	22.53 (2.26)	23.00 (2.34)	23.40 (1.80)	>0.05
Total driving mileage/KM	887 (299)	2067 (1354)	3773(1877)	<0.01
Years of education	13.93 (2.40)	14.40 (2.02)	14.40 (2.03)	>0.05

2.2 Materials

A hazard perception task was used in this study. The task contained 20 dynamic video clips (lengths ranged from 9 to 20 s), and its discrimination validity was good [7]. All video clips were shot from drivers' perspective around Dalian urban area under fine weather. Each video clip showed a traffic situation where a potential hazard was developing slowly as the camera car was approaching. During the experiment, participants could see the front part (hood) of the camera car.

Hazards in the clips were split into two types according to the visibility of their materialization. Overt hazards were totally visible in the process of materialization in front of the camera car (e.g., a car was signaling to turn right on the next intersection). Covert hazards were partially or totally blocked during the process of materialization, and these hazards became visible at the very moment when a maneuver was needed to avoid a collision (e.g., a pedestrian was walking into the road from the other side, but he was blocked by a bus moving in the opposite direction with the camera car).

Ten video clips contained overt hazards, and ten video clips contained covert hazards. The ten hazards in the clips were triggered by cars (five clips), pedestrians (three clips) or riders (two clips). The clip length of videos that contained overt and covert hazards wasn't significant, $t = 1.12$, $p > 0.05$. The road types were counter-balanced under each hazard type to minimize the effect of local familiarity. The onset time and the location of hazards were also different from one clip to another. All the hazards contained a *hazard window*, which began at the earliest point where a hazard was detectable and ended at the point where drivers' avoidance response would no longer prevent a collision [5, 8].

2.3 Design

A 3×2 mixed design was employed. The between-groups factor was driving experience (6-month drivers, 12-month drivers vs. 18-month drivers). The within-groups factor was hazard type (overt hazard vs. covert hazard).

The dependent variables were response latency (RL), time to first fixation (TFF), reaction time (RT) and mean fixation duration (MFD). RL was divided into TFF and RT according to participants' first fixation on the hazard [4, 6]. RL was calculated as the time from the onset of the hazard to the moment when a maneuver was needed to avoid a collision. TFF was calculated as the time from the onset of the hazard to the moment when participants first fixated on the hazard. RT was calculated as the time from when participants first fixated on the hazard to the moment when they reacted to it. MFD was the mean amount of time in which participants fixated on the hazard.

2.4 Procedure

Participants first finished a demographic questionnaire, and then, they were fitted with the Tobbi T120 eye tracker, which samples at 120 Hz. The viewing distance was 65 cm from the screen. After calibrating their gaze points, participants took three practice clips. They were instructed to click the left mouse button quickly when they detected a potential hazard that forced them to slow down or change their driving course. Finally, 20 video clips were randomly assigned to each participant on a 17-inch monitor at a resolution of 1280 $\times$ 720. The experiment lasted about 15 min.

3 Results

3.1 Response Latency

A 3 $\times$ 2 analysis of variance (ANOVA) compared the mean RL of the three driver groups. The main effect of driving experience was significant (F (2, 42) = 13.42, $p < 0.01$, $\eta^2 = 0.390$). Post hoc revealed that 6-month drivers ($M = 3.05$, SD = 0.22) responded to hazards slower than 12-month drivers ($M = 2.79$, SD = 0.29) ($p < 0.05$) and 18-month drivers ($M = 2.48$, SD = 0.39) ($p < 0.01$). The main effect of hazard type was significant (F (1, 42) = 50.32, $p < 0.01$, $\eta^2 = 0.545$); drivers responded to overt hazards ($M = 2.56$, SD = 0.47) faster than covert hazards ($M = 2.99$, SD = 0.39). The interaction between the two factors wasn't significant ($F < 1$, $p > 0.05$).

3.2 Time to First Fixation

A 3 $\times$ 2 analysis of variance (ANOVA) compared the mean TFF of the three driver groups. The main effect of hazard type was significant (F (1, 42) = 36.25, $p < 0.01$, $\eta^2 = 0.463$); drivers detected overt hazards ($M = 0.21$, SD = 0.17) faster than covert hazards ($M = 0.40$, SD = 0.25). No effect of driving experience and its interaction with hazard type were found (Fs < 1, ps > 0.05).

3.3 Reaction Time

A 3 $\times$ 2 analysis of variance (ANOVA) compared the mean RT of the three driver groups. The main effect of driving experience was significant (F (2, 42) = 7.72, $p < 0.01$, $\eta^2 = 0.269$). Post hoc revealed that 6-month drivers ($M = 2.69$, SD = 0.26) and 12-month drivers (M = 2.52, SD = 0.32) reacted to hazards slower than 18-month drivers (M = 2.20, SD = 0.44) (ps < 0.05). The main effect of hazard type was significant (F (1, 42) = 8.47, $p < 0.01$, $\eta^2 = 0.168$); drivers reacted to overt hazards (M = 2.36, SD = 0.49) faster than covert hazards (M = 2.58, SD = 0.46). The interaction between the two factors wasn't significant ($F < 1$, $p > 0.05$).

3.4 Mean Fixation Duration

A 3 × 2 analysis of variance (ANOVA) compared the mean MFD of the three driver groups. The main effect of hazard type was significant (F (1, 42) = 24.64, $p < 0.01$, $\eta^2 = 0.370$); drivers fixated overt hazards (M = 0.44, SD = 0.24) longer than covert hazards (M = 0.37, SD = 0.19). The main effect of driving experience wasn't significant (F (2, 42) = 1.16, $p > 0.05$). The interaction between the two factors was significant (F (2, 42) = 3.43, $p < 0.05$, $\eta^2 = 0.140$). However, simple effect test showed that the three groups' MFD on covert hazards ($F < 1$, $p > 0.05$) and overt hazards (F (2, 42) = 1.67, $p > 0.05$) weren't significant.

4 Discussion

The present study examined the effects of driving experience and hazard type on young drivers' hazard perception performance. First, the three driver groups were only different in their total driving mileage. Thus, the relationship between young drivers' driving experience and their hazard perception performance could be better understood when the other demographic factors are well controlled.

Second, we found driving experience did affect drivers' response latency to hazards. The more driving experience a driver had, the faster he or she reacted to hazards. The experience-related differences in response latency were due to the faster processing time after the initial fixation. The three driver groups were not significantly different in the time to spot a potential hazard. One possible explanation for this was that participants haven't driven long enough to form flexible visual strategies. In addition, young drivers reacted to overt hazard faster than covert hazards. This indicated that how fast a young driver could react to the hazard, to some degree, depended on the salient nature of the hazard. Although drivers' HP processing mechanism on covert and overt hazards was similar, our data suggested that overt hazards were more effective in distinguishing the three driver groups than covert hazards. Overall, these findings provided some insight into why young novice drivers had poorer ability to address particular hazards.

Finally, no effect of driving experience on mean fixation duration was found in this study. Although the mean fixation duration of the three groups was similar, the reaction time of the two groups of less experienced driver was slower than drivers who had 18-month driving experience. This indicated that compared to more experienced drivers, when the similar amount of attention was given to a specific hazard, the two groups of less experienced drivers could not extract sufficient information from the stimuli, or at least, the efficiency of their information-to-action translation was worse [3].

Nonetheless, we found overt hazards were fixated more time than covert hazards. Due to the nature of covert hazards, it could be more beneficial for young novice drivers if their visual strategies on covert hazards get well trained. However, covert hazards used in the training should not be too difficult to detect because the task may require more attentional resources that young drivers may not have, especially when the training was conducted on a driving simulator.

Compliance with Ethical Standards The study was approved by the Logistics Department for Civilian Ethics Committee of Liaoning Normal University.

All subjects who participated in the experiment were provided with and signed an informed consent form.

All relevant ethical safeguards have been met with regard to subject protection.

References

1. Fisher DL, Pollatsek AP, Pradhan A (2006) Can novice drivers be trained to scan for information that will reduce their likelihood of a crash? Traffic Inj Prev 12(suppl 1):25–29
2. Horswill MS, Hill A, Wetton M (2015) Can a video-based hazard perception test used for driver licensing predict crash involvement? Accid Anal Prev 82:213–219
3. Crundall D, Chapman P, Trawley S et al (2012) Some hazards are more attractive than others: drivers of varying experience respond differently to different types of hazard. Accid Anal Prev 45:600–609
4. Yeung JS, Wong YD (2015) Effects of driver age and experience in abrupt-onset hazards. Accid Anal Prev 78:110–117
5. Sagberg F, Bjørnskau T (2006) Hazard perception and driving experience among novice drivers. Accid Anal Prev 38(2):407–414
6. Huestegge L, Böckler A (2016) Out of the corner of the driver's eye: peripheral processing of hazards in static traffic scenes. J Vis 16(2):11–16
7. Sun L, Chang R (2016) Effects of self-assessed ability and driving experience on hazard perception. J Psychol Sci 39(6):1346–1352
8. Lim PC, Sheppard E, Crundall D (2013) Cross-cultural effects on drivers' hazard perception. Trans Res Part F: Traffic Psychol Behav 21:194–206

Springer

http://www.springer.com/978-981-10-6231-5

Man–Machine–Environment System Engineering
Proceedings of the 17th International Conference on MMESE
Long, S.; Dhillon, B.S. (Eds.)
2018, XXIV, 849 p. 238 illus., Hardcover
ISBN: 978-981-10-6231-5