DRIVERS' ASSESSMENT OF HAZARD PERCEPTION

Daniela Barragan, Yi-Ching Lee
George Mason University
Fairfax, VA, USA
Email: dbarraga@gmu.edu

Summary: Encountering dangerous situations while driving is ubiquitous. Existing research suggest that specific populations such as, novice drivers are more prone to errors in detecting and responding to driving hazards. Hazard perception training programs have been developed in attempts to improve or accelerate the acquisition of such skills. However, drivers' attitudes and knowledge regarding vulnerable populations and hazard perception training programs remain largely unknown. Three-hundred-five participants completed an online survey assessing their beliefs about influential factors affecting hazard detection and response, perceived usefulness and preferred types of training programs, and self-assessment of driving skills. Although many existing training programs are computer-based, participants preferred on-road hazard perception training. Such findings may assist in improving existing programs, which currently fail to show near- and far-transfer effects. Similarly, novice drivers reported being most likely to engage in training programs – possibly linked to their reported high value of the usefulness of such programs and awareness of their vulnerability to commit errors. Although autonomous vehicles should mitigate these errors, researchers and government officials suggest automated vehicles will not be commercially available for 10 years. Therefore, the results of the present study provide insight into drivers' beliefs about dangerous situations, which may prove useful in developing and improving training programs aimed at mitigating crash risk.

INTRODUCTION

Drivers' aptitude in detecting and responding to potentially dangerous driving events is associated with crash risk (Egea-Caparros et al., 2016; Horswill, 2016). This process has been termed hazard perception (Egea-Caparros et al., 2016), which includes detecting and if necessary, responding to dangerous driving events. Research has shown that drivers' hazard perception skills are affected by driving experience (Crundall, 2016; Egea-Caparros et al., 2016; Parmet, Borowsky, Yona, & Oron-Gilad, 2015), age (Horswill et al., 2008), and skills in detecting anticipatory or environmental cues such as crosswalks and intersections (Horswill, 2016; Parmet et al., 2015). Horswill (2016) has identified the need for drivers to gain a sufficient level of hazard perception skills in order to reduce crash risk.

Several countries such as, U.K., Australia, and Netherlands require drivers to complete a computer-based hazard perception test as part of the licensure exam (Horswill, 2016). Although not required in the U.S., a U.S.-based hazard perception training program, namely Risk Awareness and Perception Training (RAPT), has been utilized in several recent studies providing promising results (cf. McDonald, Goodwin, Pradhan, Romoser, & Williams, 2015). Training programs such as this, were developed to accelerate the acquisition of hazard perception skills (Deery, 1999; Horswill, 2016; McDonald et al., 2015), which are otherwise gained through

increased driving experience (Egea-Caparros et al., 2016). Some early results showed that male (but not female) drivers who completed one session of the RAPT, were involved in significantly fewer crashes within one year proceeding training compared to control participants (Thomas, Rilea, Blomberg, Peck, & Korbelak, 2016). However, there is still limited evidence to suggest that the skills acquired through completing these training programs sustain near- or far-transfer, and the learned skills have also shown to decay in as little as one week (Deery, 1999; McDonald et al., 2015).

Given the need for an effective hazard training program in the U.S., it is important to identify why existing programs fall short. In doing so, we believe it is particularly relevant to gauge drivers' perceptions of vulnerable road users and their beliefs about hazard perception training programs. For example, existing research suggests that novice drivers have poor hazard perception due to limited driving experience (Crundall, 2016; Parmet et al., 2015). In this case, it is important to determine whether novice drivers are aware of their deficits in detecting and responding to hazards. According to Horrey, Lesch, Mitsopoulos-Rubens, and Lee's (2015) driver calibration framework, inexperienced drivers should be especially prone to errors in calibration because they tend to overestimate their driving/vehicle handling skills in dealing with complex driving situations. In particular, if novice drivers tend to believe that their limited driving experience does not make them more susceptible to committing errors in hazard perception then such training programs may be ineffective.

Similarly, there is a need to understand the type of training preferred. Currently, U.S. pre-licensure driver training programs take place on-the-road whereas, most of the existing hazard perception programs are computer-based. It is possible that drivers may prefer or find more value in experiential rather than passive learning given their experience with pre-licensure training. Alternatively, drivers may prefer a computer-based training program out of convenience.

Therefore, the current study was designed to provide a subjective understanding of drivers' assessment of hazard perception. It was hypothesized that 1) drivers would identify driving experience as being the most important factor for successful hazard detection and response; and 2) drivers would prefer computer-based training programs due to convenience; 3) novice drivers would be susceptible to miscalibration by a) overestimating their driving skills, b) reporting low likelihood of completing hazard training programs, and c) discrediting their need to complete such training programs. These results may provide insight regarding how to improve the effectiveness of existing programs or to develop new hazard perception training programs that are better aligned with learner's expectations.

METHOD

Participants

Three-hundred twenty-five participants were recruited from George Mason University and social media. Individuals were eligible to participate in this study if they held a valid U.S. driver's license and were at least 18 years of age. One participant did not meet these eligibility requirements and 19 participants withdrew from the study, resulting in a total of 20 participants who were excluded from data analysis. Participants from George Mason University were compensated with research credit. All other participants did not receive compensation for participation.

For analysis purposes, participants are usually divided into two groups: novice and experienced drivers (e.g., Crundall, 2016; Parmet et al., 2015). However, this method eliminates a large population of drivers (i.e., intermediate drivers), therefore, we decided to categorize drivers into one of three groups based on driving experience (i.e., novice, intermediate, experienced). Participants who reported having less than three years of driving experience were classified as novice drivers (Crundall, 2016), participants who reported having more than seven years of driving experience were classified as experienced drivers (Parmet et al., 2015), and all other participants were classified as intermediate drivers. Of the 305 participants, there were 120 novice (91 women, 29 men; M_{age} = 18.58, *SD* = 1.03), 127 intermediate (103 women, 24 men; M_{age} = 20.72, *SD* = 2.21), and 58 experienced (38 women, 20 men; M_{age} = 31.69, *SD* = 12.80) drivers. On average, novice drivers had 1.56 (*SD* = .56, range = <1-2) years of driving experience, intermediate drivers had 4.24 (*SD* = 1.04, range = 3-6) years of driving experience, and experienced drivers had 15.41 (*SD* = 13.19, range = 7-66) years of driving experience.

Materials

Five surveys were included in this study: Hazards Beliefs Survey, Driver Confidence Questionnaire, Hazard Perception Skill Questionnaire, Driving Questionnaire, and a demographics and driving history survey. The Driver Confidence Questionnaire (de Craen, 2010) was included to assess driver's overall confidence in their driving skills as well as in comparison to average and peer drivers. The Hazard Perception Skill Questionnaire (White, Cunningham, & Titchener, 2011) was included to assess drivers self-report level of skills, compared to the average driver, in spotting and reacting to hazards under various driving conditions. In the original study, White et al. (2011) included only young participants and thus, the word 'young' was removed from the instructions given that our sample consisted of a diverse age range. The Driving Questionnaire (Chapman, Sargent-Cox, Horswill, & Anstey, 2016) was included to assess drivers' confidence in their ability to respond to hazards. Finally, to evaluate drivers' beliefs regarding training programs and the influence of individual differences in hazard perception, we created the Hazard Beliefs Survey, which is described below.

Hazard beliefs survey. This survey consists of six items. Two items assess the level of importance of driving experience, age, knowledge of driving laws, and environmental cues (e.g., crosswalks, intersections) in 1) detecting hazards while driving, and 2) responding to hazards while driving. Participants are asked to respond to these items using a 5-point Likert scale (1 = *not important*, 2 = *somewhat unimportant*, 3 = *neutral*, 4 = *somewhat important*, 5 = *very important*). The remaining four items assess drivers' beliefs about hazard training. For example, one item assesses the level of importance of providing a training program to teach drivers to detect and respond to hazards using a 5-point Likert scale. The other three items instruct drivers to report: 1) the likelihood that they would complete training, 2) who should be required to complete hazard training, and 3) which type of training program would be most effective.

Procedure

The George Mason University Institutional Review Board (IRB) waived the requirement for signed consent. However, participants were required to acknowledge consent by clicking a button labelled, 'Accept.' Alternatively, participants who clicked the button labelled, 'Decline,' were ineligible to complete the study. Participants completed the surveys outside of the lab on Qualtrics, which took approximately 15 minutes.

All data were analyzed using R Studio. For the variables of interest, one-way analyses of variance (ANOVAs) or chi-square analyses were performed to evaluate between-group (i.e., novice, intermediate, experienced) differences and paired-samples t-tests were performed to evaluate within-group differences.

RESULTS

Hazard Beliefs Survey

Driving Experience. There were no between-group differences for the rated level of importance of driving experience in detecting and responding to hazards, *p*s > .05. Within-groups, novice [$t(119) = 3.96$, $p < .001$], intermediate [$t(126) = 2.89$, $p = .005$], and experienced [$t(57) = 3.40$, $p = .001$] drivers rated driving experience as significantly more influential in responding than in detecting.

Age. There was no significant difference between-groups for the rated level of importance of age in detecting hazards, $p = .74$. There was however, a significant between-group difference in the rated importance of age in responding to hazards, $F(2, 302) = 3.99$, $p = .01$. Specifically, novice drivers rated age as more important in responding to hazards than intermediate drivers ($p = .03$), but intermediate drivers rated age as a more important factor in responding than detecting hazards [$t(126) = 4.69$, $p < .001$]. Finally, novice and experienced drivers did not rate age as being more influential in responding compared to detecting hazards, *p*s > .05.

Knowledge of traffic laws. There were significant between-group differences for the rated level of importance of knowledge of traffic laws in detecting [$F(2, 302) = 10.01$, $p < .001$] and responding [$F(2, 302) = 9.29$, $p < .001$] to hazards. Specifically, experienced drivers rated knowledge of driving laws as significantly more important in detecting hazards than novice ($p < .001$) and intermediate ($p = .01$) drivers. Likewise, experienced drivers rated knowledge of driving laws as significantly more important in responding to hazards compared to novice ($p < .001$) and intermediate ($p = .01$) drivers. Though, novice [$t(119) = -3.93$, $p < .001$], intermediate [$t(126) = -3.65$, $p < .001$], and experienced [$t(57) = -2.85$, $p = .006$] drivers rated knowledge of traffic laws as significantly more influential in hazard detection than response.

Environmental cues. There were no significant between-groups differences for the rated level of importance of environmental cues in detecting and responding to hazards, *p*s > .05. Within-groups, novice [$t(119) = -3.50$, $p < .001$] and experienced [$t(57) = -3.26$, $p = .002$] drivers rated environmental cues as significantly more influential in hazard detection than response. However, intermediate drivers did not rate the importance of environmental cues in detecting and responding to hazards significantly different, $p = .13$.

Hazard perception training. There was no significant difference in the rated level of importance of hazard training based on driving experience, $p = .70$. Novice ($M = 4.54$, $SD = .63$), intermediate ($M = 4.52$, $SD = .70$), and experienced ($M = 4.45$, $SD = .78$) drivers rated the level of importance as *somewhat* to *very important*. There was a significant difference in drivers likeliness to complete training based on driving experience, $F(2, 302) = 6.41$, $p = .002$. Specifically, novice drivers reported being more likely to complete training than intermediate drivers, $p = .001$. There was no significant between-group difference in the type of hazard

training program preferred, $p = .12$. However, as shown in Figure 1, most participants preferred either driving simulator or on-road training.

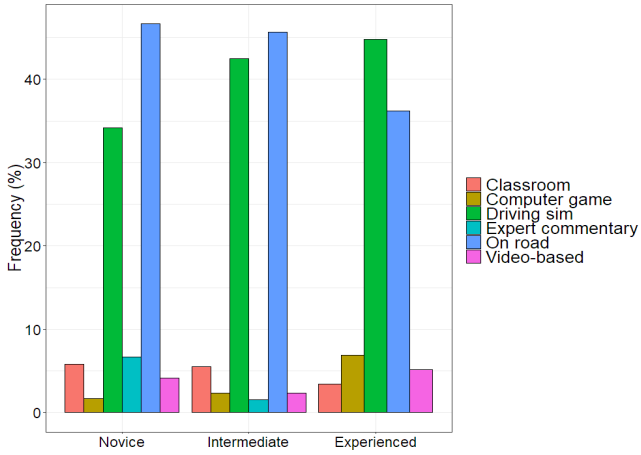

Figure 1. Preferred hazard perception training format by driving experience

Additionally, there was no significant difference in ratings for which drivers should be required to complete training by driving experience, $p = .95$. The frequencies are displayed in Table 1.

Table 1. Frequency (%) of which drivers should be required to complete hazard perception training by group

	Novice	Intermediate	Experienced
Learner's permit	82.50	75.59	86.21
Newly licensed	65.00	71.65	87.93
Older drivers	48.33	53.54	67.24
License revoked	80.00	77.17	79.31
Ticket	42.50	44.88	43.10
Crash	80.00	81.89	81.03

Note. Participants were able to select more than one group

Confidence in Driving Skills

Driver confidence questionnaire. There was no significant difference between-groups for confidence scores when drivers compared themselves to peer drivers based on driving experience, $p = .15$. However, there was a significant difference in confidence scores when drivers compared themselves to average drivers based on driving experience, $F(2, 302) = 6.94$, $p = .001$. Specifically, when compared to the average driver, novice drivers ($M = 3.39$, $SD = .67$) had significantly lower confidence scores compared to intermediate ($M = 3.60$, $SD = .65$; $p = .03$) and experienced ($M = 3.76$, $SD = .69$; $p = .002$) drivers.

Driving questionnaire. There was no significant difference in confidence scores based on driving experience, $p = .25$.

Hazard perception skill questionnaire. There was a significant difference in scores based on driving experience, $F(2, 302) = 5.74$, $p = .004$. Specifically, novice drivers ($M = 4.69$, $SD = 1.00$)

were significantly less confident in their ability to detect and respond to hazards than experienced (M = 5.21, SD = .93) drivers, p = .003.

CONCLUSION

The purpose of this study was to investigate drivers' beliefs about hazard perception including influential factors, populations most at risk of committing errors in hazard perception, views on hazard perception training programs, and confidence in driving skills. Several countries including U.K., Australia, and Netherlands acknowledge the increased crash risk resulting from insufficient hazard perception skills and have thereby included a hazard perception test as part of the driver's licensing exam (Horswill, 2016). The results of the present study provide valuable information to further develop effective hazard perception training programs for use in the U.S. For example, unlike many of the existing hazard perception training programs in the U.S. (McDonald et al., 2015) which are computer-based, most participants preferred on-road training (followed by simulator). Although speculative, it is possible that drivers understand the value in experiential training. However, for practical reasons, the effectiveness of on-road hazard perception training remains largely unknown. Alternatively, driving simulator training presents a more feasible option, but only a few studies have utilized this method and the effectiveness is also largely unknown.

One surprising, but promising result of this study was that drivers agreed that a successful training program is valuable and the majority of drivers, particularly novices, reported being *very likely* to complete hazard perception training. Such positive attitudes towards hazard perception training is likely to improve the effectiveness of such training. In support, Ericsson (2002) suggests that motivation and positive attitudes towards a task bolsters performance. However, it is important to note that our results are subjective in nature and future research should evaluate whether this holds true objectively.

Next, to evaluate the accuracy of driver calibration, participants were asked to rate their driving and hazard perception skills in comparison to average and peer drivers. Contrary to Deery (1999), novice drivers were the least confident in their ability to accurately detect and respond to hazards, as well as their overall driving skills compared to the average driver. These results suggest that novice drivers accurately calibrated their driving skills. Finally, drivers identified knowledge of traffic laws and environmental cues (e.g., crosswalks, intersections) as most influential in hazard detection skills whereas, driving experience was rated as most influential in successful hazard response. The latter two results are supported by existing research (e.g., Crundall, 2016; Egea-Caparros et al., 2016; Horswill, 2016; Parmet et al., 2015), but the influence of knowledge of traffic laws in detecting hazards has not been explored. This finding warrants further evaluation as it is possible that the findings of prior studies that driving experience predicts hazard detection may actually be mediated by knowledge of traffic laws.

In sum, novice drivers acknowledged that they have poor hazard perception skills, reported being likely to complete hazard perception training, and understood the importance of such training programs. All drivers preferred on-road training programs and identified driving experience as most influential in hazard response, but not detection. Current hazard perception training programs could be modified to incorporate the users' beliefs in attempts of improving performance outcomes.

REFERENCES

Chapman, L., Sargent-Cox, K., Horswill, M. S., & Anstey, K. J. (2016). The impact of age stereotypes on older adults' hazard perception performance and driving confidence. *Journal of Applied Gerontology, 35*(6), 642-652.

Crundall, D. (2016). Hazard prediction discriminates between novice and experienced drivers. *Accident Analysis and Prevention, 86*, 47-58. doi: 10.1016/j.aap.2015.10.006

de Craen, S. (2010). *The x-factor: A longitudinal study of calibration in young novice drivers* (Doctoral thesis, Delft University of Technology, Delft, Netherlands). Retrieved from https://www.swov.nl/en/publication/x-factor-longitudinal-study-calibration-young-novice-drivers

Deery, H. A. (1999). Hazard and risk perception among young novice drivers. *Journal of Safety Research, 30*(4), 225-236.

Egea-Caparros, D.-A., Garcia-Sevilla, J., Pedraja, M.J., Romero-Medina, A., Marco-Cramer, M., & Pineda-Egea, L. (2016). Late detection of hazards in traffic: A matter of response bias? *Accident Analysis and Prevention, 94*, 188-197. doi: 10.1016/j.aap.2016.06.002

Ericsson, K. A. (2002). Attaining excellence through deliberate practice: Insights from the study of expert performance. In C. Desforges, & R. Fox (Eds.), *Teaching and learning: The essential readings* (pp. 4-37). Hoboken, NJ: Blackwell Publishers Ltd.

Horrey, W.J., Lesch, M.F., Mitsopoulos-Rubens, E., & Lee, J.D. (2015). Calibration of skill and judgment in driving: Development of a conceptual framework and the implications for road safety. *Accident Analysis and Prevention, 76*, 25-33. doi: 10.1016/j.aap.2014.12.017

Horswill, M. S. (2016). Hazard perception in driving. *Current Directions in Psychological Science, 25*(6), 425-430.

Horswill, M. S., Marrington, S. A., McCullough, C. M., Wood, J., Pachana, N. A., McWilliam, J., & Raikos, M. K. (2008). The hazard perception ability of older drivers. *Journal of Gerontology: Psychological Sciences, 63B*(4), 212-218.

McDonald, C. C., Goodwin, M. A., Pradhan, A. K., Romoser, M. R. E., & Williams, A. F. (2015). A review of hazard anticipation training programs for young drivers. *Journal of Adolescent Health, 57*, S15-S23. doi: 10.1016/j.jadohealth.2015.02.013

Parmet, Y., Borowsky, A., Yona, O., & Oron-Gilad, T. (2015). Driving speed of young novice and experienced drivers in simulated hazard anticipation scenes. *Human Factors, 57*(2), 311-328.

Thomas, F.D., Rilea, S.L., Blomberg, R.D., Peck, R.C., & Korbelak, K.T. (2016). *Evaluation of the safety benefits of the risk awareness and perception training program for novice and teen drivers* (Report No. DOT-HS-812-235). Washington, D.C.: National Highway Traffic Safety Administration.

White, M. J., Cunningham, L. C., & Titchener, K. (2011). Young drivers' optimism bias for accident risk and driving skill: Accountability and insight experience manipulations. *Accident Analysis and Prevention, 43*, 1309-1315. doi: 10.1016/j.aap.2011.01.013