Reward versus punishment: Reinforcement sensitivity theory, young novice drivers'
perceived risk, and risky driving

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Highlights

- Reward sensitivity and driver age predicted young novice drivers' perceived risk
- Perceived risk predicted young novice drivers' reported engagement in risky driving
- Reward sensitivity and driver age predicted young novice drivers' risky driving

ABSTRACT

One reason that young novice drivers remain statistically over-represented in road deaths is their rate of engagement in risky driving. Prominent contributing factors include driver's age, sex, personality, risk perception, and their driving experience. This study applied reinforcement sensitivity theory (RST, specifically reward sensitivity and punishment sensitivity) to predict young novice drivers' perceived risk and self-reported risky driving engagement, while accounting for potential influences of age, sex, and driving experience. Drivers ($N = 643$, 490 females, 17-25 years, $M = 20.02$, $SD = 2.32$) who held an Australian driver's license (P1, P2, or Open) anonymously completed an online survey containing the Behaviour of Young Novice Drivers Scale, the Sensitivity to Punishment and Sensitivity to Reward Questionnaire, and a measure of perceived risk of driving-related behaviours. A path analytic model derived from RST showed that perceived risk had the strongest negative association with reported risky driving engagement, followed by reward sensitivity (positive association). Respondent's age and reward sensitivity were associated with perceived risk. Age, reward sensitivity, and perceived risk were associated with reported engagement in risky driving behaviours. Driver sex only had direct paths with RST variables, and through reward sensitivity, indirect paths to perceived risk, and reported risky driving. Neither punishment sensitivity nor driving experience contributed significantly to the model. Implications and applications of the model, and the unique set of variables examined, are discussed in relation to road safety interventions and driver training.

Keywords: young drivers, punishment sensitivity, reward sensitivity, perceived risk, risky driving

1. Introduction

1.1. The young novice driver

Despite declining fatalities (BITRE, 2014, 2015), road safety remains a major concern in Australia and internationally. Although driving on average fewer hours and less kilometres than more mature drivers do, young novice drivers are over-represented in national road deaths (BITRE, 2014; Scott-Parker et al., 2013; Scott-Parker et al., 2012a). One reason is young drivers' engagement in risky driving, contributing factors to which include: driver's age, sex, personality, risk perception, and their driving experience. This study applied reinforcement sensitivity theory (RST, specifically reward sensitivity and punishment sensitivity) to explore young novice drivers' perceived risk and self-reported risky driving engagement, while accounting for potential influences of age, sex, and driving experience.

Younger drivers' (< 26 years) risky driving behaviours (e.g., speeding, drink-driving) contribute to their comparatively higher crash, injury, and death rates (Laapotti et al., 2001; Machin & Sankey, 2008). Novice drivers in their early to mid-20s report engaging in risky driving for reasons that include: gaining autonomy, self-enhancement, optimism bias, to please friends, and to gain more adult-like status (Arnett, 1992; Begg & Langley, 2001; Harré, Foster, & O'Neill, 2005; Hartos et al., 2000).

The safest period for young drivers is the newly licensed learner stage, when risk exposure is attenuated by an in-vehicle supervisor (Bates, Watson, & King, 2009). Novice drivers' crash risk peaks during the first few months' of unsupervised driving upon obtaining their Provisional 1 (P1) license (Bates et al., 2009; McCartt, Shabanova, & Leaf, 2003; Preusser & Tison, 2007), decreasing substantially after the first 1600 km driven (Kinnear et al., 2013; McCartt et al., 2003). Crash risk continues to fall over the next 18 months (Williams, 2003),

further decreasing after 4000 km of driving (Kinnear et al., 2013). It is not until they have driven independently for at least three years (transitioning to an Open license) that a novice driver's crash risk reduces to that of more experienced drivers (Queensland Transport, 2005). Apart from the effect of increased experience on the road, this decrease may be due to improving important skills, including hazard perception (Deery, 1999; Machin & Sankey, 2008; Wang, Zhang, & Salvendy, 2010).

While some aspects of risky driving may be relatively stable from adolescence into early adulthood (Vassallo et al., 2014), a 17-year-old driver with a P1 license is four times more likely to be involved in a fatal crash than is an Open license driver over 26 years (Australian Transport Council, 2011). Being a young driver contributes to lower perceived risk and higher risky driving (Arnett, 1992; Begg & Langley, 2001; Hartos et al., 2000). This increased crash risk is due to young drivers' relative inexperience and underdeveloped driving skills for various driving situations, and/or to having positive perceptions of, and/or attitudes towards, risk taking (Fernandes, Hatfield, & Job, 2010). What is less clear is whether changes occur in driving risk perception, and risky driving engagement, within the 17-25 age range, particularly as these years are critical to gaining on-road driving experience. It has been reported that lack of driving experience exacerbates age effects on crash and fatality rates (McCartt et al., 2009; Queensland Transport, 2005).

While age is often confounded with driving experience (Groeger & Chapman, 1996), McCartt et al. (2009) found independent effects for driver age and experience on crash involvement. Controlling for length of licensure, McCartt et al. (2009) found that compared with older drivers, particularly those aged over 24, younger drivers had higher crash rates. However, driving inexperience has been found to be a stronger predictor of crash risk or near-crash events than has driver age (McEvoy, Stevenson, & Woodward, 2006), while driving experience, rather than age, has been found to contribute to reported risky driving (Harbeck

& Glendon, 2013). Given evidence for both age and driving experience independently affecting crash likelihood, both variables were included in the current study.

1.2. Risky driving and risk perception

Cognitive processing that can lead to risky driving involves: 1) perceiving and recognising a risk, 2) estimating the level of risk (probability of negative consequence), and 3) willingness to accept the risk level for the behaviour (McKenna & Horswill, 2006; Nordfjærn, Jørgensen, & Rundmo, 2011). Risk perception is a subjective judgement about the severity and characteristics of a risk (Deery, 1999; Fernandes, Job, & Hatfield, 2007). For young drivers, this has been reported to be context-dependent (Ivers et al., 2009), and influenced by optimism bias (Deery, 1999; Harré et al., 2005). Perceived risk has been negatively associated with self-reported engagement in risky driving (Harbeck & Glendon, 2013; Machin & Sankey, 2008), although a positive relationship has also been found (e.g., Ulleberg & Rundmo, 2003). Identifying perceived risk as an independent predictor of young drivers' crash likelihood, Ivers et al. (2009) found that this relationship was attenuated by reported engagement in risky driving. Perceived risk is important in predicting risky driving (Rhodes & Pivik, 2011), for crash risk reduction, developing safety campaigns, and promoting safe driving among young drivers (Deery, 1999; Hassan & Abdel-Aty, 2012; Shope, 2006).

Risky driving encompasses aggressive driving, speeding, and road rule violations (e.g., drink-driving, red light running, speeding, tailgating), which could result in harm to driver, passengers, and other road users (Machin & Sankey, 2008). Due to their inexperience, young drivers may engage in, but not recognize, some driving behaviours as risky (poor risk perception), and make errors of judgement (Hatfield & Fernandes, 2009; McKenna &

Horswill, 2006). Positive perceptions towards taking risks has been suggested as contributing to some young drivers' risky driving (Fernandes et al., 2010). Ivers et al. (2009) found that young drivers perceived certain traffic risks (e.g., speeding, peer passengers, mobile phone use) differently from older drivers. In the current study, risky driving encompassed intentional and unintentional behaviours: drink-driving, speeding, fatigue, not wearing a seatbelt, and distracted driving ("fatal five"), as well as: unsafe overtaking, tailgating, red light violations, illegal driving manoeuvres, drug-driving, and passenger safety.

1.3. Reinforcement sensitivity theory

Personality has been revealed as an indirect influence in motor vehicle crashes through its expression as risky driving (Constantinou et al., 2011; Ulleberg & Rundmo, 2003). Some personality characteristics (e.g., sensation seeking, impulsivity) have been associated with risky driving (Arnett, 1992; Machin & Sankey, 2008; Schwebel et al., 2006). These characteristics are part of Gray's (1987) reinforcement sensitivity theory (RST), which has been used to investigate risky driving (Castellà & Pèrez, 2004; Harbeck & Glendon, 2013; Scott-Parker et al., 2012a, 2013; Voigt et al., 2009).

RST posited three motivational systems: reward, punishment, and threat response (Gray, 1987), each linked to personality (Carver & White, 1994; Corr, 2004), and generating individual differences in sensitivity to reward and punishment. This provides a possible explanation not only for why some drivers engage in risky driving, but also perceive risks differently from other drivers. Due to their stronger motivation towards reward seeking, drivers with high reward sensitivity and who prefer immediate rewards, find learning inhibition and controlling impulsive behaviour difficult (Constantinou et al., 2011). This leads to higher reported engagement in risky driving (especially males; e.g., Scott-Parker et

al., 2012a), and lower risk perception (Castellà & Pérez, 2004). This may explain why punitive consequences do not deter many young drivers in their risky driving behaviours.

The behaviour inhibition system (BIS) underlies punishment sensitivity, which is related to habitual behaviours in response to cues of punishment, compliance, frustrating non-reward, and novel situations (Carver & White, 1994; Castellà & Pérez, 2004; Torrubia et al., 2001). It has been found to contribute positively to novice drivers' perceived risk (Harbeck & Glendon, 2013). However, with respect to its contribution to young driver reported risky driving, results for punishment sensitivity have been mixed. Voigt et al. (2009) found that BIS contributed to reported risky driving, although effect sizes were small. Constantinou et al. (2011), and Scott-Parker et al. (2012a) found that punishment sensitivity was not associated with risky driving. However, Harbeck and Glendon (2013) found an indirect effect of BIS on reported risky driving, which was mediated by perceived risk. The effect that punishment sensitivity has on young drivers' risk perception and risky driving therefore merits further research.

RST can help to explain individual differences in risk perception and young driver engagement in risky driving (Castellà & Pèrez, 2004; Constantinou et al., 2011; Harbeck & Glendon, 2013; Scott-Parker et al., 2012a). Identifying relevant motivation systems, such as sensitivity to reward and punishment, may inform road safety initiatives seeking to identify factors influencing novice drivers' risk perceptions and risky driving.

1.4. Sex of young drivers

Among young drivers, compared with females, males have consistently been found to perceive lower risk, report less concern over road accidents, overestimate their competence in responding to hazards, and engage at higher frequency and over a wider range of risky

driving behaviours (Begg & Langley, 2001; Boyce & Geller, 2001; Cordellieri et al., 2016; Fergusson, Swain-Campbell, & Horwood, 2003; Glendon et al., 1996). Reward sensitivity has been related to frequency of males' traffic violations (Castellà & Pèrez, 2004; Constantinou et al., 2011), and reported risky driving (Scott-Parker et al., 2012a). Males are also more than twice as likely as females to be killed in a motor vehicle crash (BITRE, 2014). For these reasons, young males are often the focus of road safety research and interventions. However, some young females also engage in risky driving, as revealed in the over representation of young drivers of both sexes in road deaths and injuries (Laapotti et al., 2001; Laapotti, Keskinen, & Rajalin, 2003). Thus, similar findings to those of previous research that has examined sex differences might be expected. The current study also focuses on associations between driver sex and RST variables, as well as young drivers' perceived risk, and reported engagement in risky driving.

1.5. The current study

The aim of the current study is to explore the influence of driver age, sex, and driving experience, and RST variables reward and punishment sensitivity, which were operationalised using Torrubia et al.'s (2001) Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), on young drivers' perceived risk and reported risky driving. From the literature, these hypotheses were proposed:

1. Higher perceived risk will predict lower reported engagement in risky driving.
2. a) Lower reward sensitivity, and b) higher punishment sensitivity, will predict higher perceived risk of risky driving behaviours.

3. Directly and/or indirectly: a) higher reward sensitivity will predict higher reported engagement in risky driving, and b) higher punishment sensitivity will predict lower reported engagement in risky driving.
4. Compared with females, males will be higher in: a) sensitivity to reward, and b) reported engagement in risky driving, and lower in: c) punishment sensitivity, and d) their perceived risk of risky driving behaviours.
5. Lower driver age will predict: a) lower perceived risk, and b) higher reported engagement in risky driving.
6. Longer driving experience (length of licensure) will predict: a) higher perceived risk, and b) lower reported engagement in risky driving.

2. Method

2.1. Participants

Participants were drivers ($N = 643$, 490 females, 17-25 years, $M = 20.0$, $SD = 2.3$) who held an Australian driver's license (P1, P2, or Open), and who drove a car regularly (other vehicle types excluded). A P1 license was held by 190 (29.5%), while 246 (38.3%) held a Provisional 2 (P2) license, and 207 (32.2%) held an Open license¹. Participants had held their license for an average of 3.7 years ($SD = 1.9$), and reported driving for a mean of 214.4 km ($SD = 177.5$) each week. As learner driver behaviour is overseen by a supervisor (usually a parent or licensed instructor), learner drivers were not included as they would have been unlikely to report engaging in risky driving.

¹ For licensing criteria, see: <http://www.tmr.qld.gov.au/licensing.aspx>

2.2. Measures

Participants anonymously completed an 87-item online survey, including all measured variables described below, as well as their age, sex, license type, current and previous license tenure, vehicle type usually driven, and average number of kilometres driven in a week.

2.2.1. Perceived risk of risky driving behaviours

This variable measured a driver's *perceived* riskiness of specified driving behaviours. Items were created to measure perceptions of risky driving behaviours, including some not measured by other scales. Alignment was sought between participants' perceived risk, and their reported engagement in risky driving. Items developed from measures previously used to assess driving behaviour risk (Harbeck & Glendon, 2013; Ivers et al., 2009; Machin & Sankey, 2008) were: speeding, drink driving, seatbelt use, fatigue, mobile (cell) phone use, tailgating, red traffic light violation, illegal driving manoeuvres, drug-driving, distracted driving, and having peer passengers.

Exploratory factory analysis confirmed a unidimensional 15-item measure with individual item contributions ranging from .31 to .68, and Cronbach's alpha of .83. A sample item was: "How risky do you perceive driving a vehicle while using a hand held mobile phone?" The response scale was: 1 *not risky at all*, 2 *slightly risky*, 3 *unsure*, 4 *risky*, 5 *very risky*. Total score was the composite of all 15 items, with higher scores indicating higher perceived risk.

2.2.2. *Reported risky driving engagement*

Scott-Parker, Watson, King, & Hyde's (2012b) revised Behaviour of Young Novice Drivers Scale (BYNDS; 36 items) was used. To focus on risky driving, the two subscales: transient violations (12 items, α .88; Scott-Parker & Proffitt, 2015, α .84), and fixed violations (6 items, α .72; Scott-Parker & Proffitt, 2015, α .79) were used, with a 5-point response format from 1 *never* to 5 *almost always*. A sample item was: "You spoke on a mobile [phone] that you held in your hands." The BYNDS score was computed by summing all item responses. Higher BYNDS scores indicated more self-reported risky driving. As not all BYNDS subscales were used in this research (misjudgements, risky exposure, and driver mood were excluded), this variable was named, "Reported engagement in risky driving" in the model, to reflect what was measured.

2.2.3. *Reinforcement sensitivity theory (RST)*

Torrubia et al.'s (2001) 48-item SPSRQ was used, which has two subscales, answered in a yes/no response format (*yes* = 1, *no* = 0). The sensitivity to punishment (females α .82, males α .83), and the sensitivity to reward subscale (females α .75, males α .78) each have 24 items. An example of Sensitivity to Punishment subscale item is: "Are you often afraid of new or unexpected situations?" SPSRQ scores were computed by summing all item responses for the relevant subscale. Higher sensitivity to punishment scores indicated higher sensitivity to punishment, and higher sensitivity to reward scores indicated higher sensitivity to reward.

2.3. Procedure and design

After obtaining ethical approval from the authors' University Human Research Ethics Committee, the online survey tool was created in LimeSurvey v1.91. The survey link was advertised using the University's e-news sheet Volunteer for Important Research Projects, and via the authors' school's participant pool. The survey was available for five months. Students aged 17 to 25 holding an Australian driver's license were invited to participate, as well as other drivers meeting these criteria. Incentives for participation were: 1) opportunity to win one of three \$100 gift card vouchers, and 2) one hour research participation credit for eligible students.

As the variables of interest were derived from a theoretical model, and all were measured variables, path analysis was chosen for the primary analysis. Hypotheses focused on predicted associations, and relationships between variables. Prior to path analysis, variables' distributions were examined and strengths of association were explored with bivariate correlations between continuous variables using Pearson's product moment correlation coefficient (r). Analyses used IBM SPSS v20.0, and IBM SPSS AMOS v22.0.

3. Results

Prior to data analyses, the scaled variables' distributions were examined. The only normality violations were as expected, these being slight positive skews in the age (Mean=.64, Standard error=.09), length of licensure (Mean=.88, Standard error=.09), and risky driving engagement distributions (Mean=.42, Standard error=.09). Four univariate outliers were very high scorers in the risky driving engagement distribution. However, as there were no significant differences in the analyses when these outliers were removed, or

when this variable was subject to a square root transformation, the raw data for all cases were retained for the analyses.

3.1. Correlations

Table 1 shows means, standard deviations, reliability coefficients, and zero-order correlations between variables. Driver sex (males = 0, females = 1) was significantly correlated with the RST variables, perceived risk, and risky driving engagement. Compared with males, females reported higher punishment sensitivity and perceived risk, while males were higher in reward sensitivity and reported risky driving. Driver age was negatively correlated with reward sensitivity and perceived risk, and positively associated with reported risky driving. Reward sensitivity was negatively associated with perceived risk, and positively correlated with reported risky driving. Perceived risk was negatively correlated with reported risky driving. No significant correlations were found for length of licensure. While this latter finding might have indicated that length of licensure may not contribute to the overall path model, it was included to address H6.

3.2. Path analysis

The measured variables were derived as described in the Method section. As required for structural equation modelling, the model for testing was derived from the theoretical basis for the study, described above. A path analysis included all predictor, control (driver age, sex, length of licensure), and criterion variables, with each hypothesis represented as a predicted path. Using Kline's (2011) recommendations for minimum sample size required for path analysis, the current sample exceeded the 20 cases per variable ratio. To assess and compare

Table 1

Means, standard deviations, reliability coefficients, and zero-order correlations between criterion and predictor variables ($N = 643$).

Variable	<i>Mean</i>	<i>SD</i>	Cronbach's alpha	Driver sex	Driver age	Licensure	Punishment sensitivity	Reward sensitivity	Perceived risk
Driver age (years)	20.02	2.32	-	-.06	-				
Licensure (months)	43.84	23.16	-	-.01	.07	-			
Punishment sensitivity	13.49	5.26	.84	-.16**	.02	.03			
Reward sensitivity	10.51	4.25	.77	.18**	-.08*	.04	.09*		
Perceived risk	56.00	7.40	.83	-.10*	-.09*	.02	.04	-.12**	
Risky driving engagement	17.08	9.12	.90	.09*	.12**	-.02	-.03	.30**	-.46**

Note: * $p < .05$, ** $p < .001$

the goodness-of-fit between the hypothesised and observed models, Hu and Bentler's (1999) and Byrne's (2001) recommended indices cut-off values for assessing fit were used (non-significant χ^2 , normed $\chi^2 < 3$, AGFI and CFI $> .90$, RMSEA $< .1$). The final recursive model and fit statistics are in Fig. 1.

[Insert Fig. 1 near here]

Perceived risk was negatively associated with reported engagement in risky driving, supporting H1. As lower reward sensitivity was associated with higher perceived risk, H2a was also supported. Reward sensitivity was also positively associated with reported risky driving, supporting H3a. Sensitivity to punishment was not significant, either for perceived risk (H2b), $\beta = .04$, $p = .281$, or for reported risky driving (H3b), $\beta = -.03$, $p = .314$.

Males were higher in reward sensitivity, while females were higher in punishment sensitivity, supporting H4a and H4c. There was no direct association between driver sex and perceived risk (H4d), $\beta = -.08$, $p = .061$, or between driver sex and reported risky driving (H4b), $\beta = .00$, $p = .964$. However, indirect pathways from driver sex through sensitivity to reward to perceived risk, and to reported risky driving engagement, shown in the model, suggested that reward sensitivity may mediate effects of driver sex on risk perception, and reported risky driving.

The negative relationship between driver age and perceived risk supported H5a. However, the positive relationship between driver age and reported risky driving, was the opposite of predicted (H5b); older drivers reported more risky driving engagement than younger drivers did. Length of licensure (driving experience; H6a, $\beta = .03$, $p = .412$, and H6b, $\beta = -.03$, $p = .342$) did not contribute significantly to any predicted paths.

Figure 1.

Path diagram showing effects of RST, driver sex, age, and length of licensure on perceived risk and reported engagement in risky driving ($N = 643$).

Note: Dotted lines indicate retained but non-significant pathways; p values in parentheses

χ^2 (df) = 11.26 (8), $p = .188$, Normed $\chi^2 = 1.41$, AGFI = .983, CFI = .988, RMSEA = .025 (90% CIs .000 – .056)

Fig. 1.

4. Discussion

The aim of the current study was to examine the role of reward sensitivity and punishment sensitivity in perceived risk, and self-reported engagement in risky driving, including potential influences of driver sex, age, and driving experience. Statistics showed that the data fitted the hypothesised model, revealing significant pathways and relationships between variables. Results indicated that RST, specifically reward sensitivity, as well as driver's sex and age, may help to explain individual differences in risk perception, and young driver reported risky driving. This is important: 1) as identifying relevant motivation systems could contribute to improved road safety initiatives, and 2) for providing information and support to counter factors that might otherwise facilitate young drivers' risk perceptions, and risky driving engagement.

4.1. *Punishment sensitivity*

Contrary to prediction, no support was found for a punishment sensitivity effect between perceived risk and reported risky driving, which contradicted at least one finding of punishment sensitivity being associated with perceived risk (Harbeck & Glendon, 2013). One explanation might be that different scales were used to measure behaviour inhibition (Carver & White's 1994 RST scales, compared with Torrubia et al.'s 2001 SPSRQ). Additionally, there was a significant effect of driver sex – females were higher than males in punishment sensitivity. However, this did not influence the effect of sensitivity to punishment, either in respect of perceived risk, or for reported risky driving, as had been predicted. The current findings were consistent with Constantinou et al. (2011), and Scott-Parker et al. (2012a), who also found no punishment sensitivity effect on young drivers' risky driving. Even with more driver licensing restrictions placed on young drivers, including further punitive consequences for violations (as suggested by Constantinou et al., 2011), our research showed no punishment sensitivity effect on reported risky driving.

A remote possibility is that incentives offered for research participation (three gift cards, and course credit) might have attracted people already more sensitive to reward than to punishment. However, 63.3% of the sample had higher SPSRQ scores on punishment sensitivity than on reward sensitivity, and the relatively small gifts, which were drawn in lottery fashion, as well as the less than 25% of participants receiving course credit (most responded via a general email), together make this explanation unlikely. Another possibility was the asymmetrical nature of rewards and punishments related to risky driving. For most driving violations examined in this study (speeding, drink-driving, illegal manoeuvres, traffic light violations, etc.), punishing consequences may never be detected by police, and even if detected, punishment will be delayed. Thus, regardless of sex, this young driver sample accurately assessed punishing consequences as being of low likelihood.

4.2. Reward sensitivity

Consistent with other studies, support was found for a negative association between reward sensitivity and young drivers' perceived risk, a positive association between reward sensitivity and reported risky driving engagement, and that compared with females, males reported higher reward sensitivity (Castellà & Pérez, 2004; Constantinou et al., 2011; Harbeck & Glendon, 2013; Scott-Parker et al., 2012a, 2013; Torrubia et al., 2001). High reward-sensitivity drivers may be considered to be risky drivers (Scott-Parker et al., 2012a, 2013), as they report higher risky driving (Constantinou et al., 2011; Harbeck & Glendon, 2013), and are likely to infringe traffic rules (Castellà & Pérez, 2004). Additionally, the sex effect, whereby males report higher reward sensitivity, provided additional support to previous research in which male drivers have been found to engage at higher rate, and over a broader range of risky driving behaviours when compared with females (e.g., Begg & Langley, 2001; Boyce & Geller, 2001; Fergusson et al., 2003).

Consistent with other studies (e.g., Constantinou et al., 2011; Scott-Parker et al., 2013) the current study highlights a need to revise road safety programs that focus on punitive consequences

and restrictions on young drivers, due to accumulating evidence for reward sensitivity impacting young drivers' risky driving. Punishment-based approaches may not successfully target the high risk group of reward-focused young (especially male) drivers, if rewards from engaging in some behaviours are perceived to exceed the threat of possible negative consequences. Evidence for this proposition from the current sample was the relatively strong relationship for reward sensitivity, in addition to its mediating role between driver sex and perceived risk, and between driver sex and reported risky driving, as well as its weak association with punishment sensitivity.

In light of the current study and supporting research, a more evidence-based approach might focus on reward-based programs, such as insurance or license fee monetary deductions (Constantinou et al., 2011; Harbeck & Glendon, 2013; Scott-Parker et al., 2013), as even though two-thirds of the sample identified as punishment sensitive, overall reward sensitivity was strongly associated with perceived risk, and reported risky driving. However, the impact of reward on behaviour change should be further examined, for example using protection motivation theory (Floyd, Prentice-Dunn, & Rogers, 2000), which applies both reward and perceived risk through the threat appraisal construct. Research confirming successful behaviour change through application of rewards might assist in creating more targeted intervention programs for this high-risk group.

4.3. Perceived risk

The negative relationship between perceived risk and reported risky driving was consistent with other research (e.g., Harbeck & Glendon, 2013; Machin & Sankey, 2008; Rhodes & Pivik, 2011), and was the strongest relationship within the model. That driver sex operated through sensitivity to reward, based on previous findings, was unanticipated (e.g., Boyce & Geller, 2001; Ivers et al., 2009; Rhodes & Pivik, 2011). However, this result is consistent with Cordellieri et al.'s (2016) finding that males and females did not differ on their perception of driving risk, but differed in their level of concern about the risk.

The strong negative relationship between perceived risk and reported risky driving does not imply that because a behaviour is perceived to be risky, drivers will not engage in it, or that attempting to further increase perceived risk will reduce the incidence of risky driving. Both male and female young drivers who perceived high risk also reported engaging in risky driving. Driver training interventions that focus only on perceived risk in awareness and knowledge, have either not been successful (e.g., Glendon et al., 2014; Ivers et al., 2009; Senserrick et al., 2009), or have been only marginally successful (Brijs et al., 2014).

Given that awareness and good hazard identification are essential when assessing consequences of risky driving and reducing crash risk, perceived risk remains important in safety campaigns, and in promoting safe driving among young drivers. Cognitive processes include: 1) risk perception, 2) recognising the risk of the behaviours, and 3) willingness to engage in risky driving. Our model highlighted that perceived risk was not only associated with young drivers' reported risky driving, but also had relationships with sensitivity to reward and driver age, which may need to be considered when educating this high risk group. For example, compared with their younger counterparts, older drivers who were sensitive to reward, reported lower risk perception, and higher engagement in risky driving.

4.4. Age and length of licensure

For this sample, length of licensure (driving experience) had no association with either perceived risk, or reported risky driving. A threshold effect in driving experience may pertain regardless of age. It is likely that most respondents gained their driving experience through Queensland's graduated driver licensing program, incorporated in 2007 and revised in 2011 (DTMR, 2014). This set the compulsory minimum learner driver's required driving experience at 100 hours under supervision (with Open license holders and/or professional driving instructors), before a provisional

license could be applied for. This could have meant that most of these drivers' driving experience was beyond the threshold level, thereby nullifying the possibility of detecting an experience effect.

Driver age was negatively associated with perceived risk. Younger drivers in the sample reporting higher perceived risk was predicted from: 1) changes in Queensland graduated driver licensing, 2) increased risky driving education, and 3) interventions targeting younger drivers in high school. These factors may have increased driving supervision and on-road vigilance, thereby enhancing risk perception of younger drivers in this sample. What was not predicted was the positive association between driver age and reported risky driving – with older drivers in this sample reporting higher risky driving. Compared with younger drivers, older drivers are more mature, generally have greater experience, and are more likely to adjust their driving appropriately to suit traffic and road conditions (Begg & Langley, 2001). However, this finding might indicate that the 17-25-years age range, used in many young driver studies, should be reduced to 18-22 years, as in Cordellieri et al. (2016). Results from the current study might indicate that once a certain level of driving experience is reached, driver age becomes increasingly important in influencing perceived risk and risky driving.

4.5. Limitations and further research

Study limitations include those usually associated with online survey research, specifically cross-sectional design, self-report data, and common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). However, because self-report measures can access constructs that are unavailable through other methods, they are frequently used to assess driver behaviour. Using various methodologies, a number of studies have found that such measures very adequately match corresponding driving variables, particularly for young drivers (af Wåhlberg, Barraclough, & Freeman, 2015; Lajunen & Summala, 2003; Taubman–Ben-Ari, Eherenfreund–Hager, & Prato,

2016; Zhao et al., 2012). While risk exposure could not be controlled for, proxy variables included respondent estimates of kilometres driven per week, and length of licensure.

However, the online, uncontrolled questionnaire format allowed participants to respond to questions about engaging in some illegal driving behaviours (e.g., speeding, drink driving) without repercussions, which is an advantage of online questionnaires (Ramsey et al., 2016). Despite findings being sample specific, and a tendency to obtain significance for small correlations, sample size was very adequate for the number of variables examined. Online responding enabled participation from a public beyond university students, although most (> 90%) respondents were from the student participant pool.

Scott-Parker and Senserrick (2013, 2016) reported that of young driver research studies published over a 5-year period, 51% did not report response rates, while 25% sampled from university or school populations, highlighting implications for generalizability of findings, and comparability of results. In the current sample, the proportion of university students and the survey response rate could not be precisely estimated due to mixed sampling methods, which might limit generalizability of findings. Future research using a more general driving population and examining response rates, could usefully validate current findings, and determine whether differences exist between university student and non-university drivers.

4.6. Conclusions

Results indicated that deterrence due to likelihood of punishment or negative consequences (e.g., injury, loss of life) may not significantly reduce some young drivers' engagement in risky driving, though this remains the primary approach used in Australia (Scott-Parker et al., 2013). While the current study expanded on the effects of driver sex and age, and highlighted that these variables need to be considered, other factors in the model, such as reward sensitivity and perceived risk, had stronger relationships with reported engagement in risky driving. A useful next step would be to use

extended theoretical frameworks that included reward and perceived risk, exploring these in conjunction with other prominent contributing factors such as attitudes, behavioural willingness, intention to engage in risky driving, and social influences (Rosenbloom & Perlman, 2016). Such factors could be used when examining variables that may be changed in the young risky driver, instead of variables that cannot be changed (e.g., age, sex), or that are relatively more resistant to change (e.g., personality, cognitive biases). More broadly-based theoretical frameworks might lead to more effective and targeted interventions, and be used to evaluate interventions and behaviour change programs aimed at young drivers.

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