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Effects of driver age and experience in abrupt-onset hazards

Jian Sheng Yeung *, Yiik Diew Wong

Centre for Infrastructure Systems, School of Civil and Environmental Engineering, Nanyang Technological University, 50 Nanyang Avenue N1-B1b-09, Singapore 639798

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ABSTRACT

Novice drivers and older drivers are found to have the highest crash risk among all drivers and this has motivated many research studies into various aspects of novice and older drivers. Although age-related declines were expected, studies did not find older drivers to respond slower to hazards. This study examined the hazard detection and response latencies of 14 young novice drivers, 14 young experienced drivers, and 12 older experienced drivers, to abrupt-onset hazards. Older drivers were found to take longer times before fixating on an abrupt-onset road hazard but appeared to have insignificantly faster reaction times after the initial fixation. Hence, the overall response latency did not suggest any age effects. Older drivers also scanned the roadway less as compared to their younger counterparts. No effects of experience were found. The findings provided insight on age-related declines in hazard detection whose effects have been masked by other components of hazard response.

1. Introduction

It is important for drivers to be able to react promptly and appropriately to hazards in the traffic environment, especially in complex urban environments. From several crash data analyses, it was found that crash rates per distance driven appear to follow a U-shaped relationship with age, i.e. crash rates were highest for both the youngest and oldest driver groups (Massie et al., 1995; Ryan et al., 1998; Lourens et al., 1999; McGwin and Brown, 1999). Much research effort has been invested in determining the reasons behind the increased crash risk of novice drivers and elderly drivers.

Novice drivers are new drivers who have just obtained their driving licences and generally have not acquired sufficient on-road driving experience. Novice drivers (typically between 16 to 25 years old in most studies), compared to experienced drivers, are found to have inflexible and inefficient visual scanning strategies while driving (Crundall and Underwood, 1998; Pradhan et al., 2005; Scott et al., 2013); performed poorer in identifying latent hazards (Vlakveld, 2014); committed more driving errors with low situational awareness (Kass et al., 2007); are poorer at hazard perception (Borowsky et al., 2010; Scialfa et al., 2011, 2012); and have longer reaction times to peripheral stimuli (Patten et al., 2006). Underwood et al. (2002) explained that this was due to novice drivers having inadequate mental models of the potential hazards on the roads. Huestegge et al. (2010) discovered that while the time taken to fixate on a hazard in a static hazard perception task is similar for novice and experienced drivers, experienced drivers processed the information faster and had overall shorter reaction times.

On the other hand, elderly drivers (65 years or older) experience challenges in driving primarily due to physical frailty, reduced fitness to drive and increased driving on high-risk urban roads (Robertson and Vanlaar 2008; Oxley et al., 2010). Langford et al. (2008) found that after controlling for mileage, elderly drivers have the highest crash risk only in the low annual mileage group (<3001 km). Andrews and Westerman (2012) discussed that older drivers older than 60 years, being aware of their age-related declines, adopt strategic compensatory changes in their driving patterns such as reduced speeds, greater headways, avoiding specific traffic situations, and driving shorter distances. However, these changes often result in older drivers driving more often on high-risk urban streets and less often on relatively low-risk freeways. This explanation is consistent with accident data analyses which found that older drivers' crashes mostly involve intersections and failure to give way (Langford and Koppel, 2006; Clarke et al., 2010; Rakotonirainy et al., 2012). Various studies have found that older drivers (typically >60 years old), as compared to younger experienced drivers, tend to fixate on their intended path of travel instead of scanning for potential hazards (Dukic and Broberg, 2012; Romoser et al., 2013); have slower choice reaction times (Leversen et al., 2013); have lower contrast sensitivity (Wood et al., 2009); are poor at detecting hazards in the periphery

* Corresponding author. Tel.: +65 98240624.
E-mail addresses: jsyeung1@e.ntu.edu.sg (J.S. Yeung), cydwong@ntu.edu.sg (Y.D. Wong).

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(Martin et al., 2010; Bromberg et al., 2012); and have greatly deteriorated performance with secondary tasks (Makishita and Matsunaga, 2008; Cantin et al., 2009; Kim and Son, 2011; Thompson et al., 2012).

Interestingly, despite the large pool of evidence that suggests that hazard response deteriorates with age, no significant effects of experience or age were found on response latency in hazard detection (Underwood et al., 2013) and response time for evasive manoeuvres (Dozza, 2013). As explained by Underwood et al. (2011), two main types of hazards are abrupt-onset and gradual-onset hazards, and experiential differences in hazard perception may not be found in simple stimulus–response tasks (i.e. abrupt-onset hazards) without any cues or foreshadowing events (Crundall et al., 2012).

However, perceptual speed and motor speed are known to decrease with age (Salthouse, 1996). Hence, it should be expected for abrupt-onset hazards to better reveal age effects because they are immune to strategic compensation and will be heavily affected by age-related declines. Since cognition, vision, and physical functions are the primary contributors to the capacity to drive safely (Anstey et al., 2005), the effects of age and experience on these contributors should be examined individually, especially when dealing with abrupt-onset hazards. In the present study, the visual, cognitive, and physical components of hazard responses to abrupt-onset hazards were examined.

Two main hypotheses were tested in this study: (1) older drivers take longer times to visually detect abrupt-onset hazards due to age-related declines in vision; and (2) upon hazard detection, older drivers take longer times for braking responses due to age-related declines in physical functions.

2. Methodology

2.1. Participants

In this study, young drivers were defined as ages 18–40 years, while the older drivers were defined as ages above 50 years, separated by a 10-year transition gap. It should be noted that in Singapore, the legal minimum age for driving is 18 years and the driving license requires periodical renewals when drivers reach 65 years old.

Novice drivers were defined as drivers with two years or less of driving experience while experienced drivers were defined as drivers with more than three years, separated by a one-year transitional gap.

Participants were publicly recruited from the local community. Forty participants volunteered to take part in the experiment and they were each offered an honorarium of S$25 for their time. All participants possessed a valid Singapore driving license and were in good physical health, with either perfect or corrected vision. The participants were classified into three participant groups:

- Young novice (YN) – 14 participants with ages ranging from 19 to 27 years old and had two or fewer years of driving experience. The group consisted of seven males and seven females, with a mean age of 21.93 years and mean driving experience of 1.43 years. All YN participants were students who did not drive regularly.
- Young experienced (YE) – 14 participants with ages ranging from 22 to 35 years old and had more than three years of driving experience. The group consisted of nine males and five females, with a mean age 28.57 years and mean driving experience of 8.29 years. The YE participants were students and working adults who drove regularly.
- Older experienced (OE) drivers – 12 participants with ages ranging from 53 to 66 years and had more than three years of driving experience. The group consisted of seven males and five females, with a mean age of 56.58 years and mean driving experience of 29.58 years. The OE participants were all working adults with many years of driving experience.

2.2. Apparatus and stimuli

2.2.1. Experiment video

Several hazardous incidents were staged and filmed around the Nanyang Technological University (NTU) campus (Singapore). A video recorder was positioned under the rear-view mirror in a car to provide a video perspective similar to the forward view as seen from the driver's eyes. After recording the scenes, the video clips were edited and compiled into a single video footage such that it was perceived as a single, continuous 20-min drive around the campus. The experiment video had a resolution of 1920 × 1080 (2.1 megapixels). The scenes were filmed on days with fine weather.

2.2.2. Stimuli

Four abrupt-onset hazardous incidents were identified in the experiment video and were included in the analyses. In each incident the hazardous object appeared in the road scene without any foreshadowing events which could otherwise have allowed the participant to anticipate its appearance. The appearance of each hazard necessitated immediate braking response in order for the test car to avoid a collision. For all four stimuli, the test car came to a complete stop at what was considered to be the latest possible moment to prevent a collision during filming. The incidents are described below, in order of their appearance in the experiment video. Fig. 1 shows snapshots of each incident.

Fig. 1. Snapshots of abrupt-onset hazard incidents.