



Association between higher-order driving instruction and risky driving behaviours: Exploring the mediating effects of a self-regulated safety orientation



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ABSTRACT

Adolescents' risky driving behaviours contribute to their over-representation in road trauma. Higher-order driving instruction is suggested to reduce such behaviours. To sustain positive behaviours in the long-term, self-determination theory identifies self-regulation as fundamental. The current research explored associations between higher-order driving instruction, risky driving behaviours, and a self-regulated safety orientation. Learner drivers ($n = 544$), aged 16–19 years, responded to a 91-item survey. Self-regulated safety orientation was found to fully mediate the relationship between higher-order driving instruction and *inattentive* risky driving behaviours, and between *anticipatory* higher-order driving instruction and *intentional* risky driving behaviours. A partial mediation was found between *self-regulatory* higher-order instruction and *intentional* risky driving behaviours. These results support that higher-order driving instruction, delivered to develop a self-regulated safety orientation, has potential to reduce young novice drivers' risky driving behaviours. Further research is recommended to triangulate these results through direct observation and longitudinal evaluation.

1. Introduction

Young novice drivers engage in risky driving behaviours that contribute to their road crash fatalities and serious injuries (Adanu et al., 2017). In Queensland, Australia, where the current research was conducted, risky behaviours contribute to as high as 40% of serious road trauma (Data Analysis: Department of Transport and Main Roads, personal communication). Adolescent cognitive and emotional development impacts driving due to an increased tendency for sensation-seeking and limited ability for self-control (Albert and Steinberg, 2011; Floyd-Bann and Van Tassel, 2006). These processes contribute to risk-taking behaviours with male and younger drivers more likely to take risks and consequently crash (Dahlen et al., 2005; de Winter et al., 2018; Jonah, 1986; Martinussen et al., 2017a, 2017b; Senserrick and Mitsopoulos-Rubens, 2013). Furthermore, compared to more experienced and expert drivers, young novice drivers have deficits in visual

scanning, hazard perception, and handling in-vehicle distraction; these higher-order driving skills (HO-DS) are critical for driving safely (Cassarino and Murphy, 2018; Lidestam et al., 2010; Pammer and Blink, 2018). It has been suggested that on-road practical professional driving instruction¹ could address such limitations (Mayhew, 2007; Senserrick et al., 2017; Senserrick and Williams, 2015). Professional instruction integrated to complement the successes of graduated driver licensing (GDL; Senserrick et al., 2017) has potential safety benefits (Mayhew, 2007; Senserrick and Williams, 2015). Research to date does not largely support driving instruction provided during the learner phase as contributing to improved crash rates of young novice drivers (af Wählberg, 2018; Beanland et al., 2013; Lonerio and Mayhew, 2010). However, there is a dearth of literature examining learner driver practical instruction generally, and higher-order driving instruction (HO-DI) specifically. Research investigating best-practice instruction and the potential impact on risky behaviours of young novice drivers

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¹ Professional driving instruction in Australia refers to non-mandatory, in-vehicle, on-road, practical instruction provided to learner drivers, typically one-on-one. Research shows over 90% of Queensland learner drivers employ a professional instructor (Bates et al., 2006; Scott-Parker et al., 2011). On average each lesson is of one hour's duration.

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remains largely lacking.

HO-DI is an element of practical driving instruction that ultimately aims to reduce young drivers' engagement in risky driving behaviours and consequential crash risk. A pilot study observing professional learner driver lessons found 35% of instruction was higher order (Scott-Parker et al., 2014). HO-DI teaches the *how* and *why* of key instructions, that which extends the learning from the specific immediate driving situation to driving in general, to enable the application of learnings to future driving contexts, that is, learnings considered transferable skills (Goodwin et al., 2014; Isler et al., 2011). For example, during a night drive, basic instruction to the learner driver could include, *keep a larger gap to the vehicle ahead*. Alternatively, HO-DI would more widely explain, *given reduced visibility at night, keeping a greater following distance improves visibility of the forward roadway and allows more time and space to react to potential hazards*. This example addresses both the common novice inexperience-related risky behaviour of travelling too close to the preceding vehicle, as well as indirectly the more aggressive risk-taking behaviour of tailgating.

HO-DI is provided during the learner phase and focuses on the development of sustainable, long-term safe driving practices. This element of instruction fosters effective decision-making necessary for safe interaction with the dynamic driving environment. HO-DI also aims to develop critical HO-DS (Bailey, 2002; Ehsani et al., 2015; Scott-Parker et al., 2014). Research suggests HO-DS, such as hazard perception, improve within the first year of independent, unsupervised driving (Day et al., 2018; Fisher et al., 2006). HO-DS encompass a broad skill set, including risk awareness and self-regulation, which are associated with risky driving behaviours (Jonah, 1986). If these skills can be better learnt during the supervised learner phase, this could reduce novice drivers' crash risk that peaks immediately when graduating to independent driving (Curry et al., 2015; Engstrom et al., 2003; Gershon et al., 2018; Isler et al., 2011). The transferable nature of the skills HO-DI fosters could have critical implications for this transition to independent driving (Ehsani et al., 2015; Scott-Parker et al., 2014).

The Goals for Driver Education (GDE) framework is current theoretical best practice in driver education (Hatakka et al., 2002; Keskinen et al., 1999). The GDE highlights HO-DS as integral to learning to drive. Self-assessment and risk awareness are key competencies and higher-order skills integrated at all levels of the GDE (Hatakka et al., 2002; Keskinen et al., 1999). There are four levels in the GDE hierarchy including vehicle control and manoeuvring; mastery of traffic; trip-related context and driving goals; and personal goals and motives (Hatakka et al., 2002; Keskinen et al., 1999). Young driver training programs informed by the GDE have been developed however without evaluation of the subsequent programs' effectiveness (CIECA, 2010), nor the comprehensiveness or completeness of the program in addressing the multifaceted GDE (e.g., Kiss, 2016). Additionally, while the GDE has been employed to explore the current nature of professional HO-DI, it has been found to be too theoretical for direct observation (Watson-Brown et al., 2018). Furthermore, despite recommendations regarding teaching approaches to reach the goals highlighted by the GDE, few strategies have been systematically operationalised for application in young driver professional instruction. The GDE recommends a learning environment that is student-centred and the framework is grounded in constructivism (Hatakka et al., 2002). Constructivist instructional models suggest effective learning is self-constructed in a practical and dynamic environment (Savery and Duffy, 1996; Wilson, 1996). In this way, these models promote self-directed learning with supportive, coach-like instruction to achieve sustainable skill development (Savery and Duffy, 1996; Wilson, 1996).

Theoretically, it is suggested that HO-DI is most effective when teaching strategies are applied that encourage development of self-regulated safety orientation (Deci and Ryan, 2012). When an individual develops self-regulation for driving safely the notion of safe driving becomes integrated with personal goals and values (Deci and Ryan, 2012). Consistent with the GDE there is less external influence, such as

enforcement, in determining the level of safe driving with the individual moving along a continuum toward internal regulation as driving safely becomes valued and important. Indicators of internal regulation include perceived competence, reduced pressure, effort, interest or enjoyment, perceived choice, usefulness and relatedness (Deci and Ryan, n.d.).

Self-determination theory identifies the learning environment as a critical element in the development of self-regulated behaviours. This theory provides a framework that recommends, for effective learning to occur, the environment is supportive of three basic psychological needs; autonomy, competence, and relatedness (Deci and Ryan, 2012). The satisfaction of these needs is suggested to develop self-regulated positive behaviours (such as safe following distances; Ryan et al., 2008). An autonomy-supportive environment provides opportunity for choices (e.g., *which lane are you going to choose?*). This environment thus encourages active learning and self-created driving knowledge. Perceived competence is encouraged by providing specific and authentic feedback regarding the learners' driving skills. Perceived competence may also enhance perceived autonomy when adequate skill and knowledge enables effective decision making encouraged by the instructor. Autonomy and competence need satisfaction is augmented by the development of a respectful relationship between the instructor and learner.

Self-determination theory has not been applied to driving instruction previously, although it is commonly used, and successful, in health behaviour change (Ryan et al., 2008). To sustain safe-driving practices in the long-term self-determination theory identifies self-regulation as fundamental and likely critical (Deci and Ryan, 2012; Ryan et al., 2008). Self-regulation develops during adolescence and is therefore relevant to the typical age when learning to drive (Albert and Steinberg, 2011) and may be of particular importance given the age-related increases in driving risk within the young driver road safety domain (Jonah, 1986; Senserrick and Mitsopoulos-Rubens, 2013). Goal setting and achievement, self-efficacy, and personal integration of values require HO-DS in particular, self-regulation, and are evident in the GDE (Schunk and Zimmerman, 1997). It has also been argued that risky driving behaviours occur partly due to a lack of developed self-regulatory processes that are considered a higher-order skill (Albert and Steinberg, 2011; Floyd-Bann and Van Tassel, 2006).

Research shows professional driving instructors provide HO-DI that, as informed by the GDE, aims to develop HO-DS (Scott-Parker et al., 2014). However, to what extent HO-DS are developed is largely unknown. Furthermore, no best-practice HO-DI has been proposed. Best-practice driver education, in general, aims to develop long-term sustainable safe driving practices (Hatakka et al., 2002; Keskinen et al., 1999). The GDE and self-determination theory recommend a learner-centred, coaching approach for effective HO-DI that develops sustainable long-term results with self-regulation a critical element in both theories (Deci and Ryan, 2012; Hatakka et al., 2002; Ryan et al., 2008). It is theoretically proposed in this study that the development of self-regulation is consequently an important element in the process whereby HO-DI could reduce engagement in risky driving behaviours. HO-DI delivered within self-determination theory's recommended learning environment has potential to develop self-regulated safety orientation with consequential, long-term impact on reduced risky driving behaviours and crash risk.

1.1. Study aims

Previous research has observed HO-DI during parent-learner driving lessons (Ehsani et al., 2015, 2017; Goodwin et al., 2014) and in a pilot study with professional driving instructors (Scott-Parker et al., 2014). However, no research to date has examined the perspectives of learner drivers regarding the HO-DI they receive. It is important to explore this perception for a comprehensive understanding of HO-DI current practice that will inform improvements and best practice in learner driver training and education. The aim of the current research is to explore

associations between learner drivers' self-reported perceptions of HO-DI, risky driving behaviours, and self-regulated safety orientation. Risky driving behaviours have been investigated extensively in previous research (Gershon et al., 2018; Harbeck et al., 2017; Scott-Parker et al., 2015; Scott-Parker and Weston, 2017), and HO-DI has received recent attention in research (Ehsani et al., 2015, 2017; Goodwin et al., 2014; Scott-Parker et al., 2014). A new element to young novice driver research, self-regulated safety orientation, is included to explain the potential of HO-DI to reduce engagement in risky driving behaviours. That is, a positive learning environment, as a critical element of HO-DI and informed by self-determination theory, could encourage the development of self-regulation that is suggested to be key to sustainable safe driving behaviours. Consequently, direct and mediating relationships will be explored (MacKinnon, 2011). Given the abovementioned consistent finding that males and younger drivers are more likely to take risks compared to their female and older driver counterparts, a secondary aim is to examine the relationships of age and sex with the three constructs of primary interest.

2. Method

2.1. Participants and procedure

Research participants were drawn from a larger study regarding the safe driving practices of learner drivers and the development of best-practice professional HO-DI ($n = 1647$). The selected participants ($n = 544$) were current learner drivers aged 16–19 years from Queensland, Australia who completed an online survey. In Queensland a learner licence can be obtained at 16 years of age and is held for a minimum of 12 months with mandated supervision (Scott-Parker and Rune, 2016; Senserrick et al., 2017).

The online survey (paper-based available) was piloted with a focus group ($n = 4$) of school students aged 15 years, all female, to verify the age-appropriateness of item wording. The refined survey was piloted with a further 10 individuals aged 16–17 years ($n = 8$ males). Feedback was requested regarding the time taken to complete the survey, perceptions regarding the length of the survey, and the relevance of the questions to these individuals. The University of the Sunshine Coast Human Research Ethics Committee approved the study (approval A16819). The survey was advertised from mid-December 2016 until 30 April 2017 at the University of the Sunshine Coast, via local driving instructors ($n = 15$) participating in the larger project, and Department of Transport and Main Roads' licensing centres ($n = 95$) and Facebook page, *Join the Drive*. All high schools ($n = 181$) throughout Queensland were asked to advertise the larger study, with 22 schools participating. All participants had the opportunity to enter a prize draw to win an iPhone 7 (value USD 580).

2.2. Materials

A 91-item survey sought responses regarding basic demographic information (e.g., age, sex), and information regarding driving experience (e.g., *How long have you had a learner licence?; How many hours have you recorded in your logbook?*). The survey also explored experiences of professional driving instruction (e.g., *Does your driving instructor give you 'homework' activities to help you practice driving?*) including HO-DI (e.g., *How much time does your driving instructor talk about what to look out for to see dangerous and potentially dangerous situations?*), risky driving behaviours (e.g., *When you are driving how often would you get distracted and think about things other than driving?*), driving confidence (e.g., *Do you feel that you are ready to drive unsupervised?*), crashes (e.g., *As a learner driver have you been in a crash [minor or major crash] which was your fault?*), police-reported offences (e.g., *As a learner driver have you been caught by the Police for breaking a road rule?*) and self-regulated safety orientation (e.g., *Driving safely is important to me*).

Measures of higher-order driving instruction, risky driving

behaviours and self-regulated safety orientation were developed, as detailed in the following sections, explored and refined via exploratory principal component analysis.

2.2.1. Higher-order driving instruction

The HO-DI measure consisted of 16 items (*self-regulatory* HO-DI (10 items; e.g., *driving differently in wet weather*); *anticipatory* HO-DI (6 items; e.g., *the behaviour of other drivers*) informed by the GDE (Hatakka et al., 2002; Keskinen et al., 1999), a higher-order coding taxonomy developed for naturalistic observation of HO-DI (Watson-Brown et al., 2018), and a pilot study conducted by Scott-Parker et al. (2014) observing professional HO-DI. Participants scored *how often* their driving instructor provides HO-DI on a 10-point scale from 1 *never* to 10 *always*. A higher score indicated the learner driver perceives more HO-DI.

2.2.2. Risky driving behaviours

Participants completed a 9-item scale exploring *inattentive* risky driving behaviours (6 items; e.g., *When you are driving how often would you forget the speed limit?*) and *intentional* risky driving behaviours (3 items; e.g., *When you are driving how often would you follow very closely behind other drivers?*). Items were adapted from Deffenbacher et al. (2001), Ivers et al. (2006), Reason et al. (1990), Scott-Parker et al. (2010), and Tronsmoen (2008). Items were selected from multiple scales to ensure a diversity of appropriate items were included of relevance to the supervised learner driver phase, with no single scale adequately capturing the variables of theoretical and practical interest. Participants scored *how often* they engaged in these behaviours on a 10-point scale from 1 *never* to 10 *often*. A higher score indicated engaging in risky driving behaviours more often.

2.2.3. Self-regulated safety orientation

A 12-item adapted version of the Intrinsic Motivation Inventory (IMI; Deci and Ryan, n.d.) based on self-determination theory measured self-regulated safety orientation by framing the inherent activity as driving or being a safe driver (e.g., *I feel tense while driving (pressure/tension); I put a lot of effort into being a safe driver (effort/importance); How good a driver do you think you are? (perceived competence); Being a safe driver is boring (interest/enjoyment)*). The *interest/enjoyment* subscale measures specifically intrinsic motivation and the other subscales are indicators of the tendency towards internalisation and self-regulation regarding driving safely (Deci and Ryan, n.d.). Participants rated *how true* each statement was on a 10-point scale from 1 *not true* to 10 *very true*. A higher score indicated greater self-regulated safety orientation.

2.3. Statistical analysis

Data were analysed using IBM Statistical Package for the Social Sciences Version 24. Bivariate correlations between continuous variables were assessed via Pearson's correlation coefficient (r), and bivariate correlations between continuous and categorical variables via Spearman's correlation coefficient (r_s). Correlation size was interpreted according to Cohen's (1992) criteria for interpretation, weak (.10), moderate (.30), and strong (.50). Measures of internal consistency employed Cronbach's alpha (α). Simple linear and multiple regressions were conducted to determine if a self-regulated safety orientation mediated HO-DI and fewer self-reports of engaging in risky driving behaviours. A multiple regression was also conducted to assess if sex and age were predictors of risky driving behaviours and therefore requiring any necessary adjustments in the mediation analyses. The PROCESS tool was used to test the significance of the mediation utilising the bias-corrected and accelerated (BCa) bootstrapped 95% confidence interval based on 1000 samples. All analyses were evaluated at a significance level of $\alpha = .05$. Participants with missing data were removed from analyses.

Table 1
Zero-order Correlations Among Sociodemographic, Higher-order Driving Instruction, Self-regulated Safety Orientation, and Risky Driving Behaviours.

	N	M(SD)	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	544	16.66(0.84)	1.00											
2. Sex ^a	544	1.67(0.48)	.14**	1.00										
3. Risky driving behaviours - <i>inattentive</i>	517	13.66(9.49)	-.02	.04	1.00									
4. Risky driving behaviours - <i>intentional</i>	517	4.26(4.18)	-.06	-.15**	.54**	1.00								
5. HO-DI - <i>self-regulatory</i>	506	54.34(23.08)	-.03	-.08	-.28**	-.05	1.00							
6. HO-DI - <i>anticipatory</i>	506	42.87(11.23)	-.03	-.02	-.22**	-.08	.72**	1.00						
7. IMI - <i>interest/enjoyment</i>	513	17.12(3.53)	.03	.23**	-.33**	-.34**	.18**	.17**	1.00					
8. IMI - <i>perceived competence</i>	509	14.55(2.93)	.01	-.08	-.37**	-.11*	.29**	.24**	.11*	1.00				
9. IMI - <i>effort/importance</i>	513	17.93(2.66)	.02	.18**	-.41**	-.40**	.24**	.28**	.51**	.23**	1.00			
10. IMI - <i>pressure/tension</i>	513	18.32(9.44)	.13**	.23**	.52**	.18**	-.26**	-.19**	-.05	-.41**	-.12**	1.00		
11. Offences ^b	515	1.99(0.10)	-.01	.10*	-.01	-.14**	-.01	.01	.00	-.07	.09*	-.03	1.00	
12. Crashes ^b	515	1.98(0.15)	.07	.01	-.07	-.04	-.02	.00	-.01	.04	.04	.02	-.02	1.00

Note. The score range for risky driving behaviours are 0–60 (*inattentive*) and 0–30 (*intentional*). The score ranges for HO-DI are 0–100 (*self-regulatory*) and 0–60 (*anticipatory*). The score range for the IMI indicators (7,8,9) is 0–20. The score range for the IMI indicator (10) is 0–40.

^a Male = 1; Female = 2.

^b Yes = 1; No = 2.

* $p < .05$.

** $p < .01$.

3. Results

Eligible participants for the current study were learner-licensed drivers who had engaged in professional driving instruction ($n = 544$). Participants were 67.5% female ($n = 367$) and aged 16–19 years ($M = 16.66$, $SD = 0.84$, Median = 16) from Queensland, Australia. The length of learner licensure was, on average, 10.35 months ($SD = 7.47$). The median number of reported logbook hours was 50–59 h (range of < 10 – > 100 h noting Queensland GDL legislates a minimum of 100 h (Scott-Parker and Rune, 2016)) and professional driving lessons averaged 4–5 lessons.

Means and standard deviations for the variables explored in this study (age, sex, HO-DI, risky driving behaviours, self-regulated safety orientation indicators, offences, crashes) are provided in Table 1. After conducting exploratory factor analyses on risky driving behaviours and HO-DI measures, two factors were found for each variable. Risky driving behaviours, Factor 1, *inattentive driving*, had an internal reliability of $\alpha = .76$ and Factor 2, *intentional risky driving behaviours*, had an internal reliability of $\alpha = .63$. HO-DI Factor 1, *self-regulatory*, had an internal reliability of $\alpha = .91$ and Factor 2, *anticipatory*, had an internal reliability of $\alpha = .87$. Four of the seven factors from the IMI including *pressure/tension* ($\alpha = .84$), *effort/importance* ($\alpha = .80$), *perceived competence* ($\alpha = .68$), and *interest/enjoyment* ($\alpha = .67$) were included in the analyses as self-regulated safety orientation indicators. Reported means for the risky driving and self-regulated safety orientation (*effort/importance*, *interest/enjoyment*) variables reflected a floor effect and ceiling effect respectively.

3.1. Bivariate analyses

Bivariate analyses found weak, negative correlations between both HO-DI factors (*self-regulatory*, *anticipatory*) and *inattentive* risky driving behaviours and HO-DI factors and *pressure/tension* (Table 1). Weak, positive correlations were found between HO-DI factors and *effort/importance*, *perceived competence*, and *interest/enjoyment*. There was a moderate, negative relationship between *effort/importance*, *perceived competence*, and *interest/enjoyment* and *inattentive* risky driving behaviours and between *effort/importance* and *interest/enjoyment* and *intentional* risky driving behaviours. There was a weak, negative relationship between *perceived competence* and *intentional* risky driving behaviours. A strong, positive correlation was found between *pressure/tension* and *inattentive* risky driving behaviour and a weak, positive correlation between *pressure/tension* and *intentional* risky driving behaviour.

The correlations between sex and self-regulated safety orientation

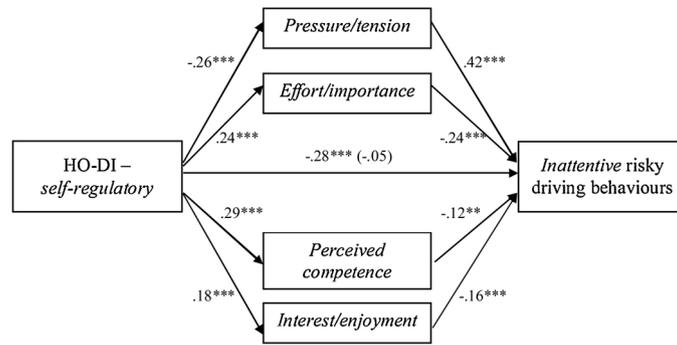
indicators (excluding *perceived competence*) were weak and positive, suggesting females might have a greater tendency for *effort/importance* and *interest/enjoyment* towards safe driving than males. Females were also suggested to have a greater tendency to experience *pressure/tension* on-road than males. Sex also had a weak, negative relationship with *intentional* risky driving behaviours and a weak, positive relationship with self-reported driving offences; with somewhat more males reporting *intentional* risky driving behaviours and being caught for a driving offence. Reporting an offence also had a weak, negative relationship with *intentional* risky driving behaviours; more *intentional* risky driving behaviours was somewhat associated with being caught for a driving offence. *Effort/importance* was the only self-regulation indicator associated with driving offences; a very weak positive relationship and therefore fewer offences associated with greater effort towards safe driving.

3.2. Mediation by regression

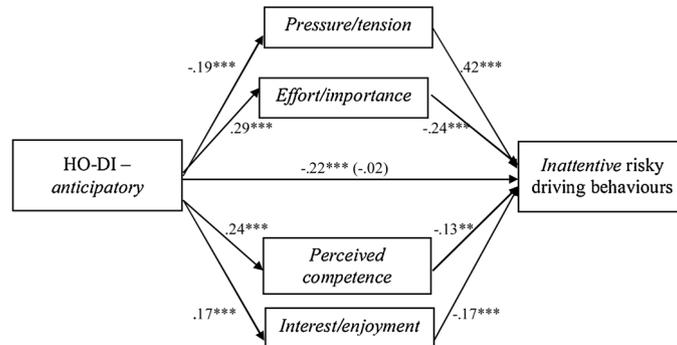
Regression analyses revealed that HO-DI (*self-regulatory*, *anticipatory*) predicted fewer *inattentive* risky driving behaviours but not fewer *intentional* risky driving behaviours (Fig. 1). HO-DI (*self-regulatory*, *anticipatory*) predicted a greater self-regulated safety orientation (*pressure/tension*, *effort/importance*, *perceived competence*, *interest/enjoyment*). *Pressure/tension*, *effort/importance*, *interest/enjoyment*, and *perceived competence* predicted *inattentive* risky driving behaviours. *Pressure/tension*, *effort/importance* and *interest/enjoyment* predicted *intentional* risky driving behaviours. Sex and age were not significant predictors of risky driving behaviours. Length of licensure, number of logbook hours, and number of professional lessons were also not significant predictors in the model.

After controlling for the effect of self-regulated safety orientation, HO-DI (*self-regulatory*, *anticipatory*) did not predict *inattentive* risky driving behaviours (Models 1 and 2), indicating a full mediation effect. *Self-regulatory* HO-DI predicted *intentional* risky driving behaviours (Model 3), indicating a partial mediation effect. *Anticipatory* HO-DI did not predict *intentional* risky driving behaviours (Model 4), indicating a full mediation effect. There was an indirect effect, through self-regulated safety orientation, of *self-regulatory* HO-DI on *inattentive* risky driving behaviours ($b = -0.093$, BCa CI [-.118, -.068]), *anticipatory* HO-DI on *inattentive* risky driving behaviours ($b = -0.171$, BCa CI [-.230, -.120]), *self-regulatory* HO-DI on *intentional* risky driving behaviours ($b = -.026$, BCa CI [-.035, -.017]), and *anticipatory* HO-DI on *intentional* risky driving behaviours ($b = -0.051$, BCa CI [-.071, -.033]).

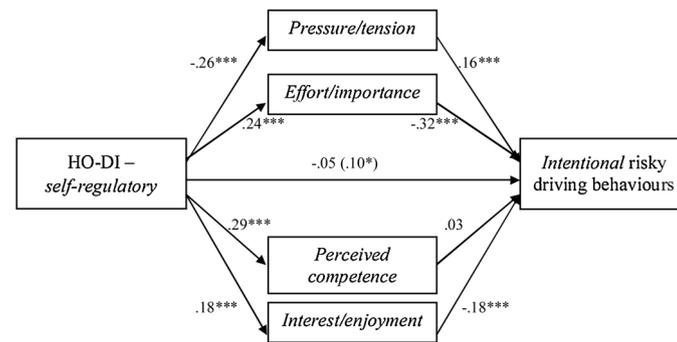
Model 1



Model 2



Model 3



Model 4

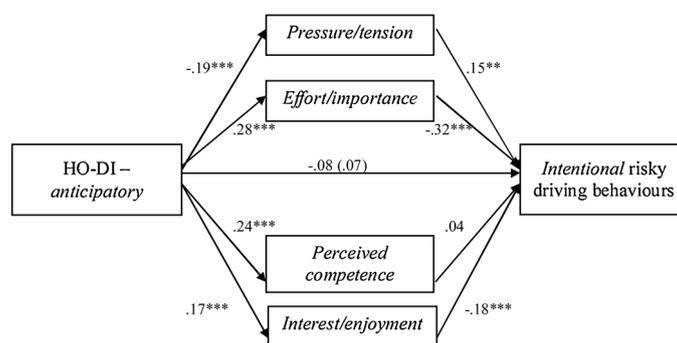


Fig. 1. The mediating effects of self-regulated safety orientation on the relationship between HO-DI and risky driving behaviours ($n = 496$). Standardised regression coefficients are reported with the coefficient between HO-DI and risky driving behaviours, controlling for self-regulated safety orientation, in parentheses. * $p < .05$. ** $p < .01$. *** $p < .001$.

4. Discussion

4.1. Synthesis of findings

The research aimed to explore the relationship between HO-DI, risky driving behaviours, and self-regulated safety orientation. The results provide support for the proposition that HO-DI has the potential to influence reduced engagement in risky driving behaviours by young learner drivers given that greater HO-DI, as perceived by learner drivers, was associated with fewer risky driving behaviours, albeit only *inattentive* risky behaviours. *Inattentive* risky driving behaviours occur when attention is diverted away from driving safely (Regan et al., 2011). Since HO-DI encourages learner drivers to think about driving and develop safe driving skills, the more HO-DI perceived by the learner would suggest a stronger focus of attention towards driving safely. In comparison, *intentional* risky driving behaviours are deliberate actions that violate socially or legally accepted behaviours (Reason et al., 1990) and are comparatively a more complex construct (Dahlen et al., 2005). The effect of HO-DI on these types of behaviours are consequently confounded and need to be investigated in future research. The HO-DI effect on risky driving behaviours was enhanced in these preliminary results when the HO-DI learning environment focused on the learner driver's development of self-regulated safety orientation. Consequently, this result reinforces that both instruction content (HO-DI measure) and the learning environment (self-regulated safety orientation measure) are critical to influencing the engagement by young drivers in both *inattentive* and *intentional* risky driving behaviours. Furthermore, current HO-DI practice, as reported by learner drivers, appears to be delivered with strategies that support learners' autonomy, competence, and relatedness encouraging development of self-regulation.

Results showed self-regulation was predictive of fewer self-reported risky driving behaviours, though this association differed between *inattentive* and *intentional* risky driving behaviours. Learner drivers' effort or importance regarding being a safe driver showed the greatest influence on reduced *intentional* risky driving behaviours. A greater effort towards safety understandably protects against engagement in risky behaviours. Pressure reported by the learner drivers had the strongest association with increased engagement in inattentive behaviours. Pressure and tension either from in-vehicle learning environment or perception of the road environment evokes emotion (Scott-Parker, 2017). Research has shown emotions impact driving performance and narrows the scope of attention which could reflect inattentive risky behaviours (Cunningham and Regan, 2016; Sani et al., 2017; Scott-Parker, 2017). Perceived competence measured by *how good and safe a driver do you think you are?* had a small to no effect on risky driving behaviours. Research has shown interpretation of 'good' and 'safe' to be inconsistent amongst young drivers (Barg et al., 2009), thus it is recommended this subscale be diversified to include more items in future research. The results presented here are based on current HO-DI practice. Best-practice on-road in-vehicle driving instruction has not, to date, been developed, despite the development of the GDE framework. The purpose of this preliminary study is to gain an understanding to inform best practice.

Conducting a mediation analysis enabled the identification of effective elements in how current practice HO-DI, as perceived by learner drivers, could be associated with reduced engagement in risky driving behaviours. Furthermore, self-regulated safety orientation indicators provided additional details regarding how HO-DI could be effective. Future research can explore the deficits suggested by self-determination theory in the HO-DI learning environment informing development of best-practice. The research allows for comparisons of HO-DI and the learning environment via multiple methods, such as naturalistic observation, in future studies. Additionally, the validity of the self-regulated safety orientation measure was able to be examined and was important given this pioneer application to driving. Further research regarding validity, beyond face validity, of all three edited scales

through mixed method explorations will clarify the reliability and validity for future application.

The current research participants were learner drivers, drivers who have been found to report engaging in a variety of risky driving behaviours (Scott-Parker et al., 2012b) despite the expectation that engagement in risky behaviours would be low regardless of age or sex given the learner is inexperienced in driving generally and that GDL and other licensing programs typically mandate that the learner driver be supervised (Poirier et al., 2018; Scott-Parker and Rune, 2016). This was supported for age, with no strong relationship found between risky driving behaviours and age, ranging 16–19 years. However, regarding sex, the results indicated that males reported marginally higher engagement in intentional risky driving behaviours; consistent with a breadth of literature reporting males have a stronger tendency to engage in risky driving behaviours (Gershon et al., 2018; Parlangei et al., 2018; Simons-Morton et al., 2005). Research has shown more males engage in intentional risks compared to females such as overtaking and being unrestrained (Brown et al., 2014). Furthermore, males have a greater risk acceptance level and tendency for thrill-seeking activities (Turner and McClure, 2003). Males reported moderately more driving offences, also consistent with previous research (Martinussen et al., 2017a,b; Scott-Parker et al., 2013), with offences somewhat associated with more engagement in intentional risky driving behaviours.

Regarding risky driving behaviours in general, 95% of learner driver participants reported having engaged in inattentive risky behaviours and 75% in intentional risky behaviours, albeit infrequently. This suggests the risky driving behaviours included in the survey were relevant to risks learner drivers take on the road. There was also a suggestion that females are somewhat more likely to develop a self-regulated safety orientation, further reflected in the results showing females engage in less intentional risky driving behaviours. These results were only weak, however are consistent with previous research (Parlangei et al., 2018; Scott-Parker et al., 2015). These sex differences however, did not contribute in a meaningful way to the effect of HO-DI, focused on the development of self-regulated safety orientation, on risky driving behaviours. This finding warrants further investigation in future research.

The GDE affirms that HO-DI is most effective when delivered with a learner-centred approach (Hatakka et al., 2002). In this way, appropriate teaching strategies are fundamental and can ensure the targeted higher-order goals are achieved in application of the GDE theoretical framework. The results of the current research support the need to operationalise and evaluate the GDE concept generally for driver training, and more specifically for on-road driving instruction. Integrating self-determination theory with the GDE guides the teaching strategies that encourages self-regulated safety orientation and supports the operationalisation of the GDE. The current results also support the operationalisation of the GDE as the foundation of HO-DI, with potential to reduce risky driving behaviours. The GDE was developed to guide the development of safe driving practices in driver education more broadly, and as current theoretical best practice, it is important to apply to driving instruction for learner drivers.

4.2. Practical implications

The current research has provided preliminary support for the potential of professional HO-DI to reduce risky driving behaviours, which consequently has implications for reducing the crash risk of young novice drivers. Given the variation in the effect on *inattentive* compared to *intentional* risky driving behaviours, further understanding of the specific elements of HO-DI that positively influence both types of risky driving behaviours require further investigation. Research shows a lack of support for driver education in general, and driving instruction more specifically, in reducing crash risk (Christie, 2001; McKenna, 2010; Stock et al., 1983). Previous evaluations of driver education, training and instruction have methodological limitations and a tendency to,

problematically, examine crash rates as the outcome measure (Beanland et al., 2011). The results presented here highlight the importance of evaluating outcomes other than crash rates, including risky driving behaviours, HO-DS and other safe driving practices. Furthermore, driving instruction should be systematically evaluated with rigorous methods and with comprehensive, transparent reporting (Scott-Parker and Senserrick, 2017). Further research is required to evaluate the effectiveness of HO-DI, however, the preliminary findings from this exploratory study of professional instruction of learner drivers suggest such investigation is warranted. The results also inform steps towards developing best-practice HO-DI to be taught to professional driving instructors. The theories presented here, constructivism and self-determination theory, in addition to the GDE, provide goals and strategies for delivering effective HO-DI. These theories should continue to inform best-practice HO-DI.

4.3. Theoretical implications

The application of self-determination theory, as a theory of self-regulation and motivation, in the current HO-DI research is a unique contribution to this field. Driver education, training and instruction has not previously used self-determination theory to inform the development and/or implementation of interventions, nor evaluations of interventions. The results support the importance of self-regulation in learner driver on-road training. As recommended by self-determination theory the satisfaction of the psychological needs of autonomy, competence, and relatedness during learning contributes to the development of self-regulated positive behaviours (Deci and Ryan, 2012). The research supports the idea of self-determination theory in that it showed HO-DI is potentially more effective in reducing inattentive and intentional risky driving behaviours when a self-regulated safety orientation is developed.

Perhaps most importantly, self-determination theory suggests the potential for long-term sustainability of safe driving behaviours, as opposed to short-term outcomes of learning to drive. Self-determination theory-recommended learning environments have been successful in interventions targeting health behaviour change and have been found to be critical in developing positive behaviours that are sustainable in the long-term (Deci and Ryan, 2012; Ryan et al., 2008). The long-term sustainability of self-regulation was not examined in the current research; it is recommended for future research. HO-DI aims to develop transferable safe driving skills and hence are important when learner drivers graduate to unsupervised driving when their vulnerability for crashes is heightened (Ehsani et al., 2015; Gershon et al., 2018; Scott-Parker et al., 2014). Finally, self-determination theory complements the operationalisation of the GDE specifically in achieving the HO-DS as teaching goals in the theoretical framework. Importantly the HO-DI measure employed in this research was based on the GDE. While the GDE has not been operationalised in this manner to date, these results enhance the theoretical underpinnings of the GDE, and further reinforce the notion that the GDE is a good foundation for exploring HO-DI and for examining the potential to influence novice driver's crash risk.

4.4. Strengths and limitations

The survey method employed allowed unique exploration of professional HO-DI from the perspective of the learner driver. Previous novice driver measures typically have examined driver training experiences more generally, and driving behaviours including crashes and offences (Ivers et al., 2006; Scott-Parker et al., 2012a; Tronsmoen, 2011); however, no survey to date has explored HO-DI. Moreover, no relevant measure operationalising the frameworks of the GDE and self-determination theory was identified by the authors at the time of the research. HO-DI is a multi-faceted concept. Survey measurement is complicated by the context-specific nature and dynamic driving environment in which HO-DI is delivered. The items included in the final

HO-DI measure were rigorously developed to be able to reflect the transferability of the learning outcomes. For example, explaining *why* is a critical indicator of HO-DI and therefore applied to items where appropriate, such as, *why I need to be able to anticipate events on the road*. This was suggested by Watson-Brown et al. (2018) in the development of a coding taxonomy that is employed to observe missed and taken opportunities for HO-DI by driving instructors in a naturalistic setting.

The current survey was developed to explore the perceptions of learner drivers and was therefore a self-report format. This creates the potential for bias, including recall errors which may be relative to the stage of learning, given it is possible HO-DI is more prevalent later rather than earlier in the learning stage (Ehsani et al., 2017). On average, learners were approximately half-way through the 100-h supervision requirement, although some reported few hours and others more than 100 h, and professional instruction could have occurred anytime during this period. Nonetheless, current learners represent the population with the most recent experience of professional instruction. Moreover, learner drivers develop driving knowledge from a range of sources such as parents and/or the media that could influence their self-report of instruction and self-regulation. However, it is the learning outcome and the influence on their driving behaviours that was the centre of this research. This study was exploratory in nature, and these self-report results are intended to be triangulated with other research methods including naturalistic observation of learner driver professional lessons in future phases of the larger research program.

Response rates could not be determined due to the nature of the advertising and recruitment of the survey. However, representativeness of the sample by residence, age, and sex was somewhat commensurate with the overall population of Queensland (Data Analysis: Department of Transport and Main Roads, personal communication; Department of Transport and Main Roads, 2017) and the findings for sex-based comparisons were found to be consistent with extensive historical research in this field.

Notably, a ceiling effect was observed for some self-regulated safety orientation indicators, and a floor effect was observed for some risky driving behaviours. Even though the results were significant, and it is not uncommon to encounter such effects in young novice driver research (Bates, unpublished doctoral dissertation; Seibokaite, Endriulaitiene, Zardeckaite-Matulaitiene, Oviedo-Trespalacios, Watson-Brown, Scott-Parker, unpublished), ceiling and floor effects can decrease the accuracy of results (Taylor, 2010). The items and scales chosen may reflect instead the measurements' parameters. Nonetheless, learner drivers' risky driving behaviours are expected to score at the lower end of the scale given mandated supervision. The self-regulated safety orientation subscale has not been applied in the context of driving previously and it would be worthwhile testing more specific items to measure greater diversity.

4.5. Future research

In addition to future avenues of research as noted above, further research is needed to examine the long-term implications of self-regulated safety orientation on reduced crash risk of young novice drivers. The results of the current research will be compared to data collected from provisional (intermediate/restricted) drivers to determine if the provision of HO-DI has longer-term (safety) effects on risky driving behaviours, and whether this development of a self-regulated safety orientation plays a key role. Moreover, future research will explicate potential sex differences in the HO-DI – self-regulated safety orientation – risky driving behaviour models given the overwhelming finding regarding sex-based differences in young driver behaviour (Brown et al., 2014; Turner and McClure, 2003). Exploration in other contexts, such as HO-DI provided by parents as supervisors of learner drivers and remedial instruction following offences, could collectively provide support for the effectiveness of HO-DI and the development of self-regulated safety orientation.

Furthermore, in developing best-practice HO-DI the outcomes determining its effectiveness should be explored beyond crash rates and engagement in risky driving behaviours. The lack of support for driving instruction, and driver education more generally, on reduced crash risk for young novice drivers should not constrain research regarding mechanisms to enhance driving instruction (Christie, 2001; McKenna, 2010; Stock et al., 1983). The current research also demonstrates support for exploring and gaining a greater understanding of the intricacies of learner driver lessons and the strategies and techniques employed by professional driving instructors. This preliminary support for HO-DI suggests research regarding driving instruction merits further attention.

5. Conclusion

This research has contributed to an otherwise limited literature regarding professional driving instruction, specifically higher-order driving instruction, and teaching strategies for effective instruction. An understanding of 544 novice drivers' perspectives of professional driving instruction and their self-reported engagement in risky driving behaviours has provided preliminary support for the potential of HO-DI, delivered with an effective teaching approach to develop a self-regulated safety orientation in learner drivers *prior* to independent driving. There is support for the notion that a self-regulated safety orientation is associated with reduced engagement in risky driving behaviours. The potential to reduce risky driving behaviours through HO-DI therefore has implications for the high crash risk faced by newly independent young drivers. Continued research and evaluation could prove critical to determining new ways to address the persistent challenge of improving young novice driver road safety.

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