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Driving in fog: The effects of driving experience and visibility on speed compensation and hazard avoidance

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ABSTRACT

Inexperience is one of the strongest predictors for collisions, but it remains unclear how novice drivers differ from experienced drivers in terms of safety-related behavioural adaptations such as speed reduction in the presence of reduced visibility. To investigate the influence of driving experience on behavioural compensations to fog, average speed, speed variability, steering variability, collision rate, and hazard response time were measured in a driving simulator. Experienced drivers drove faster in clear visibility than novice drivers, yet they reduced their speed more in reduced visibility so that both groups drove at the same speed in simulated fog. Compared to experienced drivers, novice drivers had higher hazard response times, greater speed and steering variability, and were the only drivers to have collisions.
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1. Introduction

Young novice drivers are overrepresented in collision statistics around the globe (AAA Foundation for Traffic Safety, 2009; Emery et al., 2008; Insurance Institute for Highway Safety, 2009; World Health Organization, 2009). Curry et al. (2011) and McKnight and McKnight (2003) found that most collisions involving young novice drivers are typically the result of cognition errors rather than performance errors per se (e.g., overcompensation, inappropriate vehicle control, panic and freezing). Those cognition errors involve the inability to maintain attention, inappropriate visual search strategies, failure to recognize hazards, and poor decision-making (e.g., selecting inappropriate speeds for particular situations and poor maintenance of space around other vehicles). Novice drivers also tend to hold inaccurate expectations about hazards and where they are likely to be located, which explains in part their largely ineffective visual search strategies for hazards in the driving environment (Lerner and Westat, 2001; Pradhan et al., 2009; Vidotto et al., 2011). Moreover, they have the tendency to overestimate their ability to successfully manage hazardous events on the road (De Craen et al., 2011; Wallis and Horswill, 2007), which can be even further complicated by their propensity to underestimate braking distances to hazards (Deery, 1999).

When understanding the cognition errors made by young novice drivers, it is useful to consider Shiffrin and Schneider's (1977) distinction between automatic and controlled processing. Controlled processes are engaged whenever a person is performing a complex or unfamiliar task. These processes are carried out consciously and slowly, and they demand cognitive resources (attention), which means that they interfere with other controlled processes when performed in tandem. With adequate practice, some controlled processes become automatic, which is to say that these processes come to be carried out unconsciously and quickly and they do not require cognitive resources. Consequently they do not interfere with other processes performed at the same time (automatic or controlled). Given that young drivers are less practiced, they may require controlled processing resources to carry out aspects of the task that more experienced drivers perform automatically. For example, novice drivers may require controlled processing to carry out aspects of speed control, steering, and visual search for hazards that experienced drivers carry out automatically, and this may contribute to cognition errors insofar as it is more difficult for novice drivers to carry out the basics of vehicle control while maintaining high levels of situational awareness and thinking ahead (Trick et al., 2004).

As the demands of the driving task increase so too does the risk of collision; however, the risk appears to be greater for young novice drivers than for experienced drivers. Young novice drivers seem to be unable to cope as successfully as experienced drivers when the challenges of the driving task increase (Patten et al., 2006), and thus their risk of collision may increase under those circumstances. A common situation in which the demands of the driving task

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increase is when visibility is reduced, as occurs in adverse weather and at night.

Reduced visibility increases the risk of collision for everyone (Andrey et al., 2003; Cavallo et al., 2000; Clarke et al., 2006; Edwards, 1999; Sullivan and Flannagan, 2004); however, it appears that not all drivers are affected equally. Some are more likely to perform safety-related adaptations than others, and those adaptations chiefly involve reducing speed. Speed is an aspect of the driving task that can be altered in challenging situations to reduce the risk of collision. For example, in fog the distance from which a driver is able to perceive hazards is much shorter than in normal conditions. Consequently, speed reduction in fog gives drivers more time to react to hazards (Al-Ghamdi, 2007). Trick et al. (2009) found that older drivers (M = 71 years of age) reduced their speed substantially in fog whereas younger and less experienced drivers (M = 18 years of age) did not––they reduced speed by less than 1 kph––and had more collisions.

There are several possible causes for this differential speed reduction. Elderly drivers are generally more experienced. It is possible that their speed compensation reflects an accurate understanding of the risks involved in reduced visibility, to which novice drivers are relatively insensitive (Borowsky et al., 2009; Deery, 1999; Wallis and Horswill, 2007). Then again, age affects numerous aspects of driving performance, such as how often people drive and how cautious they are behind the wheel––older drivers are typically more cautious than younger drivers (Hakamies-Blomqvist and Wahlström, 1998). Moreover, impaired sensory and attentional functioning differentiates elderly drivers from younger drivers in many ways unrelated to driving expertise (Chao and Knight, 1997; Ivers et al., 1999).

The evidence concerning speed compensation in drivers is mixed. Some studies show that younger drivers do in fact reduce their speed in poor visibility (Horrey et al., 2003; Owens et al., 2010), though the specific effects of driving experience have not yet been examined. In this study we hypothesized an interaction between driving experience and visibility, as the speed reduction in fog compared to clear visibility should be greater for experienced drivers than for novice drivers. In fact, we expected experienced drivers to reduce their speed considerably in fog and also have faster hazard response times and fewer collisions. In contrast, novice drivers should not reduce their speed adequately to meet the demands of the driving environment in reduced visibility, and they should therefore have slower hazard response times and more collisions. Given that young novice drivers are less able to manage the driving task when the demands of the task increase, we also hypothesized that they would have more variability in their speed control compared to experienced drivers, particularly in fog when the driving task demands are greatest.

The goal of this study was to identify how drivers of different levels of experience adjust their driving behaviour to meet the demands of the environment. Simulated fog was presented as a potential hazard in order to increase the demands of the driving task. Experiment 1 examined how drivers adjust and maintain their speed based on their level of driving experience and the degree of visibility. Experiment 2 investigated whether the speed drivers selected in fog in Experiment 1 was adequate to safely avoid hazards in both clear (low demand) and foggy conditions (high demand).

2. Experiment 1 – method

2.1. Participants

Participants were recruited from public advertisements and the university undergraduate participant pool, and were paid $10.00 or one credit towards the research component of their course grade for their participation. They were divided into groups based on their license type[1] and number of years of experience. In order to reduce the possibility of age-related impairment as a cause for speed compensation, only drivers under the age of 35 were tested. Comparisons were made between young drivers with a full G license (the young experienced group) and young drivers that had G1 and G2 licenses (the young novice group) based on the Ontario Graduated Licensing System (MTO, 2011).

The young experienced drivers (n = 19, 14 males) were on average 24 years old (SD = 3.07), had an average of 8 years of driving experience (SD = 3.08), and held a full valid driver's license (G license). In contrast, young novice drivers (n = 19, 5 males) were on average 19 years old (SD = 2.19), had an average of half a year of driving experience (SD = 0.30), and held at minimum a valid entry-level driver's license (G1 license). Table 1 contains descriptive statistics related to driving history for the two groups, as indicated by

Table 1
Participant driving history as percentages for items 1–7. Mean (SD) for item 8.

	Young experienced drivers (n = 19)	Young novice drivers (n = 19)
1. Road environments they drive[a]		
Highway	94.7%	42.1%
Rural	73.7%	68.4%
Suburban	73.7%	57.9%
Urban	94.7%	73.7%
2. Drive in adverse weather[b]	96.1%	47.4%
3. Time of day they drive[c]		
Early morning	26.3%	15.8%
Morning	78.9%	42.1%
Afternoon	84.2%	84.2%
Evening	89.5%	73.7%
4. Received a traffic ticket	47.4%	10.5%
5. Been the driver in a traffic collision	42.1%	15.8%
6. Taken a driver's education course	84.2%	68.4%
7. Level of driver's license		
G1	0.0%	57.9%
G2	0.0%	42.1%
G	100.0%	0.0%
8. Average hours per week spent driving[d]		
Spring	6.2 (5.9)	2.6 (2.8)
Summer	11.7 (10.1)	4.7 (6.7)
Fall	6.4 (6.0)	4.4 (6.2)
Winter	6.9 (7.6)	0.9 (2.6)

[a] Participants were asked to select the following road environments they typically drive in at present: highway, rural, suburban and urban. The numbers reflect the percentage of sample that said that they had traveled in each environment.

[b] Adverse weather was a composite variable created from participant responses to whether they drive in rain, fog, snowfalls, and storms (rain, snow and hail). The numbers represent the percentage of the sample that said they drove in those weather conditions.

[c] Participants were asked to select the following times of day that they typically drive: early morning (12:00–6:00 a.m.), morning (7:00–11:00 a.m.), afternoon (12:00–5:00 p.m.), and evening (6:00–11:00 p.m.). The numbers represent the percentage of the sample that said that they drove at each time of day.

[d] Participants gave an estimate of the average number of hours they spend behind the wheel per season within the past two years.

[1] In Ontario, individuals are eligible for an entry-level license at the age of 16. Upon passing a written exam about traffic rules and regulations, entry-level drivers hold a G1 license. The G1 license has restrictions concerning access to certain roads (e.g., they cannot drive on major highways), the time of day during which they may drive (i.e., they cannot drive between 24:00 and 5:00 h), zero blood alcohol content, and passengers present in the vehicle (i.e., a fully licensed driver who has had their full license for at least four years must always be present in the front passenger seat). After at least 12 months of holding a valid G1 license and upon successfully passing a road test, novice drivers may acquire a G2 license, which has fewer restrictions (see MTO, 2011 for further information). Drivers must hold a G2 license for at least another 12 months and then, upon passing another road test, they can graduate to a full G license.

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