CHAPTER 2

DRIVER EDUCATION AND LICENSING PROGRAMS

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ABSTRACT

Purpose – *Driver education and licensing are two mechanisms used to reduce crash rates. The purpose of this chapter is to provide an overview of these countermeasures and consider how simulators can be used to augment more traditional approaches.*

Approach – *A literature review was undertaken evaluating key concepts in driver licensing including: graduated driver licensing, the role of parents in licensing, compliance and enforcement, driver testing ,how the driver licensing system impacts on levels of unlicensed driving. Literature regarding driver education for individuals who have and not yet obtained a licence was also reviewed.*

Findings – *Graduated Driver Licensing is a successful countermeasure for reducing the crash rates of young novice drivers as it limits their exposure to higher risk situations. The support for driver education initiatives is mixed. As there are big differences between education programs, there is a need to consider each program on its own merits. Driving simulators provide a safe environment for novices to gain experience. In particular, they may be bifacial for development of hazard perception and visual scanning skills.*

Practical Implications – *Graduated Driver Licensing systems should be introduced where appropriate. Existing systems should be strengthened where possible by including additional, best-practice, restrictions. When considering driver education as a countermeasure, the type of program is very important. Education programs that have been shown to increase crashes should not be introduced. Further research and development are necessary to ensure that driver education and licensing adequately equip novice drivers with the skills necessary to drive in the 21st Century.*

INTRODUCTION

This chapter is the first of three chapters focused on driver behaviour impacts on transport network safety and crash risk. Whilst this chapter focuses on driver licensing and education, it complements Chapter 3 which focuses on aggressive driving and speed, and Chapter 4 which delves into driver distraction.

Driver licensing and education are countermeasures used to facilitate greater safety of road users. There are extensive variations in the way in which these countermeasures are implemented. This chapter focuses on car drivers and discusses the evidence base available for

various forms of driver licensing and education. As well as the more traditional forms of licensing and education, this chapter considers the emergence of simulators and their use in this area.

DRIVER LICENSING

Almost all motorised societies have implemented driver licensing systems. Generally speaking, the four major objectives of driver licensing are to: 1) ensure that drivers are competent enough to commence driving, maintain their driving privileges and proceed to a higher class of licence; 2) acknowledge the obligations associated with driving and discourage inappropriate behaviour that may result in that person losing their licence; 3) administer a more graduated entry to driving that reduces the potential impact of high-risk road use; and (4) provide a method that can be used to identify drivers in order to monitor and manage their behaviour on the road (Watson et al., 1996).

Novice Driver Licensing

Young, newly licensed drivers are over-represented in car crashes (Bates, Davey, Watson, King, & Armstrong, 2014; Shope, 2006). As a result, jurisdictions throughout the world have focused considerable attention on designing and applying licensing to reduce the crash risk of inexperienced drivers.

Minimum driver licensing age

Younger drivers are more likely to crash than older drivers (McKnight & McKnight, 2003). This is related to their lack of experience and tendency to drive in high-risk conditions. Additionally, younger drivers are immature, lack risk-perception abilities and overestimate their driving skills (Bates, Davey, et al., 2014). Although it is difficult to know if age or inexperience is a more important contributing factor to crash risk, evidence is emerging which suggests that experience is a more significant factor in crash risk when compared with age (McCartt, Mayhew, Braitman, Ferguson, & Simpson, 2009).

The age at which individuals can obtain a licence differs across jurisdictions. Delaying when individuals are able to obtain their driver licence limits the learner's exposure to risky driving situations as well as allowing them time to mature (Simons-Morton, 2007). This development can occur both by increasing the amount of time that must be spent as a learner driver or increasing the minimum age at which individuals can obtain a learner licence (McCartt, Farmer, & Jenness, 2010; Williams, 2009).

Graduated driver licensing

Graduated driver licensing (GDL) systems aim to reduce the number of novice driver crashes by limiting the risks for the group, rather than for individual drivers, while still enabling them to gain experience in lower-risk situations (Shults, 2010). Generally speaking, there are three

stages within a GDL system: learner, intermediate or provisional and full (Bates, Allen, et al., 2014).

Learner licence

The learner phase enables new drivers to learn on the road while being supervised by an experienced driver. This provides an opportunity to learn about vehicle handling, perceiving hazards and other drivers' behaviour (Foss, 2007). Supervised driving is inherently different from unsupervised driving as it provides a learning opportunity and allows accumulation of experience (Scott-Parker, Bates, Watson, King, & Hyde, 2011).

While it is possible to obtain the basic motor skills required for driving relatively quickly, higher-order skills such as perception, attention and judgement develop over several years (Sagberg & Bjørnskau, 2006). Research suggests that more supervised practice undertaken by a learner driver reduces their risk of crashing once they commence driving by themselves (Gulliver, Begg, Brookland, Ameratunga, & Langley, 2013).

Most learner drivers use a combination of both professional driving instruction and practice with parents and friends to learn to drive (Bates, Watson, & King, 2009; Nyberg, Gregersen, & Wiklund, 2007). Research with young Norwegian drivers identified that professional driving instruction and supervised practice with family and friends complements each other. Tronsmoen (2011) found that professional driving instructors tend to teach the more demanding aspects of driving, while private supervisors tend to allow the learner to develop their driving skills. The combination of both types of supervisors may be beneficial for learner drivers as each tends to focus on different aspects of the process.

In some jurisdictions, including various states within the United States (US) and Australia, learners must practice for a certain number of hours or record that practice in a log book. The requirements vary, with different states in the US requiring between 0 to 65 hours (Insurance Institute for Highway Safety, 2015). In Australia the requirements are greater, with learner drivers in Victoria and New South Wales required to complete 120 hours, while those in Queensland must record 100 hours (Senserrick, 2009). It appears that mandating a number of supervised hours of driving practice does increase the amount of practice undertaken (Bates, Watson, & King, 2010). While there is little research basis for the selection of particular time requirements, there is some research support for lower crash rates for novice drivers that complete close to 120 hours of supervised driving practice (Gregersen et al., 2000). It appears that there is higher parental involvement with the supervision of learner drivers if licensing systems require them to accumulate 50 or more hours of practice (Jacobsohn, Garcia-Espana, Durbin, Erkoboni, & Winston, 2012). One potential drawback of mandating the number of hours of practice is that it may indicate to these learners and their parents that this driving practice is sufficient to acquire all the necessary driving skills (Foss, 2007).

Provisional or intermediate licence

A key element of the most effective GDL systems is restricting driving in high-risk circumstances for the first few months or years after the new driver receives their licence (Preusser & Tison, 2007). Thus, the provisional phase limits novice drivers' exposure to high-

risk situations such as at night, with passengers or after drinking alcohol (Preusser & Leaf, 2003).

When compared with older drivers, younger drivers are more likely to crash at night (Preusser & Tison, 2007). As a result, night driving restrictions have been introduced in several jurisdictions (Williams & Mayhew, 2003) and have been shown to be effective in reducing fatalities for this group (D. Carpenter & Pressley, 2013). The effectiveness of this restriction is affected by when it starts, the support of parents and the availability of exemptions (Williams, 2007). Night driving restrictions that start before midnight are more effective even when the compliance rate is about half (Jones, Begg, & Palmer, 2012).

When young drivers are accompanied by young passengers they are more likely to crash (Bates, Davey, et al., 2014), with the risk increasing with more passengers (Williams, 2007). When a passenger restriction is in place drivers are unable to take passengers under a particular age in the car with them. However, family members are generally exempt from this restriction (Williams, 2007). Research suggests that this restriction is effective in reducing crashes by provisionally licensed drivers (Fell, Todd, & Voas, 2011) even when compliance rates are approximately 50% (Jones et al., 2012). However, young drivers are less likely to comply with a passenger restriction than with a night driving restriction (Williams, 2007).

Despite young people drinking alcohol and driving less frequently than adults they do have an increased risk when they drive under the influence (Bates, Davey, et al., 2014; Shope & Bingham, 2008). Licensing systems often restrict the percentage of alcohol allowed in the bloodstream for all drivers. However, within GDL systems the blood alcohol content is frequently lower for new drivers (Bates, Allen, et al., 2014). There is a more stringent blood alcohol content restriction for young drivers in Australia, New Zealand, the US and Canada (C. Carpenter, 2006), with research evidence suggesting that this reduces crash risk for new drivers (D. Carpenter & Pressley, 2013).

When compared to older drivers, young drivers are more likely to use their mobile phone while driving (Gauld, Lewis, & White, 2014), which, as research suggests, increases the risk of crashing (Cazzulino, Burke, Muller, Arbogast, & Upperman, 2014), including when drivers use hands-free mobile phone devices (McEvoy et al., 2005). The introduction of a mobile phone ban is designed to reduce distraction for new drivers (Williams, 2007)—see Chapter 4 for a comprehensive discussion of distracted driving. Within Australia and the US there are restrictions on mobile phone use for either all drivers or newly licensed drivers (Senserrick, 2009; Williams, 2007). These restrictions appear to have little impact on the use of mobile phones by young drivers (Foss, Goodwin, McCartt, & Hellinga, 2009), thus the method used to enforce this restriction is important in maximising its effectiveness (Foss et al., 2009).

Vehicle power restrictions refer to limitations placed on the type of car that a newly licensed driver can use (Keall & Newstead, 2013). For instance, new drivers may be restricted to a certain number of cylinders or a power-to-weight ratio, as young drivers in vehicles with above-average engine power tend to have more risky attitudes toward driving than other young drivers (Clarke, Ward, & Truman, 2002). However, research suggests that the effectiveness of this restriction is quite limited, as very few newly licensed drivers drive high-powered vehicles. Even with 100% compliance with this restriction, researchers estimate that the reduction in injury rates would range from 0.4% in New Zealand to 2.5% in the Australian states of Queensland and Victoria (Keall & Newstead, 2013).

P-plates or decals indicate to others that the vehicle's driver does not yet have a full licence (Curry, Pfeiffer, Localio, & Durbin, 2013). The rationale behind the use of P-plates is that they will increase compliance with (Triggs & Smith, 1996), and enforcement of, other restrictions (Williams & Shults, 2010). It may also encourage the driver to limit their risk-taking behaviours (Senserrick & Whelan, 2002). One study evaluated the decal law within New Jersey and found that it positively affected provisional drivers' safety and reduced their crash rate by 9% (Curry et al., 2013). However, this requirement is not popular with young people (Williams & McCartt, 2014).

Role of parents

The level of support that parents provide to new drivers is a key factor in the effectiveness of GDL systems (Williams & Shults, 2010). Parents involved in the learning process tend to be strong supporters of GDL (Brookland & Begg, 2011; Campbell, Chaudhary, Saleheen, Borrup, & Lapidus, 2009), although the licensing system tends not to systematically encourage their involvement (Simons-Morton, 2007). Parental involvement in the learner phase of GDL is essential for most learner drivers to obtain sufficient driving practice (Harrison, 2004) given that many learner drivers believe that professional driving instructors are too expensive (Scott-Parker, 2015). Mothers take greater responsibility for supervising learner drivers while they accrue driving practice when compared with fathers (Bates, Watson, & King, 2013).

Once a new driver starts to drive unaccompanied, parents continue to influence their behaviour (S. Allen, Murphy, & Bates, 2015; Prato, Toledo, Lotan, & Taubman-Ben-Ari, 2010), with some authors suggesting that parental involvement is more important at this stage (Simons-Morton, Ouimet, & Catalano, 2008). Parents can play an active role in supporting the aims of GDL systems by enforcing the GDL restrictions for provisionally licensed drivers (Brookland, Begg, Langley, & Ameratunga, 2014). Research suggests that when parents impose stricter limits younger drivers report that they engage in less-risky driving behaviour and less frequently commit traffic offences or are involved in crashes (Ginsburg, Durbin, Garcia-Espana, Kalicka, & Winston, 2009).

Education programs to develop parents' skills and abilities to manage their child's progress through the GDL system are being developed. Indeed, there are many educational programs available for parents (Williams, Tefft, & Grabowski, 2012). One example is the Checkpoints Program in the US, which aims to encourage parents to limit their child's driving under high-risk conditions when they are first licensed (Williams & Shults, 2010). Research suggests that it influences parental limit setting, teenage risky-driving behaviour and traffic offences during the first 12 months of driving (Simons-Morton et al., 2008).

Compliance and enforcement

As novice drivers progress through their provisional driver licence they become less compliant with the road laws (Scott-Parker, Watson, King, & Hyde, 2012). As examples, 17% of learner drivers drove without a supervisor in North Carolina; while in Nova Scotia and California approximately 40% of drivers holding an intermediate licence occasionally violated the night driving restriction, although only 12–15% of drivers reported doing this often (Mayhew,

Simpson, Ferguson, & Williams, 1998; Williams, Nelson, & Leaf, 2002). Despite the lack of full compliance in some parts of the system the GDL laws are still successful in reducing crash risk for novice drivers (Senserrick & Whelan, 2003).

Generally speaking, the most common method used to modify driver behaviour in order to reduce the incidence of crashes is traffic law enforcement (Bates, Soole, & Watson, 2011). However, in the case of GDL this may be difficult, particularly if police officers are unable to recognise which driving restrictions apply to specific licences (Hedlund, 2007). If police officers do not fully understand GDL laws they may be placed in situations where they attempt to enforce driving laws where the novice driver has a greater understanding of the law (Goodwin, Wells, Foss, & Williams, 2006). Two small studies have been conducted in Queensland, Australia, which suggest that there is a limited deterrent effect of police enforcing provisional driving laws and that provisional drivers are more affected by parental enforcement (S. Allen et al., 2015; Bates, Darvell, & Watson, 2017). GDL systems support parents to set limits for their children and they clearly identify the high-risk situations and signal to parents what is appropriate driving behaviour (Hartos, Simons-Morton, Beck, & Leaf, 2005).

Driver Testing

Although current driving tests appear to have limited validity in terms of identifying drivers who are more likely to crash in the future, they serve an important function by encouraging new drivers to obtain education and training and to establish a base level of competency for entering into the driver licensing system. There are four main types of driver testing for novice drivers: theory or knowledge, on-road driving, hazard perception and exit (Senserrick & Williams, 2015).

In many places around the world individuals are required to pass a written test in order to obtain a learner permit and a practical driving test to drive independently (Mayhew, Williams, & Pashley, 2014). Written tests generally focus on the road rules. There appears to be little association between passing a written test and driving performance or attitudes (Senserrick & Williams, 2015).

On-road driving tests generally focus on vehicle skills and the driver's ability to control the vehicle in traffic. The research evidence regarding the effect of these tests on crashes is mixed, with some research from the United Kingdom (UK) indicating that fewer errors on the tests are associated with lower crash rates. However, the research from Europe is mixed (Senserrick & Williams, 2015). One Australian study suggests that failing a practical driving test four times is linked to higher risk of being involved in a crash (Boufous, Ivers, Senserrick, & Stevenson, 2011).

Passing a hazard perception test is a condition for advancing through GDL systems in some jurisdictions (Engstrom, Gregersen, Hernetkoski, Keskinen, & Nyberg, 2003). Hazard perception tests are not required as part of novice driver testing in the US or New Zealand. However, they are present at various stages of the licensing process in the UK and Australia (Senserrick & Williams, 2015). It appears that failing a hazard perception test twice is linked to a higher risk of crash involvement (Boufous et al., 2011).

An exit test aims to ensure that provisional drivers are able to hold a full driving licence (Ferguson, 2003) and may also indicate to the driver that they are still developing their driving

skills (Williams & Mayhew, 2003). Exit tests are available in a range of formats, including knowledge tests, hazard perception tests or on-road driving tests (Senserrick & Whelan, 2003). There is limited research evidence regarding the effects of exit tests on crash risk (Haire, Williams, Preusser, & Solomon, 2011).

Monitoring the Impact of Driver Licensing Changes on Unlicensed Driving

Unlicensed driving remains a serious problem in many countries, despite ongoing improvements in traffic law enforcement practices and technology. In the US, for example, over 10% of drivers involved in fatal crashes were found to not hold a valid licence, while approximately 20% of all fatal crashes involved at least one unlicensed driver (Scopatz et al., 2003). Unlicensed driving represents a major problem for road safety in two respects. Firstly, it undermines the effectiveness of GDL systems by preventing the allocation of demerit points and reducing the impact of licence loss, which otherwise has been demonstrated to be an effective deterrent to illegal driving behaviour (Nichols & Ross, 1990; Siskind, 1996). Secondly, there is a growing body of evidence linking unlicensed driving to a cluster of high-risk behaviours, including drink driving, speeding (see Chapter 3), failure to wear seat belts and motorcycle use (Watson, 2004a). Consistent with this, studies have indicated that unlicensed drivers are at a higher risk of crashing than licensed drivers, and their crashes also tend to be more severe (DeYoung, Peck & Helander, 1997; Watson, 2004b).

While many unlicensed drivers may reduce their overall driving exposure in order to avoid detection this avoidance does not appear to result in safer driving. While it remains possible that unlicensed drivers tend to act more cautiously than they would otherwise, as a cohort they are not as safe as licensed drivers. Consequently, the potential impacts of new driver licensing and testing requirements on participation in the licensing system need to be closely considered during the policy development phase. Similarly, trends in unlicensed driving should be monitored following the introduction of new driver licensing and testing requirements through the use of crash data and periodic on-road surveys (see Watson et al., 2011).

ROLE OF DRIVER EDUCATION

While many consider the terms ‘driver education’ and ‘driver training’ interchangeable there are theoretical distinctions between the two (Watson et al., 1996). Driver training tends to focus on developing a person’s vehicle control skills. In contrast, driver education may include driver training but is predominately focused on skills and attitudes required to become a safe driver (Langford, 2002). Driver education exists in many different forms (Beanland, Goode, Salmon, & Lenne, 2013). Therefore, the profession needs to develop a better understanding of the processes used in various types of education and training and determine whether these programs are effective or not (Watson, 2003).

There is research to suggest that some forms of education or training can lead to new drivers becoming overconfident, taking risks and, consequently, higher crash rates (Lonero & Mayhew, 2010). In fact, a common criticism of driver education and training is that it has limited capacity to reduce crashes (Hatakka, Keskinen, Gregersen, Glad, & Hernetkoski, 2002). While early evaluations of training and education indicate that they reduce crash risk for the

trainees, these studies had methodological flaws, limiting confidence in the results (Zhao et al., 2006).

One common theoretical framework applied to driver education and training is the Goals for Driver Education (GDE) framework (also known as the GADGET matrix). The framework can be used to both evaluate existing driver education initiatives as well as plan new programs (Hatakka et al., 2002). In this framework there are four hierarchical levels which are, from lowest to highest: vehicle manoeuvring, mastery of traffic situations, goals and context of driving (trip-related), and goals for life and skills for living (general). Within each level are three categories: knowledge and skills, risk increasing factors and self-evaluation (Berg, 2006; Hatakka et al., 2002).

The licensing system appears to influence the type of driver education and training undertaken by novice drivers (Bates, Watson, & King, 2006). However, research suggests that reducing the amount of time a novice driver spends in the GDL system because they attend a driver education course may be counterproductive as it does not reduce crashes or offences (Hirsch, Maag, & Laberge-Nadeau, 2006). For example, a time reduction is available in New Zealand; however, an analysis suggested that when novice drivers completed an approved education course after 12–18 months driving experience on a provisional licence there was greater benefit in the novice driver completing the full 18 months on a restricted licence (Lewis-Evans, 2010). There is also some evidence to suggest that when parents select a driver education program for their child they are less likely to provide supervision (Hirsch et al., 2006).

Pre-licence Training

Before obtaining a driver licence a person needs to learn basic driving skills, which may include both procedural skills, and higher-order cognitive skills (Beanland et al., 2013). This pre-licence training can occur in several ways, including school-based driver training, simulator training and resilience training. Additionally, learner drivers often receive professional driving instruction.

School-based driver training

The DeKalb County study is the largest experimental study of driver education and training provided within high schools (Young, 2002). The study aimed to identify the effect of driver education and training on crashes. In the study, over 16,000 drivers were randomly assigned to one of three groups. The first group received the Safe Performance Curriculum, which was the most advanced education and training available in the US at the time. The second group received the Pre-Driver Licensing curriculum, which taught the basic skills required to pass the driving test. The final group was a control group and did not receive any driver education through the school (Lund, Williams, & Zador, 1986). The original analysis suggested that there were no differences between the groups in terms of crash rates or traffic offences and that there was a short-term benefit for the driver education groups, with those students demonstrating better driving skills and lower crash rates when compared with the control group during the first six months of driving (Lund et al., 1986). However, this analysis only used data from

individuals who had obtained their licence. Subsequent analysis suggested that those students who were in the Safe Performance Curriculum group obtained their driver licence earlier and consequently had higher crash rates and traffic offences than those in the control group. Those in the Pre-Driver Licensing group were also more likely to receive their driver licence earlier than the control group, although there was no difference between the two groups in terms of crash rates (Lund et al., 1986). This finding suggests that providing driver education and training in schools may lead to individuals obtaining their driver licence earlier than they would otherwise, which increases their exposure to crash risk (Lonero & Mayhew, 2010).

Resilience training

Training that aims to reduce risky-driving behaviours in novice drivers is known as resilience training (Beanland et al., 2013). This type of training does not focus specifically on driving skills or abilities but rather on interpersonal skills that will help the young person to engage in safe behaviours. This may include the young person not getting into vehicles where the driver is impaired or supporting them to resist peer pressure that may encourage them to drive unsafely. One example of this type of program is *You Hold the Key*, which aims to increase safe driving and responsible passenger behaviour amongst teenagers (15–19 years) within the US. The program, which was implemented in schools for 10 weeks, involved interactive discussions and lessons, safety promotion education, cooperative learning, videos and presentations (King, Vidourek, Love, Wegley, & Alles-White, 2008). Students learnt about potential driving hazards, resistance skills and strategies that may help to reduce crashes. The program was evaluated using a pre- and post-test design and it was found that there was a positive difference in young people's intended behaviours, including in the areas of seatbelt use and drink driving situations immediately after the program, and that these differences still existed six months later. There also appears to be a positive effect of resilience programs on crashes. Researchers who compared a resilience program with a general education program for high school students in the Australian state of New South Wales identified a 44% reduction in crashes for those who undertook the resilience training (Senserrick et al., 2009).

Post-licence Education

The aim of post-licence education is to expand the current set of driving skills for individuals who are already licensed. This type of education and training often emphasises managing difficult situations, such as skid handling or advanced braking, which are not normally included in pre-licence training (Beanland et al., 2013). It is difficult to make an overall assessment of post-licence education and training given that it is delivered in so many different ways.

Procedural skills training

The focus of procedural skills training is to develop and enhance a driver's ability to operate a vehicle (Beanland et al., 2013). There is limited research evidence to suggest that procedural skills training is effective in reducing crashes. For example, the introduction of skid training for novice drivers led to an increase in the number of crashes in program participants (Katila,

Keskinen, Hatakka, & Laapotti, 2004). Some studies within Australia suggest that driver training does affect vehicle handling immediately following the training. However, these effects may be highly context-specific and there is no research regarding the longer-term impacts (Petersen & Barrett, 2009; Petersen, Barrett, & Morrison, 2006, 2008). It is possible that the safety messages provided in short courses may be undermined by other influences that shape new drivers' behaviour, such as parental, peer and other social influences (Williams, 2006).

Hazard perception skills training and education

Hazard perception skills are considered some of the most important for driving. Training and education that focuses on these skills is more likely to be beneficial (Christie, 2001; Senserrick et al., 2009). Despite this, novice drivers have a lesser ability to detect hazards and react more slowly to hazardous situations when compared with more experienced drivers (Isler, Starkey, & Williamson, 2009). There are two main types of hazard perception training: part-task or commentary. Part-task training generally involves completing activities in response to video clips that show hazards (Fisher, Pollatsek, & Pradhan, 2006; Weiss, Petzoldt, Bannert, & Krems, 2013). A novice driver who verbalises or receives commentary of the hazard perception task as it happens is undergoing commentary training (McKenna, Horswill, & Alexander, 2006).

Insight training

Insight training is another type of cognitive training that is designed to prevent overconfidence in newly licensed drivers by raising awareness of their driving skills and teaching them to adjust their behaviour according to the intricacies of various situations (Senserrick & Swinburne, 2001). Insight training does appear to be similar, conceptually, to other forms of cognitive driver education such as resilience training. While limited research has focused on insight training for novice drivers it appears that insight training may affect sub-groups of drivers differently—meaning that it is important that appropriate groups of drivers undertake this type of training (White, Cunningham, & Titchener, 2011).

USE OF SIMULATORS IN LICENSING AND EDUCATION

Driving simulators have recently become a potentially useful tool for novice driver education. They allow novices to experience a range of situations and practice their skills without risk of crashing (Flach, Dekker, & Stappers, 2008). Simulator managers can control of the environment in order that specific teachable moments are encountered and repeated. Driving instructors claim that controlling presentation of teachable moments increases the efficiency of teaching, suggesting that specific learning content can be achieved in one hour of simulator training that would otherwise take three hours of on-road training (Kappe, van Emmerik, van Winsum, & Rozendom, 2003).

When considering the potential for simulators, two important aspects are fidelity and validity. Fidelity relates to the realism of the simulator including physical fidelity (the way the

simulator looks and behaves) and psychological fidelity (the way a driver relates to the simulator). Validity relates to how well driving behaviours in a simulator transfer to real-world driving. The interaction between these two concepts means that it is possible to have a low-fidelity simulator, which has high validity. High-fidelity simulators are expensive; if deciding to purchase a simulator an education centre should consider how to get the highest validity within the fidelity they can afford. For example, risk awareness and perception training administered using a low-fidelity, PC-based, basic simulator has been shown to improve visual scanning behaviour both in subsequent simulator testing and in real-world driving (Fisher, 2008; Fisher, Narayanaan, Pradhan, & Pollatsek, 2003; Fisher et al., 2006; Pradhan, Fisher, & Pollatsek, 2006).

Education

Hazard perception and visual scanning are the skills most widely trained using simulators. Overall, research evidence suggests that hazard perception simulator training results in skill improvement, at least in the short term (e.g. Carpentier, Wang, Jongen, Hermans, & Brijs, 2012; Chapman, Underwood, & Roberts, 2002; Pradhan et al., 2006; Regan, Triggs, & Godley, 2000a, 2000b; Thomas et al., 2011). However, few studies have undertaken follow-up investigations and even fewer have investigated the transfer of skills from the simulator to on-road driving. Those completing follow-ups have reported greater hazard perception performance in simulator-trained, compared to untrained, individuals four days (Pradhan et al., 2006) and four weeks (Carpentier et al., 2012; Regan et al., 2000b) after training. Simulator training of hazard perception skills appears to be effective when follow-up occurs in a driving simulator; however, it is less clear whether there are benefits for on-road driving. For example, three to six months after completing simulator hazard perception training, there was no difference in on-road driving performance despite persistent differences in the simulator (Chapman et al., 2002). In contrast, during an on-road follow-up participants who had completed visual scanning-focused simulator training, with emphasis on driver distraction (see Chapter 4), demonstrated safer driving behaviour (shorter glances away from the road) than non-simulator trained drivers (Thomas et al., 2011). Part of the difficulty of follow-up evaluation is that both trained and untrained novices will continue to learn to drive in the intervening period, therefore skills are likely to improve for both groups.

It is less common to use simulators for teaching procedural skills. This is partly associated with the high costs of faithfully replicating the driving experience. In many cases it is considered more cost effective to teach these skills in a real car (Pollatsek, Vlakveld, Kappe, Pradhan, & Fisher, 2011). A notable exception is in the Netherlands, where simulators are used for procedural skills training. Driving instructors report simulators as beneficial for procedural skills training because they are then able to focus on higher-order cognitive skills and spend less time on basic skills during driving lessons (Fisher, Caird, Rizzo, & Lee, 2011).

Despite the emerging evidence of the benefits of driving simulators for driver education there is concern over the lack of behavioural consequence (Caird & Horrey, 2011). As crashing in a simulator provides no physical danger it is possible that users do not engage with the same level of caution as they would in real-world driving, which may potentially lead to

overconfidence. It is important that simulators do not induce overconfidence in novice drivers as this is correlated to increased crash risk (e.g. Weiss et al., 2013).

One proposed benefit of simulator education is the exposure of novices to situations which may be dangerous on real roads thereby exposing the novice's limitations and discouraging dangerous behaviour. An example of this is the Forward Concentration and Attention Learning (FOCAL) program (Thomas et al., 2011), where novices are instructed to complete a simulator drive while simultaneously completing a map-based navigation task. Following the task the novice is replayed footage of the simulated road which is blacked out every time they took their eyes off the road. In an on-road follow-up the novices who had undertaken FOCAL training spent less time with their eyes away from the road than novices who had not completed the training.

It is likely that some skills are more suited to simulator education than others. Simulators can offer the opportunity to practice and augment already acquired skills. This could be a valuable asset for novice driver training, particularly where supervised practice is not always possible. However, the simulator itself is a tool, as such the outcomes of training will be as much (if not more) influenced by the processes and goals of the education program as a whole. Currently, there is a lack of simulator research controlling for educational aims and curriculum, only altering the point of implementation (simulator vs on-road). Without such a controlled investigation it is not possible to separate the influence of the education material from that of the delivery method.

Driver Testing

Simulators are not routinely used to assess novice drivers' procedural skills but have the potential to address some of the weaknesses of on-road practical driving tests. For example, an on-road examiner cannot control traffic situations encountered during testing; additionally, there may be inter-examiner differences in interpreting safe driving (Kappe, de Penning, & Marsman, 2010). The controllable nature of simulators would allow all examinees to be tested under the same situations and evaluated against the same criteria. If such testing were to be considered, it is vital that the simulator test be able to distinguish between sufficiently competent and incompetent drivers. A vital first step has already been demonstrated, whereby simulator assessment can accurately distinguish between experienced and novice drivers (Damm, Nachtergaele, Meskali, & Berthelon, 2011), suggesting future simulator testing of novice drivers may be an option. Indeed, there is currently at least one example of experienced driver testing using a simulator. Within the context of heavy vehicle driver training in Ecuador, experienced drivers may complete their assessment for a truck driver licence on a simulator (instead of a closed training circuit) (R. W. Allen, Woon, Park, & Grant, 2010).

While it appears unlikely that simulator assessment will replace novice drivers' practical driving assessments in the near future, driving simulators may have potential applications for assessing isolated procedural skills which, although integral to driving, are rarely encountered during practical driving assessments.

FUTURE DIRECTIONS

A future challenge for driver education and training will be to keep up with advances in technology. Increasingly, new car models include autonomous technology features (e.g., parking assist). Assuming technological development continues, it is predicted that autonomous vehicles will become a common feature in the future (Fagnant & Kockelman, 2015). There is an increasing volume of autonomous vehicle research; however, to date there is a dearth of literature surrounding implications for driver education and training. It is vital that this gap is addressed in order that driver education and licensing continue to be relevant and appropriate. Presently, driver education has been slow to adapt and respond to the increasing popularity of in-vehicle technology. The most noticeable formal change in this area came in 2015, when the UK Government began trialling the inclusion of 'independent driving using satellite navigation' (Sat Nav) as a component of driver licensing (Driver & Vehicle Standards Agency, 2015). As part of the licence testing drivers are required to demonstrate independent driving following Sat Nav directions given by a TomTom Go. Arguably, this change could be seen as a step forward in preparing novices for the modern driving environment; however, it should be noted that this development was implemented 13 years after the launch of the first TomTom Sat Nav in Europe (TomTom International, 2017), demonstrating the slow pace of licencing change compared to the introduction of technology. In the context of autonomous vehicles, increasing research is needed to ensure that driver education and licensing are able to adequately equip novice drivers with the skills necessary to drive in the 21st Century.

CONCLUSIONS

Driver licensing is a key mechanism used by authorities to ensure driver competency, encourage appropriate driving behaviour while monitoring inappropriate behaviour, and introduce new drivers to the system. GDL systems involving learner, provisional and open licences have been shown to be an effective way of reducing novice driver crashes. As there are many jurisdictional differences authorities should carefully consider what components they need to include to maximise crash reductions.

The licensing system influences the type of driver education undertaken by drivers. There is a significant range of driver education programs that can be delivered at different points within the licensing system. Research suggests that some types of driver education, such as resilience and situation awareness, may be more effective at reducing crashes and altering attitudes compared with other programs.

There is increasing emerging evidence as to the value of driving simulators in novice driver education and testing. However, further research is needed regarding the long-term, on-road safety benefits. If simulators are considered for novice driver education it should be remembered that the simulator itself is a tool; the outcomes of education will only be as good as the content and purpose of the education program itself, regardless of the fidelity and validity of the simulator used.

There is a significant range of driver licensing systems, testing regimes and forms of driver education and training in use throughout the world. Given this, it is critical that any changes to these programs are based on research and best practice to maximise outcomes.

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