Young novice drivers’ perceived risk, risky driving engagement and hazard perception

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October, 2017
Statement of originality

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Emma Harbeck
Acknowledgements

This doctoral thesis was completed under the supervision of Associate Professor Ian Glendon and Dr Trevor Hine, whose guidance and support has been vital in the completion of this thesis. Their knowledge, patience, feedback and encouragement, throughout my candidature have been greatly appreciated. I would also like to sincerely thank Dr Chris Irwin for the collaboration work of study 5 and 6. His time and effort in creating the simulator scenarios, as well as his suggestions and assistance for these studies was instrumental. Thank you also to Professor Wendy Chaboyer and Professor Brigid Gillespie, for their support and wonderful opportunities you have provided me to grow and apply my skills as a researcher during my candidature. I wish to also extend my sincere gratitude to School of Applied Psychology at Griffith University for the opportunity to complete my candidature. I am similarly grateful to all who participated in and helped to facilitate this research.

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Additionally, I would like to thank both my family and friends for the encouragement and support throughout my candidature. You have always believed in and supported me. In particular, there are two people I need to thank who also without them, the thesis would not have reached this point. Thank you to the love of my life, my partner James Wilson, who has supported me and stood by me since my early undergraduate degree. Throughout the many ups and downs you have been my rock, my
joy and the calm voice of wisdom and perspective. Thank you to my dear friend Codi White, you know exactly what you did and I will always and forever be grateful to you. Thank you for all your time, patience, support and advice throughout my honours and postgraduate years. I hope we are both able to be up on that graduation stage one more time together. We did it Codi, we got there and what a journey it has been. Next I would like to thank my family, my Dad, Mum, Grandmother Gail, Aunty Anne and my sister Rebecca Harbeck, this was for you.

Last, I would like to thank my reviewers for the time and effort they have taken to read this thesis and for any feedback and suggestions for improvement they provide to help this thesis further contribute to the research for young driver road safety.
Thesis Abstract

Internationally, young novice drivers (aged 17-25 years) are often overrepresented in road-related crash injury and fatality statistics. Compared with older, more experienced drivers, prominent contributors to young driver crash-risk is their lower perceived risk, higher engagement in risky driving behaviours (e.g., speeding), and poorer hazard perception skills. This thesis describes seven studies conducted to address three research aims.

The first aim was to model and examine three psychological theories of personality, social–cognitive, and social-learning, to propose a new conceptual framework that explores how young novice drivers perceive driving risk, and whether they choose to engage or not in risky driving behaviours. In studies 1-4, using a sample of 643 young novice drivers (490 females) who held an Australian driver’s licence (Provisional-1, Provisional-2, or Open), models of: i) reinforcement sensitivity, ii) protection motivation, and iii) prototype willingness, were examined. From these models, factors of reward sensitivity, coping appraisal, threat appraisal, driver prototypes, and behavioural willingness predicted young driver perceived risk, and reported risky driving engagement.

The second aim was to examine whether a developed and piloted brief hazard perception training session can improve Provisional-1 drivers (aged 17-25 years) overall hazard perception knowledge, identification, response and handling to road user related driving hazards using a driving simulator. Educational, passive and active training methods incorporating a number of established behavioural change techniques were employed, while elements of process and product evaluation were undertaken. Also examined was whether any training group differences persisted at 2-3 week follow-up. In Study 5 a sample of 23 drivers (n=7 Provisional-1, n=7 Provisional-2, and n=9 Open
Young novice driver cognitions and behaviour

licence) piloted and validated the training methods and hazard perception outcome measures. In Study 6, a brief training session was implemented with a sample of 52 (18 male) Provisional-1 licence drivers aged 17-25 years. Participants were equally randomised to four training conditions (pamphlet, passive, active, and no-training). Participants who received training significantly outperformed the no-training participants in hazard perception identification, response, and handling of hazards, in the simulator hazard perception test. When assessed again at a follow-up session (n=40), support was found for participants who received training that was higher in interactivity (passive and active training) outperforming the no-training participants and participants who only received an educational pamphlet in the hazard perception tests (static and simulator).

The third aim was to evaluate whether the brief hazard perception training session’s key objectives were met using feedback from participants who completed the training session, and to identify whether factors identified from the new conceptual model (research aim 1) were associated with hazard perception performance. Study 7 evaluated the training session using feedback from drivers who participated in study 5 (N=52), and explored initial associations between protection motivation theory and the prototype willingness model for perceived risk, reported risky driving engagement, and hazard perception. This approach sought to expand the literature by examining factors associated with these three prominent young driver crash risk models to better adjust and address such factors in future training programs targeting safety outcomes. While potential correlates of hazard knowledge were examined, only three were found to share significant relationships: coping appraisal, previous traffic violations, and risky driver prototype similarity. From participant feedback, three key areas of learning were identified by participants: increased knowledge, awareness of new hazards, and greater awareness of driving laws and rules. A majority of participants in the training
conditions also indicated that after the training session their understanding of driving hazard perception and driving related hazards had improved. Across training conditions, 91.5% \((n=43)\) of participants who completed the evaluation measure indicated that they would recommend the session for other Provisional-I drivers.

Examining potential underlying influences for why young drivers are overrepresented in international injury and death tolls is important for road safety research and practice (e.g., driver-oriented interventions). Highlighted in this thesis are factors from the conceptual models that could be amenable to change in influencing young driver decision-making, perceived risk, and risky driving engagement, in addition to a brief training session that showed evidence of hazard perception improvement. These results may contribute to improved road safety initiatives, preventive strategies and interventions that focus on this vulnerable driver demographic.
Table of contents

Statement of originality ........................................................................................................... ii
Acknowledgements .................................................................................................................. iii
Thesis Abstract ......................................................................................................................... v
Table of contents ..................................................................................................................... viii
List of figures ........................................................................................................................... xiv
List of tables ............................................................................................................................. xvi
List of appendices ..................................................................................................................... xviii
Statement of ethical protocol ................................................................................................... xix
List of resulting conference presentations ............................................................................ xx
List of publications from doctoral research published, under review or prepared for submission ....................................................................................................................... xxii
Acknowledgment of publications included in thesis ............................................................... xxii

CHAPTER 1 ............................................................................................................................... 1
Thesis Overview ......................................................................................................................... 1
Chapter Overview ....................................................................................................................... 5
Overview of Research Design and Studies .............................................................................. 6

CHAPTER 2 ............................................................................................................................... 14
Overview of theory, definitions and frameworks .................................................................... 14
The young novice driver .......................................................................................................... 14
Perceived risk and risky driving behaviours ........................................................................... 18
Towards a new conceptual framework for the study of novice driver behaviour .......... 19
Young novice driver cognitions and behaviour ix

Reinforcement sensitivity theory ................................................................. 24
Protection motivation theory ........................................................................ 26
Prototype willingness model ........................................................................ 28
Interventions aimed at novice drivers .......................................................... 33
Graduated driver licensing systems ............................................................... 34
Hazard perception and hazard perception tests (HPTs) ................................ 36
Hazard perception training ........................................................................... 42
Evaluating driver interventions .................................................................... 47

CHAPTER 3 ....................................................................................................... 49

Statement of contribution to co-authored published paper: Paper 1 .......... 50

Reward versus punishment: Reinforcement sensitivity theory, young novice drivers’ perceived risk, and risky driving ................................................................. 51

The current study .......................................................................................... 58

Method ............................................................................................................ 59

Results ............................................................................................................. 61

Discussion ....................................................................................................... 65

Conclusions ..................................................................................................... 71

CHAPTER 4 ....................................................................................................... 73

Statement of contribution to co-authored published paper: Paper 2 .......... 74

Young driver perceived risk and risky driving: A theoretical approach to the “fatal five” ........................................................................................................... 77

The current study .......................................................................................... 83

Methodology .................................................................................................. 83
Results .......................................................................................................................... 88
Discussion..................................................................................................................... 99
Conclusion..................................................................................................................... 99

CHAPTER 5 .................................................................................................................... 106
Statement of contribution to co-authored published paper: Paper 3 ...................... 107
Driver prototypes and behavioural willingness: Young driver perceived risk and
reported engagement in risky driving.............................................................................. 108
The current study........................................................................................................... 116
Methodology................................................................................................................ 118
Results .......................................................................................................................... 121
Discussion..................................................................................................................... 130
Conclusion..................................................................................................................... 136

CHAPTER 6 .................................................................................................................... 138
Exploring the combined effect of Reward sensitivity, Protection motivation theory,
Prototype willingness model and perceived risk in young driver risky driving
engagement..................................................................................................................... 138
The current study........................................................................................................... 140
Methodology................................................................................................................ 143
Results .......................................................................................................................... 144
Discussion..................................................................................................................... 149
Conclusion..................................................................................................................... 154

CHAPTER 7 .................................................................................................................... 156
Statement of contribution to co-authored published paper: Paper 4 ...................... 157
Young novice driver cognitions and behaviour

Differences between licence types: Developing a novel brief hazard perception pilot session................................................................. 158

The current study.................................................................................. 164

Methodology.......................................................................................... 166

Results .................................................................................................... 181

Discussion.............................................................................................. 187

Conclusion.............................................................................................. 190

CHAPTER 8.............................................................................................. 192

Statement of contribution to co-authored published paper: Paper 5 .......... 193

The implementation of a brief hazard perception training session to improve hazard perception performance in young novice drivers ........................................................................... 194

The current study.................................................................................. 199

Methodology.......................................................................................... 200

Results .................................................................................................... 213

Discussion.............................................................................................. 220

Conclusion.............................................................................................. 227

CHAPTER 9.............................................................................................. 228

Statement of contribution to co-authored published paper: Paper 6 ............ 229

Evaluating a brief hazard perception training session: Conceptual framework and

Provisional licence driver evaluation of intervention................................... 230

The current study.................................................................................. 238

Methodology.......................................................................................... 240

Results .................................................................................................... 248
Young novice driver cognitions and behaviour xii

Discussion........................................................................................................ 257
Conclusion........................................................................................................ 267

CHAPTER 10 ..................................................................................................... 269

General Discussion .......................................................................................... 269
Review of research aims..................................................................................... 269
Contributions to knowledge and theory.............................................................. 272
Contributions to methods and practical implications ........................................ 281
Research context and further research directions ............................................. 282
Concluding comments ....................................................................................... 284

References ......................................................................................................... 286

Appendix A ......................................................................................................... 317
Ethical clearance to conduct research for studies 1-3...................................... 317

Appendix B ......................................................................................................... 318
Participant information sheet for online survey ................................................. 318

Appendix C ......................................................................................................... 321
Ethical clearance to conduct research for studies 4-6...................................... 321

Appendix D ......................................................................................................... 322
Research participation information Sheet-Pilot Study 5 .................................. 322

Appendix E ......................................................................................................... 325
Research participation information Sheet- Study 7-8 ...................................... 325

Appendix F ......................................................................................................... 328
Research participation example consent form studies 5-7 ............................... 328
List of figures

**Figure 1.1** Thesis research aims and studies overview

**Figure 2.1** A conceptual model of factors affecting novice drivers’ driving behaviour (Shope & Bingham, 2008)

**Figure 2.2** A conceptual model of protection motivation theory

**Figure 3.1** Path diagram showing effects of RST, driver sex, age, and length of licensure on perceived risk and reported engagement in risky driving ($N = 643$).

**Figure 4.1** Conceptual model of protection motivation theory applied to driving behaviours.

**Figure 4.2** Path diagram showing maladaptive pathway of threat appraisal variables on perceived risk and reported risky driving engagement (Sample B; $n = 300$).

**Figure 4.3** Path diagram showing protective pathway of coping appraisal variables on perceived risk and reported risky driving engagement (Sample B; $n = 300$).

**Figure 5.1** Path model showing relationships between PWM variables, perceived risk, and reported risky driving engagement ($N = 554$).

**Figure 6.1** Conceptual framework for investigating factors predicting novice driver decision making and skills for risky driving engagement.

**Figure 7.1** Driving simulator set up.

**Figure 7.2** Image of the scenario environment used in the HPT.

**Figure 8.1** Images of scenario environment with traffic and pedestrians present.

**Figure 8.2a** White ute runs a red light in phase 1 scenario.
Figure 8.2b Orange van runs a red light in phase 2 scenario. ........................................206

Figure 9.1 Conceptual model of proposed associated relationships with hazard knowledge .................................................................................................................................239

Figure 10.1 Conceptual framework examined in thesis to explore factors that influence novice driver decision making and skills when driving knowledge.................................273
List of tables

Table 1.1 Thesis and studies aims ................................................................. 3

Table 3.1 Means, standard deviations, reliability coefficients, and zero-order
correlations between criterion and predictor variables (N = 643) ......................... 63

Table 4.1 Perceived Risk and PMT Scale Items (Sample A; n = 301) ..................... 91

Table 4.2 Summary statistics for final measures (Sample A; n = 301) ................. 94

Table 4.3 Means, standard deviations, Cronbach’s alpha and Pearson correlations for
measured variables (Sample B; n = 300) .................................................................. 95

Table 5.1 Means and standard deviations for perceived risk items (N = 554) ........ 123

Table 5.2 Means and standard deviations for behavioural willingness items (N =
554). ................................................................................................................................. 125

Table 5.3 Frequency of reported driving violation engagement (BYNDS subscales; N =
554). ................................................................................................................................. 125

Table 5.4 Means, standard deviations, reliability coefficients, and zero–order
correlations between criterion and predictor variables (N = 554) ......................... 127

Table 6.1 Means, Standard Deviations and Correlations between All Measures (N =
561) ................................................................................................................................ 146

Table 6.2 Hierarchical multiple regression results (N=561) ................................. 148

Table 7.1 Driving simulator scenario for hazard perception performance test. .... 175

Table 7.2 Pilot training session order, task break down and time .......................... 179

Table 7.3 Reported ratings of presence in simulated driving environment (N=23) .... 184
Table 7.4 Descriptive statistics of evaluation questions for P1 and P2 drivers (n=14). 185

Table 8.1 Driving simulator scenario for hazard perception performance test............. 208

Table 8.2 Training session order, task break down and time................................. 211

Table 8.3 Pre-training sample descriptives (N=52)............................................. 214

Table 8.4 Pre-training Provisional 1 driver static HPT (N=52)............................... 215

Table 8.5 Descriptives and inferential statistics for outcome variables across phases... 217

Table 9.1 Means, Standard Deviations and Correlations between All Measures (N = 52)
........................................................................................................................................... 249

Table 9.2 Descriptives and inferential statistics for outcome variables across phases... 251

Table 10.1 Factors explored in conceptual model and the relationships found with
perceived risk and reported risky driving engagement.................................................... 274
List of appendices

Appendix A: Ethical clearance studies 1-3 .......................................................... 317
Appendix B: Participant information sheet for online survey .................................. 318
Appendix C: Ethical clearance studies 4-6 ............................................................... 320
Appendix D: Research participation information Sheet-Pilot Study 5 ....................... 321
Appendix E: Research participation information Sheet-Study 7-8 ............................ 324
Appendix F: Research participation consent form studies 5-7 ................................. 327
Appendix G: Hazard perception training pamphlet .................................................. 329
Statement of ethical protocol

I confirm that ethical clearance was granted by the Griffith University Human Research Ethics Committee: GU Ref No: PSY/E5/13/HREC (Appendix A) and GU Ref No: PSY/38/14/HREC (Appendix C). I confirm that the research was conducted in accordance with the approved protocols.

Emma Harbeck

October 2017
List of resulting conference presentations


List of publications from doctoral research published, under review or prepared for submission


Acknowledgment of publications included in thesis

Included in this thesis are papers (published or under review) in Chapters 3, 4 and 5 which were co-authored with other researchers. These publications are in accordance with Section 9.1 of the Griffith University Code for the Responsible Conduct of Research (“Criteria for Authorship”), Section 5 of the Australian Code for The Responsible Conduct of Research, and Section 9.3 of the Griffith University Code (“Responsibilities of Researchers”).

My contribution to each co-authored paper is outlined at the front of the relevant chapter. The bibliographic details (if published or accepted for publication)/status (if prepared or submitted for publication) for these papers including all authors are:


**Chapters 7, 8, and 9:** These chapters consist of articles in preparation for submission. Citation details for each are provided below.


Appropriate acknowledgements of those who contributed to the research but did not qualify as authors are included in each paper.

Emma Harbeck
October, 2017

A/Pro Ian Glendon
October, 2017

Dr Trevor Hine
October, 2017
Young novice driver cognitions and behaviour xxiv
CHAPTER 1

Thesis Overview

As part of the United Nations “Decade of Action on Road Safety”, in 2011 the Australian Government, in partnership with its states and territories initiated the National Road Safety Strategy 2011–2020. This strategy aims to decrease road deaths and serious injuries by at least 30 per cent by 2020 (ATC, 2011). Road accident costs, which include loss of life or injury to people, and both the destruction and damage to equipment and infrastructure, cost the Australian economy an estimated $27bn per year (ATC, 2011). The lowest number of road deaths since 1946 was recorded in 2011 at ~1300, which was about a third of the deaths recorded at the 1970 fatalities peak. From 2007 to 2016, Australia saw an annual mean reduction in road deaths of 2.9%, while over the 30 years to 2016, Australia achieved an annual fatal road toll decrease of 53.3% (BITRE, 2017).

These figures may reflect the proactive road safety initiatives conducted by Federal and State governments via the efforts of police, media campaigns, safer cars, new legislation involving the graduated licensing system, and an assumption from Australian government bodies that greater care is being taken by motorists (BITRE, 2012). However, since 2014, earlier decreasing trends have reversed, with increases seen across multiple indicators (e.g., road deaths, hospitalised injuries, and road crashes) in all Australian states and territories (BITRE, 2017).

The 1,295 recorded road deaths in 2016 represented an increase of 7.5% from 2015 (BITRE, 2017). Young novice drivers (aged 17-25 years) remain statistically over-represented in national road deaths, even though on average they drive fewer hours and kilometres on the road than older drivers do (BITRE, 2017; Scott-Parker, Watson, Hyde, & King, 2013). In 2016, the rate per 100,000 population for fatalities and hospitalised injuries, standardised by population, vehicle kilometres travelled, and
vehicle registrations showed that young novice drivers were above the national average (9.0 vs. 5.4), and had remained above the national average throughout the previous decade (BITRE, 2017). Highlighted reasons in the road safety literature for such over-representation in national injury and road death tolls are young novice drivers’: lower perception of risk, higher engagement in risky driving behaviours (e.g., the Fatal Five; speeding, drink driving, seatbelt use, fatigue, distraction), poor hazard perception skills, and maladaptive decision-making processes while driving, when compared with older more experienced drivers. Due to these contributors to higher crash risk, the research within this thesis focuses on these three driver outcomes of perceived risk, risky driving engagement, and hazard perception in samples of young drivers aged 17-25 years.

The thesis will explore the correlates and indicators of perceived risk and risky driving engagement, and potential methods for hazard perception improvement for the high-risk target population of young novice drivers. Specifically, it models key contributing factors that relate to young novice driver perceived risk, and why some young novice drivers choose to engage in risky driving behaviours, while others do not. Additionally, along the overarching theme of young driver road safety, the thesis also explores whether young novice drivers’ hazard perception skills can be improved by exposure to a short training session. The three research aims are addressed by seven empirical studies, each addressing specific research questions and hypotheses. The overarching research aims of the Thesis, and the research question and specific aims of each study, are in Table 1.1. Figure 1.1 illustrates the thesis aims and research design. Each study and its contribution to the thesis aims are also briefly described in Figure 1.1.
Young novice driver cognitions and behaviour 3

<table>
<thead>
<tr>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 4</th>
</tr>
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<tbody>
<tr>
<td><strong>Research Aim 1</strong></td>
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<td><strong>Research Aim 4</strong></td>
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<tr>
<td>Model and examine three prominent psychological theories of RST, PMT, and PWM to propose a new conceptual framework that explores how young novice drivers perceive driving risk, and whether they choose to engage or not engage in risky driving behaviours.</td>
<td>Examine whether a developed and piloted brief hazard perception training session can improve Provisional 1 licence holders’ (aged 17-25 years) overall hazard perception knowledge, identification, response and handling to road user related driving hazards using a driving simulator.</td>
<td>Evaluate whether the brief hazard perception training session’s key objectives were met using feedback from participants who completed the training session, and identify whether the factors identified from the new conceptual model are associated with hazard perception performance.</td>
<td>To summarise results from studies 1, 2, and 3 and conducted a hierarchal linear regression analysis to explore which factors from the three models (RST, PMT, PWM) best predicted young driver reported engagement in risky driving, when controlling for demographic factors, the variables from the models, and perceived risk.</td>
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<tr>
<td>1. To explore the influence of driver age, sex, and driving experience, and RST variables reward and punishment sensitivity, which were operationalized using Torrubia et al. (2001) Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), on young drivers’ perceived risk and reported risky driving.</td>
<td>1. To create, initially validate, and test a measure that examines all six PMT components, using the fatal five as the driving-related criterion variables. This is intended to identify factors that may/not influence a young driver’s perceived risk, and/or their reported risky driving engagement.</td>
<td>1. To explore whether differences would occur within a sample of Australian drivers (aged 17-25 years, licence type P1, P2, or Open) in their stated willingness to engage in the fatal five driving behaviours, perceived risk, and reported risky driving engagement.</td>
<td>1. To summarise results from studies 1, 2, and 3 and conducted a hierarchal linear regression analysis to explore which factors from the three models (RST, PMT, PWM) best predicted young driver reported engagement in risky driving, when controlling for demographic factors, the variables from the models, and perceived risk.</td>
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<tr>
<td>1. To develop a path-analytic model to identify PMT variables, as well as perceived risk, as predictors of young drivers’ reported engagement in a number of risky driving behaviours.</td>
<td>To develop methods of hazard perception training and measures of hazard perception performance (knowledge, identification, response and handling).</td>
<td>To examine whether providing a brief session of hazard perception training, and more importantly, what type of training (pamphlet, passive, or active), may improve young drivers’ (aged 17-25 years) hazard perception (knowledge, identification, response, and handling/avoidance), when compared with drivers who do not receive training. After controlling hazard knowledge, this will be evaluated by a dynamic format HPT, using a driving simulator.</td>
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<td>2. To pilot the training and measures of hazard perception; check for any difficulties in implementing the proposed procedures, whether the scenarios provided and targeted outcomes were appropriate for drivers from this age group and licence type. Investigate whether any unforeseen or contrary effects might arise, other than those outlined by the training session, while obtaining important feedback from drivers who completed the session to help improve measures, clarify any ambiguity and test if licensing type differences in hazard perception occurred.</td>
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<td>2. To evaluate the brief hazard perception training session’s key objectives of hazard perception learning, training session effectiveness, and reported confidence in their perception and response to hazards that may appear on the road. Also explored was whether participants found the training session helpful, informative, and applicable to real situations.</td>
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<td>2. Pilot the training and measures of hazard perception; check for any difficulties in implementing the proposed procedures, whether the scenarios provided and targeted outcomes were appropriate for drivers from this age group and licence type. Investigate whether any unforeseen or contrary effects might arise, other than those outlined by the training session, while obtaining important feedback from drivers who completed the session to help improve measures, clarify any ambiguity and test if licensing type differences in hazard perception occurred.</td>
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<tr>
<td>1. To examine if associations exist between factors identified in the proposed conceptual psychosocial–cognitive model of risky driving behaviour developed from studies 1-4, and hazard perception in the sample of novice drivers from Study 6.</td>
<td>1. To summarise results from studies 1, 2, and 3 and conducted a hierarchal linear regression analysis to explore which factors from the three models (RST, PMT, PWM) best predicted young driver reported engagement in risky driving, when controlling for demographic factors, the variables from the models, and perceived risk.</td>
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life, and whether they would recommend the training to other P1 drivers.

Young novice driver perceived risk and risky driving engagement: Evaluating a brief hazard perception training session

**Research Aim 1:** Model and examine three prominent psychological theories of RST, PMT, and PWM to propose a new conceptual framework that explores how young novice drivers perceive driving risk, and whether they choose to engage, or not engage, in risky driving behaviours.

**Study 1 (Chapter 3)**
**Purpose:** Test model to examine RST sensitivity to reward and punishment on novice drivers’ perceived risk and reported risky driving engagement
**Design:** Cross-sectional, online survey \((N=643)\)

**Study 2 (Chapter 4)**
**Purpose:** Test model to examine PMT coping appraisal and threat appraisal variables on novice drivers’ perceived risk and reported risky driving engagement.
**Design:** Cross-sectional, online survey \((N=601)\)

**Study 3 (Chapter 5)**
**Purpose:** Test model to examine PWM driver prototypes and risky driving behavioural willingness in novice drivers’ perceived risk and reported risky driving engagement.
**Design:** Cross-sectional, online survey \((N=543)\)

**Summary Study 4 (Chapter 6)**
**Purpose:** Summarise and review results of studies 1, 2, and 3. Examine all three models (RST, PMT, PWM) and their predictors together to explore which factors best predict reported risky driving behaviour, controlling demographic variables and each model against the others. Examine whether these relationships remain significant when controlling for perceived risk. From this analysis, propose a new conceptual framework.
**Design:** Data analysis pooled from studies 1, 2, & 3 \((N=561)\)

**Research Aim 2:** Examine whether a developed and piloted brief hazard perception training session can improve Provisional 1 licence holders’ (aged 17-25 years) overall hazard perception knowledge, identification, response and handling to road user related driving hazards using a driving simulator.

**Study 5 (Chapter 7)**
**Purpose:** Develop and pilot three brief hazard perception training session measures (pamphlet, passive viewing, active driving); test their efficacy using driving simulator scenarios comprising a hazard perception test that examines hazard identification and response
**Design:** Quasi-experimental pilot \((N=23)\)

**Study 6 (Chapter 8)**
**Purpose:** Implement the developed brief hazard perception training session in a sample of Provisional 1 licence holders (aged 17-25 years), examining hazard knowledge, identification response and handling to road user related hazards in a simulated driving environment.
**Design:** Experimental, randomised control with 4 groups \((N=52)\), and 2-3 week follow-up \((n=40)\)

**Study 7 (Chapter 9)**
**Purpose:** Examine how participants’ self-reported PWM, PMT, perceived risk, and risky driving engagement were associated with their hazard identification scores in the static hazard perception test. Evaluate the training session’s key objectives, learning outcomes and impact using participant qualitative data from Study 6.
**Design:** Cross-sectional, questionnaire, quantitative, and qualitative data \((N=52)\)

**Research Aim 3:** Evaluate whether the brief hazard perception training session’s key objectives were met using feedback from participants who completed the training session, and identify whether factors identified from the new conceptual model are associated with hazard perception performance.
Chapter Overview

The thesis consists of ten chapters: Thesis overview (Chapter 1), General Introduction (Chapter 2) and Discussion (Chapter 10), and seven results chapters (chapters 3-9), that focus on the empirical studies conducted to address the thesis research aims. The empirical study chapters are in the form of manuscripts formatted to meet the requirements of the peer reviewed academic journals where they have been – or will be – submitted/published. The thesis was prepared in accordance with Griffith University Higher Degree Research policy (http://policies.griffith.edu.au). As a result, there is some repetition among the empirical study chapters within the introduction, literature review, and methodology sections in accordance with journal publishing norms.

The current chapter presents the thesis aims and implemented research designs, including a brief overview of each subsequent chapter. Chapter 2 provides a literature review and develops the theoretical foundations of the thesis, where definitions, models, and frameworks are discussed, and linked to the various studies. Chapters 3, 4, and 5 relate to research aim 1 of the thesis, model development and testing. These chapters include journal articles that were submitted for publication. Chapter 6 summarises the results from chapters 3, 4, and 5, and explores the comparative effects of reinforcement sensitivity theory (RST), protection motivation theory (PMT), prototype willingness model (PWM), respectively, and perceived risk on reported risky driving engagement to propose a new conceptual model of young driver engagement in risky driving. Chapters 7 and 8 address research aim 2. Chapter 7 describes the creation and piloting of the hazard perception training, and Chapter 8 describes implementation of the hazard perception training for Provisional 1 drivers. To address research aim 3, Chapter 9 describes an evaluation of the hazard perception training. Chapter 10 concludes the
thesis with a general discussion, review of findings, implications, and contributions to
the traffic and transportation psychology literature. Studies from chapters 3, 4, 5, 7, 8,
and 9 are presented as submitted or unpublished manuscripts, resulting in some
inevitable repetition of material.

**Overview of Research Design and Studies**

The first aim of the thesis, addressed within studies 1, 2, 3, and 4, was to develop
a new conceptual model of young novice driver behaviour. This novel contribution was
designed to assist in evaluating young driver interventions, and not only to confirm
what may also contribute to young novice driver engagement in risky driving
behaviours (maladaptive), but also to explain why they may choose not to engage in
risky driving behaviours (adaptive). Three theoretical frameworks that aided in
understanding young novice driver behaviour for this thesis were: i) RST, which is a
personality-based approach, ii) PMT, derived from social–cognitive theory, and iii)
PWM, derived from social learning theory. Guided by these theories, model testing
studies were conducted to test hypotheses about associations between personality, social
cognitive, and social learning factors that may influence why young novice drivers
choose to engage or not, in risky driving behaviours. In pursuit of this aim, selected
personality (RST, Chapter 3, Study 1), social cognitive (PMT, Chapter 4, Study 2), and
social learning (PWM, Chapter 5, Study 3) theories were explored. From these theories,
prominent factors were identified to form a new psychosocial–cognitive conceptual
framework that attempts to explain young drivers’ perception of risk and engagement in
risky driving. To achieve this, an online questionnaire was developed and a large
sample gathered. The database that was downloaded after data collection had ceased,
and due to its size and for publication purposes, was separated to address the separate
research questions and hypotheses related to the theories and model testing and then
later reassembled to address the overall thesis research aim. This resulted in three
empirical studies (chapters 3-5) and one integrative study (Chapter 6), derived from the previous three exploring which factors from the three models (RST, PMT, PWM) best predicted young driver reported engagement in risky driving, when controlling for demographic factors, each of the other models, and perceived risk.

The second thesis aim drives exploration of the level of hazard perception through detection (knowledge and identification) of, and action to (response and handling), driving-related hazards in the most vulnerable young novice driver group: those newly licenced and no longer supervised drivers – Provisional 1 (P1) licence holders. Young drivers who have begun to drive unsupervised have the highest risk of injury and death in motor vehicle crashes (Sagberg & Bjørnskau, 2006; Williams & Mayhew, 2008). They are also more likely to be deemed at fault for the crash (Braitman, Kirley, McCartt, & Chaudhary, 2008). This is attributed to variables associated with high crash risk, such as age and gender, low on-road driving experience, and poor hazard detection and response skills (Borowsky, Shinar, & Oron-Gilad, 2010; Scott-Parker, Watson, King, & Hyde, 2012a). To explore these high crash risk likelihood factors, using a driving simulator the research will examine whether brief hazard perception training can improve a sample of P1 licence holders’ (aged 17-25 years) overall hazard knowledge, identification, response, and handling of road-user related driving hazards. This aim is addressed in studies 5 and 6, in which the development (Chapter 7), and implementation (Chapter 8), of the hazard perception training is explored and evaluated using elements of a process evaluation. This included identifying the need for hazard perception training for this sample, whether the training session methodology operated as intended, implementing improvements to the training session based on feedback, and whether the participant sample and end users were satisfied with the training. The primary goal of the training was to determine whether brief hazard perception training, when compared with a no-training condition, will result in improved performance (hazard: knowledge,
identification, response and handling) as revealed by a driving simulator hazard perception test for young novice drivers. This study used a sample of potentially vulnerable drivers, P1 licence holders.

The final and third aim of the thesis, addressed in study 7 (Chapter 9), is to evaluate whether the brief hazard perception training session’s key objectives were met using feedback from participants who completed the training. This evaluation uses elements of a product evaluation, to examine training effects (positive and or negative), and the impact of the training reported by participants. This study will also identify whether the factors identified as influential in studies 1-4 would be relevant for drivers’ hazard identification, as these may lead to potential moderators, mediators, and/or influencing factors, on hazard perception. The studies addressing this research aim are briefly described below.

**Study 1.** Chapter 3 examines demographic factors and reinforcement sensitivity of young drivers, and their influence in reported perceived risk and risky driving engagement. Cross-sectional data were collected from 643 Australian drivers aged 17-25 years, using an online questionnaire. This study explored the influence of driver age, sex, and driving experience, and RST variables: reward and punishment sensitivity, which were operationalized using Torrubia et al.’s (2001) Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), on young drivers’ perceived risk and reported risky driving. The current study addressed research aim one by path modelling the chosen personality approach of RST and driver demographics to identify which factors may contribute to young novice driver engagement in risky driving (maladaptive) behaviours, and also why they may choose not to engage (adaptive) in risky driving behaviours.

**Study 2.** Chapter 4 examines PMT’s threat and coping appraisal decision-making pathways in a cross-sectional sample of 601 young (17-25 years) Australian drivers.
Participants responded using an anonymous online questionnaire. PMT factors, and their influence in reported perceived risk and risky driving engagement, were modelled using path analysis. As assessing PMT variables across multiple risky driving behaviours has not previously been undertaken, an additional aim of this study was to develop and initially validate a measure that examined all six PMT components (reward, vulnerability, severity, response efficacy, self-efficacy, response costs), using the fatal five as the driving-related criterion variables. This study addressed research aim one by modelling the chosen social cognitive approach of PMT for driver decision-making to identify additional factors that may/not influence a young driver’s perceived risk, and their reported risky driving engagement.

Study 3. Chapter 5 examines demographic and PWM factors and their influence in reported perceived risk and risky driving engagement. This cross-sectional study also used the online questionnaire format of studies 1 and 2. This involved 564 young Australian drivers responding to measures examining driver prototypes (risky driving, and self-perception as a driver), behavioural willingness of risky driving engagement in the fatal five driving behaviours, in addition to the perceived risk and risky driving engagement measures of studies 1 and 2. Study 3 addressed research aim one as it was expected that some key PWM variables would contribute to the proposed conceptual framework that would attempt to explain young drivers’ perception of risk, and whether they choose to engage in risky driving behaviours.

Study 4. Chapter 6 addresses research aim one, by summarising the findings from studies 3, 4, and 5, and conducting a follow-up analysis of the pooled database ($N=561$) that was first separated to answer previous research questions. This study explores factors from RST, PMT, and PWM, found to be influential in the prior studies (chapters 3, 4, & 5) to determine which best predicted young driver reported engagement in risky driving when controlling for demographic factors, each of the other models, and
perceived risk. From these results, a new conceptual model of driver behaviour is proposed.

**Study 5.** Chapter 7 addresses research aim two, developing and piloting the hazard perception training session. The overall goal of research aim two was to examine whether a developed and piloted brief hazard perception training session can improve P1 licence holders’ (aged 17-25 years) overall hazard perception knowledge, identification, response and handling to road user related driving hazards using a driving simulator. The focus of Study 4 was to develop and pilot different training methods (pamphlet, passive, active), and driver performance using a static (image-based) hazard perception test, and a dynamic (interactive) driving simulator hazard perception test. The pilot study included a sample of P1 drivers \((n = 7)\), more experienced P2 drivers \((n = 7)\), and open licence drivers \((n = 9)\). Participants completed the developed training measures and hazard perception tests, providing valuable feedback that led to refinement of the training. Thus, in Study 4 these measures (training and hazard perception tests) were constructed, as well as piloting and evaluating the experimental design that is later applied in Study 5.

**Study 6.** Chapter 8 addresses research aim two, specifically implementing the brief hazard perception training session in a sample of young novice drivers (aged 17-25 years) who held a current Australian P1 licence \((n = 52)\). The goal was to determine whether providing a brief session of hazard perception training, and more importantly, what type of training (pamphlet, passive, or active), may improve young drivers’ (aged 17-25 years) hazard perception (knowledge, identification, response, and handling/avoidance), when compared with drivers who do not receive training. After controlling hazard knowledge, this will be evaluated by a dynamic format HPT, using a driving simulator. This is examined by a hazard perception test, which used traffic conflict scenarios (driving situations that may escalate to a motor vehicle crash or
collision if detection and action such as breaking, stopping, lane change, etc. is not taken by the driver) from real life. If successful, participants who completed the training should perform better (e.g., have improved hazard knowledge, earlier hazard identification, faster hazard response times, and improved hazard handling with fewer near misses and collisions) in the driving simulator hazard perception test than would participants who were not in a training condition. Also examined was what level of hazard perception training (pamphlet, passive, or active) was required for a significant improvement in novice driver hazard perception skills (knowledge, identification, response, and handling) to occur. This was a two-part experimental study in which participants ($n = 40$) also attended a follow-up session in which they completed the hazard perception tests again two-to-three weeks after the training. This follow-up session was designed to determine whether changes in hazard perception had occurred, or been maintained after this time period.

**Study 7.** Chapter 9 addresses research aim three: evaluation of the brief hazard perception training session, and to explore whether factors identified as influential in chapters 3, 4, and 5 were also relevant for drivers’ hazard identification in a P1 sample. Therefore this study had two research aims: first, to evaluate the training using structured qualitative and quantitative data collected from the study 6 participants ($n = 52$, P1 drivers). Using a survey, the P1 licence drivers who participated in the training provided qualitative and quantitative feedback on their learning, perceived effectiveness of the training, their confidence in their perception and response to hazards that may appear on the road, and suggested improvements for the training. Changes in driver reported hazard perception and hazard response confidence are also explored. The second aim of Study 6 uses the factors identified in the model testing phase of the thesis (studies 1, 2, & 3) to examine potential new associations with hazard perception knowledge and identification. Study 7 examined whether participant self-reported
measured factors of PMT (threat appraisal, coping appraisal), PWM (driver prototypes, risky driving behavioural willingness), perceived risk (likelihood, aversion), risky driving engagement, and demographic variables (e.g., gender, age, length of licence, frequency of driving) were associated with their hazard knowledge and identification scores from the hazard perception test prior to training. Results are intended to expand upon the current literature in examining what is related to these three prominent young driver crash risk contributors (perceived risk, risky driving engagement, and hazard perception) to better adjust and address such factors in future training programs that target these outcomes.

In summary, this thesis focuses on three key contributing factors proposed for why young novice drivers are over-represented in national death and injury toll on roads across the world: inexperience, engagement in risky driving behaviours, and relatively poor hazard perception skills. This thesis contributes to the literature by developing a new conceptual framework for young driver behaviour, applying previously established and prominent theories within a young novice driver context. Key factors of these theories and driver demographics are identified to understand important decision-making influences in young novice drivers’ perceived driving-related risk, and why they may engage, or choose not to engage, in risky driving behaviours. The objective of this new conceptual framework is to apply this to an untested driver context, hazard perception. To accomplish this, the thesis’s second aim is to develop and implement a brief hazard perception training session to examine participants’ pre-training level of hazard knowledge, and whether hazard perception (knowledge, identification, response, and handling) can be improved for young novice drivers (P1 licence holders). As evaluation is, and should be, a key component of any training, the thesis will evaluate the brief training session using responses from provisional drivers who took part in the training session to determine whether key outcomes were met. The new conceptual
framework developed earlier in the thesis will be applied to examine initial associations between novice drivers’ hazard identification, and their responses to road user related hazards. The general discussion and research implications are in Chapter 10.
CHAPTER 2
Overview of theory, definitions and frameworks

The young novice driver

Young novice drivers and their passengers make up a disproportionate percentage of the deaths on Australian roads (BITRE; 2017; Scott-Parker et al., 2012a). Young drivers (17-25 years) represent one-quarter of all Australian road deaths but account for 10-15% of the licenced driver population (ATC, 2011). A 17-year-old driver with a Provisional 1 (P1) licence is four times more likely to be involved in a fatal crash than is an open licence driver aged over 26 years (ATC, 2011). Compared with an older demographic, drivers aged 16-24 years report higher engagement in risky driving behaviours (Jonah, 1990). Levy (1990) found that age, specifically drivers aged 15-17 years, was a stronger predictor of a driver’s fatal crash risk than was driving experience. Younger drivers’ involvement in risky driving behaviours, such as speeding and driving under the influence of alcohol, are major contributing factors to their higher crash rate, resulting in injuries and death (Machin & Sankey, 2008; Vassallo et al., 2007). This finding has been replicated by a number of studies in which being a young driver was found to be a significant factor contributing to lower perceived risk and engaging in risky driving behaviours (Arnett, 1990, 1992; Begg & Langley, 2001; Harbeck & Glendon, 2013; Hartos, Eitel, Haynie, & Simons-Morton, 2000; Sarkar & Andreas, 2004).

Age is often confounded with driving experience (Groeger & Chapman, 1996). However, McCartt, Mayhew, Braitman, Ferguson, and Simpson (2009) demonstrated that while sharing considerable variance, these two variables have independent effects on crash involvement. This review, based on 11 studies undertaken since 1990, found that while novice 16-year-old drivers had a higher crash fatality and injury risk rates
than did novice 17-year-old drivers, there were no differences in crash rate between novice 17-year-old and 18-to-19-year-old novice drivers (McCartt et al., 2009). Across these studies, it was found that driving experience was a better predictor of reduced crash risk than was driver age. Controlling for length of licensure, McCartt et al. (2009) also found that compared with older drivers, particularly those aged 25 and above, young drivers still had consistently higher crash rates. Research now suggests that regardless of age, inexperienced drivers detect hazards less holistically, more slowly and less efficiently than more experienced drivers do, while underestimating the risk of a crash in a range of traffic situations (Deery 1999; Machin & Sankey, 2008; Wang, Zhang, & Salvendy, 2010). These conclusions were further supported by McEvoy, Stevenson, and Woodward (2006), who demonstrated that lack of driving experience, was a stronger predictor of crash risk or near-crash events than was driver age.

Neurophysiological evidence has suggested that, due to their age-related developmental stage and when compared with older drivers, young drivers do not possess the same cognitive development of the prefrontal cortex to appropriately manage the risks while operating a vehicle (Constantinou, Panayiotou, Konstantinou, Loutsiou-Ladd, & Kapardis, 2011; Glendon, 2011a). This age difference in risk management is especially apparent when young drivers are fatigued or under the influence of alcohol (Glendon, 2011a). Executive functions associated with perceived risk and personal risk management (e.g., decision making, behavioural inhibition, reasoning) are considered not entirely developed within the human brain at least until the age of 25 (Paus, 2005). Other authors have proposed that it is not until around 29-30 years is brain maturation of executive functions fully developed (Salthouse, 2009).

Gender (male and female) has been explored in driving-related perceived risk and risky driving engagement research. Compared to females, males have consistently been found to perceive lower risk, engage at higher frequency, and over a larger number of
Young novice driver cognitions and behaviour

risky driving behaviours (Begg & Langley, 2001; Boyce & Geller, 2001; Byrnes et al., 1999; Cordellieri et al., 2016; Fergusson, Swain-Campbell, & Horwood, 2003; Jonah, 1997). Males also have a higher prevalence rate of injury and death on the road than females do (BITRE, 2012, 2017). As driver sex differences are well established, this thesis recognises such differences as having a potentially strong influence on perceived risk and engagement. Therefore driver sex will be included as a control variable and where appropriate in the studies, driver sex differences will be explored in relation to other variables of interest, which are discussed below.

Young drivers are also more likely to engage in risky driving behaviours due to their lack of experience and under-developed driving skills across a range of on-road driving situations, or due to having positive perceptions and or attitudes towards taking risks (Fernandes, Hatfield, & Job, 2010). Compared to younger drivers, older drivers are more mature, generally have more experience, and are more likely to adjust their driving behaviours appropriately to suit traffic and road conditions (Begg & Langley, 2001; Bingham & Shope, 2004; Jonah, 1990). In their review of novice risky driving across a range of driving behaviours (e.g., speeding, peer passengers, mobile phone use), Ivers et al. (2009) demonstrated that young drivers perceived road related risks differently than older drivers did.

Data for crash fatalities among young drivers since 2006 have supported a lack of driving experience effect (BITRE, 2017). However, the first six months or 1000 km after gaining a provisional licence is considered to be the period of greatest crash risk for young drivers, because mandated direct driver supervision has ended (Bates et al., 2009; McCartt, Shabanova, & Leaf, 2003; Preusser & Tison, 2007). Novice drivers report engaging in risky driving behaviours for a number of reasons, including: gaining autonomy, self-enhancement, optimism bias, to please friends, and to gain a more adult-
Young novice driver cognitions and behaviour

like status (Arnett, 1997; Begg & Langley, 2001; Harré, Foster, & O’Neill, 2005; Scott-Parker et al., 2012a).

After a novice driver’s first six months of unsupervised driving experience, crash risk falls rapidly and continues to decline over the next 18 months (Williams, 2003, Williams & Mayhew, 2008). On the other hand, Transport and Main Roads Queensland, has maintained that it is not until young drivers have driven independently for at least three years (completing their transition from Provisional to open licence), that a novice driver’s crash risk reduces to the point where it is similar to that of a more experienced driver (Queensland Transport, 2005). In this thesis, for consistency, the term “novice driver” is used to refer to inexperienced (defined as <1000km of driving experience), or young drivers aged 17-25 years who do not yet hold an Australian open licence. As research has shown that inexperienced, novice drivers are more vulnerable than older, more experienced drivers, novice drivers aged 17-25 years are the proposed target population throughout the studies in this thesis.

Young drivers are frequently over-represented in road traffic death and injury tolls worldwide. While examining young driver crashes and/or collisions is an important rationale for road safety research, it is inevitably post hoc as the consequence has already occurred and in many cases preventive and intervention based strategies can no longer be implemented. Poor perceived risk and hazard perception along with engagement in risky driving does not always result in a motor vehicle crash or collision; however, these factors can increase driver risk and crash likelihood. Therefore, for this thesis, the data on crash likelihood and statistics will not be collected and the focus will be young driver perceived risk, hazard perception, and reported risky driving (measured by frequency of reported traffic violation engagement), as these constructs, once adequately operationalized in practical interventions, may be expected to influence road crashes and be amendable to change to improve driver safety.
Perceived risk and risky driving behaviours

Risky driving behaviour encompasses self-assertive driving, speeding, and road rule violations, where engagement in such driving might result in harm (via a motor vehicle crash; MVC) to the driver, passengers and other road users (Machin & Sankey, 2008). While the terms risky driving and reckless driving have been used interchangeably within the traffic psychology literature, Arnett (1992) proposed a significant distinction between risky and reckless driving behaviours. Arnett recommended that risky behaviours be defined as those which are socially approved, adventurous, or thrill-seeking (e.g., extreme sports, mountain climbing, bungee jumping, pro-racing). While behaviours, such as drink driving and substance abuse, which may lack social approval (via the law or peer group), should be considered as reckless (Arnett, 1992).

The term reckless driving is used primarily within a legal context to differentiate a major traffic violation from other driving violations that are considered to be either careless or improper, or carried out without due attention. Reckless driving is deemed to be a mental state in which a driver allegedly displays wanton disregard for road rules. However, the conceptualisation of risky driving already includes road rule violations (e.g., drink driving, not stopping at a red light). While reckless driving does not account for inadvertent or unconscious engagement in driving behaviours that are considered high risk (e.g., unintentional speeding, tailgating), or behaviours that are not a violation or illegal, but that are discouraged (e.g., driving while fatigued). For example, young drivers may engage in, but not perceive, some driving behaviours to be high risk due to inexperience and judgement error (Hatfield & Fernandes, 2009). McKenna, Horswill, and Alexander (2006) made an important distinction between error and violations where
errors refer to “a skill-based failure in information processing, whereas violations refer to risk-taking behaviour that involves deliberate infringement of a regulation” (p. 1). In this thesis, the term risky will be used to describe the driving behaviours of interest (e.g., the fatal five, comprising: drunk driving, speeding, fatigue, not wearing a seatbelt, and driving while distracted). Other driving behaviours also included are: unsafe overtaking, tailgating, red light violations, illegal driving manoeuvres, drug driving, passenger safety.

Risk perception, also conceptualised as perceived risk is a subjective judgement about a specific risk’s severity and characteristics. Within traffic psychology it has been defined as the driver’s, “subjective experience of a risk in potential traffic hazards” (Deery, 1999, p. 226), which relates to the, “perceived risk of having a car crash, incurring demerit points, or being fined while driving,” (Fernades, Hatfield, & Job, 2007, p. 61). A driver’s perceived risk is important as it can influence decision-based behaviours. Perceived risk has been reported to have a negative relationship with self-reported engagement in risky driving behaviours (Harbeck & Glendon, 2013; Machin & Sankey, 2008), though conflicting results have been found (e.g., Ulleberg & Rundmo, 2003). Ivers et al. (2009) highlighted that perceived risk is an independent predictor of young drivers’ crash risk likelihood, but that this effect is attenuated by reported engagement in risky driving. Nevertheless, perceived risk is important in predicting risky driving engagement (Harbeck & Glendon, 2013; Rhodes & Pivik, 2011), for crash risk reduction, developing safety campaigns, and promoting safe driving for young drivers (Deery, 1999; Hassan & Abdel-Aty, 2012; Shope, 2006).

Towards a new conceptual framework for the study of novice driver behaviour

Many theories and models have described, hypothesised, and empirically evaluated by studying cognitive, affective, and behavioural aspects of driving. These have included threat avoidance theory (Fuller, 1984), zero risk theory (Näätänen &
Young novice driver cognitions and behaviour

Summala, 1974), and risk homeostasis theory (Wilde, 1982). Reviews have been undertaken by Michon (1985), Huguenin and Rumar (2001), Fuller (2005), Glendon (2011b), and Lewis-Evans (2012). Driving models (specific or derivative) within traffic psychology have incorporated a wide range of conceptual frameworks to explore driving-related behaviours including, “cognitive, visual, behavioural, social, individual, emotional and human factors, either singly or in some combination,” (Glendon, 2011b, p. 548).

Glendon (2011b) reported that conceptual frameworks that applied a social, developmental, personality and cultural approach were popular in the traffic psychology field. Using some of these conceptual frameworks, Shope and Bingham (2008) extensively researched factors that influenced novice drivers’ over-representation in annual road deaths and higher motor vehicle crash risk through engaging in risky driving. Decisive elements were: driving ability, developmental factors, behavioural factors, personality factors, demographics, the perceived environment, and the driving environment (Shope & Bingham, 2008; see Figure 2.1). As these elements represent a complex set of factors that influence novice drivers’ behaviour, Shope and Bingham (2008) stated that comprehensive, multilevel interventions were needed to decrease novice drivers’ exposure to high-risk driving conditions, and to address factors identified within their framework.

Shope (2006) suggested that for interventions to successfully influence behaviour, they must derive from, and be grounded in, behavioural science theory. However, to be successful in changing novice drivers’ behaviour, the factors that influence their decision-making and skills when driving, need to be identified and explored. To understand novice driver behaviours, among many others, two prominent approaches have been identified: social learning theory, and social cognitive theory. Social learning theory is based on the influence of others around the individual behaving in ways that
have been positively reinforced. Social cognitive theory considers the reciprocal relationship between how environmental and personal factors interact to influence behaviour (Shope, 2006). These two theories form the theoretical basis of many studies that have focused on factors contributing to novice drivers’ perceived risk or engagement in risky driving behaviours and are a focus in the current thesis.

![Conceptual model of factors affecting novice drivers' driving behaviour](image)

*Figure 2.1. A conceptual model of factors affecting novice drivers’ driving behaviour (Shope & Bingham, 2008).*

As highlighted in Figure 2.1, Shope and Bingham (2008) identified numerous factors influencing novice drivers and their behaviours. However, an extensive literature search revealed no model or testable conceptual framework that explained why novice drivers consciously choose to engage, or not engage, in risky driving behaviours (such as the fatal five). This thesis will develop such a conceptual framework, through
Young novice driver cognitions and behaviour 22

research aim 1, using personality, social cognitive and social learning theories to identify factors for this conceptual model. The aim is to develop and test a new model of driver behaviour, specifically for young novice drivers, based on three prominent theories that may aid in understanding novice driver behaviour: i) the prototype willingness model (PWM), derived from social learning theory, ii) protection motivation theory (PMT), derived from social cognitive theory, and iii) reinforcement sensitivity theory (RST), which is a personality-based approach. Operationalizing scales from these theories to administer to a sample of novice drivers will aid in identifying key variables that will contribute to the model (studies 1, 2, and 3). Following this, in study 4, the model data is combined and examined to explore which factors from the three models best predict young driver reported engagement in risky driving, controlling for demographic factors, each of the other models, and perceived risk. This novel contribution is intended to help evaluate novice driver interventions by identifying contributors to novice driver engagement in risky driving (maladaptive) behaviours, and why novice drivers may choose not to engage in these behaviours (adaptive response).

This proposed model is tested in throughout studies 1-4 and again in study 7, Chapter 9, where it is used to explore possible correlates of novice drivers’ hazard perception knowledge. This model proposes a new approach to examine components of hazard perception, not previously tested. Identifying indicators that may provide insight into young drivers’ decision making are needed to assist in developing driver training and interventions, but also in evaluating interventions designed to improve young driver safety.

Within the road safety literature, many researchers have developed questionnaires and scales to measure perceived risk and risky driving engagement. Peer reviewed and published measurement instruments such as the Driver Behaviour Questionnaire (Reason, West, Elander, & Wilding, 1990), the Behaviour of Young Novice Drivers
Young novice driver cognitions and behaviour

Scale (BYNDS; Scott-Parker et al., 2012b), the Driving Style Questionnaire (French et al., 1993), the Multidimensional Driving Style Inventory (Taubman-Ben-Ari, Mikulincer, & Gillath, 2004), and the Reckless Driving Behaviour Scale (McNally & Bradley, 2014), primarily focus on driving behaviours such as the fatal five, in particular domains of: speeding, fatigue (driving while tired), substance use (alcohol and drug driving) and distraction (e.g., calling/answering a mobile phone, texting, negative emotions). Additionally items about position (e.g., tailgating, red light running, and illegal driving manoeuvres) are also measured. As these driver behaviour domains are prominent and reoccur in the literature, the thesis will use the same domains in how risky driving perceived risk and engagement is operationalized and use these behaviours to conceptualise and measure constructs described below, specifically relating to the driving context for protection motivation and prototype willingness.

In line with past research and previous practice (Harbeck & Glendon, 2013; Ivers et al., 2009; Lund & Rundmo, 2009; Machin & Sankey, 2008; McNally & Bradley, 2014; Scott-Parker et al., 2012b; Sjoberg, Moen, & Rundmo, 2004; Ulleberg & Rundmo, 2003; van Gelder et al., 2009), aggregating driving behaviour items and using averaged totals to provide measures of perceived risk, constructs of protection motivation and prototype willingness will be implemented. These aggregated scores can provide helpful information on high and lower scoring drivers on these constructs and due to the range of driving behaviours, provide driver response variation as some behaviours may be viewed less or more risky on the construct than others. Including multiple driving behaviours in measurement of risky driving is important, as highlighted by McNally and Bradley (2014), a key weakness of driver behaviour scales can be incompleteness where along with overlapping categories and over-inclusiveness, measures can fail to include items that represent the diversity of the driving behaviours construct of interest (such as reckless driving behaviours). Where appropriate the thesis
uses previously established reliable and validated driver behaviour scales (e.g., the BYNDS) and when not available for the construct of interest (e.g., protection motivation and prototype willingness) will develop items to measure the construct, guided by the literature and previous research.

**Reinforcement sensitivity theory**

A personality theory that has been used as a basis for investigating risky driving behaviours is Gray’s (1987) reinforcement sensitivity theory (RST; Brady, 2006; Castellà & Pérez, 2004; Harbeck & Glendon, 2013; Scott-Parker et al., 2012b, Scott-Parker et al., 2013a; Voigt et al., 2009). While personality is not considered to be a direct predictor of road crashes, it has been demonstrated as having a distal influence through reported perceived risk and risky driving engagement (Constantinou et al., 2011; Ulleberg & Rundmo, 2003). Research has linked personality characteristics (e.g., sensation seeking, impulsivity) with risky driving engagement (Arnett, 1990; Dahlen et al., 2005; Machin & Sankey, 2008; Schwebel, Severson, Ball, & Rizzo, 2006). The motivational components derived from RST are related to both sensation seeking and impulsivity.

The original version of RST was proposed in the 1980s with three systems, a reward, a punishment, and a threat response system. Two important RST components regulate aversive and appetitive motivation. The aversive motivational system is known as the behavioural inhibition system (BIS), also referred to as negative reactivity or sensitivity to punishment (SP) and the appetitive motivation system is known as the behavioural approach system (BAS) or sensitivity to reward (SR). The terms appetitive and approach are used interchangeably within the literature. Within these motivational systems (which are linked to personality, Carver & White, 1994; Corr, 2004), lie individual differences in the sensitivity to cues of reward and punishment. These offer a
possible explanation of why some individuals engage in risky driving behaviours or perceive risk differently than other drivers do.

BIS is sensitive to signals of non-reward, punishment, and novelty (Carver & White, 1994; Gray, 1978). BIS inhibits behaviour that could lead to painful or negative consequences and is said to be responsible for the negative feelings of anxiety, frustration, and sadness (Smillie, Pickering, & Jackson, 2006). BIS is reported to be related to compliance (Castellà & Pérez, 2004). For example, high-BIS drivers may be more aware of traffic police and the consequences of breaking the law if caught (e.g., fines, demerit points), in theory inhibiting dangerous driving behaviour and leading them to perceive a high risk of engaging in such behaviours.

BIS has been found to contribute significant unique variance in novice drivers’ perceived risk, where novice drivers who were higher in negative reactivity also reported higher perceived risk (Harbeck & Glendon, 2013). BIS or sensitivity to punishment has received mixed results in its contribution to novice driver reported engagement in risky driving behaviours. Voigt et al. (2009) found that BIS contributed to reported engagement, although effect sizes were small. Constantinou et al. (2011) found that sensitivity to punishment (BIS) was not associated with engagement in risky driving, which was also found by Scott-Parker et al. (2012b). However, Harbeck and Glendon (2013) found that negative reactivity (BIS) had an indirect effect on reported engagement, mediated by perceived risk. The effect that BIS has on novice driver perceived risk and reported engagement is still recent within the literature and warrants further research.

BAS is divided into three subsystems: drive, which enables goal pursuit; reward responsiveness, encompassing openness to reward; and fun seeking, the desire for new and potentially rewarding experiences (Carver & White, 1994; Smillie et al., 2006; Voigt et al., 2009). Collectively, BAS is the system thought to control impulsivity,
elation, hope, and happiness. BAS is sensitive to cues of reward, non-punishment, and escape from punishment. Its principal function is to initiate incentive-motivated, goal-directed behaviour (Smillie et al., 2006). For example, drivers who are high in BAS may be more likely to commit driving violations due to a goal pursuit (e.g., needing to get somewhere quickly), by being impulsive (e.g., tailgating), or by reward (e.g., to establish autonomy). BAS is conceptualised collectively as sensitivity to reward (SR) in Torrubia et al.’s (2001) sensitivity to punishment and sensitivity to reward questionnaire (SPSRQ). SR has been found to contribute to traffic violations (Constantinou et al., 2011) and risky driving in males only (Scott-Parker et al., 2012b).

RST can help to explain individual differences in perceived risk, and novice driver reported engagement (Castellà & Pérez, 2004; Constantinou et al., 2011; Harbeck & Glendon, 2013; Peters, Burraston, & Mertz, 2004; Scott-Parker et al., 2012b, Scott-Parker, Watson et al., 2013). This is important, as identifying relevant motivation systems could contribute to road safety initiatives seeking to provide information on factors that may contribute to novice drivers’ perceived risk and engagement in risky driving behaviours. Therefore, as a part of research aim 1, Chapter 3 (describing study 1) will explore and clarify the influence of RST, specifically, the role of sensitivity to reward and punishment, which were operationalized using Torrubia et al.’s (2001) SPSRQ, on novice drivers’ decision-making. It is expected that some RST variables will contribute to the proposed conceptual framework that will attempt to explain novice drivers’ perception of risk and whether a novice driver chooses to engage in risky driving behaviours.

**Protection motivation theory**

For the social cognitive approach, models such as the theory of reasoned action/planned behaviour (TRA/TPB; Ajzen, 1998; Ajzen & Fishbein, 1980) has been the conceptual framework most applied to driving behaviours (Glendon, 2011a).
Additionally the health belief model (Rosenstock, 1974), and protection motivation theory (PMT; Rogers, 1975), have also been applied to study the determinants of novice drivers’ risky driving behaviour. These models explain that variables such as attitudes, perceived risk, self-efficacy, social norms, and perceived behavioural control are essential determinants of behaviour, with evidence for the predictive value of these variables emerging from the literature (Ulleberg & Rundmo, 2003).

A social cognitive model, PMT has two primary cognitive mediating processes in decision-making, threat appraisal, and coping appraisal (Floyd, Prentice-Dunn, & Rogers, 2000; Rogers, 1975, 1983). Threat appraisal has three components: severity, vulnerability, and rewards. Coping appraisal also has three components: response efficacy, self-efficacy, and response costs. These processes combine to form the intervening variable protection motivation (see Figure 2.2).

![Figure 2.2](image.png)

*Figure 2.2. A conceptual model of protection motivation theory.*

Research conducted on PMT since its creation by Rogers (1975) to address the effects of fear appeals on health attitudes and behaviours has successfully applied PMT to various issues, including, “health-related promotion and disease prevention, injury prevention, political issues, environmental concerns, and protecting others” (Floyd et
Within traffic psychology, PMT has been successfully applied in exploring drunk driving (Cismaru, Lawack, & Markewich, 2009; Greening & Stoppelbein, 2000; Murgraff, White, & Phillips, 1999), driver fatigue (Tay & Watson, 2002), and effectiveness of anti-speeding messages (Cathcart & Glendon, 2016; Glendon & Walker, 2013). However, in their meta-analysis of PMT, Floyd et al. (2000) concluded that this model could be applied to any threat to which an individual deems to have an effective response. In study 2, PMT is used to explore a number of driving-related behaviours, including speeding, drug driving, seatbelt use, and mobile phone use, any of which could lead to a motor vehicle crash.

Theoretically applied to a potential motor vehicle crash, PMT can be used to represent a driver’s judgement of the probability of a harmful event happening to them (e.g., a motor vehicle crash resulting from dangerous driving behaviours). Through the two subsystems of coping appraisal and threat appraisal, the probability that a driver will perform a protective, rather than a maladaptive behaviour, will be greater if the driver identifies with a stronger response efficacy, has higher self-efficacy, and perceives fewer costs in performing the adaptive behaviour. Engaging in maladaptive driving behaviours is more likely if the driver has positive views about the rewards associated with the behaviour, and perceives low vulnerability and severity of the behaviour (Floyd et al., 2000). This theoretical framework is explored as a part of research aim 1 in Chapter 4 (describing study 2), where it was predicted that PMT would provide a basis for exploring young and inexperienced drivers’ threat and coping appraisal in respect of risky driving behaviours (e.g., the fatal five).

Prototype willingness model

Grounded in social learning theory, the prototype willingness model (PWM) was created to improve the predictive value of existing health behaviour theories that address youth decision-making in risky health-related behaviours (Gerrard, Gibbons,
Young novice driver cognitions and behaviour

Houlihan, Stock, & Pomery, 2008; Gibbons & Gerrard, 1995). PWM has been applied to understand a range of youth engagement in risky behaviours, such as unprotected sex (Thornton et al., 2002), smoking (Hukkelberg & Dykstra, 2009), alcohol and illicit drug use (Gibbons et al., 2004), and risky driving (Cestac, Paran, & Delhomme, 2011; Gibbons & Gerrard, 1995; Rivis, Abraham, & Snook, 2011; Scott-Parker, Hyde et al., 2013). PWM proposes that risky behaviour can be engaged impulsively in response to a situation that generates risk. This is highly relevant to young adults who are in the process of creating their own identity, opinions, and values (Cestac et al., 2011) and who are considered more sensitive to social influences than older adults (Gibbons & Gerrard, 1995).

PWM is a modified dual-processing model that is represented by two decision-making paths: a reasoned path, and a social reaction path (Gibbons & Gerrard, 1995). The reasoned path, which has many elements similar to the theories of planned behaviour and reasoned action, relates to analytic processing, which recognises rational and intentional behaviours drawn from existing information (Gerrard et al., 2008). This path is theorised to predict risky behaviour and derives from positive attitudes towards performing the behaviour and supportive subjective norms (Gerrard et al., 2008). These factors pass through behavioural intention before ending at the risk behaviour, which is a person’s conscious decision as to whether to engage in risky behaviour (Thornton et al., 2002). Factors affecting the reasoned path are: previous behaviours, attitudes, subjective norms, and intention to engage in risky behaviours.

The second PWM path, social reaction, is image-based and involves heuristic processing, which attempts to explain unplanned and unintended behaviours due to being in certain situations (e.g., an unsupervised party where alcohol and drugs are available; Gerrard et al., 2008). This path contains two important factors, the risk image or prototype (terms that are used interchangeably in the literature), and behavioural
willingness. The social reaction path is similar to the reasoned path by predicting risky behaviours based on attitudes and subjective norms, which are also influenced by a person’s previous behaviour (Cestac et al., 2011; Gibbons & Gerrard, 1995; Rivis et al., 2011). However, the social reaction path also passes through risk prototypes and behavioural willingness, before reaching risk behaviours, where the decision is made whether or not to engage in the behaviour. Therefore the social reaction path reflects the factors of previous behaviours, attitudes and subjective norms, risk prototypes and behavioural willingness to engage in risk behaviour. Of interest for the thesis are the factors of behavioural willingness and risk prototype.

Gibbons and Gerrard (1995) have argued that when risky behaviours are impulsive or socially undesirable, such as risky driving (e.g., speeding) rather than measuring one’s intentions to engage, these behaviours are better measured by behavioural willingness. Behavioural willingness is defined as the “recognition that one would be willing to engage in the behavior under some circumstances” (Gibbons & Gerrard, 1997, p. 79). An individual’s willingness accounts for motivations that do not directly rely on planning or goal formation, and though engagement in risky driving is usually volitional by youth (e.g., speeding, drag racing, illegal manoeuvres), sometimes it is not planned or intentional (e.g., speeding, driving while distracted, tailgating; Gerrard et al., 2008; Gibbons & Gerrard, 1995; Rivis et al., 2011). Therefore, when compared with similar models, such as the theory of planned behaviour, because this model allegedly accesses intentional and unconscious, unplanned or non-goal-directed driving behaviours, it may provide insights as to why novice drivers elect to engage, or not engage, in risky driving behaviours.

Willingness has been shown to successfully predict a range of risk behaviours independently of intention, even though the two are correlated (Gibbons et al., 2004; Gerrard et al., 2008; Gibbons, Gerrard, Blanton, & Russell, 1998). Measurement of
willingness differs from measuring intentions, as willingness is a response to risk-related circumstances or situations (Gerrard et al., 2008). PWM questionnaire respondents are given a description of a hypothetical scenario, where it is also explained that no assumption is being made that they would ever be in such a situation. The scenario allows the question to shift some of the focus of attention, attribution, and any bias that might influence a participant’s answer, from their self to the specified situation (Gerrard et al., 2008; Gibbons et al., 1998). For example, in a scenario describing novice drivers speeding, a willingness to speed in the company of peers may be a stronger predictor of speeding than the novice driver’s intention to speed (Gerrard et al., 2008). If a young driver holds a favourable prototype of a risky young driver, the more likely is it that the young driver will speed if the circumstances to do so arise (Scott-Parker, Hyde et al., 2013).

Prototypes or risk images are the “cognitive representations or social images of the type of person who engages in specific risk behaviors” (Gerrard et al., 2008, p. 36). For some individuals these images have a visual component, however, within PWM they represent a typology rather than a description of the physical appearance of the type of person (Gerrard et al., 2008; Gibbons & Gerrard, 1995). Two aspects of prototype perception influence risk decisions: prototype similarity, and prototype favourability (Gerrard et al., 2008; Rivis et al., 2011). These two aspects (prototype favourability and prototype similarity) interact, so that the more strongly a person identifies with a particular prototype (considered prototype similarity), and the more positively the image is viewed (prototype favourability), the combined result of these two aspects influences how willing the person is to engage in the behaviour that is defined by the prototype image (e.g., safe or unsafe driver; Gerrard et al., 2008; Gibbons & Gerrard, 1995; Rivis et al., 2011). It follows that changes in engagement in risky behaviours are linked to changes in a person’s favourability of prototype
perception (positive, more engagement or negative less engagement; Rivis et al., 2011; Thornton et al., 2002).

Furthermore, the more favourable the prototype, the more willing the person is to accept the social consequences associated with the behaviour, for example, being seen by others as someone who engages in the behaviour (Gerrard et al., 2008). In a study of risky driving in a sample of US university students, Gibbons and Gerrard (1995) found that perceptions of the typical “risky driver” prototype could predict changes in participants’ self-reported engagement in risky driving behaviour. However, Rivis et al. (2011) found that prototype evaluation (positive or negative, through its interaction with prototype similarity) predicted older, but not younger, males’ willingness to drink and drive. The interest of this finding is it is generally assumed that prototypes are more influential for younger than for older people’s risk behaviours (Gerrard et al., 2008; Rivis et al., 2011). Scott-Parker, Hyde et al. (2013) also found evidence countering earlier research, such that prototypes and intentions did not significantly predict speeding for novice drivers. However, for female provisional drivers, higher reported willingness to speed as a learner driver did predict current speeding engagement (Scott-Parker, Hyde et al., 2013).

Arising from previous findings that focused on the risky driving behaviours of speeding and drink driving, Chapter 5 (study 3) applies PWM predictors (self-perception, willingness, prototypes) to a sample of novice drivers. Study 3 will again examine speeding and drink driving, while also exploring PWM predictability of other risky driving behaviours, such as distraction, seatbelt use, and fatigue. This study also explores driver sex differences, and whether participants in this sample held safe (positive) or unsafe (negative) driver prototypes, and the influence that this has on their willingness to engage in risky driving behaviours. This study addresses research aim 1, and it is expected that some key PWM variables will contribute to the proposed
conceptual framework that attempts to explain novice drivers’ perception of risk, and whether they choose to engage in risky driving behaviours.

**Interventions aimed at novice drivers**

Changing attitudes by presenting general statistics as interventions have been found to have little effect on preventing or reducing risky driving (Frank & Lee, 2007; Paaver et al., 2013). While driving education and training are popular as driving-based interventions, little evidence has been found for their reducing novice drivers’ crash and fatality rates (Mayhew, Simpson, Williams, & Ferguson, 1998; Scott-Parker, Bates, Watson, King, & Hyde, 2011). Furthermore, evidence has been found that driver education, specifically within graduated driver licensing schemes, may actually increase crash rates (Ferguson, 2003; Mayhew, Simpson, & Pak, 2003). Scare tactics using media campaigns employing loaded imagery or intimidating statistics of the dangers of risky driving have been found not to deter drivers from engaging in these behaviours (e.g., Taubman-Ben-Ari, 2000). However, research has revealed that novice drivers do demonstrate good awareness of the riskiness of dangerous driving behaviours, and are objectively able to rate and report that driving behaviours such as the fatal five are very risky and/or dangerous to engage in (Fernades, Hatfield, & Job, 2010; Harbeck & Glendon, 2013; Paaver et al., 2013).

In spite of this, many novice drivers still engage in risky behaviours. Researchers have found that even when novice drivers are aware of the dangers, they may believe that a particular driving behaviour is not risky for them, or that possible adverse consequences (MVC, injuries, fatality) will not happen to them (Harré, Foster, & O’Neill, 2005). Novice drivers have also reported that media messages targeted at their demographic are perceived not to be personally relevant, although they may agree with the message portrayed (McKenna & Horswill, 2006). This relates to what has been dubbed the *third-person effect* (Davison, 1983), where a safety or risk awareness
message may be perceived as applicable to others, but not to the intended recipient (Cathcart & Glendon, 2016; Glendon & Walker, 2013; Lewis, Watson, & Tay, 2003, 2007; Tay & Watson, 2002). It follows that the success of interventions targeted at novice drivers are problematic unless the behaviour change techniques employed are successful.

What has been found to be effective in changing underlying attitudes in the prevention of motor vehicle crashes is teaching behavioural and cognitive skills, similar to those described below, for controlling risky driving engagement or improving hazard perception (Beanland et al., 2013; Makeham, 2000; Paaver et al., 2013). Interventions using insight-based training, which provides drivers with both knowledge and experience, have also been associated with lower self-reported engagement in risky driving behaviours (McKenna, Horswill, & Alexander, 2006). Interventions that focus on improving cognitive skills (e.g., hazard perception, situational awareness) have also been found to improve road safety and reduce crash risk in inexperienced drivers (Beanland et al., 2013; Isler, Starkey, & Sheppard, 2011; Peck, 2011). The most prominent road safety interventions targeted at young novice drivers are graduated driver licensing (GDL) programs.

**Graduated driver licensing systems**

Since 2006, through their respective government bodies of transport and main roads, Australian states have made changes to the inexperienced driver licensing system. While GDL systems differ between jurisdictions, they all adhere to a fundamental principle of providing a stepwise approach to full licensing, designed to improve the safety of novice drivers by extended supervision and driving experience over time (Scott-Parker et al., 2011; Williams & Shults, 2010). The first country to adopt a GDL program was New Zealand in 1987, and similar programs have been implemented in many countries (Scott-Parker et al., 2011). In their most basic form,
GDL programs typically involve a 3-stage licensing system consisting of a learner’s period (minimum 1 year), a provisional licence stage (minimum 2 years), and a full open licence (when learner and provisional periods have been completed successfully). GDL licence holders are required not only to adhere to all standard traffic and licensing regulations but also have special restrictions and criteria applied at each licensing stage. Therefore, GDLs are associated with reducing crash rates for novice drivers by gradually introducing them to more high-risk driving situations, and increased driving experience. A Cochrane Systematic review evaluating GDLs and reducing the crash risk for young drivers (Russell, Vandermeer, & Hartling, 2011) reported evidence that studies evaluating GDLs showed reductions in all crash types. However, these reductions varied in size and determining which aspect/s of the GDL program that had the most effect was not extracted.

In July 2007, the Queensland Government implemented a new GDL program aimed at reducing the overrepresentation of novice drivers in motor vehicle crashes. Some of these changes included the amended graduated licensing system (Learner, Provisional 1 [P1], Provisional 1 [P2], and Open Licence). Senserrick (2009) provided a full review of Australian GDLs. To address the high crash rates for P1 drivers in particular, restrictions were placed on night-time driving, carrying peer passengers, and driving high-powered vehicles (Scott-Parker & Rune, 2016; Senserrick, 2009). Further reforms were progressively implemented during 2013 and 2014 within the current licensing system (minimum age requirements for P2 and open licences of 18 and 20 years respectively; DTMR, 2013a).

The Queensland Department of Transport and Main Roads (DTMR) maintained that this licensing system encouraged safe driving and would reduce road crashes under the premise that it allowed novice drivers to gain more experience and improve their overall driving skills, before they were allowed to upgrade to a higher type or class of
licence (DTMR, 2013a). Similar messages emanated from other Australian states. Of particular interest within this reformed licensing system were: changes to the provisional stage of licensure, and completion of an online hazard perception test, before moving to the next stage of licensing.

Though all Australian states and territories follow a GDL, differences occur. For example, the minimum age requirement for novice driver to obtain their full unrestricted (open) licence is 18.5 years for the Northern Territory (NT), 19 years for South Australia (SA) and Western Australia (WA), 20 years for the Australian Capital Territory (ACT), New South Wales (NSW), Queensland (QLD), and Tasmania (TAS), and 22 years for Victoria (VIC). Differences also occur in the duration and restrictions during the provisional phase (Scott-Parker & Rune, 2016; Senserrick, 2007, 2009).

Regarding completion of a hazard perception test (HPT), an integral component for GDLs internationally, three states (ACT, NT, TAS) do not employ these tests, three states (VIC, SA, WA) require their own HPTs to be successfully completed before a novice driver can upgrade to a P1 licence, and two states (NSW, QLD) include the test during the P1 phase, before the driver can upgrade to a P2 licence (Scott-Parker & Rune, 2016; Senserrick, 2007, 2009). However, from November 2017, passing the hazard perception test was compulsory before obtaining a P1 licence, for VIC, SA, WA and NSW. QLD will be the only state to still test novice drivers during the P1 to P2 transition (Centre for Road Safety NSW, 2017). These differences among the states and territories are noteworthy as inexperience, and poor hazard perception are strongly linked with increased crash risk for novice drivers (Beanland et al., 2013; Isler et al., 2011; Sagberg & Bjørnskau, 2006; Williams & Mayhew, 2008). However, only four of the eight states and territories in Australia will examine hazard perception before the most at-risk period, the P1 stage.

**Hazard perception and hazard perception tests (HPTs)**
A driver’s ability to anticipate, judge, and respond appropriately to potentially dangerous traffic situations is considered a crucial aspect of driver competence, and an important skill that has been found to be associated with crash risk (Horswill, Taylor, Newman, Wetton, & Hill, 2013; Sagberg & Bjørnskau, 2006). A traffic conflict, is defined as a “situation where your vehicle is on course to hit another road user such as a pedestrian, cyclist, bus, truck, motorbike or another car” (DTMR, 2007, p. 5). The accurate and rapid perception of road hazards, which might otherwise lead to a traffic conflict, is considered to be a vital component of safe driving (Scialfa, Borkenhagen, Lyon, & Deschenes, 2013). Consequently tests that measure a driver’s hazard perception have been included in driver training programs, assessment and graduated licensure frameworks worldwide (Scialfa et al., 2013). Two unique components of hazard perception identified from the literature are: 1) the degree of perceived danger or crash risk associated with a situation, and 2) the driver’s perception and reaction time (identification and response) to the hazard (Sagberg & Bjørnskau, 2006). HPTs are designed to measure one or both of these components. A driver’s hazard perception is examined by testing the driver’s skill with two formats, static (still images), and dynamic (video sequences or simulations; Scialfa et al., 2013).

Hazard perception is one of the few driving-related skills that have been reliably associated with crash risk (Boufous et al., 2010; Boufous, Ivers, Senserrick, & Stevenson, 2011; Horswill et al., 2010, 2013; Wetton, Hill, & Horswill, 2011). Hazard perception has also been found to play a mediating role between factors of road safety, described below, and crash involvement (Horswill et al., 2013). The mediating effect of hazard perception between risky driving behaviours and crash risk has been found for predictors such as driving experience, sleepiness/fatigue, traumatic brain injury, distraction, and blood alcohol content (Horswill et al., 2013). Horswill and McKenna
Young novice driver cognitions and behaviour (2004) explained that driving experience, independent of age, is more likely to influence driving hazard perception.

In the first few months after obtaining their P1 licence, novice drivers’ crash risk is at its highest. Crash risk decreases substantially after the first 1600km driven (Kinnear et al., 2013; McCartt et al., 2003), and decreases even further after their first 4000km cumulative kilometres driven (Kinnear et al., 2013). Researchers have suggested that this may be due to an important driving skill being learnt, specifically improved hazard perception. Kinnear et al. (2013) stated that the, “precise mechanisms underlying hazard perception remain unknown, although there is evidence for both cognitive and visual search components” (p. 1025). However, Groeger (2000) explained that four processes involved in hazard perception were: 1) accurately detecting the hazard, 2) appraising the magnitude of the threat, 3) selecting appropriate actions to avert the hazard, and 4) implementing decided actions. Horswill and McKenna (2004) explained that, compared to experienced drivers, novice drivers seemed to fail at each stage of the hazard perception process, even though, compared with older drivers, younger drivers are thought to have greater cognitive and psychomotor capacity. More than age, driving experience (e.g., kilometres driven) is thought to be to be an influential factor in driving hazard perception, and lower crash risk has been attributed to improvement in this crucial driving skill (Beanland et al., 2013; Horswill & McKenna, 2004; Sagberg & Bjørnskau, 2006). However, there has been mixed evidence to support this claim, for example, Sagberg and Bjørnskau (2006) found no strong relationship between hazard perception reaction time and driving experience. These authors concluded that hazard perception (using the dynamic approach with a focus on the identification and response test) might only be a minor factor in explaining lower crash rates in novice drivers. This inconsistent evidence requires further research.
To help address novice drivers’ inexperience on the road, which was forwarded as the biggest factor that resulted in young driver fatalities on Queensland’s roads (DTMR, 2005), an HPT was implemented within the new GDL framework. The Queensland HPT is an online computer-based assessment that aims to measure a “driver’s ability to recognise and appropriately respond to potentially dangerous situations while driving” (DTMR, 2007, p. 2). This test takes approximately 13-15 minutes to complete. P1 licence holders must pass this test to graduate to a P2 or Open licence (dependent on age) in Queensland only (from November 2017), other states (e.g., VIC, SA, WA, NSW) use their HPT at the Learner to P1 licensing stage (Scott-Parker & Rune, 2016).

DTMR maintains that the HPT differs from conventional licence tests, which focus on road rules and vehicle control, as it is designed to test both a driver’s ability to identify a potential hazard when driving and the time required to react and avoid a potential crash (DTMR, 2013b). This is achieved by showing participants a series of video clips of traffic scenes in which identification of a potential traffic conflict that would require a decision to be made, results in a correct action being taken within an appropriate time period (e.g., slow down, overtake or change course). If the vehicle is required to slow down or change course to prevent a crash, then this is considered to be a traffic conflict. This HPT was developed by Horswill and colleagues and is described further in Wetton, Hill, and Horswill (2011).

DTMR (2005, 2017) explained that this HPT has the potential to encourage the development of novice drivers’ hazard perception skills and that testing ensured that these drivers had the skills to progress to the next level of licensing. The Queensland HPT was implemented in 2007, and at the time of writing, there were no reports or information provided by DTMR that had determined whether this had been successful. However, evaluating this computer-based hazard perception measure, Wetton et al. (2011) reporting that the measure and its video-based instructions were a valid and
reliable measure of hazard perception, able to discriminate between experienced (low crash), and inexperienced (high crash) drivers. They also provided evidence that it was a fair and accessible measure of assessment, with no bias found for education, income, computer experience, or gender and that drivers’ with lower abilities in English could comprehend the test (Wetton et al., 2011).

Other studies have examined and evaluated the use of hazard perception assessment within Australia. In Victoria, which first implemented an HPT within their licensing system in 1996, a HPT was found to predict fatal MVCs (Catchpole & Leadbeatter, 2000). The Victorian HPT was designed to focus on identifying hazards in crash scenarios that had been reported to highlight skill insufficiency (e.g., in traffic merging), which was common among provisional drivers (e.g., misjudgements), and was frequently experienced by drivers (e.g., intersections). Though the measure has been revised and shows improved reliability over its original version, the Victorian HPT does contain gender bias, whereby males score significantly higher than females do, and does not significantly discriminate between experienced and novice drivers (Catchpole, Congdon, & Leadbeatter, 2001; Catchpole & Leadbeatter, 2000). In NSW, the DRIVE study (Boufous et al., 2011) collected data from 20,822 young novice drivers, and compared their HPT scores with police recorded crashes. After controlling for demographic variables (age, gender, SES, location, driving experience), and reported risky driving behaviour, the study found that the risk of being in a motor vehicle crash was almost double for those who had failed their HPT twice or more (Boufous et al., 2011). Consequently, research has been conducted to determine whether hazard perception can be improved by training.

For the purposes of this thesis and the studies (5, 6, and 7) that examine it, hazard perception is conceptualised as having two distinct phases: detection and action. Detection describes whether a driver perceives that a road related hazard is occurring,
either abruptly (e.g., vehicles stopping ahead, a vehicle suddenly merging into the driver’s lane without prior indication, animals running onto the road ahead), or as a gradual onset (e.g., curves in the road or changing road surfaces identified by road sign, vehicles with their indicators left on, pedestrians on or near roads, navigating road works). Detection comprises two key components: knowledge and identification. Knowledge refers to the driver’s awareness and understanding to what a driving related hazard is. These can be from learned definitions, theoretical knowledge, and/or previous experience of hazards encountered that have led to a possible traffic conflict. If a driver does not have adequate knowledge of what constitutes a driving related hazard, then they may not be able to identify and appropriately respond to hazards, which may in turn reduce their perception-reaction time. Identification, refers to the level of situational awareness a driver engages in, their scanning of the road around them while they drive. It is also the degree of perceived danger or crash risk associated with a situation. Therefore, the driver recognises that a hazard (either abrupt or gradual onset) is occurring and must act to avoid a potential traffic conflict.

This leads to the second phase – action, which is defined as what the driver does to avoid the hazard. This also comprises two key components: response and handling. Response is what the driver does when a hazard has been detected. This can involve behaviours such as slowing the vehicle, emergency braking, safely stopping the vehicle (e.g., at traffic lights, intersections, stop signs), adjusting vehicle lane position, or changing lane. Sometimes no response occurs, due either to the hazard not being detected, or because the hazard has been resolved without the driver needing to respond (e.g., some gradual onset hazards, such as a pedestrian unsafely crossing the road ahead returning to a position of safety before the driver approaches). The second component, hazard handling, refers to whether the driver has avoided the potential traffic conflict. This might be an MVC, which occurs when a vehicle collides with another vehicle,
pedestrian, animal, road debris, or other stationary obstruction (e.g., a tree, pole or building). Alternatively, it might be a near miss, or close call, where a traffic collision was close to occurring, but due to evasive action was avoided. If a traffic collision or near miss was avoided in time, the driver is deemed to have handled the hazard well, and as a result resolved the potential traffic conflict. As traffic collisions can often result in injury, death (of drivers, passengers and other road users such as pedestrians, cyclists and motorcyclists), and property damage, appropriate hazard handling, in-conjunction with hazard knowledge, identification and response is important for continued road safety and provides motives for improved hazard perception through training.

**Hazard perception training**

Hazard perception has been linked to safer driving through better risk detection of potentially hazardous situations. Consequently, research has explored whether hazard perception can be improved with training. McKenna et al. (2006) proposed that skill-based training might decrease both knowledge-based (awareness that the behaviour is risky and may be dangerous) risk taking, and ignorance-based risk taking. Inexperienced drivers may participate in a driving behaviour with a relatively poor understanding of potentially risky outcomes and consequences (e.g., tailgating leading to rear-end crashes, minor speeding leading to the vehicle being unable to stop in time to avoid a collision). It is probable that, novice drivers have engaged in hazardous driving due to their inexperience, where they have failed to detect the presence of a hazard (Wang et al., 2010). McKenna et al. (2006) concluded that anticipation training, which is training in anticipating hazards, can significantly decrease drivers’ risky driving inclinations through better hazard perception. This is accomplished by increasing the anticipation of danger and reducing at least the part of risk taking that may be due to ignorance (McKenna et al., 2006). Horswill et al. (2013) summarised
numerous studies to test this proposition, concluding that hazard perception does appear to change through counteractive interventions that target inexperience and ignorance.

Targeting inexperience and ignorance is important, because even if novice drivers are able to detect a potential hazard in time, some novice drivers may not know, or may be unsure of how to appropriately avoid a collision, which could be due to time pressure, inexperience, and/or psychological strain (Wang et al., 2010). Wang et al. (2010) suggested that during training it might be helpful to safely expose novice drivers to specific virtual hazardous scenarios via a driving simulator to help improve their hazard perception skills, and the detection of and successful response to, traffic conflicts. Whether this type of training, or other interventions designed to improve hazard perception, actually lowers driver crash risk, including novice drivers, is not known.

Research has demonstrated that hazard perception training is more effective than education-based training (Horswill et al., 2013; McKenna et al., 2006; Pradhan et al., 2009; Shinar, 2007). Horswill et al. (2013) demonstrated that even brief hazard perception training (20min video-based training) could improve highly experienced drivers’ (police officers and 10+ years open licence holders) hazard perception skills. However, whether this can be applied successfully for novice drivers has yet to be determined, though preliminary research using driving simulators (e.g., Wang et al., 2010) has shown promising results for novice male drivers, as has video-based road commentary training for both genders (Isler, Starkey, & Williamson, 2009).

Many studies implementing different training and/or intervention techniques have been conducted on drivers’ hazard perception training. While Scialfa et al. (2013) demonstrated that both static and dynamic HPTs have good reliability, simulator-based training has advantages over some other training methods (e.g., PC-based, video-based). These include: preserving the safety of the driver (Brooks et al., 2010; Riener, 2011),
which is a method comparable with on-road training and allocation of cognitive resources (Vlakveld, 2011), and provides a wider field of view for detection of cues and better realism (Shahar, Alberti, Clarke, & Crundall, 2010). In their literature review, Caird and Horrey (2011) identified nine key advantages and nine key disadvantages for using driving simulators in research that incorporated driver training and assessment. The advantages and applicability of simulators to research in road safety cannot be ignored while acknowledging the disadvantages of using them: in particular generalizability, real world reproducibility, costs due to considerable hardware and software development requirements and imprecision and inflexibility in low-cost simulators unable to address all research needs (Caird & Horrey, 2011); Conversely, key advantages of using driving simulators, beyond driver safety in crash like situations include: controlling confounding variables (e.g., weather, road surface), control over scenario design, replicability, and imitation of perceptual information while driving, where the simulation is able to produce emotional reactions similar to real-world driving. These advantages allow structured driver training to be developed and implemented (Caird & Horrey, 2011).

Training, or other interventions targeted at assisting inexperienced drivers to detect and anticipate hazards, may help to reduce ignorance-based risky driving behaviours (e.g., tailgating, speeding, unsafe overtaking). The most prominent Australian study that provided hazard perception training is the DriveSmart CD-Rom program (Regan, Triggs, & Godley, 2000). This program was evaluated examining driver performance in a high fidelity simulator, with motion features and changes in the Victorian HPT. The authors reported that participants who completed the program and who were assessed via a driving simulator immediately before and four weeks after training, demonstrated safer driving skills and improved hazard perception during general driving when compared with control group participants (Regan et al., 2000).
However, this training was designed for learner drivers, and required four separate sessions to be administered, which impacted facilitation and driver retention, as not all participants completed the program.

Horswill and McKenna’s (2004) review highlighted the fact that most hazard perception studies use video-based traffic scenarios, where these measures have demonstrated good reliability and validity in hazard perception identification and knowledge of hazards. Yet, they do lack accurate driver response to hazards and there is still debate over how much the response on static or video HPT actually translates across to participants driving in the real world. Studies using either video or simulator based HPT to examine hazard perception performance, are either only experimental in design, have the research focus on evaluating only their own HPT and/or only identify the correlates of hazard perception and differences in driver experience levels (e.g., Borowsky et al., 2010; Crundall et al., 2012; Scialfa et al., 2011; Ventsislavova et al., 2016; Wetton et al., 2010). Some studies (e.g., Gugliotta et al., 2017) have only examined one component of hazard perception (e.g., hazard prediction), and other hazard perception training has either focused on learner drivers (e.g., Crundall et al., 2010; Regan et al., 2000), or male novice drivers (Wang et al., 2010). Another limitation occurs when the training session requires a lengthy time frame for completion, which can affect retention and replication in larger driver populations (e.g., Isler et al., 2011).

In a review of the efficacy of driver training, Beanland et al. (2013) reported that interventions using driver training reviewed between 2001-2011 had major methodological flaws (e.g., no control group, poor randomisation, failure to account for confounding variables, poor paradigm design). This led to inconclusive findings and poor fidelity of results. Beanland et al. (2013) highlighted the need for more robust
research and appropriate evaluation to improve the reliability and validity of interventions targeting either improving driver skills and or road safety.

In Australia, driver training is predominately focused on the learner stage of driving, with the GDLs being the intervention designed to improve post-learner drivers. However, research has highlighted that newly unsupervised novice drivers have the greatest risk of injury and death in motor vehicle crashes (Sagberg & Bjørnskau, 2006; Williams & Mayhew, 2008), are often found to be at fault for the crash (Braitman et al., 2008), and are over-represented in national road injury and death tolls (BITRE, 2017).

Due to the wide range of applicability of HPTs in research and formal assessment, an aim of this research was to examine whether additional hazard perception training, and more importantly, what type of training, may improve young (aged 17-25 years) P1 drivers hazard perception (knowledge, identification, response, and hazard handling).

To evaluate all four components of hazard perception, an active, dynamic format HPT, via a driving simulator was selected. Use of a simulator allows drivers to engage more actively in presented hazard scenarios that mimic real driving (steering, braking and acceleration as appropriate), as opposed to passive viewing.

Performance in a virtual driving simulator has been found to be highly correlated with on-road performance in young and middle-aged drivers (Ivancic & Hesketh, 2000). Use of a driving simulator should provide high fidelity, face validity and, compared with use of video sequences, enhanced reality (Caird & Horrey, 2011; Shahar et al., 2010). The driving simulator will also ensure participant safety while conducting the test. It also has the potential to reveal other significant features of novice driving behaviour that are unobtainable with other methods (e.g., self-report measures, naturalistic driving observations, driving records), such as how novice drivers actually respond to a series of hazards in a relatively short timeframe. The hazard perception training, scenario design and development are discussed further in Chapter 7.
Evaluating driver interventions

Preventing and reducing MVCs involving drivers of all age groups is important for governments, policy makers, and researchers. The focus on novice drivers arises from the factors discussed above that increase novice drivers’ MVC risk. Therefore, research on novice drivers’ perceived risk and reported engagement in risky driving is vital to understanding how and why novice drivers choose whether to engage in risky driving behaviours. Research findings can provide important information on how driving interventions can be improved for target driver groups (Ivers et al., 2009; Shope, 2006). Furthermore, as most unsafe driving behaviours do not result from deliberate risk taking, driver training provides an excellent medium to address novice driver contributing factors to increased crash risk (e.g., over-confidence, ignorance, inexperience, poor hazard perception). However, driving and road safety interventions should be tailored to specific populations and should include exit testing to assess the extent to which the training achieved its objectives (Beanland et al., 2013). While state governments have been proactive in attempting to combat the high rate of novice driver deaths on Australian roads with interventions targeting younger drivers, it is critical that interventions are evaluated (Beanland et al., 2013; Filtness, Tones, Bates, Watson, & Williamson, 2013; Glendon, McNally, Jarvis, Chalmers, & Salisbury, 2014; Queensland Government, 2009). Driving interventions need to be evaluated on their effectiveness and efficacy, regardless of popularity within the driving public (Scott-Parker et al., 2011), and to assess whether the effects of training via the intervention are maintained over time (Vlakveld, 2011).

Interventions should ideally be based on validated theory and grounded in a sound, evidence-based understanding of contributing factors (Fernandes et al., 2010; Shope, 2006; Shope & Bingham, 2008). Such interventions that address risky driving engagement are scarce within traffic psychology. In an extensive review of the traffic
psychology literature (1998-2008), Glendon (2011b) found that intervention or evaluation research only accounted for a very small percentage of published research. Of over 1400 peer-reviewed traffic psychology publications, less than two percent (28 studies) were classified as intervention or evaluation studies (Glendon, 2011b). The small number of intervention/evaluation studies with a novice driver focus represents a significant gap within the literature that needs to be filled.

This led to the third research aim of the thesis, evaluating the brief training session that was designed in study 5 and implemented in study 6. In study 7, the factors identified from models evaluated in studies 1, 2, and 3, are used to examine initial associations between novice drivers’ hazard identification and response to road user related hazards that were tested in study 6. Furthermore, key objectives of hazard perception (identification, response and handling) improvement, increased hazard knowledge, and whether the training session was helpful, informative, applicable to real life driving, and recommended for other provisional drivers were assessed. This is expanded upon and discussed further in Chapter 9.
CHAPTER 3

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

Chapter 3 presents the first study of the thesis, which is a journal article that has been accepted for publication. Due to this format, there is some repetition between the Chapter 2, in theoretical content and rational. In this study, young drivers (N = 643, 490 females) aged 17-25 years completed an online questionnaire that examined their sensitivity to reward, sensitivity to punishment, perceived risk of risky driving behaviours and reported engagement in risky driving behaviours. The aim of this study was to explore the influence of driver age, sex, driving experience, and RST variables reward and punishment sensitivity, which was operationalized using Torrubia et al.’s (2001) Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), on young drivers’ perceived risk and reported risky driving. Risky driving engagement was measured using the previously validated and reliable measure of Scott-Parker, Watson, King, and Hyde’s (2012c) revised Behaviour of Young Novice Drivers Scale (BYNDS), specifically the transient and fixed violation subscales. Therefore this chapter addresses a component of Research Aim 1 of the thesis.
Statement of contribution to co-authored published paper: Paper 1

This chapter includes a co-authored paper. The bibliographic details of the published co-authored paper, including all authors, are:


Permission to provide article (post-print) in thesis is approved by the publisher, Elsevier, where “Authors can include their articles in full or in part in a thesis or dissertation for non-commercial purposes”.

My contribution to the paper involved:

- Conception and design of the research paper,
- Review and interpretation of literature,
- Conducting data analysis to produce the article,
- Analysis and interpretation of research data,
- Writing and revising of the paper

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Supervisor: Dr Trevor Hine
October, 2017
Reward versus punishment: Reinforcement sensitivity theory, young novice drivers’ perceived risk, and risky driving

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

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., 2012a; Scott-Parker, Watson et al., 2013). One reason is young drivers’ engagement in risky driving, contributing factors to which include: driver’s age, sex, personality, perceived risk, 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 licenced 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) licence (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 licence) 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 licence is four times more likely to be involved in a fatal crash than is an Open licence 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 perceived risk, 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.

**Risky driving and perceived risk**

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). Perceived risk 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 perceived risk), 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.

**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 & Pérez, 2004; Harbeck & Glendon, 2013; Scott-Parker et al., 2012a, Scott-Parker, Watson et al., 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 risk 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, 2012b), and lower perceived risk (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. (2012b) 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’ perceived risk and risky driving therefore merits further research.

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

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 & Pérez, 2004; Constantinou et al., 2011), and reported risky driving (Scott-
Young novice driver cognitions and behaviour

Parker et al., 2012b; Scott-Parker, Watson et al., 2013). 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.

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.

Method

Participants

Participants were drivers (\(N = 643\), 490 females, 17-25 years, \(M = 20.0\), \(SD = 2.3\)) who held an Australian driver’s licence (P1, P2, or Open), and who drove a car regularly (other vehicle types excluded). A P1 licence was held by 190 (29.5%), while 246 (38.3%) held a Provisional 2 (P2) licence, and 207 (32.2%) held an Open licence. Participants had held their licence 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 licenced instructor), learner drivers were not included as they would have been unlikely to report engaging in risky driving.

Measures

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

Perceived risk of risky driving behaviours

This variable measured a driver’s perceived riskiness of specified driving behaviours. Items were written 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

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

**Reported risky driving engagement**

Scott-Parker, Watson, King, & Hyde’s (2012c) 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.

**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.

**Procedure and design**

After obtaining ethical approval from the authors’ University Human Research Ethics Committee, the online survey tool was developed 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 licence 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.

**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.

**Correlations**

Table 3.1 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.

**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 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 $\chi^2$,
Table 3.1

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

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

Note: * p < .05, ** p < .00
normed $\chi^2 < 3$, AGFI and CFI > .90, RMSEA < .1). The final recursive model and fit statistics are in Figure 3.1.

Figure 3.1. Path diagram showing effects of RST, driver sex, age, and length of licensure on perceived risk and reported engagement in risky driving ($N = 643$).

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 perceived risk, 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.

**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 perceived risk, 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’ perceived risk, and risky driving engagement.

**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. (2012b), 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.

**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., 2012b; Scott-Parker, Watson et al., 2013; Torrubia et al., 2001). High reward-sensitivity drivers may be considered to be risky drivers (Scott-Parker et al., 2012b; Scott-Parker, Watson et al., 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, Watson 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 licence fee monetary deductions (Constantinou et al., 2011; Harbeck & Glendon, 2013; Scott-Parker, Watson 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 et al., 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.

**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) perceived risk, 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 perceived risk, and higher engagement in risky driving.

**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 licence holders and/or professional driving instructors), before a provisional licence 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 the perceived risk 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.

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 (af Wåhlberg, Barraclough, & Freeman, 2015; 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 (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, 2017) 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.

**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, Watson 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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CHAPTER 4

Young driver perceived risk and risky driving: A theoretical approach to the “fatal five”

Chapter 4 presents the second study of the thesis, which consists of a journal article that has been submitted for publication and is currently under review. The original submission was returned with reviewer and editorial comments, which were responded to, and the revised paper shown here was resubmitted in March 2018. Due to this format, there is some repetition between this chapter and Chapter 2 in theoretical content and rationale. In this study, young drivers (N= 601; 457 females) aged 17-25 years anonymously completed a 143-item online survey that measured: 1) coping and threat appraisal for the fatal five, 2) perceived risk of driving related behaviours, and 3) violations subscales from the Behaviour of Young Novice Drivers Scale (BYNDS; Scott-Parker et al., 2012c). Applying protection motivation theory (PMT) as the theoretical framework, the constructs of severity, vulnerability, rewards (threat appraisal), response efficacy, self-efficacy, and response costs (coping appraisal) have not been previously operationalized across multiple risky driving behaviours. Therefore an aim of the study 2 was to develop, initially validate, and test a measure that examined all six PMT components, using the fatal five as the driving-related criterion variables. This was intended to identify factors that may/not influence a young driver’s perceived risk, and/or their reported risky driving engagement, which addresses research aim 1 of the thesis.
Statement of contribution to co-authored published paper: Paper 2

This chapter includes a co-authored paper. The bibliographic details of the published co-authored paper, including all authors, are:


Permission to provide article (post-print) in thesis is approved by the publisher, Elsevier, where “Authors can include their articles in full or in part in a thesis or dissertation for non-commercial purposes”.

My contribution to the paper involved:

• Conception and design of the research paper,
• Review and interpretation of literature,
• Conducting data analysis to produce the article,
• Analysis and interpretation of research data,
• Writing and revising of the paper

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Young driver perceived risk and risky driving: A theoretical approach to the “fatal five”

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Abstract

While enduring determinants of young drivers’ risky driving (e.g., as represented by the “Fatal five”), such as age and gender, cannot be changed, research with young drivers can identify psychological variables that may be subject to influence to inform interventions seeking to reduce risky driving. Coping and threat appraisal variables from protection motivation theory can assist understanding young driver decision making for risky driving. A sample of young provisional or open license Australian drivers ($N = 601$; aged 17-25 years, $M = 20.0, SD = 2.3$) anonymously completed an online survey measuring: 1) coping and threat appraisal for the Fatal five driving behaviours, 2) perceived risk of driving-related behaviours, and 3) violation subscales from the Behaviour of Young Novice Drivers Scale. Using path analysis, coping appraisal, threat appraisal, and perceived risk modelled both maladaptive and protective decision-making pathways applicable to young drivers when engaging in risky driving. Goodness-of-fit statistics supported both proposed conceptual models with reward, response costs, and perceived risk showing moderate associations with young driver reported risky driving. This novel adaptation of protection motivation theory assists understanding factors that may contribute to young driver engagement in risky driving (maladaptive pathway), and why young novice drivers may choose not to engage in risky driving (protective pathway). Applications and further implications of the models are discussed.

Keywords: protection motivation theory, severity, vulnerability, reward, response efficacy, response costs
Young driver perceived risk and risky driving: A theoretical approach to the “fatal five”

**Background**

With young drivers (aged 17-25 years) being over-represented in national road-related death and injuries worldwide (BITRE, 2015; WHO, 2013, 2015), determinants of contributors to young novice driver engagement in risky driving, such as the Fatal five (speeding, drink driving, fatigue, not wearing a seatbelt, and distraction) have been extensively researched. Predictors of young driver engagement in risky driving behaviours include inter alia: age, gender, (Cordellieri et al., 2016; Rhodes & Pivik, 2011) and personality variables (e.g., sensation seeking, aggression; Machin & Sankey, 2008; Olstedal & Rundmo, 2006; Scott-Parker, Watson, King, & Hyde, 2013). However, these relatively enduring determinants are either difficult or impossible to change (Shope, 2006). Therefore, research with young drivers could usefully identify psychological variables, apart from personality, such as driving related attitudes, beliefs and cognitive decision-making processes, which may be subject to influence to further inform interventions aiming to reduce the incidence of risky driving, and improving young driver road safety.

Effective preventive strategies ideally require identification of young drivers who are prone to risky driving before negative consequences, such as serious injury or death, occur. Thus, research on young drivers’ risk perception and other factors that might contribute to reported engagement in risky driving is vital to improve understanding of how and why young drivers may engage in risky driving. Such research should help to guide and evaluate targeted interventions, which is important for governments, policymakers, and practitioners.

The most prominent road safety interventions targeted at young novice drivers are graduated driver licensing (GDL) programs. In Australia, while GDL systems differ
between state jurisdictions, they all adhere to a fundamental principle of providing a stepwise approach to full licensing, designed to improve the safety of novice drivers by extended supervision and driving experience over time (Scott-Parker et al., 2011; Williams & Shults, 2010). In their most basic form, GDL programs commonly involve a 3-stage licensing system consisting of a learner’s period (minimum 1 year), a provisional licence stage (minimum 2 years), and a full open licence (when learner and provisional periods have been completed successfully). GDL licence holders are required not only to adhere to all standard traffic and licensing regulations but also have special restrictions and criteria applied at each licensing stage (Scott-Parker et al., 2011; Williams & Shults, 2010).

Strategically-derived interventions are ideally based on validated theory, and grounded in sound evidence-based understanding of contributing factors (Fernandes, Hatfield, & Job, 2010; Shope, 2006; Shope & Bingham, 2008). However, interventions that address risky driving engagement are limited within the traffic psychology literature. The small proportion of intervention/evaluation studies with a young driver focus represents a significant gap within the literature (Glendon, 2011a). It has also been reported that road safety evaluations are still being published, either without a recommended conceptualisation and methodology or are of atheoretical design (Vingilis, 2016).

Social–cognitive models, such as the theory of reasoned action/planned behaviour (Ajzen, 1998), have been the conceptual framework most applied to driving behaviours (Glendon, 2011a). The health belief model (Rosenstock, 1974), and protection motivation theory (PMT; Rogers, 1975), have also been applied to study predictors of young drivers’ risky driving. These models explain that variables such as attitudes, perceived risk, self-efficacy, social norms, and perceived behavioural control, are key predictors of behaviour (Cathcart & Glendon, 2016; Glendon & Walker, 2013; Ulleberg
& Rundmo, 2003). As highlighted by Vingilis (2016), theory-driven evaluation based on established models and frameworks can improve interpretation of outcomes, and enhance road safety initiatives, preventive strategies, and countermeasures (e.g., deterrence theory in Meirambayeva et al., 2014).

**Perceived risk**

Of interest in the current study is perceived risk, which is a subjective judgement about a specific risk’s severity and characteristics. A driver’s perception of the inherent risk in an activity may influence decision-based behaviours. However, for young drivers while perceived risk has been shown to have a significant negative association with self-reported engagement in risky driving (Harbeck & Glendon, 2013; Machin & Sankey, 2008), conflicting results have been found whereby perceived risk was found to be unrelated (i.e., had no relationship) to risky driving (e.g., Ulleberg & Rundmo, 2003).

Traditionally, perceived risk has been operationalized as a person’s perception of the likelihood of an undesired event multiplied by the worst case adverse consequences (Bauer, 1960). Other perceived risk dimensions include: frequency, severity or magnitude, the probability of involvement in an accident, worry, and concern (Cox, 2008; Machin & Sankey, 2008; Ulleberg & Rundmo, 2003). When examining perceived risk in driving-related research using scales/questionnaires to measure perceived risk, the likelihood that the risky driving behaviours would result in a motor vehicle crash (MVC) is multiplied by the perceived severity of the subsequent, negative consequences (e.g., physical harm) of each behaviour (Lund & Rundmo, 2009; McNally & Bradley, 2004; van Gelder et al., 2009). Compared with young females, young male drivers tend to rate the likelihood of an MVC occurring to themselves as lower (Cordellieri et al., 2016), perhaps due to influences such as optimism bias (a belief that they are less at risk of experiencing a negative event compared with others), and overestimating their
personal driving ability/competence (Glendon, Dorn, Davies, Matthews, & Taylor, 1996; Lewis, Watson, & Tay, 2007; Wohleber & Matthews, 2016).

Ivers et al. (2009) identified perceived risk as an independent predictor of young drivers’ crash risk likelihood, although the effect of perceived risk was attenuated by reported engagement in risky driving. Nevertheless, perceived risk is important in predicting risky driving engagement (Rhodes & Pivik, 2011), for crash risk reduction, developing safety campaigns, and promoting safe driving for young drivers (Hassan & Abdel-Aty, 2012; Shope, 2006). In the current study, Bauer’s conceptualisation was applied in a driving-related context, such that adverse consequences were conceptualised as an aversion to risky driving engagement, and the likelihood of an undesired event was conceptualised as perceived likelihood of a MVC as a result of risky driving.

**Protection motivation theory (PMT)**

A social–cognitive model, PMT’s two primary cognitive mediating processes in decision making are threat appraisal, and coping appraisal (Floyd, Prentice-Dunn, & Rogers, 2000; Rogers, 1975, 1983). Threat appraisal’s three components are severity, vulnerability, and rewards. Coping appraisal’s three components are response efficacy, self-efficacy, and response costs. These processes combine to form the intervening variable, protection motivation, which is the immediate precursor of the target behaviour (Floyd et al., 2000).

Research addressing the effects of fear appeals on health attitudes and behaviours has successfully applied PMT to various issues, including, health-related promotion and injury prevention (Floyd et al., 2000). Within traffic psychology, PMT has been successfully applied in exploring drunk driving (Cismaru, Lawack, & Markewich, 2009; Greening & Stoppelbein, 2000; Murgraaff, White, & Phillips, 1999), effectiveness of anti-speeding messages (Cathcart & Glendon, 2016; Glendon & Walker, 2013), and...
driver fatigue (Tay & Watson, 2002). The current study extends the number of risky driving behaviours that have been included within a PMT framework, including drug-driving, seatbelt use, unsafe overtaking, illegal driving manoeuvres, distraction, and mobile phone use.

Theoretically applied to a potential MVC, PMT can represent a driver’s judgement of the probability of a harmful event happening to them (e.g., a MVC resulting from risky driving; see Figure 4.1). The components comprise: a) the driver’s perceived vulnerability, b) their perception of the severity of an event (e.g., fatality, injury, loss of licence, property damage) if it happened, and c) the rewards (intrinsic or extrinsic) associated with the behaviour (e.g., personal enjoyment, peer adulation). To effectively cope with such a threat, a driver must appraise: d) the efficacy of a protective response (e.g., not engaging in driving behaviours that could increase MVC risk, such as not exceeding the speed limit), e) their self-efficacy through their perceived ability to execute coping behaviours successfully (e.g., maintaining good driving behaviours, such as following the speed limit, not tailgating), and f) potential costs associated with executing a coping response (e.g., loss of time, peer criticism). The probability that a driver will perform a protective behaviour (safe driving behaviour, such as wearing their seatbelt, not running a red light), rather than a maladaptive behaviour, will be greater if the driver identifies with a stronger response efficacy, has higher self-efficacy, and perceives fewer costs in performing the protective behaviour. Engaging in maladaptive driving behaviours (e.g., speeding, driving while distracted) is more likely if a driver has positive views about the rewards associated with the behaviour, and perceives low vulnerability and severity from engaging in the behaviour (Floyd et al., 2000).

These two decision-making pathways, protective and maladaptive, assist in identifying risky and non-risky driver models. Theoretically, the maladaptive pathway should be associated with lower perceived risk, and higher engagement in risky driving
Fig. 4.1. Conceptual model of protection motivation theory applied to driving behaviours.

Note: MVC = motor vehicle crash
behaviours, while the protective pathway should be associated with higher perceived risk, and lower engagement in risky driving behaviours. PMT is proposed as a basis for exploring young novice drivers’ threat and coping appraisal in respect of risky driving behaviours (e.g., the fatal five).

**The current study**

While a young driver may be presented with numerous opportunities to engage in risky driving, actually engaging in risky driving does not necessarily occur. Reasons for this may be situation specific and be influenced by a number of factors (e.g., peer presence, driving environment, driver ability, and affect). As a conceptual framework, PMT may help in understanding the young driver decision-making process for engaging in risky driving. As assessing PMT variables across multiple risky driving behaviours has not previously been undertaken, the current study aims to create, initially validate, and test a measure that examines all six PMT components, using the Fatal five as the driving-related criterion variables. This is intended to identify factors that may/not influence a young driver’s perceived risk, and/or their reported risky driving engagement. A measure that applies Bauer’s conceptualisation of perceived risk to a number of risky driving behaviours will also be created and initially validated.

A second study aim is to develop a path-analytic model to identify PMT variables, as well as perceived risk, as predictors of young drivers’ reported engagement in a number of risky driving behaviours. As well as direct and indirect associations between the predictor variables and the behavioural criterion, associations between the PMT variables, perceived risk, and reported risky driving are also expected. These hypotheses are proposed.
Young novice driver cognitions and behaviour 84

1. Higher: a) reward and both lower b) perceived vulnerability, and c) severity, will be associated with: i) lower perceived risk, and ii) higher reported engagement in risky driving behaviours (maladaptive behaviours path).

2. Higher: a) response efficacy, b) self-efficacy, and c) lower response costs, will be associated with: i) higher perceived risk, and ii) lower reported engagement in risky driving behaviours (protective behaviours path).

3. Within the maladaptive pathway, lower perceived risk will predict higher reported engagement in risky driving behaviours. This negative relationship should also be found within the protective path model.

Methodology

Participants

A total of 783 drivers participated in the study. However, 182 cases were removed due to incomplete responses (n = 165), or identification as a learner driver (n = 17). Learner drivers were excluded on the grounds that their behaviour would be substantially moderated by the presence of a supervisor (most commonly a parent, or a licensed instructor), which would have influenced any reported risky driving engagement. Remaining respondents (N = 601, aged 17-25 years, M = 20.0, SD = 2.3; 457 females) drove a car regularly (excluding moped, motorbike, truck, bus, etc.), and reported driving for a mean of 211.7 km (SD = 176.4) a week. Of these 176 (29.3%) held a Provisional 1 (P1) license, 231 (38.4%) a Provisional 2 (P2) license and 194 (32.3%) held an open license.

The sample was randomly split into Sample A and Sample B. Sample A was used for the item analysis, the exploratory factor analysis (EFA) of the individual PMT

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Young novice driver cognitions and behaviour 85

factors, and the perceived risk of risky driving behaviours measure. Sample B was
retained as a validation sample after the PMT and perceived risk items had been reduced
to their final scale for the study to test the proposed model. Chi-square and independent
sample t-tests indicated that these two groups did not differ on any of the demographic
variables, suggesting no bias between the samples. Sample A had 301 participants ($M = 
20.1, SD = 2.4; 74.4\%$ female). Sample B included 300 participants ($M = 19.8, SD = 
2.3; 79.0\%$ female) – both included respondents aged 17-25 years.

Measures

Participants anonymously completed a 143-item online survey, which was part of
a larger survey conducted to evaluate multiple models. Demographic items asked for
participants’ age, gender, licence type, vehicle type usually driven, and average number
of kilometres driven per week. The measures are described below.

Perceived risk. The 12 items developed for the perceived risk of risky driving
behaviours scale were based on risk perception scales created by Ivers et al. (2009), and
Machin and Sankey (2008). Items were written to focus on cognitive aspects of
Perceived risk: aversion to risk taking (perceived danger) for the driving behaviour, and
perceived likelihood of a MVC occurring as a result of each behaviour. An initial 30
items were reduced through EFA to identify the best item pool that represented
perceived risk of risky driving behaviours. The measure resulted in two subscales
named aversion to risky driving and perceived likelihood of a MVC. The risky driving
behaviours were: speeding, drink-driving, drug-driving, seatbelt use, driving while
fatigued, driving while distracted, mobile phone use, tailgating, unsafe overtaking,
illegal driving manoeuvres (e.g., U-turns at prohibited intersections), red light
violations, and driving with peer passengers.

The 6-item aversion to risky driving subscale measured the perceived riskiness of
the driving behaviours. Items focused on respondents’ cognitions as a driver rather than
their reported behaviour. The response scale ranged from: 1 = *not risky at all*, to 5 = *very risky*. Higher scores indicated higher perceived risk of risky driving behaviours.

The 6-item perceived likelihood of a MVC occurring subscale measured perceived likelihood of a MVC occurring as a consequence to the driving-related behaviour. It specified “the young novice driver”, with an explanation provided as to what this term meant. The scale ranged from: 1 = *not likely at all*, to 5 = *very likely*. Higher scores indicated higher perceived likelihood of a MVC occurring.

**Reported risky driving engagement.** Two subscales from Scott-Parker et al.’s (2012c) revised Behaviour of Young Novice Drivers Scale (BYNDS; 18 items) measured risky driving engagement. Higher BYNDS scores indicate more self-reported risky driving engagement in the previous month of driving. BYNDS subscales use a 5-point response format from: 1 = *never*, to 5 = *almost always*. As only the transient violations (12 items), and fixed violations (6 items) subscales were included in this questionnaire, this variable was renamed “reported risky driving engagement” in the model to more accurately reflect the construct that was measured.

**Protection motivation theory.** Based on previous research (e.g., Greening & Stoppelbein, 2000; Murgraff, White, & Phillips, 1999), items were designed to measure the two subscales: Threat appraisal and Coping appraisal. Each subscale contains three factors, severity, vulnerability, and rewards form the Threat appraisal subscale; while response efficacy, self-efficacy, and response costs form the Coping appraisal subscale. The items were written to measure decision-making processes relating to driving behaviours that represent the fatal five (speeding, drink-driving, seatbelt use, fatigue, distraction). An initial 90 items were reduced to 30 through EFA to identify the best item pool to represent fatal five driving behaviours.

**Threat appraisal.** This construct was measured by 15 items within three subscales: severity, vulnerability, and reward. The 5-item *perceived severity* subscale required
participants to rate the severity (short- and/or long-term consequences) of engaging in driving behaviours relating to the fatal five on a scale from: 1 = *no consequences at all*, to 5 = *the consequences are deadly*. Higher scores indicated higher perceived severity.

**Vulnerability** was assessed with a 5-item scale asking participants to rate their personal vulnerability to the possible risk of being involved in a MVC in which serious injury or a fatality occurred due to engaging in the driving behaviour presented. Ratings ranged from: 1 = *it is impossible that I will experience this event*, to 5 = *I will definitely experience this event*. Higher scores indicated higher perceived vulnerability.

**Reward** was measured by 5 items asking participants to rate how rewarding (intrinsic or social rewards – e.g., peer approval) they perceived each of the behaviours to be on a scale from: 1 = *not rewarding at all*, to 5 = *very rewarding*. Higher scores indicated higher perceived reward.

**Coping Appraisal.** This construct was measured by 15 items within three subscales: response efficacy, self-efficacy, and response costs. The 5-item *response efficacy* subscale required participants to appraise the efficacy of a protective response (not engaging in risky driving behaviours that could increase the likelihood of a MVC). The risky driving behaviours were reworded to describe behaviours that represented the protective (adaptive) response to decreasing MVC risk (e.g., driving within the speed limit, or always wearing a seatbelt), termed “safe driving” responses. These behaviours were rated on a scale from: 1 = *not effective at all*, to 5 = *highly effective*. Higher scores indicated higher perceived response efficacy.

**Self-efficacy.** Initiating alternative actions was measured by 5 items asking participants to rate how confident they would feel about their own ability to respond adaptively with the protective response driving behaviour to decrease the likelihood of a MVC. Responses were from: 1 = *not confident at all*, to 5 = *very confident*. Higher scores indicated higher perceived self-efficacy in safe driving responses.
Response costs. Implementing alternative protective responses differs conceptually from rewards, being obstacles to adopting adaptive responses, rather than incentives for a maladaptive response. Response costs can include both intrinsic and extrinsic factors (Greening & Stoppelbein, 2000). Participants indicated how much they agreed with 5 statements concerning the personal costs of safe driving alternatives to the fatal five risky driving behaviours. Responses were from: 1 = strongly disagree, to 5 = strongly agree. Higher scores indicated higher reported perceived response costs to the protective responses.

Procedure

After obtaining ethical approval from the authors’ University Human Research Ethics Committee, the online survey tool was created in LimeSurvey v1.91. The hyperlink to the online survey was advertised using the University’s e-news-sheet Volunteer for Important Research Projects, and the authors’ School of Applied Psychology participant pool. The survey was available online for three months. Participants aged 17 to 25 years, who met the licensing criteria, were invited to complete the survey. Incentives for participation included the opportunity to win one of three $100 gift vouchers, or research participation credit for eligible students. After the online survey had closed, the data were exported into a statistical software package and cleaned ready for data analysis. All analyses were conducted using IBM SPSS v22.0, and IBM SPSS Amos v22.0.

Statistical analyses

Descriptive statistics summarise scaled scores. Perceived risk and PMT items were evaluated through skew and kurtosis assessments, inter-item correlations (criterion $r < .80$), item-total correlations (criterion $r \leq .70$), and corrected item-total correlations (criterion $r \geq .30$, with redundancy indicated if $r \geq .80$ (Shum, O’Gorman, Myors, & Creed, 2013). Items that did not meet minimum cut-offs were considered for deletion.
After item analysis of both the reported perceived risk scale and PMT of the Fatal five driving behaviours scale, an EFA was conducted on remaining items. A significant Bartlett’s test of Sphericity and a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of < .70 was set for sample suitability. A 2-factor solution was predicted for the perceived risk scale (aversion and likelihood), and 3-factor solutions were predicted for the PMT coping appraisal (response efficacy, response cost, self-efficacy), and threat appraisal scales (reward, perceived vulnerability, perceived severity). Though different descriptors for the subscales were used for the response format, range (1-5), weighting and valence for the factors remained the same. As factors within the measure were correlated, an oblique rotation was applied with principal components for extraction. Item performance in each factor was examined by applying a > .40 factor loading.

Reliability for finalised measures and established scales was assessed using internal consistency (Cronbach’s alpha). Acceptable level of internal consistency was set at > .70 (Nunnally & Bernstein, 1994). Sample sizes of 300 are considered adequate for psychometric tests, such as factor analysis and path modelling (Hair et al., 2010; Tabachnick & Fidell, 2013).

Bivariate correlations examined the strength of association between variables. Bivariate correlations between continuous variables used Pearson’s product moment correlation coefficient (r). Hu and Bentler’s (1999), and Byrne’s (2001) recommended indices cut-off values for assessing fit were used and values set to an Chi-square/degrees of freedom (χ²/df) of < 3, non-significant p-value, a comparative fit index (CFI) of > .90, an adjusted goodness-of-fit (AGFI) of > .90, a standardised root mean square residual (SRMR) of < .10, and a root mean square error of approximation (RMSEA) of < .08.
Results

Item reduction and EFA

Using Sample A ($n = 301$), the initial 30 perceived risk and 90 PMT items were assessed for poor distributions (e.g., skew, kurtosis), high inter-item correlations ($r > .70$), and low item-total correlations ($r < .30$). This resulted in 14/30 items from the perceived risk subscale, and 45/90 items from the PMT subscale being excluded from subsequent analyses.

A series of EFAs (principal components) assessed the subscales’ underlying structure. Items were assessed and individually removed if a criterion was not met (cross-loaded items and items with a factor loading < .40 were removed iteratively). The EFA resulted in four items being removed from the perceived risk scale, and 15 items from the PMT subscales. The KMO measures of sampling adequacy were: .79 (perceived risk), .80 (threat appraisal), and .82 (coping appraisal). Bartlett’s test of sphericity was significant ($p < .001$), with each measure indicating that the data were suitable for an EFA. Table 4.1 shows item means, SDs, corrected item total correlations, and factor loadings for the final items in the perceived risk scale (likelihood and aversion), and the PMT factors: perceived severity, reward, perceived vulnerability, response efficacy, self-efficacy, and response cost. Six items remained in each of the perceived risk subscales, and five items remained in each of the PMT subscales. Table 4.2 summarises the EFA results, and shows Cronbach alphas and scale descriptive statistics. Finalised subscales and the construct they measured met all assessed criteria for establishing initial validity and reliability.
<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Corrected item-total correlation</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived Risk: Aversion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving while feeling tired or fatigued</td>
<td>4.03</td>
<td>0.89</td>
<td>.40</td>
<td>.77</td>
</tr>
<tr>
<td>Driving a vehicle while using a hands-free mobile phone</td>
<td>2.70</td>
<td>0.93</td>
<td>.40</td>
<td>.71</td>
</tr>
<tr>
<td>Driving a vehicle while distracted (e.g., due to drinking, eating, smoking, changing a CD).</td>
<td>3.34</td>
<td>1.02</td>
<td>.49</td>
<td>.64</td>
</tr>
<tr>
<td>Driving at 70km/hr in a designated 60km speed zone</td>
<td>2.89</td>
<td>1.05</td>
<td>.43</td>
<td>.48</td>
</tr>
<tr>
<td>Performed an illegal driving manoeuvre (e.g., illegal U-turn, donut, burnout, drifting)</td>
<td>4.04</td>
<td>0.99</td>
<td>.50</td>
<td>.47</td>
</tr>
<tr>
<td>Driving while closely following another vehicle (at less than 2 seconds distance)</td>
<td>4.11</td>
<td>0.81</td>
<td>.45</td>
<td>.45</td>
</tr>
<tr>
<td><strong>Perceived risk: Likelihood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving while closely following another vehicle (at less than 2 seconds distance)</td>
<td>3.81</td>
<td>0.92</td>
<td>.54</td>
<td>.82</td>
</tr>
<tr>
<td>Overtaken a vehicle by crossing double white lines</td>
<td>3.76</td>
<td>0.99</td>
<td>.52</td>
<td>.79</td>
</tr>
<tr>
<td>Performed an illegal driving manoeuvre (e.g., illegal U-turn, donut, burnout, drifting)</td>
<td>3.64</td>
<td>1.02</td>
<td>.56</td>
<td>.66</td>
</tr>
<tr>
<td>Driving a vehicle soon after having drunk alcohol but over the legal BAC limit of .05</td>
<td>2.94</td>
<td>0.99</td>
<td>.47</td>
<td>.63</td>
</tr>
<tr>
<td>Driving a vehicle while using a hand-held mobile phone</td>
<td>3.91</td>
<td>0.83</td>
<td>.52</td>
<td>.61</td>
</tr>
<tr>
<td>Driving at 120km/hr in a designated 100km/hr speed zone</td>
<td>2.68</td>
<td>1.04</td>
<td>.56</td>
<td>.41</td>
</tr>
<tr>
<td><strong>Threat Appraisal: Perceived Severity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive from a location (i.e., workplace, place of study, home etc.) while feeling tired or physically fatigued</td>
<td>3.04</td>
<td>1.02</td>
<td>.43</td>
<td>.74</td>
</tr>
<tr>
<td>Exceed the designated speed limit but under 10km/hr (e.g., driving 66km/hr in a designated 60km/hr zone)</td>
<td>2.25</td>
<td>0.88</td>
<td>.44</td>
<td>.73</td>
</tr>
<tr>
<td>Drive after taking medication that indicates you should not operate a vehicle</td>
<td>3.76</td>
<td>1.08</td>
<td>.33</td>
<td>.68</td>
</tr>
<tr>
<td>Driving without your seatbelt buckled in</td>
<td>2.40</td>
<td>1.07</td>
<td>.51</td>
<td>.65</td>
</tr>
<tr>
<td>Driving while having a conversation on your mobile phone with a hands free device</td>
<td>2.51</td>
<td>0.95</td>
<td>.42</td>
<td>.46</td>
</tr>
<tr>
<td><strong>Threat Appraisal: Perceived Vulnerability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exceed the designated speed limit between 10 and</td>
<td>2.37</td>
<td>0.94</td>
<td>.57</td>
<td>.89</td>
</tr>
<tr>
<td>Item</td>
<td>Mean</td>
<td>SD</td>
<td>Corrected item-total correlation</td>
<td>Factor Loading</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>------</td>
<td>-----</td>
<td>----------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>20km/hr (e.g., driving 115km/hr in a designated 100km/hr zone)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overtake a slower vehicle by exceeding the designated speed limit</td>
<td>2.74</td>
<td>0.97</td>
<td>.55</td>
<td>.74</td>
</tr>
<tr>
<td>Driven a vehicle soon after having drunk alcohol but within the legal BAC limit of .05</td>
<td>2.59</td>
<td>1.03</td>
<td>.49</td>
<td>.66</td>
</tr>
<tr>
<td>Driving during the late hours of the night (11pm-4am)</td>
<td>2.54</td>
<td>1.04</td>
<td>.52</td>
<td>.43</td>
</tr>
<tr>
<td>Driving while using your mobile phone in your hand to text someone</td>
<td>2.60</td>
<td>0.93</td>
<td>.50</td>
<td>.43</td>
</tr>
<tr>
<td><strong>Threat Appraisal: Reward</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overtake a slower vehicle by exceeding the designated speed limit</td>
<td>2.04</td>
<td>1.10</td>
<td>.67</td>
<td>.79</td>
</tr>
<tr>
<td>Driving while using your mobile phone in your hand to text someone</td>
<td>1.31</td>
<td>0.67</td>
<td>.61</td>
<td>.77</td>
</tr>
<tr>
<td>Driving while consuming food or drink, or smoking a cigarette</td>
<td>1.97</td>
<td>1.03</td>
<td>.62</td>
<td>.77</td>
</tr>
<tr>
<td>Exceed the designated speed limit between 10 and 20km/hr (e.g., driving 115km/hr in a designated 100km/hr zone)</td>
<td>1.61</td>
<td>0.99</td>
<td>.61</td>
<td>.73</td>
</tr>
<tr>
<td>Driving while having a conversation on your mobile phone with a hands-free device</td>
<td>1.80</td>
<td>1.01</td>
<td>.53</td>
<td>.73</td>
</tr>
<tr>
<td><strong>Coping Appraisal: Response Efficacy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving while avoiding to engage in distractive driving (e.g., consuming food or drink, or smoking a cigarette) that requires your hand/s to be off the steering wheel</td>
<td>3.60</td>
<td>1.42</td>
<td>.52</td>
<td>.89</td>
</tr>
<tr>
<td>To not drive after taking medication that indicates you should not operate a vehicle</td>
<td>3.71</td>
<td>1.52</td>
<td>.50</td>
<td>.79</td>
</tr>
<tr>
<td>Not driving while using your mobile phone in your hand</td>
<td>4.01</td>
<td>1.32</td>
<td>.54</td>
<td>.66</td>
</tr>
<tr>
<td>Overtake a slower vehicle only when safe and lawfully able to do so</td>
<td>3.54</td>
<td>1.46</td>
<td>.47</td>
<td>.62</td>
</tr>
<tr>
<td>Not exceeding the designated speed limit when you drive</td>
<td>4.04</td>
<td>1.17</td>
<td>.44</td>
<td>.55</td>
</tr>
<tr>
<td>Item</td>
<td>Mean</td>
<td>SD</td>
<td>Corrected item-total correlation</td>
<td>Factor Loading</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>------</td>
<td>-----</td>
<td>----------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Coping Appraisal: Self-Efficacy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overtake a slower vehicle only when safe and lawfully able to do so</td>
<td>4.05</td>
<td>1.14</td>
<td>.54</td>
<td>.78</td>
</tr>
<tr>
<td>Driving with your seatbelt buckled in</td>
<td>4.44</td>
<td>1.07</td>
<td>.46</td>
<td>.77</td>
</tr>
<tr>
<td>Not driving while using your mobile phone in your hand</td>
<td>4.14</td>
<td>1.21</td>
<td>.40</td>
<td>.74</td>
</tr>
<tr>
<td>Not exceeding the designated speed limit when you drive</td>
<td>4.18</td>
<td>1.04</td>
<td>.43</td>
<td>.69</td>
</tr>
<tr>
<td>Driving while avoiding to engage in distractive driving (e.g., consuming food or drink, or smoking a cigarette) that requires your hand/s to be off the steering wheel</td>
<td>3.80</td>
<td>1.31</td>
<td>.55</td>
<td>.50</td>
</tr>
<tr>
<td><strong>Coping Appraisal: Response Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would be at a disadvantage if I did not speed like everyone else</td>
<td>2.17</td>
<td>1.06</td>
<td>.62</td>
<td>.80</td>
</tr>
<tr>
<td>I need to speed to overtake a slower vehicle that is holding back traffic</td>
<td>3.00</td>
<td>1.12</td>
<td>.58</td>
<td>.80</td>
</tr>
<tr>
<td>Not exceeding the designated speed limit at times causes me to waste time that I don’t have</td>
<td>2.36</td>
<td>1.09</td>
<td>.61</td>
<td>.79</td>
</tr>
<tr>
<td>Driving while having a conversation on my mobile phone with a hands free device prevents me from wasting time</td>
<td>2.94</td>
<td>1.10</td>
<td>.37</td>
<td>.59</td>
</tr>
<tr>
<td>After a night of drinking, it is more convenient for me to drive my own car home than use a taxi/cab</td>
<td>2.19</td>
<td>1.30</td>
<td>.34</td>
<td>.51</td>
</tr>
</tbody>
</table>

SD = standard deviation
Table 4.2.
*Summary statistics for final measures (Sample A; n = 301)*

<table>
<thead>
<tr>
<th>Measures</th>
<th>N items</th>
<th>Eigenvalue</th>
<th>Scale Mean (SD)</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Risk</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>.83</td>
</tr>
<tr>
<td>Aversion</td>
<td>6</td>
<td>1.25</td>
<td>21.12 (3.60)</td>
<td>.70</td>
</tr>
<tr>
<td>Likelihood</td>
<td>6</td>
<td>4.19</td>
<td>20.74 (4.04)</td>
<td>.79</td>
</tr>
<tr>
<td>Threat Appraisal</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>.76</td>
</tr>
<tr>
<td>Perceived vulnerability</td>
<td>5</td>
<td>4.76</td>
<td>12.83 (3.77)</td>
<td>.83</td>
</tr>
<tr>
<td>Reward</td>
<td>5</td>
<td>2.77</td>
<td>10.73 (3.66)</td>
<td>.81</td>
</tr>
<tr>
<td>Perceived severity</td>
<td>5</td>
<td>1.22</td>
<td>13.97 (3.56)</td>
<td>.75</td>
</tr>
<tr>
<td>Coping Appraisal</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>.77</td>
</tr>
<tr>
<td>Response efficacy</td>
<td>5</td>
<td>4.46</td>
<td>18.90 (5.07)</td>
<td>.79</td>
</tr>
<tr>
<td>Response costs</td>
<td>5</td>
<td>2.49</td>
<td>12.64 (3.95)</td>
<td>.73</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>5</td>
<td>1.19</td>
<td>20.61 (4.28)</td>
<td>.80</td>
</tr>
</tbody>
</table>

*SD = standard deviation*

**Path analysis**

Using Sample B (n = 300), prior to path analysis, the constructs: perceived risk, coping appraisal, and threat appraisal were computed, using the finalised items that met the criteria identified from the EFAs. Means, *SDs*, Cronbach’s alphas, and Pearson correlations for all measured variables to be entered into the model are in Table 4.3. As required for structural equation modelling, the models for testing were derived from PMT’s theoretical basis – that is, applying the maladaptive pathway using threat appraisal variables, and the protective pathway using coping appraisal variables as directly predicting perceived risk and reported risky driving by young novice drivers. Each hypothesis was represented as a predicted path, with curved two-headed arrows connecting coping variables (response cost, self-efficacy, response efficacy), and threat
Table 4.3.
Means, standard deviations, Cronbach’s alpha and Pearson correlations for measured variables (Sample B; n = 300)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Alpha</th>
<th>Response efficacy</th>
<th>Self-efficacy</th>
<th>Response cost</th>
<th>Perceived severity</th>
<th>Reward</th>
<th>Perceived vulnerability</th>
<th>Perceived risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response efficacy</td>
<td>18.97</td>
<td>5.07</td>
<td>.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>20.61</td>
<td>4.43</td>
<td>.80</td>
<td>.59**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response cost</td>
<td>12.55</td>
<td>4.04</td>
<td>.73</td>
<td>-.02</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived severity</td>
<td>14.08</td>
<td>3.61</td>
<td>.75</td>
<td>.16**</td>
<td>-.06</td>
<td>-.33**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reward</td>
<td>8.60</td>
<td>3.56</td>
<td>.80</td>
<td>.07</td>
<td>.10</td>
<td>.39**</td>
<td>-.16**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived vulnerability</td>
<td>12.99</td>
<td>3.75</td>
<td>.83</td>
<td>-.03</td>
<td>-.18**</td>
<td>-.28**</td>
<td>.66*</td>
<td>-.15*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived risk</td>
<td>449.07</td>
<td>145.11</td>
<td>.83</td>
<td>.12*</td>
<td>-.05</td>
<td>-.33**</td>
<td>.66*</td>
<td>-.21**</td>
<td>.59*</td>
<td>.39**</td>
</tr>
<tr>
<td>Risky driving engagement</td>
<td>16.80</td>
<td>9.01</td>
<td>.88</td>
<td>-.18**</td>
<td>-.09</td>
<td>.50**</td>
<td>-.30**</td>
<td>.39**</td>
<td>-.18**</td>
<td>-.42**</td>
</tr>
</tbody>
</table>

Note: *p < .05, **p < .001
Young novice driver cognitions and behaviour 96

appraisal variables (reward, perceived vulnerability, perceived severity) to identify associations. These models were tested using IBM Amos, applying maximum likelihood for the estimation method. Fit statistics used to assess the recursive models indicated that the proposed maladaptive pathway for why young drivers may perceive less risk, and report engaging in risky driving behaviours fitted the data, $\chi^2/df = 2.75$, $p = .064$, SRMR = .020, AGFI = .946, CFI = .993, RMSEA = .076 (90% CI .000–.156), see Figure 4.2 for the conceptual model. Threat appraisal explained 49% of the variance in perceived risk and the overall model explained 27% of the variance in reported risky driving.

The second recursive model, which measured the protective pathway for why young novice drivers may perceive higher risk and not engage in risky driving behaviours, also resulted in statistics indicating that the model fitted the data, $\chi^2/df = 0.45$, $p = .714$, SRMR = .011, AGFI = .991, CFI = 1.000, RMSEA = .000 (90% CI .000–.071). Figure 4.3 shows this conceptual model. Coping appraisal explained 14% of the variance in perceived risk and the overall model explained 34% of the variance in reported risky driving.
Figure 4.2. Path diagram showing maladaptive pathway of threat appraisal variables on perceived risk and reported risky driving engagement (Sample B; n = 300).

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

Figure 4.3. Path diagram showing protective pathway of coping appraisal variables on perceived risk and reported risky driving engagement (Sample B; n = 300).

Note: *p < .05, **p < .001
Within the maladaptive modelled pathway, H1a was supported. Reward had a negative association with perceived risk (H1ai), although this was smaller than reward’s direct path to reported risky driving (H1aii). H1b and H1c were partially supported, with positive associations found for perceived risk (H1bi, H1ci). No significant direct pathways were found for either perceived severity, or vulnerability, and reported risky driving (H1bii, H1cii). However, indirect pathways through perceived risk were present for perceived severity and vulnerability in the model, indicating that mediation may have occurred. To test the strength of the respective mediating effects, bootstrapping procedures in Amos were applied, specifying 1000 samples and bias corrected confidence intervals of 95% (Cheung & Lau, 2008). The standardised indirect effect of severity on reported risky driving was -.46 (SE .10; 95% CIs: -.68 ~ -.30), and the indirect effect of vulnerability on reported engagement was -.23 (SE .08; 95% CIs: -.42 ~ -.11). As the intervals did not include zero, results indicated mediation for both sets of variables. Of the threat appraisal variables, perceived severity had the strongest positive relationship with perceived risk, while reward had the strongest positive relationship with reported risky driving.

Within the protective modelled pathway, H2a and H2c were supported, with significant associations found between coping appraisal variables: response efficacy, and response cost to perceived risk (H2ai, H2ci), and to reported risky driving engagement (H2a(ii, H2c(ii)). H2b was not supported. A negative association was found between self-efficacy and perceived risk (H2bi), such that higher reported confidence in engaging in safer driving behaviours was associated with lower perceived risk for the risky driving behaviours. No direct association was found between higher self-efficacy and lower reported engagement in risky driving (H2bii). As with the maladaptive pathway, indirect paths included perceived risk mediating the relationship between coping appraisal and reported risky driving engagement, while partial mediation was
found for response cost and response efficacy, the direct effect of self-efficacy on reported risky driving was fully mediated by perceived risk. The indirect effect of self-efficacy was .16 (SE .06) and significantly different from zero (95% CIs: .06 ~ .29). Response costs had the strongest association with perceived risk and reported engagement, such that perceived lower costs of engaging in safe driving behaviours was associated with higher perceived risk, and lower reported risky driving engagement.

H3 was supported, with a significant negative association between perceived risk and reported risky driving in both models. The relationship was stronger in the maladaptive pathway than in the protective pathway. This makes theoretical sense, as lower overall threat appraisal would be associated with lower perceived risk, and consequently be associated with higher reported engagement in risky driving.

**Discussion**

This study first aimed to create, initially validate, and test measures that applied all six PMT factors, and perceived risk, using the Fatal five as the driving-related behaviours. The second aim was to use these created measures to model protective and maladaptive decision-making pathways of reported engagement in risky driving behaviours in a sample of young drivers. The created scales showed promising initial validity (content and construct), and reliability (internal consistency) as measured constructs. Fit statistics indicated that both modelled decision pathways fitted the data, and some hypotheses were supported.

As predicted, the maladaptive pathway model showed associations between variables whereby drivers who perceived lower severity and vulnerability, and higher reward, reported lower risk perception and reported higher engagement in risky driving. We predicted that cognitions of consequences (severity) and self-risk of experiencing an MVC if engaging in risky driving (vulnerability) would be directly negatively associated with reported risky driving. However, perceived risk (aversion to risky
driving and likelihood of an MVC if other drivers engaged in risky driving) fully mediated the relationship between perceived severity/vulnerability and reported risky driving. As severity and vulnerability focus on the young driver themselves, while perceived risk focuses on risk from other drivers, young driver optimism bias, or third-person effects (the self-perception that mass media messages have a greater effect on others than on themselves), though neither were tested in this study, may be possible explanations for this mediating effect and should be examined in future research (Glendon & Walker, 2013; Horswill & McKenna, 2006; Lewis et al., 2007; Wohleber & Matthews, 2016).

Reward was the only threat appraisal construct that had a direct association with reported risky driving. Participants who rated risky driving behaviours as being rewarding also tended to report higher risky driving engagement. This significant positive association supported research that examined the influence of reward in young drivers’ reported risky driving engagement (Harbeck & Glendon, 2013; Scott-Parker et al., 2013), and traffic violations (Constantinou et al., 2011). Due to increasing evidence for the influence of reward, researchers have highlighted the requirement to re-examine road safety initiatives that focus on disciplinary consequences and higher restrictions on young drivers as a method of reducing risky driving engagement (Constantinou et al., 2011; Scott-Parker et al., 2013).

The protective pathway model indicated that drivers who perceived higher effectiveness of safe driving behaviours in preventing MVCs and fewer costs associated with these behaviours, tended to report higher perceived risk, and lower risky driving engagement. Previous research has reported evidence for the effectiveness of the coping appraisal variables in increasing road safety driver fatigue advertisement message acceptance (Tay & Watson, 2002). Additionally, higher reported confidence in engaging in safe driving (self-efficacy) was associated with lower perceived risk,
contrary to what was predicted. This may have been because participants who are reporting higher confidence in safe driving also perceived lower risk as they considered the risky driving behaviours examined were not relevant to them. As the size of the effect was quite small, though significant, further research is required to confirm this relationship.

Response costs of safe driving behaviours was the strongest factor identified in the protective pathway model, being negatively associated with perceived risk and positively associated with participants’ reported risky driving engagement. This supported research on anti-speeding messages in which response costs were the highest-rated coping appraisal message when compared with self-efficacy and response efficacy (Cathcart & Glendon, 2016). However, compared to males, females reported significantly higher effectiveness of response costs of anti-speeding messages (Cathcart & Glendon, 2016). As the current sample was predominately female, this may have influenced the strength of response costs association with perceived risk and reported risky driving. Furthermore, scale items primarily measured response costs related to need for convenience, prevention of time being wasted, and feeling disadvantaged when compared to other drivers. McKenna and Horswill (2006) reported that variables such as journey time, economics, thrill, legal constraints, driver mood, and having passengers, significantly influenced how often drivers (mean age 31 years) reported engaging in driving violations. Therefore, targeting how young drivers perceive the costs of safe driving behaviours, particularly the costs highlighted above as more salient to this demographic, may be an opportunity to examine a decision-making cognition that could be adapted to improve young driver road safety.

Perceived risk had an unexpected mediating influence on all PMT variables. Examining indirect effects within the models, bootstrapped confidence intervals indicated that the standardised indirect effects were significantly greater than zero in all
instances. These results indicated that full mediation occurred for the associations between: 1) self-efficacy, 2) perceived severity, and 3) vulnerability, on reported risky driving engagement, and also partial mediation for: 4) reward, 5) response efficacy, and 6) response costs. While perceived risk thus appeared to be influential, mediators derived from cross-sectional data can result in biased estimates of their effects, so that mediation hypothesis testing should preferably be done with longitudinal data (Jose, 2016; Maxwell, Cole, & Mitchell, 2011; Preacher, 2015). Therefore, further research is necessary, using alternative methods to confirm results reported.

Research on young drivers using PMT variables has focused on drink-driving (e.g., Cismaru, Lawack, & Markewich, 2009; Greening & Stoppelbein, 2000), the effectiveness of anti-speeding messages (Cathcart & Glendon, 2016; Glendon & Walker, 2013), and driver fatigue (Tay & Watson, 2002). The perceived risk, coping, and threat appraisal scales in the current study enabled expansion of PMT variables to a larger number of risky driving behaviours – including the Fatal five, mobile phone use, unsafe overtaking, tailgating, and illegal driving behaviours. The 5- and 6-item scales could be completed by participants in a short amount of time, which can assist in reducing fatigue that can lead to responders not completing measures (Shum et al., 2013). The new scales will also allow researchers to examine perceived risk and PMT factors, either independently, or combined as measured variables, in driving-related studies. While evidence for acceptable initial validity and reliability was found for the created measures, further testing of the scales will be needed (e.g., confirmatory factor analysis, test-rest reliability, examining gender bias).

Study limitations included using samples with a female bias from a student population, which could have influenced application of the created measures, and generalizability of the results. To address this, future research with the scales and modelled pathways with a more gender-balanced sample from the young driver
population will be needed, particularly because when compared with females, males report higher engagement in risky driving, for example as reflected in traffic violations (Scott-Parker & Proffitt, 2015; Wohleber & Mathews, 2016). However, when compared with males, female drivers are becoming over-represented in MVCs, which has been attributable to errors in speed control, merging, and tailgating (e.g., Cordellieri et al., 2016). Though differences in males and females occur, due to this growing trend in MVCs continuing research that focuses on young female drivers’ cognitions that may be associated with risky driving is needed.

Other limitations included the cross-sectional design, self-report data, and common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Research examining various methodologies has found that self-report data from young drivers adequately matches naturalistic driving variables (e.g., Lajunen & Summala, 2003; Taubman–Ben-Ari, Eherenfreund–Hager, & Prato, 2016; Zhao et al., 2012). In using an anonymous online questionnaire format, we could not calculate an accurate response rate for the sample, although using this format did allow participants to report honestly and without penalty about risky driving engagement – including some illegal driving behaviour, which might have mitigated potential social desirability bias. By applying PMT, the presented models were imposed, so that no direction could be attributed, other than what would make theoretical sense. Thus, alternative models, such as testing possible direct effects of perceived risk on PMT variables, or modelling a non-recursive model (where influence may flow in more than one direction), were not examined due to insufficient theoretical justification. However, as gender and age differences in PMT variables have yet to be established, future research could also seek to examine if differences between genders within this age demographic (17-25 years) exist.

Neurophysiological evidence has suggested that, due to their age-related developmental stage and when compared with older drivers, young drivers, especially males, do not
possess the same cognitive development of the prefrontal cortex to appropriately manage the risks while operating a vehicle (Constantinou et al., 2011; Glendon, 2011b), which may affect the operation of PMT decision-making pathways.

Theoretical frameworks, such as PMT, may lead to more effective and targeted driver interventions or preventive strategies. Applying coping and threat appraisal constructs may help in further understanding young drivers’ decision-making process in respect of engaging in risky driving behaviours as a developing application in road safety, in addition to evaluating current interventions and behaviour change programs aimed at young drivers (Glendon & Walker, 2013). This might be achieved by examining young drivers’ levels of reward, perceived vulnerability, and severity of risky driving, and their perceived response costs of safe driving behaviours. Applying the models reported here, road safety initiatives seeking to reduce young driver engagement in risky driving could target reducing the effect of the maladaptive pathway, which might be accomplished by challenging some young drivers’ view of rewards associated with risky driving, and increasing their perceptions of severity and their own vulnerability via greater perceived risk. Reducing young drivers’ perceived response costs, and enhancing their response efficacy in respect of safe driving, might be expected to further activate the protective decision-making pathway, which could be associated with lower engagement in risky driving.

Conclusion

As young drivers are typically over-represented in traffic deaths and injuries, further research is needed to explore likely determinants and predictors of risky driving behaviours. Risky driving is frequently cited as a key contributor to the road toll, with road safety initiatives targeting this demographic remaining an important issue internationally for researchers, policymakers, practitioners, and governments. Indicators that provide insight into young drivers’ decision making are needed to assist in
evaluating interventions designed to improve young driver safety. The results from applying PMT to driving in young people have enabled us to circumscribe what may motivate young people to engage, or not engage, in risky driving. Additionally, our scales created, and conceptual models proposed in this study may assist in identifying such key indicators, using constructs that can be used to evaluate campaigns to address young driver cognitions into safer driving. This can then contribute to the growing body of potentially seminal works for theoretically-guided intervention development, application, and evaluation.

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CHAPTER 5

Driver prototypes and behavioural willingness: Young driver perceived risk and reported engagement in risky driving

Chapter 5 presents the third study of the thesis, which is a journal article that has been written as a manuscript for submission and is currently under review. Due to this format, there is some repetition between this chapter and Chapter 2 in theoretical content and rationale. In this study, young drivers (N=554, 429 females) aged 17-25 years completed an online questionnaire that examined PWM predictors (self-perception, behavioural willingness, prototype), operationalized in the context of risky driving engagement (the fatal five). The study also explored driver sex differences, and whether participants could be assigned to either safe (positive) or unsafe (negative) driver prototypes, and the association that this had with their reported willingness to engage in risky driving behaviours. Perceived risk was examined by the measure developed and validated in study 2, Chapter 4, while risky driving engagement was measured by the fixed and transient violations subscales from the Behaviour of Young Novice Drivers Scale (BYNDS; Scott-Parker et al., 2012c). It was expected that some key PWM variables would contribute to the proposed conceptual framework that will attempt to explain novice drivers’ perception of risk and whether they choose to engage in risky driving behaviours, which addresses research aim 1 of the thesis.
Statement of contribution to co-authored published paper: Paper 3

This chapter includes a co-authored paper. The bibliographic details of the published co-authored paper, including all authors, are:


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My contribution to the paper involved:

- Conception and design of the research paper
- Review and interpretation of literature
- Conducting data collection and analysis to produce the article
- Analysis and interpretation of research data
- Writing and revising of the paper

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Driver prototypes and behavioural willingness: Young driver perceived risk and reported engagement in risky driving

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Abstract

**Introduction:** This study aimed to explore perceived risk and reported willingness to engage in risky driving in a sample of young Australian drivers. The study also considered the influence of gender, driving experience, and risky driver prototypes on willingness to engage in risky driving. Within this context, a prototype is a social image of the type of person who engages in specific risk behaviours. In the prototype willingness model (PWM), willingness accounts for motivations that do not directly rely on planning or goal formation.

**Method:** The PWM was applied to a sample of 554 drivers (aged 17-25 years) to explore how risky driver prototypes: similarity (extent of identification with the prototype), favourability (how positive is the image), and behavioural willingness, may influence their perceived risk and reported engagement in risky driving behaviours. Drivers holding an Australian driver’s licence (Provisional 1, Provisional 2, or Open) anonymously completed an online survey measuring: 1) driver prototypes and behavioural willingness to engage in risky driving behaviours, 2) perceived risk of driving-related behaviours, and 3) the Behaviour of Young Novice Drivers Scale transient and fixed violations subscales.

**Results:** Path analysis explored relationships between prototypes and willingness variables, perceived risk, and reported driving engagement. Goodness-of-fit statistics supported the conceptual model. Behavioural willingness showed the strongest relationship with perceived risk (negative) and reported driving violation engagement (positive).

**Conclusions:** Risky driver prototypes and behavioural willingness, as well as driver’s sex and driving experience, may help to explain individual differences in perceived risk, and young driver reported risky driving engagement.
Practical Applications: Identifying relevant factors that could be amenable to change, such as driver prototype and willingness variables, may contribute to improved road safety initiatives, and provide information and support to counter factors that might otherwise facilitate young drivers’ risk perceptions and risky driving engagement.

Keywords: Novice drivers, prototype similarity, prototype favourability, driving experience, driver sex, driver age
Driver prototypes and behavioural willingness: Young driver perceived risk and reported engagement in risky driving

Introduction

Typically over-represented in international road injury and death tolls (BITRE, 2017; WHO, 2013), while young drivers (aged 17-25 years) are 10-15% of licenced drivers, they and their passengers represent approximately 25% of Australian road deaths (ATC, 2011). A prominent explanation is their engagement in risky driving behaviours, such as the fatal five (speeding, drink-driving, seatbelt use, fatigued driving, distracted driving3), which inter alia, have been predicted by driving inexperience, poor risk perception, peer influence, and personality (Fernandes, Hatfield, & Job, 2010; Harbeck & Glendon, 2013; Hartos, Eitel, & Simons-Morton, 2001; Scott-Parker, Watson, King, & Hyde, 2012a).

Australian states have implemented graduated driver licensing (GDL) programs aimed at reducing novice drivers’ motor vehicle crash involvement. Adopting a stepwise approach, these programs are designed to improve novice driver safety by extended supervision and driving experience over time (Scott-Parker, Bates, Watson, King, & Hyde, 2011; Williams & Shults, 2010). GDL programs typically involve a 3-stage approach: 1) learner period (minimum 1 year), 2) provisional licence (minimum 2 years), and 3) open licence. As well as adhering to all traffic and licensing regulations, GDL licence holders must also conform with special restrictions and criteria at each stage (Williams & Shults, 2010). In 2007, the Queensland Government implemented a new GDL system (Learner, Provisional 1 – P1, Provisional 2 – P2, and Open Licence), which included introducing minimum age requirements for P2 and Open licences of 18

3 See information on the fatal five from https://www.police.qld.gov.au/EventsandAlerts/campaigns/fatalfive.htm
A 17-year-old driver with a P1 licence is four times more likely to be involved in a fatal crash than is a driver aged over 26 years (ATC, 2011). Compared with an older age group, drivers aged 16-24 years have reported higher engagement in risky driving (Jonah, 1990). In an 11-study review, it was reported that although novice 16-year-old drivers had higher crash fatality and injury risk rates than novice 17-year-old drivers did, there were no differences in crash rate between 17-year-old and 18-to-19-year-old novice drivers (McCartt, Mayhew, Braitman, Ferguson, & Simpson, 2009). The 17-19-year age range aligns with the transitional period from a P1 to P2 licence in Australia. While evidence suggests that driving experience is more important than driver age for reducing crash risk, controlling for length of licensure McCartt et al. (2009) found that, compared with older drivers, particularly aged 25 and older, younger drivers still had consistently higher crash rates.

Regardless of age, inexperienced drivers detect hazards less holistically, more slowly, and less efficiently than more experienced drivers do, while underestimating traffic crash risk (Deery, 1999; Machin & Sankey, 2008; Wang, Zhang, & Salvendy, 2010). These findings were supported by McEvoy, Stevenson, and Woodward (2006), who demonstrated that lack of driving experience was a stronger predictor of crash risk or near-crash events than was driver age. However, Harbeck, Glendon, and Hine (2017) reported that driver age, rather than length of licensure, was associated with young driver perceived risk and reported engagement in risky driving, noting that a threshold effect may occur in young driver experience, regardless of age. What was unclear was whether differences between young driver licence types (P1, P2, Open) occurred in their

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perception of risk and subsequent reported risky driving engagement, especially as open
licence drivers are considered experienced due to being older, with longer licensure, and
more extensive driving experience.

**Perceived risk**

In traffic psychology, perceived risk is a subjective judgment about a specific
risk’s severity and characteristics (Deery, 1999), which can influence decision-based
behaviours (e.g., speed selection). Perceived risk has been reported as being negatively
associated with self-reported engagement in risky driving (Harbeck & Glendon, 2013;
Harbeck et al., 2017; Machin & Sankey, 2008), although conflicting results have been
found (e.g., Hatfield & Fernandes, 2009; Ivers et al., 2009; Ulleberg & Rundmo, 2003).
As a predictor of risky driving engagement (Harbeck & Glendon, 2013; Rhodes &
Pivik, 2011), perceived risk has been used in safety campaigns to promote young driver
safety (Deery, 1999; Hassan & Abdel-Aty, 2013; Shope, 2006). Changes in perceived
risk have been linked with comparisons being made between the self and an “other”,
often an unrealistic stereotype who engages in the risky behaviour at a higher level than
does the self (Thornton, Gibbons, & Gerrard, 2002). This may lead to a change in
perceived personal vulnerability and increased engagement in the risky behaviour. Such
social influences have been modelled in the prototype willingness model (PWM)
framework.

**Prototype willingness model (PWM)**

Grounded in social learning theory, the PWM was created to improve the
predictive value of health behaviour theories that addressed youth decision making in
risky health-related behaviours (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008;
Gibbons & Gerrard, 1995; Thornton et al., 2002). The PWM proposes that risky
behaviour may be engaged in impulsively in response to situations that generate risk.
This impulsivity is relevant to young adults in the process of creating their identity,
Young novice driver cognitions and behaviour 114

opinions, and values (Cestac, Paran, & Delhomme, 2011). Young adults are also considered more sensitive to social influences than are older adults (Gibbons & Gerrard, 1995; Todd, Kothe, Mullan, & Monds, 2016). The PWM has been applied to understand a number of youth-engaged risky driving behaviours, including speeding, aggressive driving, substance use, distractions, moving violations, driving through flooded routes, and cell phone use (Cestac et al., 2011; Gibbons & Gerrard, 1995; Pearson & Hamilton, 2014; Rivis, Abraham, & Snook, 2011; Rozario, Lewis, & White, 2010; Schmidt, Morrongiello, & Colwell, 2014; Scott-Parker, Hyde, Watson, & King, 2013).

Prototype willingness is a modified dual-processing model represented by two decision-making paths: a reasoned path, and a social reaction path (for reviews, see Gerrard et al., 2008; Gibbons & Gerrard, 1995). The current study focuses on the second decision-making path, social reaction, which attempts to explain unplanned and unintended behaviours in certain situations (e.g., an unsupervised party where alcohol and drugs are available and having to drive home; Gerrard et al., 2008). This path contains two important factors, the risk image or prototype, and behavioural willingness.

Prototypes, or risk images, are the “…cognitive representations or social images of the type of person who engages in specific risk behaviours” (Gerrard et al., 2008, p. 36). Within the PWM these images represent a typology rather than a description of the physical appearance of the type of person (Gerrard et al., 2008; Gibbons & Gerrard, 1995). Two aspects of prototype perception influence risk decisions: prototype similarity, and prototype favourability (Gerrard et al., 2008; Rivis et al., 2011). These two aspects interact so that the more strongly a person identifies with a prototype (prototype similarity), the more positively the image is viewed (prototype favourability). The combination of these two aspects influences how willing a person is to engage in the behaviour defined by the prototype image (e.g., safe or unsafe driver;
Gerrard et al., 2008; Gibbons & Gerrard, 1995; Rivis et al., 2011). Changed engagement in risky behaviour is thereby linked with changes in a person’s favourability of prototype perception (positive = more engagement, negative = less engagement; Rivis et al., 2011; Thornton et al., 2002).

The more favourable the prototype, the more willing is the person to accept the social consequences associated with the behaviour, for example, being seen by others as someone who engages in the behaviour (Gerrard et al., 2008). In a study of risky driving in a U.S. university student sample, Gibbons and Gerrard (1995) found that perceptions of the typical “risky driver” prototype could predict changes in participants’ self-reported engagement in risky driving. However, Rivis et al. (2011) found that prototype evaluation (positive or negative, through its interaction with prototype similarity) predicted older, but not younger, males’ willingness to drink and drive. This finding might suggest that prototypes are more influential for youths’ than for older peoples’ risky behaviours (Gerrard et al., 2008; Rivis et al., 2011). Scott-Parker et al. (2013) also found evidence countering earlier research, such that prototypes and intentions did not significantly predict speeding for novice drivers. However, for females, greater willingness to speed as a learner driver did predict speeding as a provisional driver (Scott-Parker et al., 2013).

While a driver’s intentions have been considered to be a good predictor of engaging in risky behaviours, especially when these are impulsive or socially undesirable, Gibbons and Gerrard (1995) argued that these behaviours are better measured by behavioural willingness, rather than intentions. Behavioural willingness has been defined as “…recognition that one would be willing to engage in the behaviour under some circumstances” (Gibbons & Gerrard, 1997, p. 79). An individual’s willingness accounts for motivations that do not directly rely on planning or goal formation, and although engaging in risky behaviours is usually volitional by youth
(e.g., drag racing, drink-driving, illegal manoeuvres), sometimes it is neither planned nor intentional (e.g., speeding, driving while distracted, tailgating; Gerrard et al., 2008; Gibbons & Gerrard, 1995; Rivis et al., 2011). Therefore, when compared with social-cognitive models (e.g., theory of planned behaviour), as PWM accesses unintentional and unconscious, unplanned, or non-goal-directed driving behaviours, it may provide insights as to why novice drivers elect to engage, or not engage, in risky driving behaviours on the spur of the moment.

While they are correlated, willingness has been shown to predict a number of risky behaviours independently of intention (Gerrard et al., 2008; Gibbons, Gerrard, Blanton, & Russell, 1998; Gibbons et al., 2004), and willingness is measured as a response to risk-related situations (Gerrard et al., 2008). PWM questionnaires describe a hypothetical scenario, where it is explained that no assumption is being made that the respondent would ever be in such a situation. Therefore, the hypothetical scenario allows the question to shift some of the focus of attention, attribution, and any bias that might influence a participant’s answer, from their self to the specified situation (Gerrard et al., 2008; Gibbons et al., 1998). For example, in the situation of a novice driver’s speeding, willingness to speed in the presence of peers may be a stronger predictor of speeding than the novice driver’s intention to speed (Gerrard et al., 2008). A novice driver with a favorable prototype of a risky young driver makes it particularly likely that the novice driver will speed if the circumstances to do so arise (Scott-Parker et al., 2013).

The current study

The first aim of the study was to explore whether differences would occur within a sample of Australian drivers (aged 17-25 years, licence type P1, P2, or Open) in their stated willingness to engage in the fatal five driving behaviours, perceived risk, and reported risky driving engagement. The study applied PWM predictors (driver
prototypes and behavioural willingness) to this young driver sample, examining speeding and drink-driving, and expanding PWM’s potential prediction power to include distraction, seatbelt use, and fatigue. As a second aim, the study also explored sex differences and driving experience in risky driver prototypes (similarity and favourability), and the influence that these variables might have on respondents’ reported willingness to engage in risky driving.

We expected that some PWM variables (driver prototypes, behavioural willingness) would contribute to a conceptual framework that attempted to explain young drivers’ perceived risk, and whether they chose to engage in risky driving behaviours, such as the fatal five. From the PWM literature, these hypotheses were proposed.

**H1:** Higher risky driver prototype favourability will predict: a) lower perceived risk of, and b) higher reported engagement in, risky driving behaviours; c) these relationships will be partially mediated by willingness to engage in risky driving behaviours.

**H2:** Higher risky driver prototype similarity will predict: a) lower perceived risk of, and b) higher reported engagement in, risky driving behaviours; c) these relationships will be partially mediated by willingness to engage in risky driving behaviours.

**H3:** Higher willingness to engage in risky driving behaviours will predict: a) lower perceived risk of, and b) higher engagement in, risky driving behaviours.

**H4:** Higher perceived risk will predict lower reported engagement in risky driving behaviours.

**H5:** Longer driving experience (length of licensure), and higher daily driving frequency will predict higher: a) stated willingness to engage in, and b) reported engagement in, risky driving behaviours.
Young novice driver cognitions and behaviour

H6: Compared with females, males will have higher: a) risky driver prototype favourability, b) willingness to engage in risky driving behaviours, and c) reported engagement in risky driving behaviours, and lower d) perceived risk.

Methodology

Participants

The sample comprised 554 Australian drivers (134 males, 24.2%) aged 17-25 years ($M = 20.1, SD = 2.4$). A majority (95.3%) of participants reported using a car as their vehicle for transport, driving a mean of 208.6 km ($SD = 171.5$) per week. All held an Australian driver’s licence: 158 (28.5%) reporting holding a P1 licence, 214 (38.6%) a P2 licence, and 182 (32.9%) an Open (unrestricted) licence. Participants were recruited via convenience sampling using online advertising (e.g., Facebook, email), and had the option to enter a prize draw to win one of three AUD$100 gift vouchers. Invited first-year psychology students who completed the survey using the online subject pool sign up also received course credit.

Measures

Participants completed an online questionnaire measuring PWM constructs: perceived risk of, and reported engagement in, risky driving behaviours, and reported their age, sex, licence type, kilometres driven/week, and type of vehicle driven.

Prototype willingness model. Gibbons and Gerrard’s (1995) PWM constructs were used to write items, representing: risky driver prototype favourability, risky driving prototype similarity, and behavioural willingness to engage in the fatal five.

Risky driver prototype favourability: Adjectives sourced from Gibbons and Gerrard (1995), and Scott-Parker, Hyde et al., (2013), were used to derive 12 adjectives (6 positive: safe, cautious, aware of dangers, sensible, independent, and considerate; 6 negative: immature, irresponsible, show-off, careless, ignorant, and self-centred), which were then presented as statements. Example item: “A risky driver is immature.”
Participants indicated their level of agreement with each statement on a 7-point scale from: 1 *Strongly disagree*, to 7 *Strongly agree*. Scores were aggregated after reverse scoring responses to negative adjectives so that higher scores reflected a more favourable prototype.

**Risky driver prototype similarity**: Participants rated themselves on the same 12 adjectives described above on a 7-point scale from: 1 *Strongly disagree*, to 7 *Strongly agree*, to indicate their level of agreement. Example item: “As a driver I consider myself to be cautious.” An additional item sought respondents’ level of agreement for their self-perception of whether they considered themselves to be a risky driver (e.g., “As a driver I am very similar to the typical person who drives in a risky manner – e.g., exceeds speed limits, drives after consuming alcohol or while tired, does not use a seatbelt, talks on a handheld phone while driving”). After reverse scoring, total scores from the 13 items resulted in a comparable measure of participants’ reported similarity to the risky driver prototype, with higher scores indicating higher risky driver prototype similarity.

**Behavioural willingness**: Sixteen items evaluated willingness to engage in driving behaviours related to the fatal five (3 speeding items, 3 for drink-driving, 2 for seatbelt use, 4 for fatigue, and 4 for distraction). Participants responded on a 7-point scale from: 1 *Not willing at all*, to 7 *Extremely willing*. After reverse scoring, aggregate scores resulted in a comparable measure of participants’ reported behavioural willingness, with higher scores indicating a higher behavioural willingness to engage in the fatal five driving behaviours.

**Perceived risk**. The nine items developed for the perceived risk of risky driving behaviours scale were based on risk perception scales created by Ivers et al. (2009), and by Machin and Sankey (2008). Items focused on cognitive aspects of perceived risk: aversion to perceived danger of the driving behaviour. The 5-point response scale was
from: 1 Not risky at all, to 5 Very risky. An initial 15 items were reduced through exploratory factor analysis to identify the best item pool that represented perceived risk of risky driving behaviours for this sample. The final nine items examined risky driving behaviours that encompassed the fatal five driver behaviours and included these other risky driving behaviours: mobile phone use, tailgating, unsafe overtaking, drug-driving, and illegal manoeuvres (e.g., U-turns at prohibited intersections). Higher scores indicated higher perceived risk of risky driving behaviours.

**Risky driving engagement.** Scott-Parker et al.’s (2012c) revised Behaviour of Young Novice Drivers Scale (BYNDS) measured risky driving engagement. The BYNDS uses a 5-point response format from: 1 Never, to 5 Almost always. Two BYNDS subscales were included: the transient violations (12 items), and fixed violations (6 items) subscales. This variable was named “Reported risky driving engagement” in the model to accurately reflect the measured construct. Higher scores indicated more self-reported risky driving engagement in the previous month of driving.

**Procedure and design**

After obtaining ethical approval from the authors’ University Human Research Ethics Committee, an online survey tool was created in LimeSurvey v1.91, and the survey link was advertised using the University’s e-news sheet Volunteer for Important Research Projects, and the authors’ school’s research participant pool. Drivers aged 17-25 holding an Australian driver’s licence were invited to participate. The survey was available online for five months, after which the response data file was downloaded and the data cleaned and coded.

A series of between-groups ANCOVAs was run to examine if licence type differences occurred in the drivers’ perceived risk, behavioural willingness and reported driving violation engagement. Covariates of the length of licensure and driving frequency (driver experience) were included in the three ANCOVAs. Alpha levels of
.05 were used to determine statistical significance for the main analyses with a Bonferroni correction applied to determine significance when multiple comparisons between licence types were run. Partial eta squared ($\eta^2$) was used as the measure of effect size using Cohen’s rules of thumb, where $\eta^2$ threshold values of 0.01, 0.06, and 0.14 represent small, medium, and large effect sizes respectively (Cohen, 1988). Descriptive statistics are presented using unadjusted means and standard deviations.

Licence type, young driver perceived risk, and reported willingness to engage in risky driving behaviours were examined with item means and standard deviations. Driver sex, and driving frequency – measured by mean km/per month, PWM (risky driver prototype favourability/similarity, and behavioural willingness), perceived risk, and reported risky driving engagement distributions, were examined and strengths of association explored with correlations between variables using Pearson’s correlation coefficient ($r$). We used $r = .10, .30$ and $.50$ to represent respectively weak, moderate, and strong associations (Cohen, 1988). As the variables of interest were derived from a theoretical model, and all were measured variables, path analysis was chosen for the primary analysis. Analyses used IBM SPSS v20.0, and IBM AMOS v22.0.

**Results**

**Initial analyses**

Prior to data analysis, distributions of all measured variables were examined. Normality violations were as expected, risky driver prototype favourability, prototype similarity, and reported risky driving reported engagement standardized skew statistics were significant and positively skewed above 2.58. As square root transformations on these variables produced no significant differences in the analyses after transformations, the raw data for all cases were retained for the analyses.

Descriptive statistics examining perceived risk, behavioural willingness item means, and standard deviations and driving violation reported engagement frequency,
are in tables 5.1-5.3. Between-participants ANCOVAs tested for licence type differences in the sample. Table 5.1 reports responses to perceived risk, separated by licence type, to determine whether differences existed. After controlling for covariates of driver experience (length of licensure, driving frequency), similar responding was found across all licence types, with no difference between licence type and perceived risk, $F(2,549) = 2.05, p = .130$. The highest risk-rated behaviour was drink-driving, followed closely by driving without a seatbelt. The lowest rated risky driving behaviour was speeding (driving 70km/hr in a 60km/hr zone), followed closely by driving distracted (behaviours that required either or both the driver’s eyes to be off the road, and hands off the wheel).

Table 5.2 shows willingness ratings to engage in the fatal five driving behaviours. A between-participants ANCOVA compared the effect of licence type on total reported behavioural willingness. After controlling for the covariates of driver experience (length of licensure, driving frequency), there was a significant effect of licence type on reported behavioural willingness across the three licence conditions, $F(2,549) = 6.54, p = .002, \eta_p^2 = .02$. Post hoc comparisons, adjusted using a Bonferroni correction, indicated that mean behavioural willingness for P1 drivers ($M = 53.80, SD = 14.48$) was significantly lower than the mean for both P2 ($M = 59.59, SD = 12.87$), and Open licence drivers ($M = 63.10, SD = 13.92$). No difference was found between Open and P2 drivers’ mean behavioural willingness scores. Across all licence groups (P1, P2, Open), compared with drink-driving and not wearing a seatbelt, drivers reported high willingness to engage in speeding, distracted driving, and driving while fatigued.

Table 5.3 shows frequencies of whether participants reported engaging in each violation during the past month, using the BYNDS transient and fixed violation subscales. Although Table 5.3 is not split by licence type for ease of interpretation, a
Table 5.1.
Means and standard deviations for perceived risk items by licence type (N = 554).

<table>
<thead>
<tr>
<th>Perceived risk of risky driving behaviour item</th>
<th>P1 drivers</th>
<th>P2 drivers</th>
<th>Open drivers</th>
<th>Total sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving a vehicle soon after having drunk alcohol and being over the legal BAC limit of .05</td>
<td>4.75 0.49</td>
<td>4.69 0.66</td>
<td>4.65 0.66</td>
<td>4.69 0.62</td>
</tr>
<tr>
<td>Driving a vehicle without having your seatbelt buckled up</td>
<td>4.28 0.92</td>
<td>4.31 0.90</td>
<td>4.27 0.93</td>
<td>4.29 0.92</td>
</tr>
<tr>
<td>Driving a vehicle while using a hand held cell phone</td>
<td>4.34 0.80</td>
<td>4.16 0.86</td>
<td>4.12 0.88</td>
<td>4.20 0.85</td>
</tr>
<tr>
<td>Overtaken a vehicle by crossing double white lines</td>
<td>4.14 0.93</td>
<td>4.25 0.91</td>
<td>4.18 0.96</td>
<td>4.19 0.93</td>
</tr>
<tr>
<td>Driving while closely following another vehicle (at less than 2 seconds distance)</td>
<td>4.18 0.74</td>
<td>4.00 0.89</td>
<td>4.06 0.85</td>
<td>4.07 0.84</td>
</tr>
<tr>
<td>Performed an illegal driving maneuvre (e.g., illegal U-turn, donut, burnout, drifting)</td>
<td>4.17 0.92</td>
<td>4.07 0.94</td>
<td>3.87 0.99</td>
<td>4.03 0.96</td>
</tr>
<tr>
<td>Driving while feeling tired or fatigued</td>
<td>4.11 0.87</td>
<td>3.93 0.90</td>
<td>4.05 0.89</td>
<td>4.02 0.89</td>
</tr>
<tr>
<td>Driving a vehicle while distracted (e.g., due to drinking, eating, smoking, changing a CD)</td>
<td>3.58 0.98</td>
<td>3.21 1.00</td>
<td>3.25 1.01</td>
<td>3.33 1.01</td>
</tr>
<tr>
<td>Driving at 70km/hr in a designated 60km/hr speed zone</td>
<td>2.94 0.94</td>
<td>2.92 1.02</td>
<td>2.90 1.11</td>
<td>2.92 1.03</td>
</tr>
</tbody>
</table>

Note: M = mean; SD = standard deviation; P1 = Provisional 1; P2 = Provisional 2; BAC = blood alcohol concentration; the response scale was from: 1 not risky at all, to 5 very risky.
Table 5.2. *Means and standard deviations for behavioural willingness items (N = 554).*

<table>
<thead>
<tr>
<th>Behavioural willingness of driving behaviour</th>
<th>P1 $n = 158$</th>
<th>P2 $n = 214$</th>
<th>Open $n = 182$</th>
<th>Total sample $N = 554$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speeding</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exceed the designated speed limit at least once, but under 10km/hr</td>
<td>4.84 1.77</td>
<td>5.32 1.58</td>
<td>5.48 1.47</td>
<td><strong>5.23</strong> 1.62</td>
</tr>
<tr>
<td>Overtake a slower vehicle by exceeding the designated speed limit</td>
<td>4.73 1.74</td>
<td>5.00 1.65</td>
<td>5.32 1.45</td>
<td><strong>5.03</strong> 1.63</td>
</tr>
<tr>
<td>When deemed possible and or necessary, exceed the designated speed limit by more than 10km/hr</td>
<td>4.45 1.86</td>
<td>4.82 1.73</td>
<td>5.19 1.64</td>
<td><strong>4.84</strong> 1.76</td>
</tr>
<tr>
<td><strong>Drink-driving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After a night of drinking drive home assuming your BAC is under the legal limit of .05</td>
<td>2.05 1.43</td>
<td>2.25 1.62</td>
<td>3.05 1.94</td>
<td><strong>2.45</strong> 1.73</td>
</tr>
<tr>
<td>After a night of drinking call a taxi/cab instead of driving your own car home</td>
<td>1.97 1.22</td>
<td>2.31 1.41</td>
<td>2.29 1.32</td>
<td><strong>2.21</strong> 1.33</td>
</tr>
<tr>
<td>Take the offer of riding home with a friend who you saw was also drinking at a party</td>
<td>1.75 1.42</td>
<td>2.12 1.81</td>
<td>2.45 1.82</td>
<td><strong>2.12</strong> 1.73</td>
</tr>
<tr>
<td><strong>Seatbelt use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While driving pull over to a safe place and put your seatbelt on</td>
<td>2.55 1.89</td>
<td>2.66 1.82</td>
<td>3.04 2.06</td>
<td><strong>2.75</strong> 1.93</td>
</tr>
<tr>
<td>While driving not have your seatbelt on</td>
<td>2.65 1.74</td>
<td>2.14 1.46</td>
<td>1.95 1.41</td>
<td><strong>2.22</strong> 1.55</td>
</tr>
<tr>
<td><strong>Fatigue</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive while feeling fatigued (tired)</td>
<td>4.58 1.75</td>
<td>4.88 1.60</td>
<td>5.03 1.61</td>
<td><strong>4.84</strong> 1.65</td>
</tr>
<tr>
<td>Drive from a location (workplace, place of study, home, etc.) while feeling tired or physically fatigued</td>
<td>4.16 1.86</td>
<td>4.50 1.68</td>
<td>4.80 1.54</td>
<td><strong>4.50</strong> 1.71</td>
</tr>
<tr>
<td>Drive after finishing a double shift (more than 10 hours) at your workplace</td>
<td>3.77 1.71</td>
<td>4.11 1.58</td>
<td>4.32 1.61</td>
<td><strong>4.08</strong> 1.64</td>
</tr>
<tr>
<td>Drive the next morning after experiencing a poor (less than 4 hours) night of sleep</td>
<td>2.02 1.37</td>
<td>2.16 1.36</td>
<td>2.44 1.63</td>
<td><strong>2.21</strong> 1.46</td>
</tr>
<tr>
<td><strong>Distraction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While driving change the CD/radio station you are listening to by hand</td>
<td>5.30 1.51</td>
<td>5.66 1.30</td>
<td>5.68 1.26</td>
<td><strong>5.56</strong> 1.36</td>
</tr>
<tr>
<td>While driving answer and continue to talk on your mobile phone in your hand</td>
<td>4.36 1.82</td>
<td>4.92 1.49</td>
<td>5.23 1.46</td>
<td><strong>4.86</strong> 1.62</td>
</tr>
<tr>
<td>While driving answer and continue to talk on your cell phone with a hands-free device</td>
<td>4.21 1.89</td>
<td>4.91 1.78</td>
<td>5.21 1.74</td>
<td><strong>4.81</strong> 1.84</td>
</tr>
<tr>
<td>Drive a vehicle while distracted (e.g., due to drinking, eating, smoking)</td>
<td>3.55 1.72</td>
<td>4.23 1.64</td>
<td>4.25 1.68</td>
<td><strong>4.04</strong> 1.70</td>
</tr>
</tbody>
</table>

*Note: $M =$ mean; $SD =$ standard deviation; P1 = Provisional 1; P2 = Provisional 2; BAC = blood alcohol concentration; responses were on a 7-point scale from 1 *not willing at all*, to 7 *extremely willing*
Table 5.3.
*Frequency of reported driving violation engagement* (BYNDS subscales; *N* = 554)

<table>
<thead>
<tr>
<th>Item</th>
<th>Never</th>
<th>Hardly ever</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>n</em> (%)</td>
<td><em>n</em> (%)</td>
<td><em>n</em> (%)</td>
<td><em>n</em> (%)</td>
<td><em>n</em> (%)</td>
<td><em>M</em></td>
</tr>
<tr>
<td><strong>Transient violations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drove up to 10 km/hr over the speed limit</td>
<td>58 (10.5)</td>
<td>74 (13.4)</td>
<td>192 (34.7)</td>
<td>193 (34.8)</td>
<td>37 (6.7)</td>
<td>2.14</td>
</tr>
<tr>
<td>Drove over the speed limit in areas unlikely to have radar or speed camera</td>
<td>59 (10.6)</td>
<td>115 (20.8)</td>
<td>194 (35.0)</td>
<td>162 (29.2)</td>
<td>24 (4.3)</td>
<td>1.96</td>
</tr>
<tr>
<td>Travelled in the right-hand lane on a multi-lane highway</td>
<td>91 (16.4)</td>
<td>112 (20.2)</td>
<td>143 (25.8)</td>
<td>157 (28.3)</td>
<td>51 (9.2)</td>
<td>1.94</td>
</tr>
<tr>
<td>Deliberately speed when overtaking</td>
<td>73 (13.2)</td>
<td>127 (22.9)</td>
<td>160 (28.9)</td>
<td>164 (29.6)</td>
<td>30 (5.4)</td>
<td>1.91</td>
</tr>
<tr>
<td>Sped up when approaching a traffic light that turned to amber</td>
<td>57 (10.3)</td>
<td>141 (25.5)</td>
<td>204 (36.8)</td>
<td>123 (22.2)</td>
<td>29 (5.2)</td>
<td>1.87</td>
</tr>
<tr>
<td>Sped out of an intersection when the light went green</td>
<td>134 (24.2)</td>
<td>144 (26.0)</td>
<td>164 (29.6)</td>
<td>95 (17.1)</td>
<td>17 (3.1)</td>
<td>1.49</td>
</tr>
<tr>
<td>Drove 10-20 km/hr over the speed limit</td>
<td>132 (23.8)</td>
<td>177 (31.9)</td>
<td>135 (24.4)</td>
<td>95 (17.1)</td>
<td>15 (2.7)</td>
<td>1.43</td>
</tr>
<tr>
<td>Sped at night on roads that were not well lit</td>
<td>212 (38.3)</td>
<td>196 (35.4)</td>
<td>98 (17.7)</td>
<td>41 (7.4)</td>
<td>7 (1.3)</td>
<td>0.98</td>
</tr>
<tr>
<td>Did an illegal U-turn</td>
<td>252 (45.5)</td>
<td>177 (31.9)</td>
<td>94 (17.0)</td>
<td>26 (4.7)</td>
<td>5 (0.9)</td>
<td>0.84</td>
</tr>
<tr>
<td>Spoke on a hand-held cell phone</td>
<td>301 (54.3)</td>
<td>126 (22.7)</td>
<td>95 (17.1)</td>
<td>26 (4.7)</td>
<td>6 (1.1)</td>
<td>0.75</td>
</tr>
<tr>
<td>Drove more than 20 km/hr over the speed limit</td>
<td>300 (54.2)</td>
<td>170 (30.7)</td>
<td>57 (10.3)</td>
<td>22 (4.0)</td>
<td>2 (0.9)</td>
<td>0.67</td>
</tr>
<tr>
<td>Overtook someone on the left</td>
<td>368 (66.4)</td>
<td>122 (22.0)</td>
<td>46 (8.3)</td>
<td>16 (2.9)</td>
<td>2 (0.4)</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Fixed violations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If there was no red light camera, ran a red light</td>
<td>480 (86.6)</td>
<td>58 (10.5)</td>
<td>12 (2.2)</td>
<td>4 (0.7)</td>
<td>0 (0.0)</td>
<td>0.17</td>
</tr>
<tr>
<td>Drove after taking an illicit drug (e.g., marijuana, ecstasy)</td>
<td>511 (92.2)</td>
<td>30 (5.4)</td>
<td>8 (1.4)</td>
<td>2 (0.4)</td>
<td>3 (0.5)</td>
<td>0.12</td>
</tr>
<tr>
<td>Did not always wear your seatbelt</td>
<td>508 (91.7)</td>
<td>32 (5.8)</td>
<td>9 (1.6)</td>
<td>4 (0.7)</td>
<td>1 (0.2)</td>
<td>0.12</td>
</tr>
<tr>
<td>Carried more passengers than could legally fit in the car</td>
<td>496 (89.5)</td>
<td>49 (8.8)</td>
<td>8 (1.4)</td>
<td>1 (0.2)</td>
<td>0 (0.0)</td>
<td>0.12</td>
</tr>
<tr>
<td>Carried more passengers than there were seatbelts in car</td>
<td>508 (91.7)</td>
<td>35 (6.3)</td>
<td>9 (1.6)</td>
<td>1 (0.2)</td>
<td>1 (0.2)</td>
<td>0.11</td>
</tr>
<tr>
<td>Drove without a valid licence</td>
<td>521 (94.0)</td>
<td>22 (4.0)</td>
<td>9 (1.6)</td>
<td>2 (0.4)</td>
<td>0 (0.0)</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Note: *M* = mean; *SD* = standard deviation; the response scale was from: 0=Never, to 4=Always.
between-participants ANCOVA compared effect of licence type on total reported risky driving engagement across subscales. After controlling for covariates of driver experience (length of licensure, driving frequency), there was a main effect of licence type for reported risky driving engagement for the three groups, $F(2,549) = 5.70$, $p = .004$, $\eta^2_p = .02$. Post hoc comparisons, adjusted using a Bonferroni correction, indicated that mean reported engagement in risky driving behaviours for P1 drivers ($M = 14.75$, $SD = 8.36$) was significantly lower than that for P2 ($M = 17.36$, $SD = 8.92$), and for Open licence drivers ($M = 19.06$, $SD = 9.38$). No difference was found between Open and P2 licenced drivers’ reported risky driving engagement mean scores.

Table 5.3 shows that the most frequent transient violations reportedly engaged in during the previous month were speeding (speeding up when a traffic light changed to amber, and driving up to, or 10-20 km/hr over, the designated speed limit). For fixed violations, the most frequently reported driving behaviour was running a red light if it was known that there was no intersection camera. The least frequently reported transient violation was overtaking another vehicle on the left (drivers keep left in Australia)$^5$, and for fixed violations, driving without a valid licence.

**Correlations**

Table 5.4 shows means, standard deviations, reliability coefficients, and zero-order correlations between variables. Due to the significant effect found for licence type in the descriptives and analyses, length of licensure (in months) was substituted for licence type as these variables were highly correlated ($r = .76$). The correlation between age and length of licensure was .86. Before model testing using path analysis, relationships between demographic variables (driver sex, driving frequency measured by mean kilometres driven/week, and length of licensure in months), PWM variables

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$^5$ Not always a violation, depending upon road type and traffic conditions.
Table 5.4.

Means, standard deviations, reliability coefficients, and zero-order correlations between criterion and predictor variables (N = 554)

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>α</th>
<th>Driver sex</th>
<th>Length of licensure</th>
<th>Driving frequency</th>
<th>Risky driver prototype favourability</th>
<th>Risky driver prototype similarity</th>
<th>Behavioural willingness</th>
<th>Perceived risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of licensure</td>
<td>43.81</td>
<td>23.22</td>
<td>-</td>
<td>.07</td>
<td>43.81</td>
<td>23.22</td>
<td>43.81</td>
<td>23.22</td>
<td>43.81</td>
<td>23.22</td>
</tr>
<tr>
<td>(months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving frequency</td>
<td>208.59</td>
<td>171.50</td>
<td>-</td>
<td>-.03</td>
<td>208.59</td>
<td>171.50</td>
<td>208.59</td>
<td>-0.03</td>
<td>208.59</td>
<td>171.50</td>
</tr>
<tr>
<td>(mean km/week)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risky driver prototype favourability</td>
<td>26.95</td>
<td>11.29</td>
<td>.88</td>
<td>-.08</td>
<td>.02</td>
<td>-0.08</td>
<td>.02</td>
<td>-.08</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>Risky driver prototype similarity</td>
<td>27.12</td>
<td>9.83</td>
<td>.88</td>
<td>-.17**</td>
<td>.06</td>
<td>-.17**</td>
<td>.06</td>
<td>-.17**</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>Behavioural willingness</td>
<td>59.09</td>
<td>13.92</td>
<td>.86</td>
<td>-.14**</td>
<td>.21**</td>
<td>-.14**</td>
<td>.21**</td>
<td>-.14**</td>
<td>.21**</td>
<td></td>
</tr>
<tr>
<td>Perceived risk</td>
<td>35.75</td>
<td>4.96</td>
<td>.79</td>
<td>.09*</td>
<td>-.05</td>
<td>-.09*</td>
<td>-.05</td>
<td>.09*</td>
<td>-.09*</td>
<td></td>
</tr>
<tr>
<td>Reported risky driving engagement</td>
<td>17.18</td>
<td>9.07</td>
<td>.88</td>
<td>-.09*</td>
<td>.11*</td>
<td>-.09*</td>
<td>.11*</td>
<td>-.09*</td>
<td>.11*</td>
<td></td>
</tr>
</tbody>
</table>

Note: *p < .05, **p < .001
Young novice driver cognitions and behaviour

(risky driver prototype similarity/favourability, behavioural willingness), perceived risk, and reported driving engagement were examined.

As shown in Table 5.4, correlations between PWM variables and perceived risk were moderate, with higher prototype favourability, similarity, and behavioural willingness being negatively associated with perceived risk. Associations between PWM variables and reported risky driving engagement were positive. The strongest relationship was between behavioural willingness and reported risky driving engagement ($r = .55$). Though correlations were small, significant driver sex differences were found, when compared with females, males reported higher: risky driver prototype similarity, behavioural willingness, and risky driving engagement. Compared with males, females reported higher perceived risk. Length of licensure and driving frequency had significant positive relationships with behavioural willingness and reported risky driving engagement. Only relationships significant at $p < .05$ were entered as paths in the proposed model.

**Path analysis**

Measured variables were derived as described in the Method section. The model for testing was derived from the study’s theoretical basis, described above. The proposed model included all predictor (risky driver prototype favourability and similarity), control (driver sex, length of licensure, driving frequency), mediating (behavioural willingness, perceived risk), and criterion (reported risky driving engagement) variables, with hypotheses represented as predicted paths. Applying the recommendations for minimum sample size required for path analysis, the current sample exceeded the 20 cases per variable ratio (Kline, 2011). To assess and compare the goodness-of-fit between the hypothesized and observed models, Hu and Bentler’s (1999), and Byrne’s (2001) recommended indices cut-off values for assessing fit were
Figure 5.1. Path model showing relationships between PWM variables, perceived risk, and reported risky driving engagement.

Note: Dotted lines indicate retained but non-significant pathways; \( *p < .05, \quad **p < .001 \)
used (non-significant $\chi^2$, normed $\chi^2 < 3$, AGFI and CFI > .90, RMSEA < .1). The fit statistics indicated that the data fitted the proposed model, $\chi^2$ (df) = 11.79 (10), $p = .304$, Normed $\chi^2 = 1.17$, SRMR = .025, AGFI = .982, CFI = .998, RMSEA = .018 (90% CIs .000, .051). The final recursive model is shown in Figure 1. Adding the direct and indirect (multiplied together) standardized path coefficients of the PWM and other variables explained 29% of the variance in perceived risk, while the overall model explained 42% of the variance in reported risky driving.

Although significant direct pathways existed between PWM variables and perceived risk, and between PWM variables and reported risky driving engagement, indirect pathways through behavioural willingness and perceived risk were present for the driver prototypes, indicating possible partial mediation. To test the strength of the respective mediating effects, bootstrapping procedures in AMOS were applied, specifying 1000 samples and bias-corrected confidence intervals of 95% (Cheung & Lau, 2008). The standardized indirect effect of driver prototype similarity on perceived risk was, $\beta = -.05$ ($SE .02$, 95% CIs -.09 ~ -.02, $p = .011$), and on reported risky driving engagement was, $\beta = .09$ ($SE .02$; 95% CIs .05 ~ .14, $p = .012$). The standardized indirect effect of behavioural willingness on reported risky driving engagement was, $\beta = .04$ ($SE .01$; 95% CIs .03 ~ .09, $p = .003$). Of the PWM variables, behavioural willingness had the strongest negative relationship with perceived risk and the strongest positive relationship with reported risky driving. In summary, as shown in Figure 1, there was support for all hypotheses, except H6, where sex differences were only found for male drivers reporting higher risky driver type prototype similarity, and behavioural willingness.

**Discussion**

Considering the differences between young driver licence types, the study aimed to enhance understanding of the predictive value of risky driver prototypes
Young novice driver cognitions and behaviour (favourability, similarity), behavioural willingness to engage in the fatal five driving behaviours and perceived risk on self-reported engagement in risky driving. Potential influences of driver sex and driving experience (length of licensure, driving frequency) on reported engagement in risky driving were also examined. Some differences were found between driver licence types, and goodness-of-fit statistics showed that the data fitted the hypothesized model, revealing significant pathways and relationships between variables. Results indicated that risky driver prototypes and behavioural willingness, as well as driver’s sex and driving experience, may help to explain individual differences in perceived risk and young driver reported risky driving. These relationships are important, as identifying relevant factors that could be amenable to change, such as PWM variables, may contribute to improved road safety initiatives, and provide information and support to counter factors that might otherwise facilitate young drivers’ risk perceptions and risky driving engagement.

While respondents representing the three licence types did not differ in their perceived risk, there were differences between P1 drivers compared with P2 and Open licence drivers on other variables, which were sustained after controlling for driver experience (length of licensure, driving frequency). Specifically, P1 drivers reported lower willingness to engage in the fatal five driving behaviours, and lower reported risky driving engagement (engagement in driving violations), compared with P2 and Open licence drivers. No differences were found between P2 and Open licence drivers on these variables.

Table 5.1 (perceived risk by licence type) showed that this sample of young drivers reported that driving behaviours such as drink driving, driving without a seatbelt, or while fatigued, mobile phone use, unsafe overtaking, tailgating and illegal driving manoeuvres were risky. Previous research has demonstrated a negative association between perceived risk and risky driving engagement where, generally
young drivers who engage in, or who are exposed to, risky driving behaviours, also perceive driving risks as low, and that those perceiving risk as high were less likely to undertake the driving behaviour (Harbeck et al., 2017; Ivers et al., 2009; Sarkar & Andreas, 2004; Ulleberg & Rundmo, 2003).

Similar to previous research, young drivers who perceived driving behaviours as high risk still reported engaging in these behaviours (Harbeck & Glendon, 2013; Harré, Brandt, & Dawe, 2000; Ivers et al., 2009). This was seen in the current study (see Table 5.3) as frequency of engaging in the last month was reported as sometimes or above (range 2-4: sometimes, often, always) for over 50% of the sample in half of the transient driving violations. From a survey of 20,822 young Australian provisional drivers, Ivers et al. (2009) reported that high risky driving engagement scores were associated with a 50% increased crash risk. Therefore, what young drivers are willing to engage in (Table 5.2) as well as what they report engaging in (Table 3) is likely to be important. Table 5.3 indicated that speeding-related behaviours (e.g., driving up to 10km/hr over the speed limit, speeding in areas unlikely to have speeding radar/cameras, speeding while overtaking, speeding out of intersections, and when traffic signals/lights are amber) were reported to be engaged in most frequently.

Compared with the other risky driving behaviours measured, young drivers in this sample also reported the highest behavioural willingness to engage in speeding-related behaviours (Table 5.2). Specifically, driving at 70km/hr in a designated 60km/hr speed zone was reported to be perceived as the least risky for this sample (Table 5.1), while driving up to 10km/hr over the speed limit was the most frequently reported driving behaviour engaged in. However, the likelihood of a motor vehicle crash when driving at 70 km/hr is four times the likelihood at 60 km/hr (Kloeden, McLean, Moore, & Ponte, 1997). Similarly, driving while distracted was also perceived as less risky compared to the other driving behaviours (Table 5.1), and had higher behavioural willingness (Table
5.2). These results indicated that driving behaviours of speeding and driving while distracted need further targeted preventive strategies and interventions for this driver demographic.

In the path model, driver experience variables (length of licensure, driving frequency) were positively related to behavioural willingness. While only driving frequency was positively associated with reported risky driving engagement, the correlation was small (albeit significant). Research has highlighted that young P1 drivers, who have begun to drive unsupervised, have the greatest risk of injury and death in motor vehicle crashes (Sagberg & Bjørnskau, 2006; Williams, 2009), and are also often found to be at fault for the crash (Braitman, Kirley, McCartt, & Chaudhary, 2008). This risk level is attributed to variables associated with high crash risk, such as driver sex, age, low driving experience, and poor hazard detection and response skills (Borowsky, Shinar, & Oron-Gilad, 2010; Scott-Parker et al., 2012a).

After a novice driver’s first six months’ unsupervised driving experience, crash risk falls rapidly and continues to fall over the next 18 months (Williams, 2003, 2009; Williams & Mayhew, 2008). As young drivers adjust to further unsupervised driving on the road, this may be one reason why P2 and Open licence young drivers reported higher willingness to engage in risky driving. It is also during this time that restrictions (e.g., higher speed, number of passengers, hands-free cell phone use) placed on P1 drivers are removed (Scott-Parker & Rune, 2016). Drivers have also reported high engagement in risky driving behaviours during this time for various reasons, including: gaining autonomy, self-enhancement, optimism bias, to please friends, and to gain a more adult-like status (Arnett, 1997; Begg & Langley, 2001; Fernandes et al., 2007; Harré, Foster, & O’Neill, 2005; Scott-Parker et al., 2012a). Knowing such differences may aid traffic safety initiatives and prevention strategies in what demographic (e.g., licence type) to target, and at what GDL system stage.
The PWM, specifically the prototypes and willingness antecedents, was associated with young driver perceived risk and reported risky driving engagement. As modelled in Figure 1, support was found for H1-H4 – if young drivers had a favourable risky driver prototype, and identified as being similar to the risky driver represented by that prototype, then they expressed higher willingness to engage in the fatal five driving behaviours. This pathway was associated with lower perceived risk and higher reported engagement in risky driving, specifically in driving violations. These relationships were also consistent with research examining PWM and risky driving behaviour (Cestac et al., 2011; Pearson & Hamilton, 2014; Scott-Parker et al., 2012a; Thornton et al., 2002).

Contrary to our findings, Schmidt et al. (2014) found that for their sample of drivers, prototypes were not related either to willingness or to risk-taking in four risky driving domains (aggressive driving, substance use, distraction, moving violations). However, strong positive direct pathways were reported between behavioural willingness and these four risky driving domains. Schmidt et al.’s (2014) sample demographics were similar to ours, being characterised by a high proportion of females, comprised of undergraduate students (mean age 18 years, range 17-22), but only included provisionally licenced drivers. The focus of Schmidt et al. (2014) was the influence of PWM variables in explaining relations between parent and teen risky driving practices within each of the four risky driving domains measured. As the current sample comprised young Australian drivers, and Schmidt et al.’s (2014) were Canadian, the respective young driver samples would have been exposed to different driving licence systems, which may help to explain the contrary findings.

Although a negative relationship was found between perceived risk and reported driving engagement (supporting H4), young drivers still reported engaging in risky driving. That drivers are aware of the risks associated with driving is often reported in the literature, and has been linked with actual and perceived driving skills improvement.
young drivers may still choose to engage in risky driving (Delhomme, Verlihiac, & Martha, 2009).

The anonymous online questionnaire allowed participants to report honestly and without penalty about their risky driving engagement, including some illegal driving behaviours, which may have reduced potential social desirability bias. Research examining various methodologies has found that self-report data from young drivers adequately matches naturalistic driving variables (e.g., Lajunen & Summala, 2003; Taubman – Ben-Ari, Eherentfreund-Hager, & Prato, 2016; Zhao et al., 2012).

While study limitations included using a predominately female student sample, which affects results generalizability, sufficient males were included to be able to identify sex differences. As research has found that university student populations and general populations can differ in predictors of risky driving (e.g., Fernandes et al., 2007), caution is needed in interpreting our findings beyond the current sample. To address this, future research with the proposed modelled pathways using a more sex-balanced sample from the general population of young drivers will be needed. Particularly because when, compared with females, males report higher engagement in risky driving, for example as reflected in traffic violations (Scott-Parker & Proffitt, 2015; Wohleber & Mathews, 2016), and other fatal five behaviours (e.g., speeding, drink-driving, fatigue; Fernandes et al., 2010). Other limitations include the cross-sectional design, self-report data, and common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).
Conclusion

Our model using the psychosocial theoretical framework of prototype willingness showed that young driver prototypes and their behavioural willingness was associated with lower perceived risk and higher reported engagement in driving violations. Campaigns designed to address these factors may lead to improved perceived risk and lower engagement in risky driving behaviours, such as the fatal five. Risky driving engagement is frequently cited as a key contributor to international road deaths and injury tolls for young drivers who are often over-represented when compared with other driver demographics. Further research is needed to explore likely determinants and predictors of risky driving behaviours for this high-risk group. Road safety initiatives targeting this demographic should remain an important issue internationally for researchers, policymakers, practitioners and governments.

Practical applications

Examining potential underlying influences for young driver risky driving engagement, and for the different driving, behaviours is important for road safety interventions, as identifying relevant factors that could be amenable to change, such as the PWM variables, may contribute to improved road safety initiatives and provide information and support to counter factors that might otherwise facilitate young drivers’ risk perceptions and risky driving engagement. Knowing such differences may aid traffic safety initiatives and prevention strategies in what demographic (e.g., licence type) to target, and at what GDL system stage. For example, a suggestion might include media portrayals of “risky driver prototypes” so that while their behaviour might appear attractive to young novice drivers, the outcomes of their risky driving (e.g., cell phone use, speeding) can have unintended consequences (e.g., front end collisions, death of a friend or family member). In addition, incorporating driver prototypes may assist in
research that examines the influence of peers and parents who may be perceived as a risky driver prototype on young driver behaviour.

Rather than focusing on factors that are difficult or unable to be changed in a young driver, such as age, sex, personality, and cognitive biases, research exploring whether these prototypes and their behavioural willingness are responsive to change in young drivers may be a significant next step in supporting road safety initiatives. The newly created measure of perceived risk and behavioural willingness, which includes an expanded range of driver behaviours, also provides future research with preliminary psychometrics of reliability and validity for use of the measures.

Acknowledgements and conflict of interest statement

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CHAPTER 6

Exploring the combined effect of reward sensitivity, protection motivation theory, prototype willingness model and perceived risk in young driver risky driving engagement

Thesis research aim 1

The first aim of the thesis was to identify factors (personality, social–cognitive, and social learning) that may influence young novice drivers’ perceptions of risk, and why they choose to engage, or not to engage, in risky driving behaviours. To accomplish this, the current thesis used model testing with three theoretical frameworks to aid understanding young novice driver cognitions and behaviour: i) reinforcement sensitivity theory (RST), ii) protection motivation theory (PMT), and iii) the prototype willingness model (PWM). These were described in chapters 3, 4, and 5 respectively. Demographic and psychological factors that provide insight into young drivers’ decision making are needed to assist in evaluating interventions designed to improve young driver safety (Delhomme et al., 2009; Fergusson et al., 2003; Fernandes et al., 2007; Hassan & Abdel-Aty, 2012; Ivers et al., 2009; Scott-Parker, Hyde et al., 2013; Scott-Parker, Watson et al., 2013). The developed scales and conceptual models proposed in this study may assist in identifying such key indicators, using constructs that can be used to evaluate campaigns to address, and positively influence, young driver cognitions related to safer driving.

Factors associated with risky driving behaviours

Shope (2006) proposed that for interventions to be effective in influencing behaviour, they must develop from, and be grounded in, behavioural science theory. Yet, to be effective in changing novice drivers’ behaviour, the factors that influence young driver decision-making and skills when driving, need to be identified and
Young novice driver cognitions and behaviour 139

explored. Chapters 3, 4, and 5 described three studies conducted to help identify which factors from prominent personality, social–cognitive, and social learning theories, as well as relevant driver demographics, were significantly associated with novice driver perceptions of risk and decision making for engagement in risky driving behaviours. Specifically, RST, PMT, and PWM theoretical frameworks were used to help design and test different models. Overall many significant relationships were found, and factors that were found to increase or decrease perceived risk and reported risky driving engagement are described below.

Factors found to be significant and positively related to perceived risk were:

- Perceived severity, (PMT)
- Perceived vulnerability (PMT)
- Response efficacy for safe driving behaviours (PMT).

Factors found to be significant and negatively related to perceived risk were:

- Driver age
- Reward sensitivity (RST)
- Reward (PMT),
- Self-efficacy (PMT),
- Response costs (PMT)
- Risky driver prototype favourability (PWM)
- Risky driver prototype similarity (PWM)
- Behavioural willingness to engage in the fatal five driving behaviours (PWM).

Factors found to be significant and positively related to reported risky driving engagement were:
• Driver age
• Driving frequency (estimated kilometres travelled/week)
• Reward sensitivity (RST)
• Reward (PMT)
• Response costs for safe driving behaviours (PMT)
• Risky driver prototype favourability (PWM)
• Risky driver prototype and similarity (PMW)
• Behavioural willingness to engage in the fatal five driving behaviours (PWM).

Factors found to be significant and negatively related to reported risky driving engagement were:

• Response efficacy for safe driving behaviours (PMT)
• Perceived risk.

Perceived risk was also a mediator between many factors and reported risky driving behaviour, in some cases completely mediating the relationship. Specifically perceived risk mediated associations between PMT variables of perceived vulnerability, severity, and self-efficacy on reported risky driving engagement. These relationships were described in Chapter 4.

The current study

The studies described in chapters 3, 4, and 5 contributed to the literature by exploring the influence of RST, PMT, and PWM on young driver perceived risk and reported risky driving engagement. To test research aim 1, the following needs to be determined: which factors from the three models best predict young driver reported engagement in risky driving when controlling for demographic factors, each of the other
Young novice driver cognitions and behaviour 141

models, and perceived risk. These factors will be investigated in the current study. Therefore the aim of the current study is to summarise results from studies 1, 2, and 3 and conduct a hierarchal linear regression analysis to explore which factors from the three models (RST, PMT, PWM) best predicted young driver reported engagement in risky driving, when controlling for demographic factors, the variables from the models, and perceived risk (see Figure 6.1).

Drawing from the models it is hypothesised that the demographic variables of age, driver sex, licence type, and driving experience will predict the reported risky driving of young drivers (H1). It is also hypothesised that variables identified from RST, PMT, and PWM will predict the risky driving of young drivers over and above demographic factors (H2). It is further hypothesised that perceived risk will add to the model and predict the risky driving of young drivers over and above demographic factors, and in addition to RST, PMT, and PWM variables (H3).

A new, integrated conceptual model will result from the analysis for this young (17-25 years) and inexperienced driver demographic. Examining the three models and perceived risk together is important as incorporating multiple theories to create more broadly-based theoretical frameworks has the potential to lead to more effective and targeted interventions, and be used to evaluate interventions and behaviour change programs aimed at young drivers.
Figure 6.1. Conceptual framework for investigating factors predicting novice driver decision making and skills for risky driving engagement.
Methodology

Participants

A total of 783 cases were exported from the online database that contained all measures. Drivers who reported holding a learner licence \((n = 17)\) were removed from this database on the grounds that their behaviour would be substantially moderated by the presence of a supervisor (e.g., parent, licenced instructor), which would have influenced any reported risky driving engagement. As listwise deletion was to be used for all analyses, 205 cases were removed from the dataset, on the criterion of having incomplete responses (e.g., incomplete measures, or missing data). This resulted in a sample of 561 Australian drivers \((135 \text{ males, } 24.1\% \text{ aged } 17-25 \text{ years } (M = 20.06, SD = 2.36))\). A majority \((95.4\%)\) of participants reported using a car as their vehicle for transport, driving a mean of 207.57 km \((SD = 172.01)\) per week. All participants held an Australian driver’s licence with 165 \((29.4\%)\) reporting holding a P1 licence, 214 \((38.1\%)\) a P2 licence, and 182 \((32.4\%)\) an Open (unrestricted) licence. Length of current licence held ranged from 11 to 112 months \((M = 43.62, SD = 23.19)\).

Measures

Participants anonymously completed an online questionnaire, which provided the database for studies 1, 2, 3, and the current study (study 4). This questionnaire included demographic items: age, sex, licence type, length of licence, vehicle type usually driven, and average number of kilometres driven in a week (driving frequency). The questionnaire also included measures of perceived risk of risky driving behaviours \((12 \text{ items})\), and reported risky driving engagement \((18 \text{ items})\) using Scott-Parker et al.’s \((2012c)\) revised BYNDS transient and fixed violation subscales. RST used Torrubia et al.’s \((2001)\) Sensitivity to Punishment and Sensitivity to Reward Questionnaire \((48 \text{ items, see Chapter 3})\). Other items were derived from PMT threat and coping appraisal \((30 \text{ items, see Chapter 4})\), PWM risky driver prototype favourability and similarity, and
behavioural willingness (39 items, see Chapter 5). Measures and results of these scales are described fully in chapters 3, 4, and 5.

Procedure and design

Drivers aged 17-25 who held an Australian driver’s licence were invited to participate. The questionnaire was available online for five months, after which the response data file was downloaded, and the data cleaned and coded. Each respondent’s unique code was linked with all demographic and measured variables. This allowed the data files from studies 1, 2, and 3 to be merged for this combined analysis.

The strength of the correlations between the variables was examined using Pearson’s correlation coefficient ($r$), with $r = .10$, .30, and .50 representing respectively weak, moderate, and strong associations (Cohen, 1988). Internal consistency was measured using Cronbach’s alpha ($\alpha$), where scales with $\alpha \geq .70$ were considered appropriate for use in analyses (Nunnally & Bernstein, 1994). Hierarchical multiple regression was used to control the order in which variables were entered into the regression equations. To conduct this analysis, a sample size of $n \geq 50 + 17m$ ($m =$ number of independent variables; Tabachnick & Fidell, 2013) was required for a preferred power of .80, and to detect a medium effect size of .20. Though 26.2% of the dataset contained missing data and incomplete data, data imputation methods were not used as the remaining sample size ($n = 561, 71.6\%$) met all sample size requirements. Analyses were evaluated at significance level $p = .05$. All analyses used IBM SPSS v20.0.

Results

Correlates of outcome measures

Demographic variables and proposed correlates outlined from Figure 6.1 were examined for their associations with perceived risk and reported risky driving engagement. Means, standard deviations, Cronbach alphas of measured variables, and
correlations are in Table 6.1, which shows that PMT severity and vulnerability had the largest positive relationship with perceived risk. For reported risky engagement, PWM behavioural willingness had the largest positive relationship, followed closely by the positive relationship with PMT response costs. As length of licence held and RST sensitivity to punishment did not have significant associations with reported risky driving engagement, they were not included in the subsequent hierarchal multiple regression analysis.

**Predicting risky driving engagement from RST, PMT, PWM, and perceived risk**

Prior to conducting the hierarchical multiple regression, relevant assumptions of this statistical analysis were tested. A sample size of 561 was deemed adequate given fifteen independent variables to be included in the analysis (Tabachnick & Fidell, 2013). The assumption of singularity was also met as the independent variables from RST, PWM, and PMT did not constitute a combination of other independent variables. An examination of correlations (see Table 6.1) revealed that no independent variables were highly correlated, with the exception of severity, vulnerability, and perceived risk. However, as the multicollinearity statistics (i.e., tolerance) were all within accepted limits, the multicollinearity assumption was deemed to have been met (Hair et al., 2010).

Four variables included extreme univariate outliers, and were significantly skewed. Reward and risky driver prototype favourability were positively skewed and required log transformations, while response efficacy and self-efficacy were negatively skewed and both required a square-root transformation and reflection of the distribution (Tabachnick & Fidell, 2013). Mahalanobis distance scores indicated no multivariate outliers in the remaining sample. Residual and scatter plots indicated that the assumptions of normality, linearity, and homoscedasticity were all satisfied (Hair et al., 2010).
Table 6.1

*Means, Standard Deviations and Correlations between All Measures (N = 561)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>α</th>
<th>Perceived risk</th>
<th>Reported risky driving engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver sex (0 = male)</td>
<td>0.76 (0.43)</td>
<td>−</td>
<td>.11*</td>
<td>-.10*</td>
</tr>
<tr>
<td>P1 licence (0 = no)</td>
<td>0.29 (0.46)</td>
<td>−</td>
<td>.14**</td>
<td>-.20**</td>
</tr>
<tr>
<td>Age (years)</td>
<td>20.06 (2.36)</td>
<td>−</td>
<td>-.09*</td>
<td>.13*</td>
</tr>
<tr>
<td>Length of licence (months)</td>
<td>43.62 (23.19)</td>
<td>−</td>
<td>.02</td>
<td>-.02</td>
</tr>
<tr>
<td>Driving frequency (km/week)</td>
<td>207.57 (172.01)</td>
<td>−</td>
<td>.01</td>
<td>.12*</td>
</tr>
<tr>
<td>Sensitivity to punishment</td>
<td>13.47 (5.34)</td>
<td>.84</td>
<td>.04</td>
<td>-.02</td>
</tr>
<tr>
<td>Sensitivity to reward (RST)</td>
<td>10.49 (4.35)</td>
<td>.77</td>
<td>-.08</td>
<td>.28**</td>
</tr>
<tr>
<td>Severity</td>
<td>13.99 (3.48)</td>
<td>.73</td>
<td>.63**</td>
<td>-.27**</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>12.67 (3.65)</td>
<td>.81</td>
<td>.61**</td>
<td>-.14**</td>
</tr>
<tr>
<td>Reward (PMT)</td>
<td>8.76 (3.57)</td>
<td>.80</td>
<td>-.17**</td>
<td>.35**</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>20.78 (3.97)</td>
<td>.76</td>
<td>-.03</td>
<td>-.11*</td>
</tr>
<tr>
<td>Response efficacy</td>
<td>19.08 (4.75)</td>
<td>.75</td>
<td>-.23**</td>
<td>-.20**</td>
</tr>
<tr>
<td>Response costs</td>
<td>12.64 (4.09)</td>
<td>.73</td>
<td>-.41**</td>
<td>.52**</td>
</tr>
<tr>
<td>Risky prototype favourability</td>
<td>26.80 (11.03)</td>
<td>.88</td>
<td>-.35**</td>
<td>.35**</td>
</tr>
<tr>
<td>Risky prototype similarity</td>
<td>27.02 (9.78)</td>
<td>.88</td>
<td>-.27**</td>
<td>.46**</td>
</tr>
<tr>
<td>Behavioural willingness</td>
<td>62.12 (14.34)</td>
<td>.86</td>
<td>-.45**</td>
<td>.56**</td>
</tr>
<tr>
<td>Perceived risk</td>
<td>41.64 (6.59)</td>
<td>.82</td>
<td>−</td>
<td>-.39**</td>
</tr>
<tr>
<td>Reported risky driving engagement</td>
<td>17.03 (9.02)</td>
<td>.88</td>
<td>-.39**</td>
<td>−</td>
</tr>
</tbody>
</table>

Note: SD = standard deviation. *p<.05; **p<.001

Based on the studies described in chapters 3, 4, and 5, a three-stage hierarchical regression was conducted, with reported risky driving engagement as the dependent variable. Demographic variables found previously to contribute in prior models were entered at step 1 to control for their influence. Sensitivity to reward from RST, all PMT variables, designated PMT, PWM, and RST variables were entered at step 2, and perceived risk was entered at step 3. The regression statistics are in Table 6.2.
The hierarchical multiple regression revealed that at step 1, the demographic variables contributed significantly to the regression model, $F(4,556) = 9.09, p < .001$, and accounted for 6.1% of the variance in reported risky driving engagement. All demographic variables excluding age, contributed significantly to the model (see Table 6.2). Including the PMT, PWM, and sensitivity to reward variables explained an additional 41.0% of variance in reported risky driving engagement, and this change in $R^2$ was significant, $F(10,546) = 42.19, p < .001$. At step 2, driver, age and P1 licence were no longer significant predictors of reported risky driving engagement.

Additionally, the PMT variables severity and self-efficacy, and PWM variable risky driver prototype favourability, did not significantly contribute to reported risky driving engagement. At step 3, including perceived risk explained an additional 2.3% of the variance in risky driving engagement and this change in $R^2$ was significant, $F(1,545) = 24.48, p < .001$. When all variables were included at step 3, only driving frequency, sensitivity to reward, PMT vulnerability and reward, PWM prototype similarity and behavioural willingness and perceived risk continued to contribute significant unique variance in reported risky driving engagement. The most important predictor of risky driving engagement was PWM behavioural willingness, which uniquely explained 9.1% of the variance in reported risky driving engagement. Together, the demographic variables, PWM, PMT, sensitivity to reward, and perceived risk variables accounted for 49.0% of the variance in reported risky driving engagement (see Table 6.2).
Table 6.2

Hierarchical multiple regression results (N=561)

<table>
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<th>Variable</th>
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<th>Step 2</th>
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Note: Each step was found to be significant: step 1 $F(4,556) = 9.09, p<.001$; step 2 $F(14,546) = 34.66, p<.001$; step 3 $F(15,545) = 35.37, p<.001$

a square-root transformed, b logarithmically transformed.
Discussion

The current study summarised results from studies 1, 2, and 3 and conducted a combined data analysis to explore which factors from the three models (RST, PMT, PWM) best predicted young driver reported engagement in risky driving, when controlling for demographic factors, relevant variables from the models, and perceived risk. From the results, a new conceptual model to describe young driver engagement in risky driving behaviours, such as the fatal five, is proposed. From this, factors that may be targeted and able to be influenced in driver training and road safety initiatives are also identified.

Support was found for all hypotheses, where 6% of the variance in reported risky driving was explained by driver sex, age, having a P1 licence and driving frequency (H1); the RST, PMT, and PWM variables included predicted an additional significant 41% of variance in reported risky driving (H2); and perceived risk contributed a further significant 2% of variance (H3). All variables in the analysis explained almost half of the variance in young driver reported risky driving engagement.

Theoretical implications

Examining the personality, social cognitive and social learning constructs together within RST, PMT, and PWM has not previously been applied to young drivers, and the findings of the current study provide support for further research exploring these predictors of risky driving engagement. The amount of variance in young driver reported risky driving behaviour explained by the traditional applications of age, driver sex, licence type, and driving frequency was more than tripled when selected variables from the three models were included. However, apart from driving frequency (operationalized as average number of kilometres driven in a week), demographic variables that were significant in step 1 were no longer significant in subsequent steps. That these demographic factors did not continue to remain influential highlights that
sensitivity to reward, social cognition, and social learning factors may be more prevalent in this young driver sample and driving behaviour context. This is a positive result for driver training, as demographic factors such as driver sex, age, and current licence type are not factors amenable to change in training, or have been found to have adverse effects on increasing crash risk (e.g., early upgrading of licence type; Beanland et al., 2013; Peck, 2011).

Driving frequency was the only demographic variable to consistently remain significant throughout the three steps of the model. Its positive relationship with reported risky driving engagement indicated that with increased driving experience, more risky driving engagement is reported. The predominant driving intervention aimed at young novice drivers is graduated driving licensing. In this system, the amount of driving experience that needs to be logged by learner drivers before they can apply for a provisional licence ranges from 50-120 hours, depending on Australian state or territory. The time needed to elapse before an open licence can be applied for by a provisional driver ranges between 24 and 36 months, depending on state or territory (Scott-Parker & Rune, 2016). However, increased driving provides more opportunities to engage in risky driving behaviour. As length of licence was not found to be related to risky driving, and as the magnitude of the effect of driving frequency was quite small in the current study, due to their use in driver interventions, it is important to consider other variables that may influence reported risky driving engagement in conjunction with, and controlling for driving frequency.

Another road safety initiative is using deterrents, specifically applying strict regulations and punitive consequences for young drivers. However, these have been reported to be not entirely successful in targeting changes in risky driving (e.g., Constantinou et al., 2011; Scott-Parker et al., 2012a, 2012b), and for most driving violations examined in this study (speeding, drink-driving, illegal manoeuvres, traffic
light violations, etc.), consequences meriting punishment according to the law, may
never be detected by police, and even if detected, punishment will be delayed. In fact,
sensitivity to punishment was not found to be related to reported risky driving
engagement. Instead, as shown in the current study, both RST sensitivity to reward and
PMT reward variables were positively related to reported risky driving engagement.
This probably indicates that young drivers find risky driving to be a rewarding
experience. Young drivers are often reported to have positive attitudes towards, or
perceptions of risky driving engagement (Fernandes et al., 2010), and report reasons for
such engagement as: gaining autonomy, self-enhancement, optimism bias, to please
friends, thrill or sensation seeking, and to gain a more adult-like status (Arnett, 1990,
1997; Begg & Langley, 2001; Harré et al., 2005; Scott-Parker et al., 2012a). Although
the magnitude of the effect of sensitivity to reward a PMT reward was quite small in the
current study, it still provided a construct to target in driver interventions that seek to
improve road safety.

Variables in the model that contributed significantly to reported risky driving
engagement were behavioural willingness, risky driving prototype similarity, response
costs and vulnerability, all of which had a positive association with risky driving.
Therefore, it is recommended that for driving training and safety initiatives a young
driver’s perception of their own vulnerability, which can be difficult to adapt due to
their optimism bias (Harré et al., 2005; White et al., 2011) be examined. In addition to
whether their driver self-prototype is similar to a risky driver when they drive on the
road, and how detrimental they perceive the response costs of safe driving. These
constructs may assist in the design and evaluation for driving training and safety
initiatives.

In fact, targeted road safety messages derived from PMT variables have been
successfully applied for drunk driving (Cismaru, Lawack, & Markewich, 2009;
Greening & Stoppelbein, 2000; Murgraff, White, & Phillips, 1999), effectiveness of anti-speeding messages (Cathcart & Glendon, 2016; Glendon & Walker, 2013), and driver fatigue (Tay & Watson, 2002). Behavioural willingness was the strongest predictor in the current model. Willingness has been proposed to be a better predictor of risky driving than has intentions, as it can account for motivations that do not directly rely on planning or goal formation, and although engagement in risky driving is usually volitional by youth (e.g., speeding, drag racing, illegal manoeuvres), sometimes it is neither planned nor intentional (e.g., speeding, driving while distracted, tailgating; Gerrard et al., 2008; Gibbons & Gerrard, 1995; Rivis et al., 2011). PWM and its constructs have been applied to understand a number of youth-engaged risky driving behaviours, including speeding, aggressive driving, substance use, distractions, moving violations, driving through flooded routes, and mobile phone use, and shown initial support for targeting (Cestac et al., 2011; Gibbons & Gerrard, 1995; Pearson & Hamilton, 2014; Rivis et al., 2011; Rozario et al., 2010; Schmidt et al., 2014; Scott-Parker, Hyde et al., 2013).

The maintained negative relationship between perceived risk and reported risky driving was consistent with other research (e.g., Harbeck & Glendon, 2013; Harbeck et al., 2017; Machin & Sankey, 2008; Rhodes & Pivik, 2011), and was the second strongest relationship within the regression model. 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. However, 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). Therefore, it is proposed that for driving interventions, training and safety initiatives, using multiple constructs from
validated theories and models is required to appropriately address what may influence driver cognitions and behaviours. Using a multifaceted approach is therefore recommended to improve young driver safety.

**Limitations and future research**

An advantage of the methodology used in the study is that it is thoroughly based in psychological theory, attempting to explore predominantly social learning (PWM), and social cognitive (PMT) relationships with young driver in risky driving engagement. However, it should be recognized that increasing the number of variables in hierarchical multiple regression analyses increases the amount of variance explained (Tabachnick & Fidell, 2013). In the current study, only variables of theoretical interest that were found to have an initial relationship with reported risky driving were included, and samples were sufficiently large to maintain the power of the analyses.

Similar to studies 1, 2, and 3, using the combined dataset, this study had similar limitations (i.e., self-report data, unequal driver sex numbers, and a predominately university student sample). 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; Zhao et al., 2006). Although participants were undergraduate university students, who are likely to be of a generally high socioeconomic status, and therefore may not be representative of the general population, especially as these populations can differ in predictors of risky driving (e.g., Fernandes et al., 2007), caution is needed in interpreting our findings beyond the current sample. However, using university student populations are often sampled in the research field of road safety, especially for young driver populations (Glendon & Cernecca, 2003; Greening & Stoppelbein, 2000; Scott-Parker et al., 2009). To address this, future
research with a larger sample that is more gender balanced from the general population of young drivers will be needed to confirm and expand upon findings.

Finally, although mediators (perceived risk and behavioural willingness) were shown to be potential mediators in previous studies (see chapters 3, 4, and 5), mediation analysis was not undertaken due to the cross-sectional design. While perceived risk and behavioural willingness appeared to be influential in the current results, it has been shown that mediators derived from cross-sectional data can result in biased estimates of their effects, and that mediation hypothesis testing should preferably be done with longitudinal data (Jose, 2016; Maxwell, Cole, & Mitchell, 2011; Preacher, 2015). To examine the effect of perceived risk and behavioural willingness appropriately, future research will require longitudinal designs.

**Conclusion**

Risky driving is frequently cited as a key contributor to the road toll, with young drivers continuing to be over-represented in road crash injury and fatality statistics. Therefore this is a continually important issue internationally for researchers, policy makers, practitioners, and governments, as we work towards the National Road Safety Strategy 2011–2020 to decrease road deaths and serious injuries by at least 30 per cent by 2020 (ATC, 2011), which includes young drivers. Countermeasures, such as the proactive road safety initiatives conducted by federal and state governments via the efforts of police, media campaigns, safer cars, new legislation involving the graduated licensing system (BITRE, 2012), have contributed to reducing these road toll statistics. However, since 2014, and more recently in 2016, earlier decreasing trends have reversed, with increases seen across multiple indicators (e.g., road deaths, hospitalised injuries, and road crashes) in all Australian states and territories (BITRE, 2017) Therefore, further research and targeted interventions are required. To influence young
Young novice driver cognitions and behaviour

Driver behaviour, it is important to recognize how their behaviour is initiated and maintained, but also the effect of the social–cognitive and social learning influences upon the young driver’s decision making and consequently their behaviour (Scott-Parker et al., 2009). Indicators that provide insight into young drivers’ decision making are needed to assist in evaluating interventions designed to improve young driver safety. Compared to demographic variables and perceived risk, constructs from RST, PMT and PWM significantly contributed to the majority of variance explained in reported risky driving for this study. The practical implications of using such indicators such as those identified (e.g., perceived vulnerability, response costs, risky driver prototype similarity, behavioural willingness, and perceived risk) provide constructs for future driver training and interventions to target and evaluate. It is becoming clearer, that multifaceted interventions and driver safety approaches are required, combining and evaluating multiple theoretical approaches is a first step to help improve the road safety of young novice drivers.
CHAPTER 7

Differences between licence types: Developing a novel brief hazard perception pilot session

Chapter 7 presents study 5 of the thesis, which has also been written as a manuscript for publication. Due to this format, there is some repetition of material from Chapter 2, in theoretical content and rationale. This study addresses a component of research aim 2: Can a brief hazard perception training session improve young drivers’ (aged 17-25 years) hazard perception, and if so, what type of training is optimal? To accomplish this, the current study first involved a pilot to develop these training methods: i) reading pamphlet, ii) passive viewing hazard scenarios, and iii) active engagement in the scenarios in a simulation. Outcome measures of hazard perception performance were: knowledge, identification, response, and handling. Driver hazard performance components were assessed using: 1) a static (image) hazard perception test, and 2) a dynamic (using a driving simulator) hazard perception test. The pilot sample included drivers of difference experience levels: the target sample for the training (Provisional 1 drivers \( n = 7 \)), and more experienced drivers (Provisional 2 drivers \( n = 7 \); Open Licence drivers \( n = 9 \)), who completed the training measures and hazard perceptions tests. The outcomes from this pilot work were used to design the experiment in study 6.
Statement of contribution to co-authored published paper: Paper 4

This chapter includes a co-authored paper. The bibliographic details of the published co-authored paper, including all authors, are:


*Unpublished manuscript.*

My contribution to the paper involved:

- Conception and design of the research paper
- Review and interpretation of literature
- Conducting data collection and analysis to produce the article
- Analysis and interpretation of research data
- Writing and revising of the paper

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Student/Corresponding author of paper: Emma Harbeck
October, 2017

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Supervisor: A/Pro Ian Glendon
October, 2017

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Supervisor: Dr Trevor Hine
October, 2017
Differences between licence types: Developing a novel brief hazard perception pilot session

Emma Harbeck
Trevor Hine
Chris Irwin
Codi White
Ian Glendon
Abstract

The goal of the present study was to evaluate a pilot session designed to improve hazard perception in young Provisional 1 (P1) drivers. Appropriate piloting and evaluation of a hazard perception training and testing should take place prior to implementation of the full study. This research discusses the requirements of training conditions and materials (pamphlet, passive, active), and simulator hazard perception test to examine P1 driver hazard perception. The sample ($N=23$) included open licence drivers ($n=9$), Provisional 2 ($n=7$), and the target sample of P1 drivers ($n=7$). Participants (males = 11, 47.8%) were aged 17-35 and reported a range of 2-17 years of driving experience, traveling between 45 and 420 km a week. The pilot study was designed to reveal any difficulties in implementing the proposed procedures, to assess whether the hazard perception scenarios and targeted outcomes from training were appropriate for drivers from our target sample (P1 drivers aged 17-25), and to investigate whether any unforeseen or contrary effects than those outlined by the training session occurred. Feedback was also sought from participants, including areas requiring further clarity or improvement for the materials or procedures used. Results highlighted that hazard perception differences were evident between licence types. P1 participants in particular showed lower hazard perception knowledge and identification when compared with participants representing the other licence types. The outcomes of the pilot work assisted in refining the methodology of the brief training session conditions and simulator scenarios generated to examine hazard performance in young novice drivers. Implications for future research using these training conditions and outcome measures are discussed.
Differences between licence types: Developing a novel brief hazard perception pilot session

**Background**

A driver’s ability to anticipate, judge, and respond appropriately to potentially dangerous traffic situations is considered a crucial aspect of driver competence, and an important skill that has been found to be associated with crash risk (Horswill et al., 2013; Sagberg & Bjørnskau, 2006; Scialfa et al., 2011). Young drivers who have begun to drive unsupervised have the highest risk of injury and death in motor vehicle crashes (Sagberg & Bjørnskau, 2006; Williams, 2009). This is attributed to demographic factors, such as driver age and sex, less on-road driving experience, and poor hazard detection and response skills in response to on-road hazards (Borowsky et al., 2010; Scott-Parker et al., 2012a).

A road hazard can be defined as a, “situation where your vehicle is on course to hit another road user such as a pedestrian, cyclist, bus, truck, motorbike or another car” (DTMR, 2007, p. 5). Perception and response to such hazards is considered to be vital to safe driving (Scialfa et al., 2013). Consequently, tests that measure a driver’s hazard perception (HPTs) have been included in driver training programs, assessment and graduated driver licensure (GDL) systems/frameworks worldwide (Scialfa et al., 2013).

In the Australian GDL systems, three states (ACT, NT, and TAS) do not employ HPTs to examine driver competence in perceiving road-related hazards. Three states (VIC, SA, and WA) require an online video or picture-based HPT to be passed, based on the test’s scoring system, before a novice driver can upgrade to a P1 licence. Two states (NSW, QLD) include an online HPT during the P1 stage, before a driver can upgrade to a P2 licence (Scott-Parker & Rune, 2016; Senserrick, 2007, 2009). These online HPTs are not the same measure, although they employ similar hazard perception...
measurement techniques (e.g., videos). These differences in hazard perception assessment between the states are noteworthy as inexperience and poor hazard perception are strongly linked with increased crash risk for novice drivers (Beanland et al., 2013; Isler et al., 2011; Sagberg & Bjørnskau, 2006; Williams, 2009). What is unclear is whether differences in hazard perception skills exist between P1 and P2 drivers. Use or non-use of HPT assessment at different licence stages between states suggests that differences in these skills at P1 and P2 levels may be hard to measure.

Most research in hazard perception only compares novice with experienced drivers. When hazard perception training is provided for young novice drivers, the distinction only seems to be for learner or unexperienced drivers within their first 3 years of licensure, which includes both P1 and P2 licence types.

**Hazard perception training**

Hazard perception has been linked to safer driving through better risk detection of potentially hazardous situations (Fisher, Pollatsek, & Pradhan, 2006; McKenna et al., 2006; Scialfa et al., 2011). Research has demonstrated that hazard perception training is more effective than education-based training (Horswill et al., 2013; McKenna et al., 2006; Shinar, 2007). Horswill et al. (2013) demonstrated that even brief hazard perception training (20min video-based training) could improve highly experienced drivers’ (police officers and 10+ years open licence holders) hazard perception skills. McKenna et al. (2006) found that hazard anticipation training can significantly decrease drivers’ risky driving inclinations through better hazard perception and situation awareness.

However, young novice drivers do seem to need further time to develop the complex, higher-order cognitive skills associated with hazard perception (Deery, 1999; Horswill & McKenna, 2004). Groeger (2000) explained that four processes involved in hazard perception were: 1) accurately detecting the hazard, 2) appraising the magnitude
of the threat, 3) selecting appropriate actions to avert the hazard, and then 4) acting.

When compared with experienced drivers, novice drivers seemed to fail at each stage of the hazard perception process, even though younger drivers are thought to have higher psychomotor and cognitive capacity (Horswill & McKenna, 2004). Consequently, research has explored whether hazard perception can be improved with training.

For the purposes of this study, drawing from the existing literature hazard perception is conceptualised as having two distinct phases: detection and action. Detection describes whether the driver perceives a road related hazard occurring either abruptly (e.g., vehicles stopping ahead of the driver, a car suddenly merging into the driver’s lane without prior indication, animals running onto the road ahead), or gradual onset (e.g., curves in the road, changing road surfaces identified by road sign, vehicles with their indicators left on, pedestrians on or near roads, navigating road works). Detection has two components: knowledge and identification.

Knowledge refers to the driver’s awareness and understanding of what a driving-related hazard is. These can be from learned definitions, theoretical knowledge, and/or previous experience of hazards encountered that have led to a possible traffic conflict. If a driver does not have adequate knowledge of what constitutes a driving-related hazard, they may not be able to identify and appropriately respond to hazards, which may in turn reduce their perception-reaction time. This is operationalized through a static HPT, which tests their knowledge of driving related hazards described further in the methods section.

Identification refers to the level of situational awareness a driver engages in, their scanning of the road around them while they drive. It is also the degree of perceived danger or crash risk associated with a traffic situation. Therefore, when a driver recognises a hazard (either abrupt or gradual onset) is occurring, they must act to avoid a potential traffic conflict. This is operationalized in the current study using the
simulator HPT, which asks participants to indicate they have perceived a hazard by flashing their vehicle headlights.

The second phase – action, is defined as what the driver does to avoid the hazard. This also has two key components: response and handling. Response is what the driver does when a hazard has been detected. This can involve behaviours such as slowing the vehicle down, emergency braking, safely stopping the vehicle (e.g., at traffic lights, intersections, stop signs), adjusting vehicle lane position or changing lane. Sometimes there is no response, due to either the hazard not being detected, or the hazard has been resolved without the driver needing to respond (e.g., some gradual onset hazards, such as a pedestrian unsafely crossing the road ahead returning to safety before the driver approaches). Hazard perception response is measured as the distance (in metres) between a potential gradual onset hazard (GOH) ahead, and when the participant flashes the simulator headlights.

The second component, hazard handling refers to whether the driver has avoided the potential traffic conflict. This can indicative of a traffic collision or motor vehicle collision (MVC), which occurs when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction (e.g., a tree, pole, or building). A near miss, or close call, where a traffic collision was close to occurring, but due to evasive action was prevented. If a traffic collision was avoided, it is considered that the driver handled the hazard well and as a result resolved the potential traffic conflict. The hazard handling scores are comprised of drivers who had near misses and collisions during their scenario HPT drive for this study. As traffic collisions can often result in injury, death (of drivers, passengers and other road users such as pedestrians, cyclists, or motorcyclists), and property damage, appropriate hazard handling, in-conjunction with hazard knowledge, identification and response is important for continued road safety and provides motives for improved hazard perception through training.
Many studies implementing different training and or intervention techniques have been conducted on drivers’ hazard perception training. However, studies that employ either video or simulator-based scenarios to examine hazard perception performance have focused on evaluating their own HPT design, and/or identifying correlations between hazard perception performance and driver experience (e.g., Borowsky et al., 2010; Crundall et al., 2012; Scialfa et al., 2011; Ventsislavova et al., 2016; Wetton et al., 2010). Some, such as Gugliotta et al. (2017), have only examined one component of hazard perception – for example, hazard prediction and other hazard perception training, either focus on learner drivers for their target sample (e.g., Crundall et al., 2010; Regan et al., 2000), or the training session is lengthy and difficult to replicate in larger driver populations (e.g., Isler et al., 2011). While Scialfa et al. (2013) demonstrated that both static and dynamic HPTs had good reliability, simulator-based training has advantages over some other training methods (e.g., PC-based, video-based). These include: preserving “driver” safety (Brooks et al., 2010; Riener, 2011) compared with on-road training, controlling cognitive resource allocation (Vlakveld, 2011), and a wider field of view for detecting cues and better verisimilitude (Shahar et al., 2010).

In a review of driver training efficacy, Beanland et al. (2013) reported that interventions that used driver training reviewed between 2001 and 2011 had major methodological flaws (e.g., no control group, poor randomisation, failure to account of confounding variables, or poor paradigm design), which had led to inconclusive findings and poor reliability of results. To improve the reliability and validity of interventions targeting either improving driver skills and or road safety, Beanland et al. (2013) highlighted a need for more robust methodology and appropriate evaluation.

**The current study**

The primary objective of the brief training session was to assess whether providing hazard perception training would result in improved performance presented in
traffic conflict scenarios compared with the no-training condition, examined by a driving simulator HPT. If successful, participants who completed the training should perform better (e.g., have better hazard knowledge, earlier hazard identification, higher number of hazards perceived, and fewer collisions) in the driving simulator hazard perception test than participants who were not in the intervention group. However, before these research questions could be examined, the proposed brief hazard perception training session required developing and piloting of its validity and feasibility prior to implementation. Driver education needs to be firmly based on previous research and theory concerning young driver skills, behaviour, motivation, and risk, and use effective behavioural change techniques (Glendon, 2014; Glendon et al., 2014; Lonero, 2008). The current training session evaluation was designed from research discussed above, and followed Beanland et al.’s (2013) recommendations to improve intervention methodology. It also implemented appropriate and relevant behavioural change techniques for improving the effectiveness of road safety interventions for young novice drivers as reported by Fylan and Stradling (2014). These are discussed further in the measures section of the methodology.

Glendon et al. (2014) highlighted that for interventions and training programs to maximise their effectiveness, appropriate evaluation should take place, recommending that a combined pilot intervention evaluation should be included. Therefore the current has two aims; first to develop methods of hazard perception training and measures of hazard perception performance (knowledge, identification, response, and handling). This aim will also involve the development of the training conditions and materials (pamphlet, passive, active), and the hazard perception tests (static and simulator). Second to pilot the training and measures of hazard perception using a sample of experienced drivers (open licence and P2 licence holders who had passed the Queensland Transport and Main Roads HPT), and the intended target population (P1
drivers aged 17-25 years). The pilot was designed to allow checking for any difficulties in implementing the proposed methodological procedures and whether the scenarios provided and targeted outcomes were appropriate for drivers from this age group and licence type. The pilot would also allow us to investigate whether any unforeseen or contrary effects may occur other than those outlined by the training session. In addition to obtaining important feedback from participant drivers who completed the session to help improve measures, clarify any ambiguity and finally test if differences in hazard perception scores on the measures (static and simulator) occurred between the P1, P2 and Open licence type drivers.

**Methodology**

**Participants**

The pilot sample (N=23) included a range of Queensland drivers; the target sample (P1 drivers n=7), and more experienced drivers (P2 drivers n=7; Open Licence drivers n=9). The seven P1 drivers (4 males, 57.1%) were aged 17-24 years (M=19.29, SD=2.29) and had held a licence, including their learners permit, for 2-6 years (M=3.14, SD=1.49), and reported driving 50-400 km/week (M=229.29, SD=136.94). The seven P2 drivers (3 males, 42.9%), were aged 24-26 years (M=24.86, SD=0.69) had held a licence for 7-8 years (M=7.71, SD=0.49), and reported driving 50-200 km/week (M=140.00, SD=50.3). The nine Open Licence drivers (4 males, 44.4%), were aged 23-35 years (M=27.67, SD=4.92), had held a licence for 7-17 years (M=10.89, SD=3.76), and reported driving 45-420 km/week (M=168.89, SD=126.16).

A separate sample (N=10) of open licence drivers (5 males, 50.0%; M=29.2 years, SD=5.16, range 25-40) was used to examine the static hazard perception measure only. These ten experienced drivers had a mean length of licensure of 12.60 years (SD=4.50; range 8-22) and reported driving on average 151 km/week (SD=60.41; range 50-250).

**Measures**
Hazard perception training. There were three training (pamphlet, passive, active) and one no-training condition developed for this study. These are described below.

Pamphlet. The pamphlet was an educational tool that provided information on what constituted hazard perception in driving, why it was important, and how it impacted novice drivers. This was divided into six sections: Foreword, What is a hazard? What is hazard perception? What is good hazard perception? What is a hazard perception action plan? Where is more information available? The pamphlet also had a 5-item multiple choice quiz for the reader to complete, with answers provided at the bottom of the pamphlet (see Appendix C). Participants were given ten minutes to read and complete the quiz. The pamphlet information was compiled from multiple sources, predominantly replicating information provided to young drivers from online sources available to drivers wanting to improve their hazard perception knowledge and skills, or who were preparing for their hazard perception test. The training measure was designed only to be educational, and replicated the behaviour change technique of “giving information” where information about risk and consequences was provided (Fylan & Stradling, 2014). As previous research has shown driver education to be associated with significant reductions in collision risk for provisional drivers (e.g., Zhao et al., 2006) it was included as a training type for the study.

Passive. The passive intervention training required the participant to sit before a computer to observe ten short video sequences of an experienced driver verbally narrating his driving behaviour, hazards that he perceived, and his driving response to hazards identified ahead to remain safe. These videos were sourced from Queensland Transport and Main Roads (TMR) online website (see http://www.tmr.qld.gov.au/Safety/Driver-guide/Identifying-hazards-when-driving.aspx), and are freely available to the public to download and view. Permission
from TMR was granted for use in this study. The ten videos were selected from those available from these everyday driving situations for identifying hazards when: 1) driving through business areas, 2) driving through road works, 3) driving through school zones, 4) when sharing the road with other road users, and 5) driving through suburban streets. Watching all ten videos took approximately 10 minutes. This training measure was intended reproduce drivers receiving verbal commentary training while driving, which has been found to improve hazard perception (e.g., Crundall et al., 2010; Isler et al., 2009). This training used the behaviour change technique of “supporting” (Fylan & Stradling, 2014), where specifically observing others, facilitates learning and exposure to hazardous driving situations, with an appropriate driving response (e.g., slow down, change lanes to avoid) is provided to the viewer.

**Active.** The active intervention training implemented the use of a high fidelity driving simulator. Participants operated the controls (steering wheel, accelerator, brakes) to navigate a simulated driving environment. Participants were directed to travel from location A to B as safely as possible, following all road rules and signage encountered. They were encouraged to drive in their usual manner as they travelled along an approximate 10km journey, where they encountered everyday driving situations where hazards can be present (e.g., red lights, merging traffic, pedestrians). This session was designed to be interactive, whereby the researcher who was present, observed the participant’s progress throughout the scenario, and provided direct feedback on their driving behaviour (e.g., monitoring speed, lane positioning), and commented on hazards perceived ahead of the driver (e.g., pedestrians in view, indicating vehicles ahead), with appropriate driver responses to identified hazards (e.g., slow down, change lanes). This was intended to simulate the actual learner driver experience, however, with a focus on hazard perception identification and practising safe responding to identified hazards.
Though interactive, the scenario was structured, and for consistency between participants who received this training condition, the researcher had a set script that included prompts of what, and when, to provide feedback. The simulator also provided the option to pause the scenario if required (e.g., participant was progressing through the scenario too quickly, and script needed to catch up). Modifying driver behaviour through passenger feedback has received research support (Hutton, Sibley, Harper, & Hunt, 2002; Lenné et al., 2011). This training replicated the behaviour change technique of “teaching” (Fylan & Stradling, 2014), whereby instruction and feedback on learner driving performance is provided.

The scenario contained 18 driving-related hazards that the researcher commented on, with nine requiring a safe driving response to avoid a possible traffic conflict. The 18 hazards were separated into four types: 1) pedestrian/cyclist (4 hazards), 2) intersections, traffic lights, and stop signs (6), 3) other vehicles, including buses (6), and road obstructions (2). This session took approximately 10 minutes.

**Static hazard perception test.** The static HPT required each participant to view 12 photo images from a driver’s visual perspective in everyday driving situations, and report the number of potential driving-related hazards that they saw. Images were sourced from the online videos from the TMR website, but did not duplicate any used in the passive training condition. Fifty potential driving-related hazards could be identified throughout the 12 images. To identify the range and types of hazards within the images, they had previously been evaluated by ten experienced drivers. The types and numbers of hazards were: pedestrian (6 hazards), cyclist (3), other cars/drivers on the road, parked and moving in the driving lanes in motion (24), road related (10; e.g., intersections, road changes, visibility), and road works (7). Each image has from two to seven potential hazards.
The participant viewed a PowerPoint® presentation of each image, with instructions to write the number of hazards they saw, and to identify each hazard on a paper response sheet. Participants were directed to record driving-related hazards that may or may not lead to a potential traffic conflict. This term was defined within the instructions to participants. Each participant had 10 minutes to complete the task, which was scored by the researcher. Each correctly identified hazard received one point (scores range from 0-50), and provided an initial measure of driver hazard knowledge.

**Driving simulator.** The driving simulator was a fixed-based model with original controls (accelerator and brake pedals, steering wheel, seat, safety belt, indicator, automatic gear shift, hand brake), from a Hyundai Getz, linked to dedicated graphics computer equipment. In this study, all driving was performed in a simulated standard automatic 4-cylinder vehicle, and hence no gear changes were required. Visual images were displayed on three 32-inch LCD monitors using three channels, set to provide a 100° forward field of view. A rearwards view simulating a car rear-view mirror was displayed on the central monitor (see Figure 7.1 for the simulator set up). Images from the simulation software were refreshed at a rate of 60 Hz, with the driver’s vehicle dynamics data sampled at a rate of 20 Hz. Auditory feedback was provided using a stereo sound system (sound effects included braking, engine noise, etc.). A force feedback steering and vibrations through the driving seat from a 4-channel sound system provide a sense of motion. During each of the simulated driving tests, kinematic and behavioural data of the controlled vehicle were recorded by the simulator’s software program, which included measures of lateral position, speed, pedal use (brake and accelerator), and steering wheel movements.

An OKTAL SCANeR® studio academic driving simulation software for universities and research institutes (SCANeR studio simulation engine v1.6, OKTAL, Paris, France) was used to create traffic scenarios and collect data during each session.
This SCANeR studio simulator software is equipped with an analysis module allowing recordings of each drive to be collected, which can subsequently be replayed either as a video file to view the entire driving scenario, or converted to a spreadsheet data file, allowing analysis of the driver’s vehicle’s dynamics within the simulation. Both videos of the drive and vehicle dynamic’s data in the response to hazards during the scenarios were used.

![Driving simulator set up with participant in the driver’s seat and responding to images displayed on the three screens (Irwin et al., 2014).](image)

*Figure 7.1.* Driving simulator set up with participant in the driver’s seat and responding to images displayed on the three screens (Irwin et al., 2014).

**Simulator familiarisation tasks.** To provide familiarity with the virtual environment and ease of using the driving simulator, participants completed three separate driving familiarisation tasks. This allowed participants to practice using the driving simulator, (e.g., speed control, braking, changing lanes, emergency stopping), and to enabled them to use the equipment effectively. Prior to testing, it was confirmed that participants were comfortable and felt confident to drive with no illness (e.g., simulator sickness, vertigo) affecting their performance. During their practice drives, participants experienced scenarios that included the following familiarisations: a car
following on a multilane highway task, a single one-way lane driving, and a brake-reaction task.

The single one-lane driving familiarisation allowed the participant to practice speed control using the accelerator, lane positioning, and driving along a straight road. The car following familiarisation on a multilane highway also allowed participants to practise speed control and lane position, but increased the difficulty level by having roads that curved, and included elevations and depressions. There were also two additional required tasks for this familiarisation: safely following a car in front of the driver, and when directed, safely overtaking a vehicle using an available lane. This also allowed the driver to practise lane changing. The final familiarisation involved increased driving complication. Here participants were required to practise braking and stopping the vehicle when a red indicator (hexagon) appeared on the screen and flashing the vehicle's headlights when a green (hexagon) indicator appeared. This task was designed for participants to practise breaking (5 instances), and flashing the headlights (5 instances), which are behaviours that are used in the simulator HPT.

Oncoming traffic was included in all three scenarios, so that the driver could become familiar with movement on the road. Pedestrians and cyclists were present in the third familiarisation. Each familiarisation took approximately 5 minutes, which allowed participants to have up to 15 minutes practise in learning how to use the simulator before further testing.

**Hazard Perception Test Scenario.** A computerised driving simulation task measured driving performance in the hazard perception scenarios generated for this study. Participants drove a fixed course of approximately 15 km, which took 14-16 minutes. The 10-sector course was conducted under simulated daylight conditions. The environment was designed as a rural/suburban area, with a 4-lane dual carriageway road; had 60, 70, and 90 km/hr speed signs posted throughout; contained eight
intersections with traffic signals, and one intersection with a stop sign. Buildings (e.g., houses, apartments, farms), lightly landscaped areas (e.g., parks and trees), and moderate traffic (may encounter 6-8 other vehicles) was present (see Figure 7.2 for an example image of the scenario environment). While other vehicles and pedestrians were present in the scenario, only some were scripted to actively interact with the participant’s vehicle.

![Image of the scenario environment used in the HPT. This is a bird’s eye view of the vehicle; the driver viewed the road and surrounds from the point-of-view of being in the driver’s seat.](image)

To navigate the simulated driving environment, participants operated the simulator controls (steering wheel, accelerator, brakes). Participants were directed to travel from the starting point, until the simulation ended, following all road rules and signage encountered. For standardisation, all instructions were provided in written form. Participants were asked to drive in their usual manner as they travelled through the scenario, where they encountered 31 road-related hazards. Hazards that were presented in this HPT were categorised as either: 1) abrupt-onset, or 2) gradual onset hazards (Underwood et al., 2013). Abrupt-onset hazards require sudden attention capture and fast reaction time to successfully avoid a traffic collision (e.g., a pedestrian suddenly running across the road in front of the vehicle). Gradual-onset hazards require identification of the hazard emerging, and anticipation to safely navigate it (e.g., bus
with indicator light on signalling to merge into traffic ahead of the driver; Underwood et al., 2013).

Of the 31 hazards, 23 were coded as gradual-onset hazards (GOH), and eight were coded as abrupt-onset hazards (AOH). Of the eight AOHs, three were further coded as critical reaction events, where a hazard appeared suddenly and without warning (e.g., parked car suddenly pulled into lane, or a car is in the intersection when the driver’s traffic signal was green). The remaining five AOHs were still scripted to occur abruptly, although a more situationally-aware driver would have a greater opportunity to see the hazard developing (e.g., bus indicated to merge into the driver’s lane, pedestrian ran across road from the right side). All eight AOHs and 13 GOHs required a driver response (e.g., slow down, stop vehicle, emergency brake, change lane) to avoid a traffic conflict. These hazards are described in Table 7.1. There were six types of hazards: moving vehicles (5 hazards), parked cars (6), large vehicles (3), pedestrians (6), road obstructions (4), and intersections (7).

Participants were instructed to flash the simulator headlights using the indicator on the steering wheel when they saw a hazard. This allowed the simulator data file to record the number of hazards “identified” by a participant, and it recorded the vehicle speed (in km/hr), and distance (in meters) from each oncoming hazard. For recoding and scoring, this also provided a visual stimulus within the video recording of where and when a participant indicated that they perceived a hazard.

**Questionnaire booklet.** Participants completed a 123-item questionnaire booklet, which contained eight scales, which took 30-45 minutes to complete. Six demographic items requested participants’ age, gender, licence type, number of years licence had been held (since learner), average number of kilometres driven per week, and number of
Table 7.1.  

Driving simulator scenario for hazard perception performance test

<table>
<thead>
<tr>
<th>Section / speed limit</th>
<th>Traffic signal</th>
<th>Hazard/Driving task</th>
<th>Hazard perception</th>
<th>Hazard type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 60km</td>
<td>A Green Signal</td>
<td>Re-familiarisation</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2 60km</td>
<td>B Stop sign</td>
<td>-Car familiarisation</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Stop sign</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td>3 70km</td>
<td>C Green Signal</td>
<td>-Speed limit change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 60km</td>
<td>D Red Signal</td>
<td>-Parked cars (x2) on drivers side of road</td>
<td>-Parked cars</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Speed limit change</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Farm trailers (x2) on drivers side of road</td>
<td>-Road obstruction</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Herd of cows on right side of road (static)</td>
<td>-Road obstruction</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked car pulls out from left side road, misjudgement of gap</td>
<td>-Moving vehicles (merging)</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars (x2) on drivers side of road</td>
<td>-Parked cars</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Red traffic signal ahead</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td>5 60km</td>
<td>E Red Signal</td>
<td>-Car parked on left hand side of road</td>
<td>-Parked cars</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Car (above) pulls out of kerb, gap misjudgement</td>
<td>-Moving vehicle (merging)</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars (x2) on drivers side of road</td>
<td>-Parked cars</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Red traffic signal ahead</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Ute runs red signal and is in intersection while driver’s signal green</td>
<td>-Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Speed limit change</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars (x2) on drivers side of road</td>
<td>-Parked cars</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian running across road driver’s side (left to right)</td>
<td>-Pedestrians</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Road works with barrier</td>
<td>-Road obstruction</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian on road walking southbound</td>
<td>-Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Amber traffic signal ahead</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Car indicating to turn right at intersection</td>
<td>-Moving vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Car (above) does not give driver right of way</td>
<td>-Moving vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrians (x2) static at bus stop</td>
<td>-Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian running on road from right to left towards</td>
<td>-Large vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bus stop with bus indicating it wants to merge into drivers lane</td>
<td>-Large vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bus pulls out into lane turns right at the next signals</td>
<td>-Large vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Amber traffic signal ahead</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Speed limit change</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Higher speed zone</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Amber traffic signal ahead</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td>8 90km</td>
<td>H Signal amber to red 50m from signals</td>
<td>-Speed limit change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 70km</td>
<td>I Signal amber to red 50m from signals</td>
<td>-Rubbish bins on drivers side of road (x3)</td>
<td>-Road obstruction</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars (x3) on drivers side of road</td>
<td>-Parked cars</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrians (x3) on right side of road</td>
<td>-Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Amber traffic signal ahead</td>
<td>-Intersections</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bus still in intersection when signal turns green</td>
<td>-Large vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td>10 60km</td>
<td>Finish</td>
<td>-Speed limit change</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian crossing with pedestrians crossing the road</td>
<td>-Pedestrians</td>
<td>GOH</td>
</tr>
</tbody>
</table>

Note: AOH = abrupt-onset hazard, GOH = gradual-onset hazard
violations recorded since P1 licence. The questionnaire included measures of perceived risk (12 items), risky driving engagement (36 items) using Scott-Parker et al.’s (2012c) revised BYNDS, protection motivation theory threat and coping appraisal (30 items), and prototype willingness model risky driver prototype favourability and similarity, and behavioural willingness (39 items). These measures were included in the pilot study for testing completion time, item ambiguity, or required clarification. Pilot responses were not included in the main analyses. The measures are described further in Chapter 9.

These measures were previously found to have a significant contribution in explaining young driver behaviour (chapters 4 and 5) and therefore were implemented to determine whether they were associated with hazard perception. This research question is addressed in Chapter 9.

**Presence Questionnaire.** As a simulated virtual driving environment was used, a shortened version of the 24-item Presence Questionnaire (Cronbach’s $\alpha=.81-.88$; Witmer, Jerome, & Singer, 2005; Witmer & Singer, 1998) was included as a measure of internal validity for the hazard perception test. Presence is defined as the, “subjective experience of being in one place or environment, even when one is physically situated in another” (Witmer & Singer, 1998, p. 225). Twenty items were measured with four subscales: 1) involvement/control (11 items), which measured perceived control of events, responsiveness to user-initiated actions, immersion of visual aspects and the level of involvement the participant felt in the virtual environment; 2) interface quality (3 items), which measured participant concentration on tasks, and whether participants experienced distraction due to control or display devices; 3) natural (3 items), which measured the extent to which the interactions and control felt natural and consistent with reality; 4) auditory (3 items), which measured the extent to which auditory aspects of the virtual environment could be identified and localised. These subscales have been reported to measure a single construct called presence (Witmer et al., 2005; Witmer &
Singer, 1998). Items are measured with a 7-point semantic differential response scale, where higher scores indicate stronger presence. Three items required reverse coding (items 12, 14, 15), and each subscale and the overall total were summed and averaged to provide measures of involvement/control, interface quality, natural, and auditory, as well as an overall measure of presence experienced when using the driving simulator. Two items measuring haptics, and two items measuring resolution, were not included as they were not applicable to this simulator task.

**Training appraisal survey.** A 15-item survey was written to appraise the training session. The questionnaire contained items written to obtain quantitative information using response formats (6-point response range), and qualitative information using open-ended questions. Quantitative items included: confidence of perceiving and responding to driving related hazards, and effectiveness of training session (overall, learning about their own reactions). Other items asked: how well the training session compared with what was experienced on the road, how important hazard perception was for driving, and whether the participant would recommend the training session for P1 drivers. Qualitative items were written to obtain participant feedback on: their learning, changes in understanding hazard perception and driving related hazards, where young drivers sought information for hazard perception, what participants liked or did not like about the session, and feedback for improvement. Thematic analysis, using an inductive approach (Braun & Clarke, 2006) was used for identifying, analysing and reporting patterns (themes) within the data, while maintaining the participants' perceptions, feelings and experiences of the training session. Coding and analysis was undertaken by two researchers (EH and CW) independently to enhance rigor and as a method of member checking for the extracted codes and themes (Braun & Clarke, 2006). Completing the survey was voluntary, with
feedback linked to a participant’s group code only, allowing responses to remain anonymous. The survey took 7-10 minutes.

**Procedure**

After ethical approval was obtained from Griffith University Human Research Ethics Committee, participants were convenience sampled from a university population, advertised through the University’s online participant pool and email listing of research projects requiring volunteers. For their time and participation, pilot participants had an opportunity to enter a prize draw to win one of three $100 gift cards. Students in the first-year online participant pool were also given participating course credit. The training session was divided into 10 stages, summarised in Table 7.2. There was only one participant per session, where sessions occurred across the months of October-December 2016.

All participants completed an initial screening for experiment suitability and if they met eligibility criteria (i.e., informed consent, no alcohol consumed in last 24 hours, had consumed a recent meal, low level of fatigue assessed, previous history of simulator sickness or driver training, had a recent (last 3 years) involvement in a motor vehicle crash). Participants were asked to rate their subjective confidence in identifying and responding to hazards that may appear on the road from: 1 *not confident at all* to 6 *extremely confident*. All P2 and Open Licence drivers were automatically allocated to the no-training condition. P1 drivers were randomly assigned to a training condition (pamphlet, passive, active) prior to screening. This training condition order was formulated using an online random number generator, specifying that a minimum of three instances per condition were to occur for an estimated sample size of nine participants. P1 drivers were blind to the knowledge that other training conditions existed.
### Training session order, task break down and time

<table>
<thead>
<tr>
<th>Stage</th>
<th>Task</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participant screening for suitability and eligibility</td>
<td>5 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Static hazard perception measure</td>
<td>10 minutes</td>
</tr>
<tr>
<td>3</td>
<td>Driving simulator familiarisation tasks</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>- Single lane highway drive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Car following task drive on a multi-lane highway</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Brake-reaction task drive in a built up urban environment</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Questionnaire Booklet</td>
<td>30 minutes</td>
</tr>
<tr>
<td></td>
<td>- Demographics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Perceived risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- BYNDS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Threat and coping appraisal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Prototype similarity and favourability</td>
<td></td>
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<tr>
<td></td>
<td>- Behavioural willingness</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Break</td>
<td>10 minutes</td>
</tr>
<tr>
<td>6</td>
<td>Hazard perception training session a</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>- Pamphlet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Passive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Active</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Simulator hazard perception test and debrief</td>
<td>20 minutes</td>
</tr>
<tr>
<td>8</td>
<td>Presence questionnaire</td>
<td>5 minutes</td>
</tr>
<tr>
<td>9</td>
<td>Training appraisal survey b</td>
<td>5-10 minutes</td>
</tr>
<tr>
<td>10</td>
<td>Session debrief and wrap up</td>
<td>5 minutes</td>
</tr>
</tbody>
</table>

*Participants only completed one of these training tasks, according to their group allocation.*

*This survey was optional, with the option to decline provided.*

After screening, all participants completed the static hazard perception test on the computer in the simulator laboratory. Participants viewed the PowerPoint® presentation and recorded their responses on paper. The researcher, who was present in the simulator laboratory but not within the participant’s view, monitored and recorded the time taken to complete the task. Participants then completed the driving simulator familiarisation tasks. The researcher confirmed with the participant that they felt confident and competent using the driving simulator, and that they agreed to move to the next task. Completing the paper questionnaire booklet followed. Participants received a 10-minute break before completing their training condition, as described above in the measures section.
After this training session, participants were tested using the HPT simulator scenario. Participants received the same standardised written instructions to read over before completing the test. They were instructed to flash the driving simulator headlights, located on the steering wheel, right-hand side indicator, whenever they saw a road-related hazard, which may or may not lead to a potential traffic conflict. Participants were also required to verbalise the hazard they saw as they flashed the headlights. Participants’ verbal responses were recorded using a voice recording device, to account for delayed or pre-emptive headlight flashes relative to the where trigger points were set in the scenario script. Once the simulation had commenced, a voiceover reminded participants of the following: “Please adhere to all road rules and speed limits, drive straight, and to flash the headlights whenever you perceive a hazard”. The researcher monitored the participant’s performance throughout the scenario and recorded performance details (i.e., number of flashes, driver response to abrupt onset hazards) using a standardised response sheet.

On completion of the simulator task, debriefing was conducted and feedback was obtained from participants using a standard series of questions about how they felt about their performance. Positive feedback from the researcher was provided, which was general and non-specific, and was given to all participants regardless of their simulator performance. After completing the presence questionnaire, P1 and P2 pilot participants only were invited to complete the hazard perception training evaluation questionnaire.

To account for further possible ethical concerns, time was taken to debrief each participant at the end of their simulator session. This was intended to help reduce any possible effect of negative transfer; whereupon exposure to driving in a consequence-free environment might have led to a participant not being adequately or fully recalibrated to real-world driving, and might proceed to operate their own vehicle with an analogous disregard for consequences (Fisher, Rizzo, Caird, & Lee, 2011). To reduce
hazard hyper-vigilance due to the quick succession and number of hazards that appeared in a relatively short time during the scenario, the researcher highlighted to participants that although the scenario was designed to simulate a road driving environment, it was developed to include many hazards, which may not be representative of their normal driving experience. Participants were also reminded that they had left the simulated environment, and that before they left the research area they must feel competent in driving within a non-simulated driving environment. This agreement was included in the voluntary signed Consent Form.

**Results**

**Hazard perception static measure**

Ten experienced (Open Licence) drivers reviewed the 12 images and identified a mean of 49.50 ($SD=3.69$; range 45-55) hazards. The static HPT took these drivers an average of 10 minutes to complete. From these results, a final sample of 50 hazards was chosen to represent the expected number of hazard presented throughout the 12 images.

In the pilot sample ($N=23$), we wanted to compare if mean differences in correct identification of hazards in the static hazard perception measure occurred between the three licence types. Though group sizes were small, they met the minimum condition of seven participants per cell, although this would only yield a power of approximately 50% for an effect size of .50 (VanVoorhis & Morgan, 2007). The test for normality, examining standardized skewness and the Shapiro-Wilks test indicated that the data were normally distributed. However, as Levene’s $F$ Test revealed that the homogeneity of variance assumption was not met ($p = .030$), Welch’s $F$ test was used. An alpha level of .05 was used for all subsequent analyses to ascertain statistical significance. Significant mean differences were found among licence type groups, Welch’s $F(2, 9.89)=27.71, p<.001, est.\omega^2=.70$. 


Post-hoc comparisons, using the Games-Howell correction, were conducted to determine which licence types differed significantly. P1 licence drivers ($M=22.29$, $SD=9.29$) had significantly lower static hazard perceptions scores compared with those of P2 licence drivers ($M=40.43$, $SD=4.28$), $p=.003$, and with those of Open Licence drivers ($M=47.44$, $SD=2.40$), $p=.001$. P2 licence drivers also had significantly lower static hazard perception scores compared with those of Open Licence drivers ($p=.009$).

**Simulator hazard perception performance**

Participants’ performance in the hazard perception test using a driving simulator environment was recorded and scored. Scores were obtained for each correctly identified hazard in the scenario. In the pilot sample ($N=23$), it was desired to test whether mean differences in correct identification of hazards in the driving simulator hazard perception test differed between licence types. Assumptions of normality and homogeneity of variance were met. A one-way ANOVA examined whether licence types differed in hazard perception scores. Differences were found among licence types, $F(2, 20)=6.35$, $p=.007$, $est.\omega^2=.32$.

Post-hoc comparisons using the Bonferroni correction examined which groups differed. P1 drivers ($M=21.43$, $SD=3.46$) identified fewer hazards on the simulator hazard perception test than Open Licence drivers did ($M=27.78$, $SD=3.49$), $p=.006$. However, there were no differences in identified hazards between P2 drivers ($M=25.14$, $SD=3.67$), and P1 drivers, or between P2 and Open Licence drivers.

Descriptively, between hazard types in the measure, the number of abrupt-onset hazards identified in the simulated scenario was similar between licence types. However, the number of gradual-onset hazards identified increased according to licence type. P1 drivers identified on average 14.57 ($SD=2.37$) gradual-onset hazards, compared with P2 drivers who identified on average 17.43 ($SD=3.36$), and Open licence drivers who identified on average 19.89 ($SD=3.26$).
As two methods of HPTs were implemented for this pilot, static and simulator, it was expected that the two outcome measures would be related. A Pearson’s $r$ correlation tested this relationship. As predicted, a strong positive relationship was found between the measures ($r=.74, p<.001$). High scorers in the static measure also identified more hazards in the simulator measure. When examining hazard types, this relationship was stronger for gradual-onset hazards ($r=.73, p<.001$), than for abrupt-onset hazards ($r=.54, p=.008$).

**Presence measure**

Participants rated their subjective experience in engaging in the driving tasks using the driving simulator. It was desired to determine whether overall reported presence while driving in the simulator differed between licence types. After examining the assumptions of normality and homogeneity of variance, which were met, a one-way ANOVA was run to examine whether licence type differences occurred in reported presence. No significant mean differences in reported presence among the licence types were found, $F(2, 20)=0.38, p=.689$. Descriptives and Cronbach’s alpha of the presence scale and its subscales are shown in Table 7.3. As no differences were found between licence types, data were not split by licence type. Participants rated the auditory aspects of the virtual environment the lowest in presence and interface quality (the ability to concentrate on task without distractions) the highest in presence.
Table 7.3.

*Reported ratings of presence in simulated driving environment* (N=23)

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Presence</td>
<td>.89</td>
<td>5.63 (0.64)</td>
<td>4.10-6.60</td>
</tr>
<tr>
<td>Sub scales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>.72</td>
<td>5.43 (0.92)</td>
<td>3.33-6.67</td>
</tr>
<tr>
<td>Auditory</td>
<td>.87</td>
<td>5.13 (1.38)</td>
<td>1.00-7.00</td>
</tr>
<tr>
<td>Interface Quality</td>
<td>.72</td>
<td>6.13 (0.66)</td>
<td>4.00-7.00</td>
</tr>
<tr>
<td>Involvement/control</td>
<td>.76</td>
<td>5.69 (0.59)</td>
<td>4.45-6.64</td>
</tr>
</tbody>
</table>

**Training appraisal survey**

Descriptive statistics for the survey are presented in Table 7.4. As Open Licence drivers did not complete the questionnaire, only the P1 and P2 driver responses are shown. Overall the sample indicated high confidence in identifying and responding to hazards, with all participants responding as moderately confident or above for these items. Learning effectiveness in hazard identification and response was also rated at a high level. All but one participant rated the training session moderately effective or above for learning about hazard identification, and all but one participant rated the learning effectiveness in responding to hazards in the driving scenario as very effective. Overall, participants also rated the driving simulator scenario as moderately comparable to driving in the real world. While P2 drivers rated the importance of hazard perception as very important or above, P1 drivers rated this as somewhat to very important. All drivers indicated that they would recommend this brief training session for P1 drivers.
Table 7.4
Descriptive statistics of evaluation questions for P1 and P2 drivers (n=14).

<table>
<thead>
<tr>
<th>Item</th>
<th>P1 drivers (n=7)</th>
<th>P2 drivers (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence in identifying hazards</td>
<td>5.29 (0.76)</td>
<td>4.71 (0.49)</td>
</tr>
<tr>
<td>Confidence in responding to hazards</td>
<td>5.14 (0.90)</td>
<td>4.57 (0.54)</td>
</tr>
<tr>
<td>Comparable to real life driving using the simulator</td>
<td>4.14 (0.69)</td>
<td>5.00 (0.82)</td>
</tr>
<tr>
<td>Effectiveness in learning about hazard identification</td>
<td>4.43 (0.79)</td>
<td>4.71 (0.76)</td>
</tr>
<tr>
<td>Effectiveness in learning about hazard response</td>
<td>5.00 (0.00)</td>
<td>4.86 (0.38)</td>
</tr>
<tr>
<td>Importance of hazard perception</td>
<td>3.86 (0.90)</td>
<td>5.86 (0.38)</td>
</tr>
</tbody>
</table>

P1 drivers were invited to complete the qualitative items in the evaluation
questionnaire as this training session was targeted specifically for them. All but one
participant responded to these questions (n=6). Thematic analysis identified response
themes within the data. All six pilot responders indicated that they had learnt something
new (e.g., hazards that related to parked vehicles, pedestrians near the road, and changes
in the road surface). Additionally, drivers also indicated a need for higher awareness of
what is happening on, and/or near the road as indicated by participant PTSIM01: “That
there are far more hazards in real world driving than I had anticipated prior to
participating today.”

When questioned about whether their original understanding of hazard perception
changed after the session, all participants replied positively, indicating that their
understanding and knowledge of the types of hazards had improved. For example
participant PSIM03 stated: “I feel far more educated on what actually constitutes a
driving related hazard than had I not completed this research participation.”
Participant PVID01 highlighted that: “I need to be more aware of people on and near
roads” and PPAM01 said: “I have a better understanding now.” A reoccurring theme
was that there was an increase in the number of hazards participants now knew they needed to look out for while driving on the road.

As the session involved training and expanding novice driver hazard knowledge, participants were asked where they would seek additional information. All participants indicated that they would seek this information from an online source (e.g., Google search), or TV advertising campaign, with four specifying this to be government or Queensland transport related (e.g., PSIM02: “Any government website relating to roads i.e., Queensland transport”).

Positive comments about the session highlighted the realism felt in driving the simulator (e.g., PSIM03: “How it really felt like driving a 'real' car”, PVID02: “I specifically liked how the speed adjusted to the hills requiring more acceleration”). In addition to how educational and representative the driving scenario was compared with previous real-life experiences (e.g., PSIM01: “It was an accurate representation of real world experiences”, and PPAM02: “Educational and realistic”). Participants also indicated that having the opportunity to experience abrupt-onset hazards was helpful to their understanding of how they would respond on the road, should any of these occur during real driving. For example PVID01 said: “Good to see how to respond in 'real life’” and PSIM03 wrote: “You get to see how you would react to things on the road that could happen.”

Negative comments and recommendations for improvement included themes of difficulty in adjusting to the simulator accelerator and brake pedals, (e.g., PSIM01: “The brakes were too touchy and too much pressure needed to be applied on the brakes and accelerator to get a response”), the screens not having side mirror vision of the car, and that the scenario environment design could be improved (e.g., removing repetitive building graphics).
Discussion

The aim of this study was to develop and pilot methods of hazard perception training and measures of hazard perception performance (knowledge, identification, response). It was desired to screen for any difficulties in implementing the proposed procedures, to assess whether the hazard perception scenarios and targeted outcomes from training were appropriate for drivers from our target sample (P1 drivers aged 17-25), and to investigate whether any unforeseen or contrary effects than those outlined by the training session would occur. Through piloting each component of the brief training session it was possible to assess the duration for each component, resulting in higher accurate estimations of training and testing length. Instructions that were perceived as ambiguous to some drivers could be clarified and later standardised in written form.

The novel static hazard perception measure was finalised to a presentation measure with 50 road-related hazards that could occur during driving. Similar to previous research (e.g., Isler et al., 2009; Scialfa et al., 2012), the static HPT could differentiate between licence types. This measure can be helpful to obtain a general knowledge test of road-related hazards for drivers, particularly P1 drivers, as during debriefing P1 drivers commented on a lack of hazard knowledge. Novice drivers not recognising hazards have been found (e.g., Scialfa et al., 2011), indicating a weakness that driver training can target for improvement in future research, and which have implications for young driver behaviour.

If young drivers are not able to recognise an emerging hazard, then the time that they will have to respond appropriately is reduced, and may lead to increased likelihood of a traffic conflict. The greater variance in the static HPT scores for P1 drivers, compared with the other driver groups, also suggests a possible use of this measure to identify low and high scorers among P1 licence holders. Examining participants’ current hazard identification before any training is an important methodological check,
particularly in establishing whether the groups differed at baseline, or controlling for potential confounding variables (Beanland et al., 2011). Future research using this measure is needed, especially in determining whether scores will change after implementing hazard perception training.

The simulator HPT could discriminate between P1 drivers and Open Licence drivers. The clear trend showed P1 drivers identifying the least hazards, and Open Licence drivers correctly identifying more scenario hazards. Differences between P2 drivers and Open Licence participants were not expected, as previous research has shown that novices who had more than 1600kms driving experience were more similar in physiological responses to those of more experienced drivers (Kinnear et al., 2013). It was noteworthy that differences in hazard perception scores between P1 and P2 driver samples were not significant. P1 drivers received the pilot hazard perception training (either pamphlet, passive, or active), which may have contributed to increased performance in the scenario, producing similar hazard perception identification with their P2 counterparts, who had more driving experience. Further research with a larger sample size and with a no-training control group is needed to confirm these findings. Due to small sample size, it is also unclear whether a training type (pamphlet, passive, active) effect occurred. However, a follow-up study with a larger sample taking into account the feedback from the participants is warranted and is explored in Chapter 8.

During participant debriefing and research team feedback sessions, suggestions for further improvement to the simulator HPT were discussed to refine and test for the follow-up study discussed in Chapter 8. Due to the ambiguity of some road hazards expressed by experienced drivers (e.g., road-related), and ceiling effects found for some hazard types (road obstructions), it was decided to narrow the focus of hazard types tested in the scenario to road-user related hazards (e.g., pedestrians, motorcyclists, other car drivers). These hazards occur more frequently in the road and driving environment,
and are linked to higher accident involvement rates as drivers have been reported to fail in perceiving vulnerable road users (Borowsky, Oron-Gilad, Meir, & Parmet, 2012; Horswill & McKenna, 2004; Sanocki, Islam, Doyon, & Lee, 2015). It was also observed that drivers were not aware of changes in speed limit signage, which was later highlighted in feedback and debriefing sessions that the changes in speed were too frequent, and added another level of increased difficulty. As the focus was hazard perception, it was recommended to keep the speed limit constant throughout the scenario. This was implemented as it would also help monitor when drivers did engage in speeding and when they drove too cautiously and perhaps themselves become a road related hazard.

That there was no difference among licence groups in responding to AOH events supports previous findings (e.g., Underwood, Ngai, & Underwood, 2013; Yeung & Wong, 2015). Only GOHs that required anticipation appeared to reveal individual driver differences in hazard perception. However, having AOHs present in HPT is important, as even if novice drivers detect a potential hazard in time, some may not know, or may be unsure of how to appropriately avoid a collision (Wang et al., 2010). To address this, it was recommended to increase the number of AOH events for hazard response, and that some of the presented hazards contain covert and overt hazards to further test young driver skills in their response, and how they handle the hazards. As research has shown that when compared with more experienced drivers, differences occur in visual scanning patterns of the road for young novice drivers (e.g., Gugliotta et al., 2017; Pollatsek, Narayanaan, Pradhan, & Fisher, 2006; Scialfa et al., 2011; Underwood et al., 2013; Underwood, Crundall, & Chapman, 2011), ensuring that presented hazards appear not only centrally, but peripherally during the scenario, will provide higher variability in detection and response to hazards when comparing training groups.
After examining responses on the evaluation and presence measures used during this pilot, there were no differences in the ratings of presence between licence types using the simulated environment. This provided support for the validity of the training and testing conditions used across groups. Ratings on the presence questionnaire were also similar to feedback received on the evaluation questionnaire. Participants (P1 and P2 drivers) indicated that they found driving in the simulator comparable to real life driving, and that hazards used in the scenario were hazards experienced while driving. Overall, feedback from the target pilot sample of P1 drivers on the training appraisal survey was positive. Participants indicated they had learned something from the session and enjoyed using the driving simulator, although it was designed to measure driver performance. While hazard perception confidence in identification and response was high, it was unclear whether this was due the training or to their normal level of confidence. Examining confidence before and after training is recommended to further test the relationship that perceived confidence has in identifying and responding to hazards, particularly because overconfidence can lead to detrimental consequences when responding to hazards on the road (Beanland et al., 2013).

Conclusion

The few months after gaining a provisional driver’s licence is considered to be the greatest crash risk period for young drivers as driver supervision has just ended. This high-risk timeframe is crucial for young novice drivers to develop and improve their hazard perception skills. Results from this pilot highlighted that hazard perception differences occur between licence types, such that P1 drivers in particular show lower hazard perception identification compared with the other licence types, including their P2 peers. The next study described will examine in a larger sample, both the level of hazard perception present in P1 drivers, and also whether three types of the proposed novel brief training sessions are effective in improving hazard perception. Measures
used in the next study will incorporate previously discussed feedback from participants and research team to best evaluate these outcomes.
CHAPTER 8

Implementation of a brief hazard perception training session to improve hazard perception performance in young novice drivers

Chapter 8 presents the results of study 6, which assessed whether the brief hazard perception training session via the intervention that was designed and piloted in study 5 resulted in improved road user hazard perception performance examined by a novel driving simulator HPT. This chapter is presented as a manuscript that has been written and prepared for publication. This study addresses research aim 2 of the thesis. A sample of P1 licence holders (n=52, aged 17-25 years) took part. We explored whether participants in a training condition performed better on hazard perception measures compared with participants in a non-training condition. Hazard perception performance was examined in three modes, identification, response, and vehicle control. It was predicted that participants who received training would have higher correct identification of road user hazards, show earlier hazard detection (longer distance from gradual-onset hazards), and have better hazard handling/avoidance driving responses to abrupt-onset road user hazards in a driving simulator hazard perception test. The study also explored participants’ prior level of static hazard perception (static hazard knowledge score), and whether differences were found in the training conditions (control, pamphlet, passive, active) on the driving simulator hazard perception performance scores when accounting for the covariate of hazard perception knowledge. Differences were also explored in the training condition’s overall driving simulator hazard perception performance at 2-3 week follow up (n=42).
Statement of contribution to co-authored published paper: Paper 5

This chapter includes a co-authored paper. The bibliographic details of the published co-authored paper, including all authors, are:


My contribution to the paper involved:

- Conception and design of the research paper
- Review and interpretation of literature
- Conducting data collection and analysis to produce the article
- Analysis and interpretation of research data
- Writing and revising of the paper

Student/Corresponding author of paper: Emma Harbeck
October, 2017

Supervisor: A/Pro Ian Glendon
October, 2017

Supervisor: Dr Trevor Hine
October, 2017
Implementation of a brief hazard perception training session to improve hazard perception performance in young novice drivers

Emma Harbeck
Codi White
Chris Irwin
Trevor Hine
Ian Glendon
Abstract
The purpose of the present study was to evaluate a novel brief training session designed to improve hazard perception in young Provisional 1 drivers. Fifty-two novice drivers (18 males, 34.62 %) aged between 17 and 25 years (\(M=18.13, SD=1.73\)) were randomly assigned to one of three training conditions (pamphlet, passive, or active) or a no-training condition, resulting in four equal groups of 13 drivers. Designed to be brief, the training sessions incorporated previously established behaviour change techniques, and differed in degree of interactivity. Outcome measures included hazard perception knowledge and road user hazard identification, response, and hazard avoidance. To assess current level of hazard knowledge, and to control for group prior differences, prior to training participants completed a static hazard perception test (HPT). After training, drivers completed a simulator-based HPT during which road user hazard identification and response were measured. All training groups differed significantly in hazard identification compared with the no-training group. Compared with those in the no-training condition, participants in the active-training condition responded to hazards at a greater distance. Participants \((n=42)\) returned 2-3 weeks later for a follow-up assessment session. All groups, except participants in the no-training condition, significantly improved on the static hazard perception measure. Participants in the active, passive, and pamphlet training conditions identified significantly more road user hazards than did no-training condition participants. In hazard response, compared with those in the no-training condition, active training condition participants responded to hazards at a greater distance. Preliminary findings are discussed in the extended context of driver training and evaluation for this vulnerable young driver population.
Implementation of a brief hazard perception training session to improve hazard perception performance in young novice drivers

Background

A crucial aspect of driver competence is the ability to anticipate, evaluate, and respond appropriately to potentially dangerous traffic situations and road-related hazards (Horswill et al., 2013; Sagberg & Bjørnskau, 2006; Scialfa et al., 2011). The accurate and rapid perception of road hazards, which may lead to a potential traffic conflict (collision with another road user, pedestrian or object), is vital to safe driving while on the road (Scialfa et al., 2013). This is known as the driving skill of hazard perception (Horswill, 2016a). Two unique components of hazard perception are: 1) the degree of perceived danger or the crash risk associated with a situation, and 2) a driver’s perception and reaction time (identification and response) to the hazard (Sagberg & Bjørnskau, 2006).

Hazard perception is one of the few driving-related skills that have been reliably associated with crash risk (Boufous et al., 2011; Horswill et al., 2010, 2013; Wetton et al., 2011). Hazard perception has also been found to mediate between road safety factors and crash involvement (Horswill et al., 2013). The mediating effect of hazard perception between risky driving behaviours and crash risk has been found for predictors such as driving experience (e.g., km driven), sleepiness/fatigue, traumatic brain injury, distraction, and blood alcohol content (Horswill et al., 2013). Measures of hazard perception (HPTs) have been created and implemented worldwide to assess drivers’ ability in this important skill.

HPTs are often designed to test a driver’s skill using one of two formats: static (still images), and dynamic (video sequences or simulations; Scialfa et al., 2013). Hazards presented in these HPTs can be categorised as either abrupt-onset, or gradual-
onset (Underwood et al., 2013). Abrupt-onset hazards (e.g., a pedestrian suddenly running across the road in front of the driver) require sudden attention capture, and fast reaction time to successfully avoid a collision. Gradual-onset hazards (e.g., bus with indicator light on signalling to merge into traffic ahead of the driver) require identification of, and anticipation to navigate, the emerging hazard (Underwood et al., 2013). Therefore, hazard perception can be measured by a driver’s: 1) knowledge of hazard types, 2) ability to identify hazards ahead, 3) response time from when a hazard is perceived, and 4) how the hazard is handled or avoided to prevent a traffic conflict. HPTs can measure one or all of these aspects of hazard perception, depending on the HPT format. Formats include static (image or video) and dynamic (driving simulator).

**Young driver hazard perception**

Driving experience is thought to be more influential than age as a factor affecting driving hazard perception, while lower crash risk has been attributed to improvement in this crucial driving skill (Beanland et al., 2013; Horswill & McKenna, 2004; Sagberg & Bjørnskau, 2006). Compared with older drivers, drivers aged 17-25 are often over-represented in international injury and death tolls due to motor vehicle crashes (BITRE, 2017; Williams, 2009). This is attributed to variables associated with higher crash risk, such as age and driver sex, less on-road driving experience, and poor hazard detection and response skills (Borowsky et al., 2010; Horswill et al., 2013; Horswill & McKenna, 2003). Data for crash fatalities among young Australian drivers since 2006 have supported a lack of driving experience effect (BITRE, 2017).

For young novice drivers the first six months, or 1000km driven, after gaining a provisional driver’s licence is considered to be the period of greatest crash risk, as mandated direct driver supervision has recently ended (Bates et al., 2009; McCartt et al., 2003; Preusser & Tison, 2007). However, for novice drivers, crash risk decreases substantially after the first 1600km driven (Kinnear et al., 2013; McCartt et al., 2003),
and continues to decrease further over the next 18 months after obtaining their licence (Williams, 2003, 2009). Researchers have suggested that this may be due their improving hazard perception and response skills obtained with the increases in time and experience driving on the road. Consequently research has examined whether hazard perception can be improved with training.

Research has highlighted that novice drivers’ inexperience and ignorance of what constitutes a hazardous situation increases crash risk and poor hazard perception (Beanland et al., 2013; Crundall et al., 2012). Thus, novice drivers may engage in hazardous driving as they have failed to detect the presence of a hazard emerging (e.g., merging traffic, pedestrians close to road; Scialfa et al., 2011; Wang et al., 2010). Most hazard perception studies and HPTs use image-based, video, or animated traffic scenarios to improve and test hazard perception. These measures have demonstrated good reliability and validity in hazard perception identification and knowledge of hazards and can discriminate between driver types (experienced/novice). They also have advantages of being cost-effective and easy to implement for testing large numbers of drivers (Horswill, 2016a; Horswill & McKenna, 2004; Wetton et al., 2010, 2011).

However, HPTs may lack accurate and precisely timed measures of driver response to hazards – variables that can be measured using a driving simulator.

Debate persists on the extent to which a static or video response translates to participants’ naturalistic driving (Chan et al., 2010). This is important, because even if novice drivers can detect a potential hazard in time, some may not know, or may be unsure of how to drive to avoid a collision (appropriate hazard handling), which could be due to inexperience, psychological strain, or time pressure (Wang et al., 2010). Therefore, hazard perception training that can safely expose novice drivers to hazardous scenarios within a driving simulator could help to improve hazard perception skills, and responding to emerging traffic conflicts (Wang et al., 2010). Whether this methodology
can be applied successfully for novice drivers has yet to be determined, although preliminary research using driving simulators to improve hazard avoidance (e.g., Wang et al., 2010) has shown promising results for novice male drivers, as has commentary training for both genders (Crundall et al., 2010; Isler et al., 2009), and higher-order driving skills training (perceptual, motivational, insight) for inexperienced drivers (Isler et al., 2011).

The current study

Driver training in Australia focuses predominately on the learner stage of driving, with graduated driver licensing as the intervention designed to improve post-learner drivers. Newly unsupervised novice drivers who have recently gained their provisional licence, have the highest risk of injury and death in motor vehicle crashes (Sagberg & Bjørnskau, 2006; Williams, 2009), and are often found to be at fault for the crash (Braitman et al., 2008). Therefore focusing on at-risk provisional drivers represents a gap in the literature where the creation of hazard perception training session that is brief in duration and tests not only hazard identification, but also knowledge, response, and hazard handling, is needed for this vulnerable target population.

Consequently, an aim of this study was to examine whether providing a brief session of hazard perception training, and more importantly, what type of training, may improve young driver (aged 17-25 years) hazard perception (knowledge, identification, response, and handling), when compared with drivers who do not receive training. After controlling for previously highlighted confounding variables (hazard knowledge, age, gender, driving experience, driving frequency, and underlying reaction time), this will be evaluated by a dynamic format HPT, using a driving simulator. A second aim was to examine whether any changes in hazard perception had occurred, or been maintained in a follow-up session scheduled 2 weeks post training. Therefore this study seeks to answer the following questions:
1. For hazard knowledge:
   a. What is novice driver (P1) current level of hazard knowledge (static hazard perception score) prior to any training?
   b. Does participation in training result in significant improvements to hazard knowledge for each training condition?

2. For hazard identification, response and handling:
   a. Do groups with hazard perception training (pamphlet, passive, active) perceive more hazards (higher hazard identification scores), and detect hazards at a greater distance (hazard response score) on the driving simulator road users HPT, compared with the P1 condition that did not receive training (after controlling for prior hazard knowledge)?
   b. Amongst training groups that performed significantly better than control, do training conditions with greater interactivity perform better (i.e., active > passive > pamphlet)?
   c. Do groups with hazard perception training have fewer: i) near misses, and ii) collisions, during their simulator HPT drive when responding to hazards that result in traffic conflicts if not appropriately handled?

3. As there are two testing phases, are any training group differences for hazard knowledge, identification, or response observed after session 1, maintained at follow up?

**Methodology**

**Participants**

Drivers with an Australian Provisional 1 (P1) driver’s licence, who drove a car regularly (not a moped, motorbike, truck, bus, etc.) were invited to participate in the pilot of this brief intervention. Drivers were required to be within the first ten months of
acquiring their P1 licence and not intending to take their compulsory (QLD/NSW) Hazard Perception Test in order to transition to a P2 licence within eight weeks of volunteering to participate. Participants who held a P2 licence would have passed their compulsory Queensland Transport Hazard Perception Test, making them ineligible to participate. The final sample included 52 P1 drivers (18 males, 34.6%), aged 17-25 years ($M=18.13$, $SD=1.73$). Since obtaining their learner licence, drivers had a mean length of licensure of 25.69 months ($SD=11.75$), and reported driving on average 220.38 ($SD=172.09$) kilometres a week.

**Measures**

Measures including the static HPT, hazard perception training, the driving simulator, driving simulator familiarisations, questionnaire booklet, and evaluation questionnaire used in the current study were described and piloted in Chapter 6. Where appropriate these are provided here again briefly.

**Static hazard perception test.** Twelve photo images from a driver’s visual perspective in everyday driving included 50 driving-related potential hazards (2-7 per image). These included: pedestrian (6 hazards), cyclist (3), other cars/drivers on the road, parked and moving in the driving lanes in motion (24), road-related (10), and road works (7). A Powerpoint® presentation of each image, with instructions to write the number of hazards perceived on a response sheet was provided. Participants had 10 minutes to complete the task, which was scored by the researcher. Each correctly identified hazard received 1 point, for a total score from 0-50. Static hazard perception responses were scored by two researchers (intra-class correlation coefficient = .98) before being entered into the data file.

**Hazard perception training.** There were three training conditions (pamphlet, passive, active), and one no-training condition. These are described briefly below (full details in Chapter 6).
Pamphlet. The pamphlet was an educational tool designed to replicate the behaviour change technique of “giving information”, whereby information about risk and consequences is also provided (Fylan & Stradling, 2014). The pamphlet provided the reader with information on what hazard perception is when driving, why it is important, and how it impacts novice drivers. The pamphlet also had a 5-item multiple choice quiz for the reader to complete, with answers provided at the bottom of the pamphlet. Participants had 10 minutes to read and complete the quiz.

Passive. Ten short video sequences of an experienced driver verbally narrating his driving behaviour, hazards he perceived, and his driving response to hazards identified ahead to remain safe, were observed by participants. This training measure was intended to imitate drivers receiving verbal commentary training, and applied the behaviour change technique of “supporting” (Fylan & Stradling, 2014). These videos were sourced from the Queensland Transport and Main Roads (TMR) website (http://www.tmr.qld.gov.au/Safety/Driver-guide/Identifying-hazards-when-driving.aspx), and are freely available to the public to download and view. Permission from Queensland TMR was granted for use in this study. Watching all 10 videos took approximately 10 minutes.

Active. The active intervention training required participants to operate the simulator controls and to navigate a virtual driving environment. The training was designed to be interactive, whereby the researcher who was present throughout, observed the participant’s progress throughout the scenario and provided direct feedback on their driving behaviour (e.g., monitoring speed, lane positioning). The researcher also commented on hazards ahead (e.g., approaching intersections, merging buses) and suggested appropriate driver responses to identified hazards (e.g., slow down, change lanes). The researcher had a set script with prompts of what and when to provide feedback. By providing instruction and feedback on performance, this training
applied the behaviour change technique of “teaching” (Fylan & Stradling, 2014). The scenario had 18 driving related hazards, on which the researcher commented, with nine requiring a safe driving response to avoid a possible traffic conflict. This training took approximately 10 minutes to complete.

**No training.** Participants who receive no additional hazard perception training completed a card game task. This required two coloured card decks (blue and red) with jokers included (108 cards). The decks were shuffled to be completely out of order. With their view obstructed, the participant selected an unknown random card from the pile of cards. The task was to correctly identify the random unknown card selected from the decks using the remaining 107 cards. Participants were given 10 minutes to complete the task using a sorting method of their choice.

**Questionnaire booklet.** Participants completed a paper 123-item questionnaire containing eight scales and demographic items, which took approximately 30 minutes to complete. After de-identification, questionnaire responses were matched with a unique participant code, thereby allowing responses to remain anonymous. Demographic items were participants’ age, gender, licence type, length of licensure (since learner), average number of kilometres driven per week, and number of violations recorded since P1 licensure. The questionnaire measured perceived risk (12 items), and risky driving engagement (36 items) using Scott-Parker et al.’s (2012c) revised BYNDS. Other items were derived from protection motivation theory threat and coping appraisal (30 items), prototype willingness model risky driver prototype favourability and similarity, and behavioural willingness (39 items). The measures and results of these scales are described in another study (see Chapter 9).

**Training appraisal survey.** A 15-item survey evaluated the phase 1 training session. Items were structured to obtain quantitative information using a 6-point response scale, and qualitative information using open-ended questions. This voluntary
survey took 7-10 minutes to complete. The measures and results of this survey are
described in another study (see Chapter 9).

**Driving simulator.** The driving simulator used for the active training condition
and HPT testing was a fixed-based model with original controls (accelerator and brake
pedals, steering wheel, seat, safety belt, indicator, automatic gear shift, and hand brake)
from a Hyundai Getz linked to dedicated graphics computer equipment. Visual images
were displayed on three 32-inch LCD monitors using 3 channels, set to provide a 100°
front field of view (Irwin et al., 2014; Irwin, Monement, & Desbrow, 2015; for a full
description of the simulator, see Chapter 7). In this study all driving was performed in a
simulated standard automatic vehicle, similar to a 4-cylinder sedan. An OKTAL
SCANeR® studio academic driving simulation software for universities and research
institutes (SCANeR studio simulation engine v1.6, OKTAL, Paris, France) was used to
create traffic scenarios, and to collect data from the sessions. The analysis module
collected video recordings of each drive, and data to be converted to a spreadsheet,
allowing analysis of mathematical determinants from the vehicle model.

**Simulator familiarisation tasks.** To allow familiarity with the virtual
environment and ease of using the driving simulator, participants completed three
separate driving familiarisation tasks. Participants practised operating the driving
simulator, including speed control, braking, changing lanes, emergency stopping,
flashing headlights, etc., prior to testing. During their practice drives, participants
experienced scenarios that included a car following task on a multilane highway, a
single one-way lane driving task, and a brake-reaction task. Each familiarisation session
lasted approximately five minutes, allowing participants 15 minutes practice in learning
to use the simulator before further testing.

**Hazard Perception Test Scenarios.** A computerised driving simulation task was
used to measure driving performance in the hazard perception scenarios generated for
this study for phases 1 (after training), and 2 (follow-up). Participants took 14-16 minutes to drive a course of approximately 15 km. The 10-sector driving scenario was set during daylight conditions. The environment was designed as a rural/suburban area, with a 4-lane dual carriageway road; had 60 km/hr speed signs posted throughout; containing eight intersections with traffic signals, and one intersection with a stop sign. Buildings (e.g., houses, apartments, farms), lightly landscaped areas (e.g., parks, trees), and moderate traffic (may encounter 6-8 other vehicles) were present (see Figure 8.1). While other vehicles and pedestrians were present in the scenario, only some were scripted to actively interact with the participant’s vehicle.

![Figure 8.1](image)

*Figure 8.1. Images of scenario environment with traffic and pedestrians present. The participant viewed these scenes from the point-of-view of the driver’s seat.*

At follow-up, to reduce practice effects and recall of hazards, the scenario visual appearance was substantially altered so that participants would not recognize the simulated environment as being the same as previously used. In this alternative scenario, changes were made only to the visual appearance of vehicles and pedestrians (e.g., white ute runs a red light in phase 1 scenario, orange van runs a red light in phase 2, see Figure 8.2), and not their behaviour. The background was also changed from a rural/urban to an urban/cityscape. No changes were made to the number of models included in the scenario, hazards, or scenario scripts.
Figure 8.2a. White ute runs a red light in phase 1 scenario

Figure 8.2b. Orange van runs a red light in phase 2 scenario. Also note change in cityscape from Figure 8.2a

Participants operated the driver controls (steering wheel, accelerator, brakes) in the simulator, and navigated the simulated environment. They were directed to travel from the starting point, and to follow all road rules and signage encountered throughout. For standardisation, all instructions were provided in written form. Participants were further instructed to drive in their usual manner as they travelled through the scenario, in which 33 road user-related hazards were encountered. Of these, 21 were coded as road user gradual-onset hazards (GOH), and 12 as abrupt-onset hazards (AOH). Of the 12 AOHs, five were further coded as critical reaction events, in which the hazard
appeared suddenly and without warning (e.g., parked car suddenly pulls in to the lane ahead, or a hidden pedestrian runs out on to the road when the driver reaches a set trigger point). While the other seven AOHs were also scripted to still occur abruptly (e.g., bus indicates to merge into the driver’s lane, pedestrian running across road from the right), in these instances the driver had a greater opportunity to see the hazard imminently emerging, if they were more situationally aware. All 12 AOHs and nine GOHs required a driver response (e.g., slowing down, stopping the vehicle, emergency braking, changing lanes) to avoid a traffic conflict. The six hazard types were: moving vehicles (9 hazards), parked cars (5), motorcyclists (3), cyclists (2), large vehicles (3), and pedestrians (11), and are described in Table 8.1.

Participants were instructed to flash the simulator headlights using the indicator on the steering wheel when a hazard was seen. Participants were also required to verbalise the hazard to reduce ambiguity, which also provided an indication of false positives for the researcher when scoring the drive. Flashing the headlights allowed the simulator software to record a count of the number of hazards ‘identified’ by participants, and recorded the vehicle speed (in km/hr), and distance (in metres) from the hazard ahead. This distance is the hazard response score for each GOH hazard perceived. Number of correct headlight flashes with matching verbal response provided the simulator HPT score (from 0 to 33). The headlight flash also provided a visual marker in the video recording of where and when a participant indicated that they saw the hazard for recoding and scoring purposes. The researcher, who was in the room, but not in view of the participant, monitored the participant’s performance and simulation software throughout the scenario. The researcher recorded performance details (number of flashes, false positives, driver response to emergent hazards) on a structured hazard response scoring sheet. There was no interaction between researcher and participant driver during the scenario.
<table>
<thead>
<tr>
<th>Section</th>
<th>Traffic signal</th>
<th>Hazard/Driving task</th>
<th>Hazard perception</th>
<th>Hazard type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Green Signal</td>
<td>Re-familiarisation</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>B Stop sign</td>
<td>-Car familiarisation</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Car traveling through stop sign intersection from left</td>
<td>Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td>3</td>
<td>C Green Signal</td>
<td>-Pedestrian crossing with pedestrians crossing the road</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrians grouped-static on left-hand side</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked motorcyclist waiting to merge into lane</td>
<td>Motorcyclist</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked motorcyclist pulls out into drivers side of road (trigger 50m away)</td>
<td>Motorcyclist (merging)</td>
<td>AOH</td>
</tr>
<tr>
<td>4</td>
<td>D Red Signal</td>
<td>-Bicycle rider on drivers side of road travelling north with driver</td>
<td>Cyclists</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars</td>
<td>Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked car pulls out from left side road, misjudgement of gap</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td>5</td>
<td>E Red Signal</td>
<td>-Car parked on left hand side of road</td>
<td>Moving vehicle (merging)</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-White car pulls out of kerb</td>
<td>Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Group of pedestrians static on left hand side</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars on drivers side of road</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Ute runs red signal and is in intersection while driver’s signal green</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td>6</td>
<td>F Signal green to amber at 80m from signals</td>
<td>-Parked car on drivers side of road</td>
<td>Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian running across road driver’s side (from left to right)</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrians (x2) static</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian crossing, with static pedestrian not crossing (right side)</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td>7</td>
<td>G Signal changes from amber to red 50m from signals</td>
<td>-Car indicating to turn right at intersection</td>
<td>Moving vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Car (above) does not give driver right of way</td>
<td>Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrians (x2) static at bus stop</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked motorcyclist on drivers side of road, waiting to merge</td>
<td>Motorcyclists (static)</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrian running on road from right to left towards motorcyclist</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bus stop with bus indicating it wants to merge into drivers lane</td>
<td>Large vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bus pulls out into lane turns right at the next signals</td>
<td>Large vehicles (merging)</td>
<td>AOH</td>
</tr>
<tr>
<td>8</td>
<td>H Signal amber to red 50m from signals</td>
<td>-Truck parked on left hand side of road</td>
<td>Large vehicles</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Truck pulls out of kerb, misjudges merging gap</td>
<td>Large vehicles (merging)</td>
<td>AOH</td>
</tr>
<tr>
<td>9</td>
<td>I Signal green to amber at 80m from signals</td>
<td>-Parked cars on drivers side of road</td>
<td>Moving vehicles</td>
<td>AOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bicycle rider on drivers side of road travelling north with driver</td>
<td>Cyclists</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Pedestrians static on opposite side of road (right hand)</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Bus still in intersection when signal turns green</td>
<td>Large vehicles on road</td>
<td>AOH</td>
</tr>
<tr>
<td>10</td>
<td>Finish</td>
<td>-Pedestrian crossing with pedestrians crossing the road</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Parked cars (x2) on drivers side of road</td>
<td>Pedestrians</td>
<td>GOH</td>
</tr>
</tbody>
</table>

Note: AOH=Abrupt-onset hazard, GOH=Gradual-onset hazard
Using the driving simulator software, videos of each participant’s HPT drive were rendered into Audio Video Interleave (AVI) files and the driving simulator driver’s vehicle dynamics data were converted into an Excel file format allowing analysis of mathematical determinants from the vehicle model for initial and follow-up sessions. Summary information from these Excel files was also entered into the data file. Simulator data and videos provided counts on numbers of near misses and collisions. A hazard handling rating scale was used to score responses to the 12 AOHs and nine GOHs that would lead to a traffic conflict if participants did not respond to the hazard, similar to Wang et al. (2010). Scale levels were: 0 = *no conflict occurred* – participant successfully managed and or avoided the hazard; 1 = *near miss* – participant successfully avoided the traffic conflict, but with sharp turn or brake (indicated by tire noise given by the simulation system); 2 = *collision* – participant unable to avoid the traffic conflict, resulting in a collision (e.g., with car, or pedestrian). The simulator vehicle dynamics engine recorded each collision, which could also be seen in the video as the simulated actor traveling through the participant’s vehicle. In the scenario, there was no consequence for collision, and the participant could continue through the scenario without interruption. This coding system thereby provided identifiers for participants who had near misses and collisions.

For an accurate estimation of hazard perception performance, the simulator data were checked against responses recorded by the researcher in each session. Each participant’s performance was scored twice, once at the initial testing, and again using the recorded videos, to check for ambiguities or differences in the recorded hazard perception scores. As this was a performance measure, a second independent rater, blind to participant condition allocation, coded and scored a sample of videos across the training conditions for initial and follow-up sessions (n=20). Post-training performance
measure intra-class correlation coefficient (ICC) between raters .98, at follow-up ICC=.95.

**Procedure**

After obtaining ethical approval from Griffith University Human Research Ethics Committee, the study was advertised using the University’s e-news-sheet Volunteer for Important Research Projects, and the authors’ school participant pool. The study collected participant data for three months (March, April, May). Participants aged 17-25, who met the eligibility criteria were invited to participate. Incentives for participation included the opportunity to win one of eight $50 gift vouchers and research participation credit for eligible first-year students.

Prior to screening, an online sequence generator was used to randomly assign participants to a training condition (pamphlet, passive, active), or no-training condition. Participants were blind to the knowledge that other training conditions existed. All participants completed an initial screening for experiment suitability, and to ensure that they met the eligibility criteria (i.e., informed consent, no alcohol consumed in last 24 hours, had consumed a recent meal, low level of fatigue assessed, no previous history of simulator sickness or driver training, and no recent involvement in a motor vehicle crash). There was only one participant per session. For structure and task breakdown, see Table 8.2.

A follow-up session occurred 2-3 weeks later, in which participants from all conditions were asked to return. Of the 52 participants who completed the first session, 42 (80.8%) returned for the follow up session. During this session no hazard perception training was given, however, all returning participants completed the static hazard identification measure and a driving familiarisation task again. All returning participants then completed the alternative simulator road user hazard perception test described earlier.
Table 8.2.

*Training session order, task break down and time*

<table>
<thead>
<tr>
<th>Stage</th>
<th>Task</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participant screening for suitability and eligibility</td>
<td>5 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Static hazard perception measure</td>
<td>10 minutes</td>
</tr>
<tr>
<td>3</td>
<td>Driving simulator familiarisation tasks</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>• Single lane highway drive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Car following task drive on a multi-lane highway</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Brake-reaction task drive in a built up urban environment</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Questionnaire Booklet</td>
<td>30 minutes</td>
</tr>
<tr>
<td></td>
<td>• Demographics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Perceived risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• BYNDS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Threat and coping appraisal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prototype similarity and favourability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Behavioural willingness</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Break</td>
<td>10 minutes</td>
</tr>
<tr>
<td>6</td>
<td>Hazard perception training session <em>a</em></td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>• Pamphlet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Passive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No training (card game task)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Simulator hazard perception test and debrief</td>
<td>20 minutes</td>
</tr>
<tr>
<td>8</td>
<td>Evaluation survey <em>b</em></td>
<td>5-10 minutes</td>
</tr>
<tr>
<td>9</td>
<td>Session debrief and wrap up</td>
<td>5 minutes</td>
</tr>
</tbody>
</table>

*a* Participants only completed one of these training tasks, according to their allocated condition.

*b* The survey was optional, with the option of declining being available (3 of 52, 5.8%, declined the survey).

**Statistical analyses**

After data collection had concluded, a data file was created using IBM SPSS v.22 (IBM Corp, 2013) to store and analyse participant session data from the questionnaires and hazard perception (knowledge, identification, response, and handling) measured during the study. These outcomes of hazard perception were assessed using a mixed-
model ANOVA for hazard knowledge, a series of analyses of covariance (ANCOVA) for hazard identification and response, and $\chi^2$ for hazard handling. Each of these analyses assessed the between-groups effect of training (no-training, pamphlet, passive, and active). The within-group effect of phase (pre- and post-training) was also assessed for hazard knowledge. The covariate used for ANCOVA analyses was hazard knowledge (static HPT score) due to significant differences among training groups on this measure prior to training. Training groups were also examined for differences in length of licensure, age, gender, and driving frequency (average km driven per week), as research has indicated these variables as potential confounds for younger drivers’ hazard perception (e.g., Horswill, 2016b; Horswill & McKenna, 2004), as well as testing for differences among groups in simulator brake reaction time. However, as no significant differences were found among groups on these variables, they were not retained as covariates in subsequent analyses. Assumptions (normality, homogeneity of variance) were checked for all analyses, heterogeneity of variance was found for hazard knowledge before training and GOH hazard identification after training, and the data were transformed (square-root) to address this issue. To analyse group differences in hazard handling, $\chi^2$ was used to compare numbers of participants involved in near misses and collisions after training and at follow-up.

Alpha levels of .05 were used to determine statistical significance for the main analyses with a Bonferroni correction applied to determine significance when multiple comparisons between training groups were run. Partial eta squared ($\eta^2_p$) was used as the measure of effect size using Cohen’s rules of thumb, where $\eta^2_p$ threshold values of 0.01, 0.06, and 0.14 represent small, medium, and large effect sizes respectively (Cohen, 1988). For $t$-tests, Cohen’s $d$ was calculated using Morris and DeShon’s (2002) correction for within-subjects analyses, and interpreted using Cohen’s rules of thumb where $d$ threshold values of 0.20, 0.50, and 0.80 represent small, medium, and large
effect sizes respectively (Cohen, 1988). The software program Power Analysis and Sample size software (PASS 14, 2015) was used to determine appropriate sample sizes and power calculations. To achieve a power level of .90 with an alpha of .05 and including a single covariate, a minimum of 10 participants per group (4) was required. Descriptive statistics are presented using unadjusted means and standard deviations.

**Results**

**Sample**

There were 68 signups for this brief training session. Of these 52 (76.5%) participated in the training. Of the 16 non-participants, seven did not meet eligibility requirements (licence type, aged over 25 years), and nine failed to arrive for their scheduled timeslot. At follow up, 2-3 weeks after training, of the 52 participants who completed the training, 42 (80.8%) returned to complete the study. Differences in the outcome measures assessed in phase 1 between participants who did (n=42), and did not (n=10) return for the follow-up, were examined. Descriptives of the sample and across groups are in Table 8.3, alongside tests of group difference prior to training.

**Static HPT performance**

Prior to training, P1 driver hazard perception was measured. P1 drivers had a total mean of 22.02 (SD=9.64) hazards identified out of a possible 50. Participants’ hazard perception was also assessed for each of the seven hazard types. These results are summarised in Table 8.4.

To examine training condition effects across phases, a mixed 4 (Training condition) × 2 (Pre-training vs. Follow-up) ANOVA was conducted on static HPT score (hazard knowledge). While there was no main effect of training condition (see Table 8.5), there was a main effect of phase, $F(1,39) = 46.24, p < .001, \eta^2_p = .54$, with increased hazard knowledge across phases.
Table 8.3.

*Pre-training sample descriptives (N=52)*

<table>
<thead>
<tr>
<th>Group difference</th>
<th>No-training</th>
<th>Pamphlet</th>
<th>Passive</th>
<th>Active</th>
<th>Gender n (%)</th>
<th>Age (years) Mean (SD)</th>
<th>Length of licence (months) Mean (SD)</th>
<th>Mean kilometres driven in a week (SD)</th>
<th>Previous driver training experience n (%)</th>
<th>Reported involvement in recent (3 years) car accident n (%)</th>
<th>Reported n (%) driving violations</th>
<th>Brake reaction time (seconds) Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>18.62 (2.69)</td>
<td>30.46 (18.08)</td>
<td>156.15 (112.29)</td>
<td>5 (38.5)</td>
<td>2 (15.4)</td>
<td>2 (15.4)</td>
<td>1.32 (0.25)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Female</td>
<td>17.77 (0.83)</td>
<td>21.77 (5.80)</td>
<td>219.62 (144.55)</td>
<td>1 (7.7)</td>
<td>4 (30.8)</td>
<td>2 (15.4)</td>
<td>1.27 (0.25)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.85 (0.90)</td>
<td>27.31 (9.19)</td>
<td>276.92 (215.10)</td>
<td>1 (7.7)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td>1.23 (0.21)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.31 (1.84)</td>
<td>23.23 (9.57)</td>
<td>228.85 (195.13)</td>
<td>4 (30.8)</td>
<td>3 (23.1)</td>
<td>3 (23.1)</td>
<td>1.31 (0.28)</td>
</tr>
</tbody>
</table>

Note: SD=standard deviation.
### Table 8.4.

*Pre-training Provisional 1 driver static HPT (N=52)*

<table>
<thead>
<tr>
<th>Hazard Type</th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Maximum score</th>
<th>Percentage identified (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrians</td>
<td>3.52 (1.29)</td>
<td>1-6</td>
<td>6</td>
<td>58.67</td>
</tr>
<tr>
<td>Moving vehicles</td>
<td>10.73 (4.08)</td>
<td>2-17</td>
<td>18</td>
<td>59.61</td>
</tr>
<tr>
<td>Parked vehicles</td>
<td>1.58 (2.10)</td>
<td>0-6</td>
<td>6</td>
<td>26.33</td>
</tr>
<tr>
<td>Cyclists</td>
<td>1.10 (0.50)</td>
<td>0-3</td>
<td>3</td>
<td>36.67</td>
</tr>
<tr>
<td>Road related</td>
<td>2.65 (2.71)</td>
<td>0-10</td>
<td>10</td>
<td>26.50</td>
</tr>
<tr>
<td>Road works</td>
<td>2.48 (1.58)</td>
<td>0-5</td>
<td>7</td>
<td>35.43</td>
</tr>
</tbody>
</table>

This was modified by a Phase × Training interaction effect, $F(3,39) = 5.90$, $p = .002$, $\eta^2_p = .31$. To interpret this interaction, paired samples $t$-tests examined effect of phase for each training condition. The no-training condition showed no difference between phases, $t(11) = -.29$, $p = .779$, $d = -0.08$. While it was found that the pamphlet condition showed greater hazard knowledge at follow-up, $t(10) = -5.06$, $p < .001$, $d = -1.61$, as did the passive, $t(9) = -4.62$, $p = .001$, $d = -1.56$, and active conditions, $t(9) = -4.54$, $p = .001$, $d = -1.46$.

**Effect of training on the simulator HPT**

The simulator hazard perception test provided three dependent outcome variables for analysis: HP identification, HP response, and hazard handling. The HP identification measured number of correctly perceived hazards (AOHs and GOHs) during the scenario. The HP response measured the distance (in metres) between the GOH ahead, and when the participant flashed the simulator headlights. The hazard handling scores indicated drivers who had near misses and collisions during their scenario drive. These were assessed after training and at follow-up 2-3 weeks post-
training. Therefore the results are separated by outcomes and by phase (post-training and follow-up).

Eight one-way ANCOVAs were run to examine whether training group differences occurred for HPT identification (total score, GOH subscale, AOH subscale), and HPT response post-training, while controlling for hazard knowledge (static HPT score) pre-training. Evaluations of the assumptions of normality of sampling distributions, linearity, homogeneity of variance, homogeneity of regression, and the covariate reliability (static HPT score) were satisfactory. However, due to outliers, a square root transformation was made to the covariate and the GOH subscale to meet assumption conditions. All unadjusted means and SDs are in Table 8.5.

**Hazard identification simulator scores.** After controlling for effect of prior hazard knowledge, a main effect of training condition was found, $F(3,45) = 8.28, p < .001, \eta^2_p = .36$, in simulator HPT identification scores (number of correctly identified hazards during the scenario). Pairwise comparisons examined which conditions differed significantly. The no-training condition had lower hazard identification scores than did the pamphlet ($p = .039$), passive ($p = .001$), and active ($p < .001$) conditions. However, hazard identification scores did not differ significantly between the pamphlet, passive, and active training conditions (all $ps > .05$).

Hazard identification scores were also compared between training groups at follow-up. After controlling for the effect of prior hazard knowledge, a main effect of training condition was found, $F(3,37) = 4.32, p = .010, \eta^2_p = .26$. Pairwise comparisons examined which conditions differed significantly. The no-training condition had significantly lower hazard identification scores than did the passive ($p = .017$) and active ($p = .028$) conditions. However, hazard identification scores did not differ significantly between the no-training and pamphlet conditions ($p = .386$). Neither did
Table 8.5.  
*Descriptives and inferential statistics for outcome variables across phases*

<table>
<thead>
<tr>
<th>Training condition</th>
<th>Difference between conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No training</td>
<td>Pamphlet</td>
</tr>
<tr>
<td>Static HPT score (n)</td>
<td>12</td>
</tr>
<tr>
<td>Before training Mean (SD)</td>
<td>26.58 (9.20)</td>
</tr>
<tr>
<td>At follow up Mean (SD)</td>
<td>27.42 (10.95)</td>
</tr>
<tr>
<td>Simulator HPT score post-training (n)</td>
<td>13</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>20.15 (5.81)</td>
</tr>
<tr>
<td>Mean (SD) in meters</td>
<td>110.40 (39.10)</td>
</tr>
<tr>
<td>Mean (SD) at follow-up (n)</td>
<td>23.09 (5.27)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>118.05 (32.90)</td>
</tr>
<tr>
<td>GOH identification Mean (SD)</td>
<td>13.69 (6.47)</td>
</tr>
<tr>
<td>AOH identification Mean (SD)</td>
<td>6.46 (2.15)</td>
</tr>
<tr>
<td>Traffic conflict near misses n (%)</td>
<td>12 (92.30%)</td>
</tr>
<tr>
<td>Traffic conflict collisions n (%)</td>
<td>5 (38.46%)</td>
</tr>
<tr>
<td>After training (n)</td>
<td>13</td>
</tr>
<tr>
<td>GOH identification Mean (SD)</td>
<td>15.91 (5.58)</td>
</tr>
<tr>
<td>AOH identification Mean (SD)</td>
<td>7.18 (3.03)</td>
</tr>
<tr>
<td>Traffic conflict near misses n (%)</td>
<td>7 (63.63%)</td>
</tr>
<tr>
<td>Traffic conflict collisions n (%)</td>
<td>5 (45.45%)</td>
</tr>
</tbody>
</table>

Note: SD = standard deviation, GOH = gradual onset hazard, AOH = abrupt onset hazard
To determine whether differences reported above were due to the type of hazards (GOH and AOH) in the scenario, GOH and AOH condition scores were examined separately. For simulator HPT GOH scores, after controlling for effect of prior hazard knowledge, a main effect of training condition was found, \( F(3, 45) = 11.87, p < .001, \eta_p^2 = .44 \), after training. Pairwise comparisons examined which conditions differed significantly. The no-training condition had significantly lower GOH scores than did the pamphlet \((p = .017)\), passive \((p = .001)\), and active \((p < .001)\) conditions. However, GOH scores did not differ significantly between the pamphlet, passive, and active conditions \((all \ p s > .05)\). Condition differences in GOH scores were also examined at follow-up. After controlling for prior hazard knowledge, a significant main effect was found for training condition at follow-up in GOH identification scores, \( F(3, 37) = 5.15, p = .004, \eta_p^2 = .30 \). Pairwise comparisons examined which conditions differed significantly. The no-training condition had significantly lower GOH scores than did the passive \((p = .020)\), and active \((p = .005)\) conditions. There was no difference in GOH scores between the no-training and pamphlet conditions \((p = .247)\). Neither did GOH scores differ between the pamphlet, passive, and active conditions \((all \ p s > .05)\) at follow-up.

Group differences in AOH identification after training and at follow up were also examined. After controlling for prior hazard knowledge, there was no significant main effect of group found after training, \( F(3, 45)=0.69, p=.563, \eta_p^2=.04 \) and at follow up, \( F(3, 37)=0.24, p=.868, \eta_p^2=.02 \). Table 8.5 shows unadjusted means and standard deviations.

**Hazard response simulator scores.** For post-training simulator HPT response scores, after controlling for effect of prior hazard knowledge, a main effect of training
condition was found, $F(3,45) = 4.88$, $p = .051$, $\eta^2_p = .25$. Pairwise comparisons examined which conditions differed significantly. Compared with active training condition participants, no-training condition participants responded to hazards at a significantly shorter distance ($p = .003$). No other significant differences in mean hazard response scores were found between the training (pamphlet and passive), and no-training conditions.

Hazard response scores were also compared between training conditions at follow-up. After controlling for effect of prior hazard knowledge, a main effect of training condition was maintained, $F(3,37) = 4.44$, $p = .009$, $\eta^2_p = .27$. Pairwise comparisons were conducted to examine which conditions differed significantly in response distance. No-training condition participants responded to hazards at a significantly shorter distance than did active training condition participants ($p = .015$). Similar results were found at follow-up, where no other significant differences in mean hazard response scores were found between the training (pamphlet and passive), and no-training conditions.

**Hazard handling simulator scores.** The number and percentage of participants per training condition who were identified as having a near miss and collision during their simulator HPT drive are also shown in Table 8.5. Using a $4 \times 2$ contingency table, a $\chi^2$ test was conducted for both near miss and collision data post-training and at follow-up. Due to small sample sizes across conditions, Fisher’s exact test was used to determine whether there were training condition differences in numbers of drivers who had, or did not have, a near miss. Post-training, Fisher’s $\chi^2 = 12.63$, $p = .005$, indicating that differences were found. From the expected cell count standardised residuals, the no-training condition differed in the number of participants who did not have a near miss. However, at follow-up, no between-condition differences were found, Fisher’s $\chi^2 =$
Discussion

The aim of this study was to examine hazard perception amongst P1 driver participants, and to assess whether a brief hazard perception training session was sufficient to improve road user hazard perception performance using a driving simulator hazard perception test. The study also sought to examine whether training conditions differed in performance, and whether any training type could be shown to have higher effectiveness in measured hazard perception when compared with other types. Also examined was whether any group differences persisted at 2-3-week follow-up. By examining these questions, this study could contribute to the literature by providing further information about hazard perception, which was measured by hazard knowledge, identification, response, and handling, within this young novice driver sample. The results could also provide preliminary effectiveness data for the impact of three novel brief training sessions on hazard perception.

After obtaining their provisional licence, the time when a young driver is most at risk of motor vehicle crash involvement is during the first few months of unsupervised driving, when hazard perceptions skills are still being developed. Despite this, there has been little examination of hazard perception amongst P1 drivers in Australia. The current study sought to provide some initial data for hazard perception, both overall, and for different types of hazards prior to any training.

Hazard knowledge and identification (static HPT)

Consistent with prior research (e.g., Borowsky, Oron-Gilad, & Parmet, 2009; Fisher et al., 2006; Ventsislavova et al., 2016) examining young novice drivers, participants’ knowledge and identification of hazards within the static measure was poor. Current study participants identified fewer than half the test hazards. Hazards that
were most likely to be identified were vehicles in motion, while the least likely to be reported were stationary (e.g., parked) vehicles, and road-related (e.g., intersections, road changes, crests) hazards. This finding might indicate a relative lack of prior knowledge of certain on-road hazards that drivers typically experience during the early months of their P1 licensure. These results may also suggest that some hazards are more “obvious” (e.g., something moving) than others (e.g., static things), which might be an indicator of where further P1 training might usefully be directed – i.e., at things that might happen (and how likely this is), as well as the more obvious events that are actually underway.

One of the key contributions to young driver involvement in road accidents is errors in visual search and hazard recognition (McKnight & McKnight, 2003). In the current study, vulnerable road users, such as cyclists, were only identified on average one out of three times, and for pedestrians, less than 60% of the time. These findings are similar to Sanocki et al. (2015), and Borowsky et al. (2012), particularly when the simulated image contains multiple hazards, and pedestrians appear in more urban settings, such as the images used in the current study. This also has implications for areas to target in driver education and formalised testing, as shown in the current finding that hazard knowledge improved at a 2-3-week follow-up for all participants who received some form of hazard perception training, but not in the control, no-training condition.

**Hazard identification and response (simulator HPT)**

The effect of hazard perception training using three novel conditions compared with a control, no-training condition was also compared for hazard identification and response. While findings indicated preliminary support for the impact of these brief training sessions on static hazard perception, there is also a need to examine the effectiveness of this session in improving performance relating to hazard perception
Young novice driver cognitions and behaviour 222

skills. Effects of condition training were examined for hazard identification and response, both immediately post-training, and at 2-3-week follow-up. For hazard identification, significant differences were found between conditions after training, with all training conditions (pamphlet, passive, active) showing significantly greater hazard identification than participants in the control condition, who did not receive training. At 2-3-week post-training follow-up assessment, passive and active training condition participants continued to demonstrate significantly greater hazard identification than did those in the control condition. However, at 2-3-week follow-up, pamphlet condition participants’ hazard identification scores no longer significantly differed from those in the no-training condition. Similar to previous research, hazard perception training possessing more interactivity was more effective than was education-based training alone (Horswill et al., 2013; McKenna et al., 2006; Shinar, 2007).

Overall, the preliminary data suggested that all three training conditions might be effective in increasing hazard identification immediately post-training. However, the different findings at 2-3-week follow-up tend to indicate that greater interactivity within the training context (as shown in the active and passive training) may be necessary for greater retention of training improvements over time. This is also consistent with research suggesting that training involving active engagement improves hazard perception scores (e.g., Horswill, 2016a, 2016b; Isler et al., 2011; Wang et al., 2010). Hazard perception performance differences were seen after training, indicating that some aspect of the training was effective. Therefore, future research could usefully seek how to maintain improved hazard knowledge and perception for P1 drivers until hazard perception performance is similar to that of more experienced drivers (e.g., having multiple follow-up sessions or additional brief training sessions).

While current study findings indicated preliminary support for the impact of these training sessions on hazard knowledge and identification, there is also a need to
examine the effectiveness of these sessions in improving performance related to hazard perception skills. Effects of training were examined on both hazard response (distance from hazard) and handling (collisions and near misses), immediately post-training and at 2-week follow-up. Significant differences were found between some conditions post-training. The active training group scores in hazard response (identifying hazards at a greater distance from the hazard ahead) differed from the no-training group was found at post-training and at follow-up. However, participation in pamphlet and passive training conditions did not result in significant training effects compared with the control group for hazard response.

Overall, the preliminary data suggests that the active training condition may be the most effective and superior in increasing hazard response. However, these results must be interpreted with caution, as active training condition participants also received greater exposure to the simulator environment due to the nature of this training condition. Training conditions that are similar to the testing conditions often report higher performance (Beanland et al., 2013; DeWinter et al., 2009). Future research may seek to differentiate this potential confound by creating a simulator control condition in which participants spend equal time in the simulator on non-hazard related tasks instead of training. Furthermore, as each training component provided improved hazard performance when compared with the condition that received no training, and because this performance difference was maintained over time, future research may seek to test the accumulative or additive effects of the three training conditions used in the current study, rather than implement them separately.

**Hazard type differences**

To further examine the effect of training group differences in hazard identification and response, performance on the simulator HPT was separated into the hazard types used in the scenario, GOH and AOH scores. Specifically GOH hazard identification
score differences were found between conditions, yet post-training and at follow-up there were no condition differences in AOH scores. While current study results might indicate that training is effective in longer-term hazard identification, this may not match the way in which drivers respond to an immediate hazard. This may indicate that response to hazards is influenced by factors other than identification, as young drivers were able to identify and quickly respond to abrupt hazards that may appear on the road in the simulated scenario. Similar results were also found in the number of participants who had a near miss and who had collision while responding to AOHs. No condition differences were found in number of collisions, post-training and at follow-up. While a difference was found in the number of participants who had a near miss in the no-training condition post-training (12/13), when compared with training condition participants, this difference was not sustained at follow-up. This supports research indicating that complete situational awareness is not required for drivers to swiftly identify a hazard, and respond appropriately to hazards when they appear (e.g., Gugliotta et al., 2017).

AOH hazards in the HPT scenario that had the highest near miss and collision rates were those that happened when the driver’s view was obscured by environmental objects (e.g., pedestrians hidden behind vehicles), supporting previous findings on hazard perception for young drivers (e.g., Crundall et al., 2012). Hazards appearing suddenly from right or left of the driver also had higher near miss and collision rates. This is indicative of research findings using eye tracking devices, which have revealed that young drivers tend to fixate ahead, and pay comparatively less attention to merging vehicles (Borowsky et al., 2010), while older drivers can adapt their visual search strategies to anticipate various demands under different driving conditions (Underwood, 2007). That drivers were able to appropriately handle and respond to hazards in the current simulated scenario, but still have low identification scores in the simulator HPT,
is consistent with other research (Borowsky et al., 2010; Gugliotta et al., 2017; Pollatsek et al., 2006; Scialfa et al., 2011) where young drivers were found not to visually search roadside areas for potential hazards, and that a trend was found where participants stopped reporting hazard identification for a time, after exposure to highly hazardous situations. That participants in the current study were exposed to a high frequency of road user hazards, with a potential 21 traffic conflicts occurring within a relatively short driving time (14-16 minutes), may have contributed to the under-reporting of hazards perceived during the simulator HPT. Future research may seek to determine whether differences occur in HPT testing length when split into smaller components at multiple testing time-points (e.g., 5- minute blocks) versus one single testing (15-minute block) at the end.

Limitations and directions for future research

As the study design included no baseline simulator data prior to training, condition differences may have occurred as a result. However, we decided not to have a baseline simulator drive to reduce the possibility of practice effects due to the short timeframe from after training to follow-up and the distinctive nature of the testing stimuli (e.g., parked cars suddenly pulling into the driver’s lane). To address any potential pre-existing differences, pre-training hazard knowledge (static hazard perception) scores were included as a covariate. In future studies, researchers may seek to assess baseline performance in advance of training in order to maximise time between assessment sessions, thereby reducing the possibility of practice effects. Using the same scenario script design both after training and at follow-up may have also increased practice effects in the simulator HPT. However, masking the follow-up trial by changing the visual models only, seemed to reduce participant familiarity, as only one driver of 42 in the second testing reported that this was the same test but looked different (cityscape, different car and pedestrian models).
Generalizability of results is also limited, so that findings should be interpreted with caution. As this study constituted a preliminary pilot, sample sizes were small and participants recruited using convenience sampling. Despite this, allocation to condition was randomised and there were approximately equal sample sizes across conditions. As the hazards presented were only road-user hazards, future research might investigate whether similar findings would apply to hazard perception for other driving hazard types (e.g., road-related) for comparable samples. A further limitation was that hazard perception skills were assessed in a simulated driving environment. Whilst the simulator was designed to closely mimic naturalistic driving environments, with full car feel and engagement, naturalistic driving and hazard perception may differ in ways from simulated conditions.

Nevertheless, advantages of using driving simulators include: controlling confounding variables (e.g., weather, road surface), control over scenario design, replicability, and the ability to create and implement a structured driver training session, which are key strengths of this methodology (Caird & Horrey, 2011). Additional advantages included low cost – compared for example with using telemetry with a fully instrumented vehicle and having full control over the simulated environment, which is not possible to have in naturalistic driving settings. Furthermore, as the simulator testing exposed novice drivers to scripted scenario events, with high traffic conflict likelihood, using a simulated environment remains a safe option due to real danger in corresponding naturalistic environments. Researchers have also argued that using a driving simulator provides real world driving generalizability for hazard anticipation, speed management, and attention maintenance (Chan et al., 2010). One aspect that may be able to be improved using a simulated environment is the use of a fully immersive simulator with 360° view, to allow both forward facing hazards, as assessed in the
current study, and hazards that appear from behind the driver and in their ‘blind spot’ to be examined.

**Conclusion**

The effect of hazard perception training using three novel conditions on hazard perception measured by identification, response, and handling, using a driving simulator HPT were compared with a control, no-training condition. It was found that participants who received no training did not differ significantly in hazard perception from their baseline score at a follow-up assessment. However, participants who received some form of training, in either the pamphlet, passive, or active training sessions, displayed a training effect such that significant improvements were found in their overall knowledge, detection, and response in respect of hazards when assessed at 2-3-week follow-up. This major finding indicated that even a brief training session focused on building knowledge, situational awareness, and hazard identification, could significantly improve hazard perception amongst P1 drivers. However, differences were evident between the different components of hazard perception performance (knowledge, identification, response, and handling). Therefore, examining a single component of hazard perception may be insufficient to evaluate young driver hazard perception, as changes in hazard identification may not reflect changes in response to hazards, or how hazards are handled during driving. Study findings may provide a new focus for development and assessment of driver training and interventions targeting this young driver demographic.
CHAPTER 9

Chapter 9 presents the seventh and final study of the thesis and addresses research aim 3 of the thesis: Evaluation of the brief hazard perception training session’s key objectives using the target sample that participated in study 6, and examination of the initial associations between the factors identified in the model testing of study 4. The format of this chapter is a manuscript that has been written and prepared for publication. This study explores and reports on the results of measures that were not previously discussed in Chapter 8, links those to the models that were examined in the first half of the thesis (chapters 3-6), and applies this to the driver behaviour of hazard perception. The first aim of this study was to examine potential correlates of young driver hazard perception, specifically hazard knowledge and identification, drawing both from theory and previously measured relationships with perceived risk and risky driving engagement. The young drivers (N=52) of study 6 completed a questionnaire that included the measures of studies 2 and 3, specifically the newly constructed measures of protection motivation theory’s threat appraisal and coping appraisal, prototype willingness model driver prototypes and risky driving behavioural willingness, perceived risk (likelihood and aversion), and risky driving engagement, using the full Behaviour of Young Novice Drivers Scale (BYNDS; Scott-Parker et al., 2012c). Additionally in evaluating the brief training session of study 6, the second aim of the study was to explore the self-reported learning outcomes of the brief training session amongst the target sample of Provisional 1 drivers. Qualitative feedback was also collected regarding areas of the training session perceived as effective or needs improvement by participants. Feedback was also obtained on whether participants found the training session helpful, informative, and applicable to real life, and whether they would recommend the training to other provisional drivers.
Statement of contribution to co-authored published paper: Paper 6

This chapter includes a co-authored paper. The bibliographic details of the published co-authored paper, including all authors, are:


My contribution to the paper involved:

- Conception and design of the research paper
- Review and interpretation of literature
- Conducting data collection and analysis to produce the article
- Analysis and interpretation of research data
- Writing and revising of the paper

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October, 2017

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Evaluating a brief hazard perception training session: Conceptual framework and Provisional licence driver evaluation of intervention

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Abstract

Evaluating driver interventions is important for establishing overall training effectiveness and validity. This study aimed to evaluate a previously implemented hazard perception training session and provide further insight into driving related hazard perception and methods of improving this in a young novice driver sample (N= 52, aged 17-25 years). The first study aim was to examine potential correlates of young driver hazard perception, specifically hazard knowledge and identification, drawing from both social–cognitive and social learning theory, and previously established relationships with perceived risk and risky driving engagement. While many potential correlates were examined, only three (traffic violations, coping appraisal and risky prototype similarity) shared significant relationships with hazard knowledge prior to training. The second aim explored the reported learning outcomes of the brief training session amongst the target sample of Provisional 1 drivers. Feedback was also collected regarding areas of the training session perceived as effective by participants and areas that could benefit from improvement. Study findings, implications and applications to driver training, and interventions that seek to increase novice driver hazard perception and ultimately enhance the safety of young novice drivers on our roads are discussed.
Evaluating a brief hazard perception training session: Conceptual framework and Provisional licence driver evaluation of intervention

Background

Preventing and reducing motor vehicle crashes, which involve drivers of all age groups is important for governments, policy makers, and researchers. However, young novice drivers (aged 17-25 years) are often found to be disproportionally represented in national road deaths and injury tolls, even though on average they drive fewer hours and kilometres on the road than more mature drivers do (BITRE, 2017; Scott-Parker, Watson, et al., 2013). Understandably, the focus on young novice drivers arises from the factors that have been reported to increase their motor vehicle crash risk, such as their age, gender, level of driving experience, engagement in risky driving behaviours (e.g., the fatal five), lower perceived risk, and poor hazard perception skills (Borowsky et al., 2010; Harbeck et al., 2017; Scott-Parker et al., 2012a). Consequently developing prevention and intervention strategies that target this at risk group of drivers has been and continues to be a crucial contribution to the road safety literature.

Research provides information on how driving interventions can be improved for targeting specific driver groups (Ivers et al., 2009; Shope, 2006). As state governments and researchers have been proactive in attempting to combat the high rate of novice driver deaths on Australian roads with interventions targeting younger drivers, it is essential that interventions are evaluated (Beanland et al., 2013; Filtness et al., 2013; Glendon et al., 2014; Peck, 2011). Moreover, driving interventions need to be evaluated on their effectiveness, efficacy and to assess whether the effects of training via the intervention are maintained over time (Beanland et al., 2013; Vlakveld, 2011). Interventions often include a focus on increasing awareness of risk, and highlights the severity of potential consequences should risky driving occur. Many interventions have
used only a small subset of behavioural change techniques, which may reduce or limit
the overall effectiveness in changing the targeted behaviour (Fylan & Stradling, 2014).

Interventions designed to change attitudes by presenting to the target audience
general road crash statistics have been found to have little effect on preventing or
reducing risky driving (Frank & Lee, 2007; Paaver et al., 2013). While driving
education and training are popular as driving-based interventions, little evidence has
been found for reducing novice drivers’ crash and fatality rates (Mayhew et al., 1998;
Scott-Parker et al., 2011). Furthermore, there is evidence that driver education and
driver skills training, specifically within graduated driver licensing schemes, may
actually increase crash rates (Ferguson, 2003; Mayhew et al., 2003), particularly if it
enables the length of the restricted period of driver licensing to be reduced (Beanland et
al., 2013; Peck, 2011). It follows that the success of interventions which target novice
drivers are problematic unless the behaviour change techniques employed are successful
and outcomes of training are as intended.

Teaching behavioural and cognitive skills has been found to be somewhat
effective in changing underlying attitudes in the prevention of motor vehicle crashes, in
particular instruction which is intended to appropriately manage risky driving
engagement or improving hazard perception (Beanland et al., 2013; Makeham, 2000;
Paaver et al., 2013). Improving cognitive skills like hazard perception and situational
awareness has been found to improve road safety and reduce crash risk in novice drivers
(Beanland et al., 2013; Isler et al., 2011; Peck, 2011). Interventions that use insight-
based training, which provides drivers with both knowledge and experience, have also
been associated with lower self-reported engagement in risky driving behaviours
(McKenna et al., 2006) and may help to reduce driver overconfidence (White et al.,
2011).
Previous research has highlighted that novice drivers tend to overestimate their driving skills and underestimate road risk (Harré et al., 2005). It is not until drivers become more experienced driving on the road that self-ratings become commensurate with actual skill level (Beanland et al., 2013). Drivers’ assessments of their own driving skills can be an important source for managing the demands of driving situations, particularly in those that may lead to traffic conflicts (e.g., adapting to sudden changes in other driver’s driving behaviour on the road), or are hazardous to navigate (e.g., poor weather). However, this is only the case if self-assessments match the driver’s current skill level. Young driver overconfidence or optimism bias is a psychological construct that can be manipulated, leading to negative consequences (e.g., a driver attempts to navigate hazardous road environments beyond their skill level and experience). As such driver training that targets driving skills, such as hazard perception, need to assess changes in driver confidence and check for overconfidence due to training (Beanland et al., 2013; Isler et al., 2011; White et al., 2011). Further checks include whether confidence may be inadvertently undermined if performance on measures of assessments are found to be difficult for the participant (Ivancic & Hesketh, 2000).

Furthermore, as there are unsafe driving behaviours that do not result from deliberate risk taking (e.g., misjudgements, inattention), driver training provides an excellent avenue to address novice driver contributing factors that increase their crash risk (e.g., over-confidence, ignorance, inexperience, poor hazard perception). Driver training interventions should be tailored to specific populations and include appropriate exit testing to assess the extent to which the training achieved its objectives (Beanland et al., 2013).

Interventions should ideally be based on validated theory and grounded in a sound, evidence based understanding of contributing factors (Fernandes et al., 2010; Shope, 2006; Shope & Bingham, 2008), yet relatively few interventions are evidence
based, or supported by theoretical frameworks (Fylan & Stradling, 2014; Vingilis, 2016). In an extensive review of the traffic psychology literature (1998-2008), Glendon (2011b) found that intervention or evaluation research only accounted for a very small percentage of published research. Of over 1400 peer-reviewed traffic psychology publications, less than two per cent (28 studies) were classified as intervention or evaluation studies (Glendon, 2011b). The small number of intervention/evaluation studies with a novice driver focus represents a significant gap within the literature.

For interventions that did employ the use of a theoretical framework, Glendon (2011b) found that conceptual frameworks that applied a social, developmental, personality and/or cultural approach were popular. Using some of these conceptual frameworks, Shope and Bingham (2008) widely researched factors that influenced novice drivers’ over-representation in annual road deaths and higher motor vehicle crash risk through engaging in risky driving behaviours. Decisive elements included: driving ability, developmental factors, behavioural factors, personality factors, demographics, the perceived environment, and the driving environment (Shope & Bingham, 2008). As these elements represent a complex set of factors that influence novice drivers’ behaviour, Shope and Bingham (2008) stated that comprehensive, multilevel interventions are needed to decrease novice drivers’ exposure to high-risk driving conditions, and to address factors identified within their framework.

Shope (2006) highlighted that for interventions to successfully influence behaviour they must derive from, and be grounded in, behavioural science theory. However, to be successful in changing novice drivers’ behaviour, the factors that influence their decision making and skills when driving, need to be identified and explored. To understand novice driver behaviours, among many others, two prominent approaches have been identified: social learning theory, and social–cognitive theory. These two theories form the basis of many studies, including those that have been
previously tested in this thesis (chapters 3-5), where factors contributing to novice drivers’ perceived risk or engagement in risky driving behaviours have been identified. These frameworks have not been previously applied to hazard perception, which presents a gap in the literature the current study will address.

The most prominent intervention in Australia is the graduated driver licensing (GDL) system. This system provides a 3-year stepwise approach to full licensing, designed to improve the safety of novice drivers by extended supervision and driving experience over time (Scott-Parker et al., 2011; Williams & Shults, 2010). To address the high crash rates for young novice drivers in particular, restrictions are placed on night-time driving, carrying peer passengers, driving high-powered vehicles, and a hazard perception test (Scott-Parker & Rune, 2016; Senserrick, 2009). Hazard perception is one of the few driving-related skills that have been reliably associated with crash risk (Boufous et al., 2010, 2011; Horswill et al., 2010, 2013; Wetton et al., 2011). Examining a young driver’s hazard perception is a form of licensing assessment adopted in most Australian states, and worldwide.

Hazard perception tests (HPTs) are a popular form of assessment in licensing as they have been found to discriminate between safe (experienced) and unsafe (unexperienced) drivers (Horswill et al., 2013, 2015; Ventsislavova et al., 2016). Hazard perception is often defined as a driver’s ability to perceive and predict unsafe situations on the road ahead (Horswill & McKenna, 2004). If a driver’s hazard perception is poor, they may not be able to appropriately respond in time (hazard avoidance), which may lead to traffic conflicts (collisions with objects or other road users). Two unique components of hazard perception identified from the literature are: 1) the degree of perceived danger or crash risk associated with a situation, and 2) the driver’s perception and reaction time (identification and response) to the hazard (Sagberg & Bjornskau, 2006). HPTs are designed to measure one or both of these components. This is done by
testing the driver’s skill with two formats, static (still images) and dynamic (video sequences or simulations; Scialfa et al., 2013). Most HPTs involve the use of image, filmed, or animated traffic sequences, to which drivers respond either by rating the level of perceived risk or by pressing a response button to indicate when a hazard has been detected (Horswill & McKenna, 2004). Deery (1999) emphasised that learning responses to a range of potentially hazardous situations is a key contribution to driver safety. However, when compared with more experienced drivers, young drivers tend to underestimate the risk of a traffic conflict in a variety of hazardous driving situations, while overestimating their own driving skill. Additionally due to their inexperience, novice drivers seem to have difficulties identifying hazards (Pollatsek, Fisher, & Pradhan, 2006; Scialfa et al., 2011), and have engaged in hazardous driving where they have failed to detect the presence of a hazard (Beanland et al., 2013; Wang et al., 2010).

Numerous studies have examined hazard perception in young novice drivers, such as those mentioned above. However, what is lacking is studies which explore what factors may be related to young driver hazard identification performance. Horswill, Garth, Hill, and Watson (2017) reported that relationships between self-ratings of hazard perception ability and objective, performance measures of hazard perception ability are not significant. A potential reason for this is that drivers have often been found not to have the insight to appropriately assess their own driving skill or ability compared to others or for the driving conditions (Horswill et al., 2017). Therefore exploration of other potential self-reported factors that may relate to driving behaviours, such as hazard perception, is needed. This is important as driving training interventions that aim to improve hazard perception in this target population need to be aware of influencing factors that may increase or reduce hazard perception performance (e.g., driver confidence).
The current study

In the previous study (Chapter 7), a driving intervention was implemented that focused on improving a small sample of Provisional 1 licence drivers’ hazard perception skills. The training session was designed to be brief and employed three unique training conditions (pamphlet, passive, and active) that incorporated the behavioural change techniques of: giving information (information about risk and consequences); teaching (instruction, demonstrating, feedback on performance), talking through a driving situation and thorough use of a follow up session (Fylan & Stradling, 2014). Evaluating this training session required a conceptual model/framework based in validated theory and strong evidence based understanding of what factors contribute to young novice drivers’ hazard perception, perceived risk and reported engagement in risky driving behaviours. Therefore this study had two distinct aims; first to examine whether associations exist between factors identified in the proposed conceptual psychosocial–cognitive model of risky driving behaviour developed from studies 1-4, and hazard perception in this driving population of novice drivers from study 6. Second, to evaluate the brief hazard perception training session’s key objectives of hazard perception learning, training session effectiveness and reported confidence in their perception and response to hazards that may appear on the road.

To address research aim 1, factors from reinforcement sensitivity theory, protection motivation theory (PMT), and the prototype willingness model (PWM) measured from studies 1-4 were included. In addition, key factors from Shope and Bingham’s (2008) model; behavioural factors, driving ability and demographic factors (see Figure 9.1) were also measured.
Using a social–cognitive and social learning approach in examining hazard perception is a novel (to our knowledge) contribution to literature for hazard perception. Previous literature that used theoretical frameworks to examine hazard perception and situational awareness has focused on cognitive (e.g., attentional, risk assessment), or behavioural (e.g., gaze direction, response time) mechanisms required for driving and perceiving hazards, such as risk homeostasis theory (Wilde, 1982, 1998); zero risk theory (Näätänen & Summala, 1974); Fuller’s task difficulty, task–capability interface (TCI; Fuller, 2005) model, and signal detection theory, or fuzzy signal detection theory...
(Parasuraman, Masalonis, & Hancock, 2000). It is not known what social–cognitive and or social-learning factors may also be related to hazard perception.

To address the second aim, using a training appraisal survey, P1 licence drivers who participated in the training session ($N=52$, study 6, Chapter 8) provided qualitative (open-ended) and quantitative feedback on their learning, ratings of effectiveness of the training session, and reported confidence in their perception and response to hazards that may appear on the road. We also wanted to know whether participants found the training session helpful, informative, and applicable to real life, and whether they would recommend the training to other P1 drivers. Feedback was sought to identify areas of the training session perceived as effective by participants and areas that could benefit from improvement. Examining these questions and evaluating the session is important as it has implications for participant attrition and retention rates, while perceived effectiveness of the training may influence a driver’s ability to internalise knowledge and apply it beyond the training setting (Beanland et al., 2013; Lonero, 2008; Mayhew et al., 1998; Sidani, 2015). Because driver confidence can affect driving behaviour, and confidence can be changed through driver training (Beanland et al., 2013; Ivancic & Hesketh, 2000), as a part of the training session evaluation, we also wanted to examine whether changes occurred in reported confidence in hazard perception and response to road user-related hazards across the three time points (prior to training, after training/assessment, and at follow up).

**Methodology**

**Sample**

The sample included the 52 P1 drivers who participated in the brief training session (Chapter 8). However, the current study reports a different focus, analysis and results. Drivers (males=18, 34.62%), were aged 17-25 years ($M=18.13$, $SD=1.73$), had a mean length of licensure of 25.69 months ($SD=11.75$), and reported driving on average
220.38 (SD=172.09) kilometres a week. Of the 52 participants, 7 (13.4%) reported that they had obtained a driving related traffic violation, which result in some penalty (e.g. monetary fines, loss of demerit points) and 11 (21.2%) indicated that they had received previous driver training beyond the learner licensing GDL requirements. At follow up, 2-3 weeks after training, of the 52 participants who completed the training, 42 (80.8%) returned for the follow-up evaluation phase.

**Measures**

**Questionnaire booklet.** Participants completed a pen and paper 123-item questionnaire booklet containing eight scales and demographic items, which took approximately 30 minutes. Responses were de-identified, and matched with their unique participant group code. This code and any data collected that was linked to the code did not provide enough information to identity the participant, allowing participants responses to remain anonymous. Demographic items asked for participants’ age, gender, licence type, number of years licence has been held (since learner), average number of kilometres driven per week and number of violations obtained since Provisional 1 licence. The measures are described below.

**Perceived risk.** The 12-item Perceived Risk of Risky Driving Behaviours scale focused on cognitive aspects of perceived risk, and is measured with two subscales: aversion to risk taking (perceived danger) for the driving behaviour, and perceived likelihood of a motor vehicle crash occurring as a result of each driving behaviour. The risky driving behaviours examined in the scale are: speeding, drink-driving, drug-driving, seatbelt use, driving while fatigued, driving while distracted, mobile phone use, tailgating, unsafe overtaking, illegal driving manoeuvres (e.g., U-turns at prohibited intersections), red light violations, and driving with peer passengers. The 6-item aversion to risky driving subscale measured the perceived riskiness of the driving behaviours. Items focused on respondents’ cognitions as a driver rather than their
reported behaviour. The response scale ranged from: 1 = not risky at all, to 5 = very risky. Higher scores indicate higher perceived risk of driving behaviours. The 6-item perceived likelihood of a motor vehicle crash occurring subscale measures perceived likelihood of a motor vehicle crash occurring as a result of the driving-related behaviour. The scale ranges from: 1 = not likely at all, to 5 = very likely. Higher scores indicate higher perceived likelihood of a motor vehicle crash occurring. This scale was previously implemented and validated in chapters 3-5 of the thesis.

Reported risky driving engagement. Scott-Parker et al.’s (2012c) revised Behaviour of Young Novice Drivers Scale (BYNDS; 36 items) measured reported risky driving engagement. The measure has 5 subscales (transient violations, fixed violations, risk exposure, misjudgements, and driver mood). Higher BYNDS scores indicate more self-reported risky driving engagement in the previous month of driving. BYNDS subscales use a 5-point response format from: 1 = never, to 5 = almost always.

Threat appraisal. This construct was measured by 15 items within three subscales: severity, vulnerability, and reward. The 5-item perceived severity subscale required participants to rate the severity (short- and/or long-term consequences) of engaging in driving behaviours relating to the fatal five on a scale from: 1 = no consequences at all, to 5 = the consequences are deadly. Higher scores indicate higher perceived severity. Vulnerability was assessed with a 5-item scale asking participants to rate their personal vulnerability to the possible risk of being involved in a motor vehicle crash involving serious injury or a fatality due to engaging in the driving behaviour presented. Ratings range from: 1 = it is impossible that I will experience this event, to 5 = I will definitely experience this event. Higher scores indicated higher perceived vulnerability. Reward was measured by 5 items asking participants to rate how rewarding (intrinsic or social rewards – e.g., peer approval) they perceived each of the behaviours to be on a scale from: 1 = not rewarding at all, to 5 = very rewarding.
Higher scores indicated higher perceived reward. This scale was implemented and validated in Chapter 4 of the thesis.

**Coping Appraisal.** This construct is measured by 15 items within three subscales: response efficacy, self-efficacy, and response costs. The 5-item *response efficacy* subscale required participants to appraise the efficacy of a protective response (not engaging in risky driving behaviours that could increase the likelihood of a motor vehicle crash). The risky driving behaviours were reworded to describe behaviours that represented the protective (adaptive) response to decreasing motor vehicle crash risk (e.g., driving within the speeding limit, or always wearing a seatbelt), termed ‘safe driving’ responses. These behaviours were rated on a scale from: 1 = *not effective at all*, to 5 = *highly effective*. Higher scores indicated higher perceived response efficacy. *Self-efficacy* which was defined as initiating alternative actions was measured by 5 items asking participants to rate how confident they would feel about their own ability to respond adaptively with a protective response driving behaviour to decrease the likelihood of a motor vehicle crash. Responses were from: 1 = *not confident at all*, to 5 = *very confident*. Higher scores indicated higher perceived self-efficacy in safe driving responses. *Response costs* were defined as implementing alternative protective responses, which differ conceptually from rewards, being obstacles to adopting adaptive responses, rather than incentives for a maladaptive response. Response costs can include both intrinsic and extrinsic factors (Greening & Stoppelbein, 2000). Participants indicated how much they agreed with 5 statements concerning the personal costs of safe driving alternatives to the fatal five risky driving behaviours. Responses were from: 1 = *strongly disagree*, to 5 = *strongly agree*. Higher scores indicated higher reported perceived response costs to the protective responses. This scale was implemented and validated in Chapter 4 of the thesis.
**Risky driver prototype favourability.** Adjectives were sourced from Gibbons and Gerrard’s (1995) and Scott-Parker, Hyde et al.,’s (2013) study. This resulted in 12 statements (6 positive: safe, cautious, aware of dangers, sensible, independent, and considerate; 6 negative: immature, irresponsible, show-off, careless, ignorant, and self-centred). Participants indicated their level of agreement with each statement on a 7-point Likert scale from: 1= *strongly disagree*, to 7= *strongly agree*. Scores were aggregated after reverse scoring responses to negative adjectives so that higher scores reflected a more favourable prototype. This scale was implemented and validated in Chapter 5 of the thesis.

**Risky driver prototype similarity.** Participants rated themselves on the same 12 adjectives described above on a Likert scale from: 1= *strongly disagree*, to 7= *strongly agree*, which indicated their level of agreement with the statements. An additional item sought respondents’ level of agreement for their self-perception of whether they considered themselves to be a risky driver (e.g., “As a driver I am very similar to the typical person who drives in a risky manner – e.g., exceeds speed limits, drives after consuming alcohol or while tired, does not use a seatbelt, talks on a handheld phone while driving”). After reverse scoring, total scores from the 13 items resulted in a comparable measure of participants’ reported similarity to the risky driver prototype, where higher scores indicated higher risky driver prototype similarity. This scale was implemented and validated in Chapter 5 of the thesis.

**Behavioural willingness.** Fourteen items evaluated willingness to engage in driving behaviours related to the Fatal Five (Speeding = 3, Drink driving = 3, Fatigue = 4, and distraction = 4). Participants responded to a 7-point scale from 1= *not willing at all* to 7= *extremely willing*. After reverse scoring, total scores resulted in a comparable measure of participants’ reported behavioural willingness, where higher scores indicated
higher behavioural willingness to engage in the fatal five driving behaviours. This scale was implemented and validated in Chapter 5 of the thesis.

**Static hazard perception test.** The static hazard perception test required each participant to view 12 photo images from a driver’s visual perspective in everyday driving situations and provide the number of driving related hazards they perceive. Images were sourced from videos downloaded from an online website and used with permission from Queensland Transport and Main roads (TMR). A total of 50 driving related hazards can be identified throughout the 12 images. Participants had 10 minutes to complete the task, with scoring by the researcher. Each correctly identified hazard received 1 point, for a total score ranging from 0-50. The measures were implemented and validated in Chapter 6 of the thesis. The static hazard perception responses were independently scored by two research team members before being entered into the database. The correlation coefficient between raters on this measure was ICC=.98. Full measure description and results are in chapters 7-8.

**Driver confidence.** Driver confidence was measured at three time points, at screening, after assessment, and at follow-up. A single item examined hazard perception confidence, and a single item was used to rate hazard response confidence. Participants were asked to rate their level of confidence separately for hazard perception and hazard response using a 6-point response scale where 1=not confident at all and 6=extremely confident.

**Training appraisal survey.** A 15item survey evaluated the training session. Questionnaire items were phrased to obtain quantitative information using response formats (scoring range 1-6), and qualitative information using open ended questions. Quantitative items included: driver reported confidence of driving related hazard perception, and in responding to driving related hazards, reported effectiveness of training session (e.g., overall, learning about their own driving responses), and training
session rating comparison with what is experienced on the road. Additionally items that asked how important hazard perception is for driving and whether the participant would recommend training session for Provisional 1 drivers were also asked. Qualitative items were written to derive responses to themes surrounding: participant learning, changes in understanding hazard perception, and what a driving related hazard is, where young drivers seek out information for hazard perception, what participants liked or did not like about the session, and feedback for session improvement. Thematic analysis, using an inductive approach (Braun & Clarke, 2006) was used for identifying, analysing, and reporting patterns (themes) within the data, while maintaining the participants' perceptions, feelings and experiences of the training session. Coding and analysis was undertaken by two researchers (EH and CW) independently to enhance rigor and as a method of checking for extracted codes and themes (Braun & Clarke, 2006).

Completing the survey was voluntary, with feedback linked to participant’s group code only, allowing responses to remain anonymous. The survey took approximately 7-10 minutes to complete. This measure was piloted tested in Chapter 7.

Procedure

Ethical approval from the authors’ University Human Research Ethics Committee was granted. The study collected participant data between March and May. Participants had been randomly assigned to a training condition (pamphlet, passive, active) or no-training condition prior to screening. During the training session (described in Chapter 8) participants completed the static hazard perception test (hazard knowledge) and questionnaire booklet prior to training. At the end of the session, participants were invited to complete the evaluation questionnaire, which was voluntary and not a part of the training session.
Data analysis

Data from the questionnaires and hazard perception knowledge measure were entered into IBM SPSS Statistics Version 22 (IBM Corp, 2013), then screened and cleaned for analysis. Prior to data analyses, the distributions of all measured variables were examined. No violations to normality or significant skew were present in the measured variable distributions.

To examine changes over time in reported confidence in hazard perception and response, a mixed factorial ANOVA was conducted. The within group effect of phase (before training, after training, and at follow-up), and the between-groups effect of training (no-training, pamphlet, passive, and active) for confidence in hazard perception and response were examined. For t-tests, Cohen’s $d$ was calculated using Morris and DeShon’s (2002) correction for within-subjects analyses, and interpreted using Cohen’s rules of thumb where $d$ values of 0.20, 0.50, and 0.80 respectively represent small, medium, and large effect sizes (Cohen, 1988). Descriptive statistics are presented using unadjusted means and standard deviations. Alpha levels of .05 were used to determine statistical significance for main analyses. Partial eta squared ($\eta_p^2$) was also used as an indication of effect size using Cohen’s rules of thumb where $\eta_p^2$ values of .01, .06 and .14 respectively represent small, medium and large effect sizes (Cohen, 1988).

The measured variables’ strengths of association were explored with zero-order correlations between continuous variables using Pearson’s product moment correlation coefficient ($r$). Alpha of $p < .10$ was used to examine marginal significance, as well as alpha levels of $p < .05$ and $p < .001$ to confirm significance for these correlations: $r = .10$, .30, and .50 were used to represent respectively weak, moderate, and strong levels of association (Cohen, 1988). A series of one-way ANOVAs were run to examine if training group differences occurred in the quantitative responses on the evaluation questionnaire items. Qualitative responses were transcribed and thematically coded for
each question. Themes will then be named and categorised and closely examined to compare for similarities, differences, and connections between the categories. Researcher triangulation (using two independent raters) will be employed while collecting and analysing the data to capture the complexity of the area studied and to enhance the validity of the findings. This methodology will ensure vigour and precision to the analysis. As rigour is essential in research and the research team will ensure this in the following ways. First, audit trails will be kept and continued reflexive discussions will be undertaken to ensure consensus of all thematic decision-making (dependability). Second, raw data drawn from the participants and descriptions of the context from which the data are drawn will be included to ensure interpretations and conclusions are accurate (confirmability; Creswell & Poth, 2018).

**Results**

**Correlates of outcome measures**

Demographics variables and proposed correlates outlined from Figure 9.1 were examined for outcomes of hazard knowledge, perceived risk and reported risky driving engagement. Means, standard deviations, Cronbach’s α of measured variables and correlations are in Table 9.1.

As seen in Table 9.1 many associations between variables of interest and hazard knowledge were non-significant. However, there were a few exceptions. The strongest association found for hazard knowledge was coping appraisal, and whether participants reported receiving a traffic violation penalty. These positive associations indicated that as scores on coping appraisal increased, and if traffic violations penalties were reported, the number of hazards identified in the static hazard knowledge measure was higher. Significance was also found for risky prototype similarity, where those drivers who perceived themselves to be less similar to a risky driver, also correctly identified a higher number of hazards.
### Table 9.1

*Means, Standard Deviations and Correlations between All Measures (N = 52)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>α</th>
<th>Perceived risk</th>
<th>BYNDS</th>
<th>Hazard identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender male</td>
<td></td>
<td>.06</td>
<td>.23*</td>
<td>-.01</td>
<td></td>
</tr>
<tr>
<td>Previous driver training n (%)</td>
<td></td>
<td>.06</td>
<td>-.05</td>
<td>.20</td>
<td></td>
</tr>
<tr>
<td>Traffic violations n (%)</td>
<td></td>
<td>-.26*</td>
<td>.35**</td>
<td>.36*</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>18.13 (1.73)</td>
<td>-.20</td>
<td>-.02</td>
<td>.20</td>
<td></td>
</tr>
<tr>
<td>Length of licence (months)</td>
<td>25.69 (11.75)</td>
<td>-.22</td>
<td>.02</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>Driving frequency (km/week)</td>
<td>220.38 (172.09)</td>
<td>-.07</td>
<td>.05</td>
<td>.04</td>
<td></td>
</tr>
<tr>
<td>Brake reaction time (secs)</td>
<td>1.28 (0.24)</td>
<td>-.04</td>
<td>.10</td>
<td>-.13</td>
<td></td>
</tr>
<tr>
<td>Hazard perception confidence</td>
<td>4.59 (0.71)</td>
<td>.08</td>
<td>-.24*</td>
<td>-.17</td>
<td></td>
</tr>
<tr>
<td>prior to training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazard reaction confidence</td>
<td>4.53 (0.81)</td>
<td>.05</td>
<td>-.23*</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td>prior to training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived likelihood</td>
<td>23.13 (2.79)</td>
<td>.65</td>
<td>.38**</td>
<td>-.27*</td>
<td>.11</td>
</tr>
<tr>
<td>Threat appraisal</td>
<td>40.37 (6.27)</td>
<td>.70</td>
<td>.32*</td>
<td>.31*</td>
<td>.19</td>
</tr>
<tr>
<td>Coping appraisal</td>
<td>54.77 (4.71)</td>
<td>.65</td>
<td>.04</td>
<td>.26*</td>
<td>.36**</td>
</tr>
<tr>
<td>Risky prototype favourability</td>
<td>31.75 (9.99)</td>
<td>.77</td>
<td>-.27*</td>
<td>.31*</td>
<td>.18</td>
</tr>
<tr>
<td>Risky prototype similarity</td>
<td>24.79 (6.98)</td>
<td>.83</td>
<td>-.26*</td>
<td>.62***</td>
<td>-.29*</td>
</tr>
<tr>
<td>Behavioural willingness</td>
<td>51.25 (12.33)</td>
<td>.82</td>
<td>-.38**</td>
<td>.57***</td>
<td>.24*</td>
</tr>
<tr>
<td>Perceived risk</td>
<td>23.19 (2.49)</td>
<td>.62</td>
<td>-</td>
<td>-.16</td>
<td>.05</td>
</tr>
<tr>
<td>BYNDS</td>
<td>75.85 (13.68)</td>
<td>.89</td>
<td>-</td>
<td>-</td>
<td>-.12</td>
</tr>
<tr>
<td>Hazard knowledge</td>
<td>22.02 (9.64)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: BYNDS Behaviour of young novice driver scale, measuring reported risky driving engagement. SD = standard deviation.

*p < .10; *p < .05; **p < .01; ***p < .001

Associations between previously established demographic and theoretical variables with perceived risk and reported risky driving engagement were also examined. As shown in Table 9.1, for perceived risk, the strongest relationship was with perceived likelihood of motor vehicle crash, and behavioural willingness to engage in the fatal five driving behaviours. Drivers who perceived a higher likelihood of an MVC occurring, and reported a lower willingness to engage in the fatal five driving behaviours, had higher perceived risk scores in the risky driving behaviours presented, where the strength in the relationship was closely followed by threat appraisal and risky
Young novice driver cognitions and behaviour 250

prototype favourability. For reported risky driving engagement (BYNDS), the strongest relationship was with risky prototype similarity, specifically participants who reported higher prototype similarity with risky drivers, also reported a higher engagement in risky driving behaviours. This strength in the relationship with risky diving was also closely followed by a having a higher behavioural willingness to engage, receiving a traffic violation, higher threat appraisal, and higher risky driver prototype favourability. Drivers with lower scores in perceived likelihood of motor vehicle crash also indicated higher engagement in risky driving.

Training appraisal survey

Of the 52 participants invited to complete the survey, 47 (90.38%) responded. Quantitative responses are provided first. One-way ANOVAs were run to examine training group differences in mean responses to these items. No significant differences were found between the training groups on all questions (see Table 9.2). Overall the sample indicated high confidence in identifying and responding to hazards, with all participants responding as moderately confident or above for these items. Learning effectiveness in hazard identification and response was also rated at a high level. All but four participants rated the training session moderately effective or above for learning about hazard identification. All participants also rated the learning effectiveness in responding to hazards in the driving scenario as moderately effective to extremely effective. Participants also rated the driving simulator scenario as moderately comparable to real-world driving. Across training groups, 91.5% (n=43) of participants who completed the evaluation measure indicated that they would recommend the session for other P1 drivers, 4.3% (n=2) indicated maybe and 4.3% (n=2) indicated no.
Table 9.2

*Means and standard deviations of evaluation questions after training (N=47)*

<table>
<thead>
<tr>
<th>Item</th>
<th>No training</th>
<th>Pamphlet</th>
<th>Passive</th>
<th>Active</th>
<th>Total sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence in identifying hazards</td>
<td>4.73 (0.47)</td>
<td>4.69 (0.63)</td>
<td>4.73 (0.65)</td>
<td>4.92 (0.79)</td>
<td>4.77 (0.63)</td>
</tr>
<tr>
<td>Confidence in responding to hazards</td>
<td>4.73 (0.47)</td>
<td>4.62 (0.65)</td>
<td>4.73 (0.65)</td>
<td>4.75 (0.75)</td>
<td>4.70 (0.62)</td>
</tr>
<tr>
<td>Comparable to real life driving using the simulator</td>
<td>4.64 (0.67)</td>
<td>5.00 (1.01)</td>
<td>5.36 (0.67)</td>
<td>4.42 (0.79)</td>
<td>4.85 (0.88)</td>
</tr>
<tr>
<td>Effectiveness in learning about hazard identification</td>
<td>4.91 (0.54)</td>
<td>5.15 (0.69)</td>
<td>5.09 (0.70)</td>
<td>4.92 (0.29)</td>
<td>5.02 (0.57)</td>
</tr>
<tr>
<td>Effectiveness in learning about hazard response</td>
<td>4.18 (0.75)</td>
<td>4.15 (0.99)</td>
<td>4.45 (0.69)</td>
<td>4.17 (0.58)</td>
<td>4.23 (0.76)</td>
</tr>
<tr>
<td>Importance of hazard perception</td>
<td>5.82 (0.41)</td>
<td>5.69 (0.48)</td>
<td>5.73 (0.47)</td>
<td>5.33 (0.89)</td>
<td>5.64 (0.61)</td>
</tr>
</tbody>
</table>

Note: No significant mean differences were found between training conditions on these items.
Qualitative summary

In total, 46 participants provided feedback in response to at least one of the eight qualitative questions asked in the training appraisal survey. Below, the main coding and themes of participant responses to each question as agreed and validated by the researchers EH and CW using member checking will be reported for the overall sample.

Learning and Knowledge Related Questions

The first qualitative question (Q4), asked what new things had been learned during the session. For this question, 31 participants (67.4%) provided a response. From these responses, four primary areas of learning were identified, with 14 participants (48.3%) reporting increase awareness of hazards (e.g., PV13: “There's a lot more going on whilst driving than what you think about, i.e., pedestrians on pathway.” PP01: “I learnt that there is a potential for any number of wide ranging hazards to occur at any time”, and PC11: “To observe much more of my surroundings whilst driving”). Ten participants (34.4%) reported that they had learned about new types of hazards (e.g., pedestrians, parked cars, intersections, merging vehicles), three participants (10.3%) reported learning new driving laws and rules (e.g., giving way to merging buses, right of way in single traffic light intersections), and two participants (6.5%) reported other learning gains (e.g., PP02: “The bumps on the outer lines of more country roads are used to stimulate (as they make a loud noise if you drive over them) fatigued drivers”, and PP11: “How to drive a simulator (properly)”). Two participants (6.5%) indicated that they had not learned anything (1 Control, 1 Pamphlet condition).

The second qualitative question (Q5), asked whether participant’s original understanding of hazard perception for driving had changed since the start of the session. To this question, 40 participants (86.9%) responded. Of those responding, 27 (67.5%) indicated that their understanding had changed (e.g., code of ‘Yes’ or a specific change in understanding specified - e.g., PS12: “Hazards can be stationary,” PC13;
“Need to be more aware of parked cars and hidden pedestrians”, and PS04: “I am just now slightly more aware of how I would react in various situations since I had a chance to try it in a simulated environment”). Thirteen participants (32.5%) reported no change in understanding (e.g., Code of ‘No’ or ‘Not really’, or specified reinforcement; e.g., PS02: “Was pretty much what I expected”, PV08: “My original understanding has not changed since the start of this session”, and PP04: “Not really, I was already practicing my perception of hazards just the same”).

The third qualitative question (Q6), asked whether participant’s original understanding of what constituted a driving related hazard had changed since the start of the session. To this question, 35 participants (76.1%) responded. Of those responding, 22 (62.9%) indicated that their understanding had changed (e.g., code of ‘Yes’ or a specific change in understanding specified; e.g., PP12: “There are a lot of things that I would probably not usually consider a hazard that I now will”, PS04: “I didn’t realise a driving related hazard could include so many things like parked cars and pedestrians as well as other cars on the road”, and PC02: “Yes, a driving related hazard is something which may or may not result in an accident depending on how the driver responds to the hazard.”). Thirteen (37.1%) participants reported no change in understanding (e.g., Code of ‘No’ or themes of reinforcement; e.g., PP08: “My original understanding was rather accurate” and PV10: “No, I already had an understanding of what hazards are”).

The fourth qualitative question (Q10), asked participants where they would go to seek further information about driving related hazard perception. To this question, 35 participants (76.1%) responded. From these responses, three primary sources of further information were reported, with 17 participants (48.6%) reporting that they would seek further information online (e.g., codes of ‘online’, ‘the internet’, or ‘Google’), 12 participants (34.3%) reporting that they would seek further information from
government sources (e.g., ‘government websites’, ‘Queensland Transport and Main Roads’, and ‘RTA’), and 6 participants (17.1%) reporting that they would seek further information from driving schools or driving courses.

Feedback and Evaluation Related Questions

The fifth (Q11) and sixth (Q12) qualitative questions, asked participants which aspects they liked or did not like about the driving simulator session. To Q11, 39 participants (84.8%) responded. From these responses, four primary themes were identified. In particular, 23 participants (59.0%) reported that they liked the realistic nature of the simulator session, (e.g., PS10: “It's so cool how it's set up like an actual car, felt very real”, PV03: “Was easy and comparable to driving, I didn't have to struggle or do anything unfamiliar”, and PP04: “I liked how real it was, how it was exactly like a normal car”). Nine participants (23.1%) reported that they liked the opportunity to test and develop driving and hazard related skills (e.g., PV05: “I liked how it incorporated real life scenarios like people aimlessly walking out on the street. The hazard driving video showing a driver indicate road hazards whilst driving, made me learn some vital points whilst driving”, PP01: “I enjoyed the variety of hazards as it allowed me to see how many possible hazards there are”, and PS06: “Getting to drive and understand potential hazards and how to respond to them”). Five participants (12.8%) reported that they felt the simulator session was fun or interesting (e.g., PP02: “It was a fun and interesting way to learn”, PC12: “It's somewhat similar to driving and fun to use”, and PV12: “Interesting way to gain new knowledge”). While two (5.1%) participant responses fell into another category (e.g., PC01: “Interactive” and PP03: “It was a unique experience”).

To Q12, 22 participants (47.8%) responded. From these responses, four primary themes were identified. Twelve participants (54.6%) did not like the controls and sensitivity of the driving simulator (e.g., PP04: “The steering wheel was very sensitive
so the slightest move of it affected the position in the lane of the car”, PP10: “Very hard to judge speed if you aren't constantly looking at the speedometer”, and PC13: “Hard to control/use brakes”). Six participants (27.3%) did not feel that the driving simulator graphics and scenarios were realistic enough (e.g., PS01: “Animation wasn't up to scratch so lost some realism”, PS04: “There was no ability to check my blind spot. There was no need to turn any corners, so it could be boring just staying straight constantly” and PV03: “It was just hard to get use to the depth and how long it would take to stop at red lights”). Two participants (9.1%) reported that they felt the simulator session to be stressful (e.g., PP12: “It was slightly stressful” and PP13: “The adjustment from my own car to that of the simulation, also I found the people running across the road during the simulation to be quite stressful”). Two participants (9.1%) reported feeling a little motion sickness (e.g., PV07: “Slight motion sickness involved”, and PP03: “Made me feel a little bit sick”).

As part of the training appraisal, participants were also asked if they would recommend the driving simulator session and to provide reasons for this response. Of the 46 participants, 42 (91.3%) recommended the session with elaboration on why. From this, four themes were identified. In particular, 23 participants (54.8%) reported that they would recommend the session as they felt that it was informative and or helpful (e.g., PC02: “It is important, especially for those who have just received their licence, to be aware of all hazards/potential hazards when they are on the road”, PP11: “Helps you receive a better understanding of it all because of the practical side”, and PV13: “Simulates real-life dangers and teaches about hazards you may not know existed”). Nine participants (21.4%) reported that they would recommend the session as a method of evaluating driving and hazard perception in a safe environment (e.g., PV08: “It is a great way to test and practice hazard perception in a safe environment”, PS01: “As inexperienced drives, L plates and P platers could benefit greatly from learning
how to identify and react safely to road hazards and conditions in an environment where mistakes won’t harm anyone, physically or financially”, and PS11: “Good way to test skills with no real world consequences”). Seven (16.7%) reported that they would recommend the session in order to increase hazard awareness (e.g., PV10: “A good experience to become more aware of hazards whilst driving”, PV13: “Simulates real-life dangers and teaches about hazards you may not know existed”, and PP01: “It enabled me to see the variety of potential hazards). Three (7.1%) participants reported that they would recommend the session as it was ‘enjoyable’.

The final question asked participants for feedback to improve the driving simulator session. For this question, 15 (32.6%) participants did not provide a response, eight (17.4%) responded ‘No’, and 15 (32.6%) participants responded ‘No’ with a positive response (e.g., PC02: “None, you have made this session engaging, informative and fun”, PP11: “Great work and would be happy to do again”, and PS04: “No, I think it was run very well’). Eight (17.4%) participants reported that they had specific feedback of the simulator session. Of these, three reported that they would like to see further hazards incorporated into the session, two that they felt the session was too easy, two said that they wanted to increase the realism of the simulator session, and one participant reported that they would have liked more practice in the simulator.

Confidence in hazard perception and response

To examine effects of training condition across phases, a mixed 4 (Training group) ×3 (Before training, after training and at follow up) ANOVA was conducted on both participant reported confidence in hazard perception and hazard response. For confidence in hazard perception, assumptions of equality of covariance and sphericity were met. There was no main effect of training group, \( F(3, 39)=0.77, p=.516, \eta_p^2=.06 \), or phase, \( F(2, 78)=2.12, p=.127, \eta_p^2=.05 \), ratings of hazard perception confidence did not differ among groups or between time points.
For confidence in hazard response, while assumption of equality of covariance was met, Mauchly’s test of sphericity was not. Therefore the Huynh-Feldt correction was applied. There was no main effect of training group, $F(3, 39)=0.51, p=.678, \eta^2_p=.04$. However, there was a main effect of phase, $F(1.88, 73.16)=4.20, p=.021, \eta^2_p=.10$, with increases in reported confidence in hazard response across phases. To examine which time points differed between phases, a series of paired samples $t$-tests were conducted. Hazard response ratings from prior to training ($M=4.65, SD=0.80$) and after training ($M=4.71, SD=0.61$) for the sample were compared, no difference was found $t(48)=-0.50, p=.617, d=-0.07$. Hazard response ratings from prior to training ($M=4.60, SD=0.80$) and at follow up ($M=4.93, SD=0.55$) for the sample were compared, a significant increase in hazard ratings was found, $t(42)=-2.54, p=.012, d=-0.42$. Hazard response rating after training ($M=4.72, SD=0.63$) and at follow up ($M=4.93, SD=0.55$) were compared for the sample, with a significance increase in reported confidence found, $t(42)=-2.46, p=.018, d=-0.38$.

Discussion

The overall aim of this study was to provide further insight into driving related hazard perception and methods of improving this for a young novice driver sample. The first study aim was to further knowledge by examining potential correlates of young driver hazard perception, specifically hazard knowledge and identification, drawing from both theory and previously established relationships with perceived risk and risky driving engagement. Of the many potential correlates examined, only three had significant relationships with hazard knowledge prior to training. The second study aim was to explore reported learning outcomes of the brief training session amongst the sample of Provisional 1 drivers. Feedback was also collected regarding areas of the training session perceived as effective by participants, and areas that could benefit from improvement. Study findings, implications and applications are described below.
Correlates of hazard knowledge

Hazard perception tests that are static (image and video) are a popular form of hazard perception testing due to the time and cost effective nature of the measure. They are often also found to be a reliable and valid form of assessment testing, able to discriminate between experience and novice drivers. As an aim of the current research was to explore potential correlates of hazard perception, these correlates were chosen as they have been found to be related to other prominent driver behaviour (perceived risk and risk driving engagement) models that were examined previously in the thesis (chapters 3-6). Confirming these relationships in a new sample, and testing potential relationships to see if other self-reported factors extend to hazard perception can have important implications for driver training and assessment that target these driving constructs.

A number of potential correlates were examined for perceived risk and reported risky driving engagement, of these many were found to be non-significant including demographic and cognitive variables (e.g., age, gender, driving experience, coping appraisal, and confidence in hazard perception and response). However, some significant relationships were found for traffic violations, where drivers who reported receiving a traffic violation had higher risky driving engagement scores. As the BYNDS has a subscale of transient and fixed violations for potentially risky driving behaviours (Scott-Parker et al., 2012c), overlap between these two variables was expected. Similar to previous research examined and highlighted in the thesis (chapters 4, 5, and 6), perceived likelihood of motor vehicle crash, threat appraisal, risky driver prototype favourability and similarity and behavioural willingness to engage in the fatal five driving behaviours were associated with higher/lower perceived risk and reported risky driving engagement. This highlights that even when examining a small sample of at risk P1 drivers, social–cognitive and social learning factors may influence young driver
perceptions of risk and engagement in risky driving behaviours, which are key contributors to why young drivers may be over-represented in national injury and death tolls.

When we explored these correlates, including perceived risk and reported risky driving engagement on hazard perception for identification scores, only three were significant. Specifically correlates of whether participants reported they had received a penalty for a traffic violation, their scores on coping appraisal and risk prototype similarity, had moderate associations with hazard identification prior to training. These results may indicate that drivers with driving-related traffic violations may be more sensitive or aware of road related hazards when compared with those drivers who have not received a traffic violation penalty, and that future research may need to examine this variable in future research as a possible confound. Young drivers with traffic violations do not differ in hazard prediction when compared with non-offenders (e.g., Gugliotta et al., 2017). Yet other research has found evidence that hazard perception measures can discriminate between driving offenders (e.g., Castro et al., 2016), and that offenders have lower hazard sensitivity, yet have similar situational awareness and report lower cautiousness in decision-making when compared to non-offending drivers (Ventsislavova et al., 2016). However, our research findings are contrary to these studies’ results as drivers who had received traffic violation penalties correctly identified more hazards than did drivers without violations. However, as this was self-reported and not confirmed with actual driving records, whether there were other drivers with violations who did not report this, and the degree and type of traffic violation penalty (e.g. speeding, drink/drug driving) was not examined, results must be interpreted with caution. It is clear from all of this that the research debate on hazard perception and offender drivers continues.
Coping appraisal, which is a cognitive decision making pathway identified in PMT (see Chapter 4), also shared a moderate positive association with hazard identification scores. Coping appraisal is measured by three domains: driver response efficacy, self-efficacy, and response costs. Therefore when coping appraisal is activated for a driver to effectively cope with perceived threats, the driver must appraise: the efficacy of a protective response (e.g., slowing down, changing lanes), their own self-efficacy through their perceived ability to execute coping behaviours successfully (e.g., maintaining good driving behaviours, such as following the speed limit, not tailgating), and potential costs associated with executing a coping response (e.g., loss of time). Therefore drivers who have higher scores on coping appraisal may correctly identify more road and driving related hazards as they engage in decision-making processes that result in driver behaviours that have allowed them to effectively identify and respond to hazards while driving. PMT has successfully been applied and related to other driving behaviours such as perceived risk and risky driving engagement (see Chapter 4), effectiveness of anti-speeding messages (Cathcart & Glendon, 2016; Glendon & Walker, 2013), and driver fatigue (Tay & Watson, 2002). However, it has yet (to our knowledge) to be applied to hazard perception. These initial results highlight a further direction for future research, as findings will need to be replicated in larger sample sizes, and whether this relationship also exists for other measures of hazard perception beyond identification (e.g., hazard response).

The last significant correlate found was risky driver prototype similarity, which had a negative relationship with hazard perception scores. A prototype is a cognitive representation or social image of the type of person who engages in specific risk behaviours. This image can represent a typology rather than a description of the physical appearance (see Chapter 5). A prototype of a risky driver was presented to participants and they rated themselves on how similar their driving behaviour was to
this risky driver prototype. Drivers with high similarity also correctly identified less hazards in the hazard identification measure. The risky driver prototype is represented as an overconfident driver, who engages in risky driving behaviours (e.g., tailgating, speeding, illegal driving manoeuvres). Drivers who subscribe to this driver prototype may identify fewer hazards, because they do not perceive the hazard presented in the image as hazardous to their driving ability or skill. Research has examined whether risky drivers perform poorer in hazard perception tests due to a criterion bias of driver skill (e.g., Gugliotta et al., 2017), however, these drivers were found to be similar in hazard perception to non-risky drivers. This is contrary to the relationship found in our study, however, Gugliotta et al. (2017) highlighted that their measure of hazard perception may not have been sensitive enough to discriminate between driver types. Therefore this correlate also highlights a further direction for future research, and similar to coping appraisal, findings will need to be replicated in larger sample sizes, and whether this relationship also exists for other measures of hazard perception beyond identification (e.g., hazard response).

That there was no relationship between ratings of perceived risk and hazard perception identification is similar to previous findings in the literature. Horswill and McKenna (2004) highlighted that this relationship is often non-significant due to a response bias in the driver’s search strategies (e.g., scanning road visual field) and decision-making thresholds at which they classify an event or object as a hazard. That there was also no relationship between reported risky driving engagement and hazard perception identification might indicate that these driving behaviours are independent, though further research will need to be conducted.

**Participant feedback and perceived learning**

Participants were asked for qualitative feedback on new areas of learning, whether their understanding of hazard perception for driving and driving related hazards had
changed, and which sources they access for further information on these topics. Overall three key areas of learning were identified by participants, including increased knowledge of new hazards, increased awareness of hazards, and increased awareness of driving laws and rules. A majority of participants also indicated that after the training session their understanding of driving hazard perception and driving related hazards had changed. Finally, participants identified three key sources from which they would seek further information, including online information, driving schools, and government sources.

Overall, this indicated that participants viewed the session as generally effective in the primary aims of increasing knowledge of hazards and hazard perception, and may indicate that the training programs were particularly effective in targeting hazard awareness and knowledge of new hazard types. Due to the small sample size, responses from the sample as a whole were considered, however, future research may focus on feedback from each training condition separately to identify whether areas of learning differed depending on training content, and adapt programs to most effectively target desired training outcomes.

Participants were also asked for feedback regarding elements of the training and simulator task that they viewed as useful and areas that needed improvement. Feedback from participants can be particularly important in identifying elements of the procedure that were perceived as effective, and could either be kept or emphasised further in future research, as well as identifying areas that hindered participants’ engagement with, and learning from, the training session. Key themes that participants identified as strengths of the current training and simulator session included its realistic nature. This realism related not only to their driving behaviour in using the simulator, but also in the scenarios presented, where participants commented on experiencing these driving situations in their everyday driving (e.g., merging traffic, pedestrians running across the
Many participants indicated that they felt the simulator session provided a good opportunity to both test and develop skills in hazard identification, perception and response. Similarly, reasons for recommending this program to other P1 drivers placed a strong focus on its informative nature, ability to test skills and ability to increase hazard awareness. This feedback indicated that for many participants the driving simulator was effective in providing realism. Feedback also highlighted that participants perceived the simulator not only as an effective gauge of driving and hazard related skills, but also a ‘risk-free’ method of further developing those skills. Feedback from participants aligned with the intended aims of the training session overall and the driving simulator assessment in particular.

By contrast, only a minority of participants reported areas for improvement, with the main areas of dislike including oversensitive simulator controls, the simulated nature of the test/driving (screen graphics), and stress from viewing numerous hazards in quick succession. Only eight participants suggested areas for improvement, with participants identifying a desire for more difficulty, increased range of scenarios and realism, and increased practice time. This feedback is useful for future studies, as it highlighted specific areas of methodological change (e.g., sensitivity of controls) that may help participants become more engaged in the training as well as suggestions for future research to expand driving simulator studies to include a wider range of hazards and perhaps also to assess differing grades of difficulties, with some participants finding the difficulty too hard and others too easy.

**Confidence in hazard perception and response**

As previous research has highlighted that driver confidence can be influenced by driver training and that inflation of confidence is not representative of actual driver skill level, and has been known to increase crash risk (e.g., Beanland et al., 2013; Horswill et al., 2017). Consequently driver reported confidence in hazard perception and response
was assessed at three time points during the intervention, prior to training, after training, and at follow-up. For reported confidence in hazard perception, there were no differences in mean rating among groups or across time points. At all three time points, participants rated themselves as moderately to very confident in identifying hazards on the road. However, hazard identification was low overall and there was no relationship found between confidence and hazard knowledge prior to training. That rated confidence in perception of hazards did not change after training or at follow-up is a positive finding, as changes in confidence was not an outcome of the training session.

Conversely, changes in reported confidence ratings for hazard response did occur across time points, but not among training groups. A significant increase in confidence rating occurred between after training and at follow-up, and between before training and at follow-up, but not between before and after training. A time lapse of 2-3 weeks occurred between prior to training/after training and at follow-up. All participants tended to rate themselves as moderately to very confident in responding to road user hazards that may occur on the road while driving. That changes did not occur among groups may indicate that this increase was not due to training. The driving simulator HPT assessment task required participants to respond to a number of hazards that if not appropriately responded to (e.g., by braking, or changing lanes) would lead to a traffic conflict. That increased confidence in hazard response did not occur after training and assessment, but at the second time point, may reflect the nature of the HPT assessment task itself, and that participants were more prepared in knowing what to expect in responding to hazards. Training and assessments that are difficult and variable, which are likely to lead to driving errors, such as in our assessment (the higher chance of traffic conflict), care needs to be taken to ensure that the confidence of young drivers is not completely undermined (Ivancic & Hesketh, 2000). That decreases in confidence were not found was encouraging for the training and assessment session.
However, that self-report confidence ratings did not reflect performance on the static measure and that ratings were generally high, has been previously reported (Beanland et al., 2013). Young inexperienced drivers tend to overestimate their driving ability and report overconfidence, especially when compared with more experienced drivers, and this has been linked to cognitive biases (e.g., optimism bias) and poor self-assessment or little insight (Beanland et al., 2013; Harré et al., 2005; Horswill et al., 2017, White et al., 2011). What also may have contributed to this finding is that confidence was only measured using one overall item for hazard perception and one overall item for hazard response. Future research could usefully include a previously validated confidence measure that contains more items (e.g., the driver confidence measure from Isler et al., 2011) to examine changes in confidence due to training rather than a global item. This was not conducted in the current study to avoid over-taxing participants with questionnaire measures. Finally, not all participants were assessed at all three time points. Attrition ($n=9, 17.3\%$) from time 2 (after training and assessment) to 3 (at follow up), did occur. It may be that those who chose not to return might have different ratings in confidence compared with participants who had measures taken at all three time points.

**Limitations and future research directions**

This research is primarily exploratory and had key weakness and limitations. First, the sample size was quite small and was not representative of the young driver provisional licence population, thereby limiting generalizability of findings. This sample size also restricted the ability to appropriately examine proposed correlates using more advanced statistical analyses, such as linear regression or structural equation modelling (Tabachnick & Fidell, 2013). While the total sample size for overall qualitative feedback was appropriate to draw out and report themes of the training session, the sample size was insufficient to separate this by the different training
conditions (no training, pamphlet, passive, and active). Such small group sizes would not achieve a point of saturation, particularly in relation to a qualitative approach like grounded theory methodology, which requires that all of the properties and the dimensions are saturated (Mason, 2010). Therefore, future research that implements this research methodology would require a larger sample size to confirm and expand upon the current findings.

Second, the measures used to examine potential correlates with hazard perception knowledge and ratings of driver confidence in hazard perception and response relied on self-report. These measures have been previously highlighted to be vulnerable to self-serving and social desirability biases, and may also share residual variance with other self-report measures (Schwebel, Severson, Ball, & Rizzo, 2006). While participant anonymity was maintained and participants were informed that there were no consequences for honest responses that may be indicative of risky or poor driving behaviours that might be illegal, participant responses and feedback may have been influenced by these biases. However, research that has examined the validity and reliability of self-report measures as indicators of driving behaviours for this population has found initial support for use of these measures for the purposes of research intervention and evaluation (Taubman – Ben-Ari, Eherenfreund – Hager, & Prato, 2016).

Third, participants indicated that the hazard perception simulator assessment was realistic and allowed them to test and develop their hazard perception and reactions, without the risk of harming others. Safely exposing participants to high risk driving scenarios that may lead to potential traffic conflicts is a primary strength of this training and assessment methodology. However, this involved a driving simulator, and while is appropriate use for small groups, it may not be time and cost effective to implement across large sample sizes (Filtness et al., 2013). There are also some disadvantages to
using driving simulators. Confounding or interacting variables (such as driver behaviour) that occur in the real world are not fully understood, and cannot be fully recreated in simulators. Traffic conflicts in a simulator may also have an unknown psychological impact on participants. Additionally high-end simulators such as the one used in our study, required considerable software and scenario development and piloting before implementation. Finally, how much driver training that is learned in a simulated environment is transferred and applied to a driver’s real world driving behaviour and skill is not known (Caird & Horrey, 2011; Filtness et al., 2013).

Feedback was sought primarily after training and assessment using the driving simulator so that participants could provide responses while the training and assessment was still recent and memorable. However, this also resulted in drivers not having the opportunity to reflect and possibly use or apply the knowledge and training in practice before completing the evaluation form.

Also, as the researcher administered and collected data from the participants, responses may contain more positives due to demand characteristics and impression management (specifically, for the sample perhaps wanting to be viewed as a good student or driver). Having the evaluation questionnaire as optional, ensuring anonymity and requesting honest feedback while highlighting no penalty were methods employed to help reduce the bias in responding. Nonetheless, it is suggested that future research evaluate and obtain feedback at multiple time points and without the researcher present to examine whether feedback differs, though this needs to be appropriately balanced to not overtax and frustrate participants with a battery of assessment and measures to complete.

Conclusion

Evaluating driver interventions is important for examining if learning objectives and training outcomes have been met, as this helps to establish overall training
effectiveness and validity (Sidani, 2015). Evaluating the training session from the perspective of the target sample is essential, regardless of training outcomes. If recipients do not perceive the training to be effective in their learning, helpful or applicable to their driving experience, they may not apply the provided training knowledge or skills to their everyday driving behaviours (Beanland et al., 2013; Sidani, 2015). For driver training to be successful in changing novice drivers’ behaviour, factors that may influence the outcome measures need to be identified and explored. Findings from this study add to the growing literature on hazard perception and hazard perception driver training. Training should always be designed for specific driver populations, especially for novice drivers in different stages of licensing. What participants in the training and assessment sessions responded well to, what can be improved in the session, and what was found to be related to their hazard perception identification, can help to improve the current training session and other driver training interventions that seek to increase novice driver hazard perception, and ultimately enhance the safety of young novice drivers.
CHAPTER 10

General Discussion

Review of research aims

Young novice drivers aged 17-25 years are a population at increased and disproportionate risk of road crash and road deaths. As such, there is a need for further research as to why this is the case and in developing methods to reduce this risk, both of which have been key focuses throughout the thesis. Past research has highlighted young novice drivers’ poor hazard perception skills, lower perceived risk and subsequent higher engagement in risky driving behaviours (e.g., the fatal five) as areas that need continued research. This thesis aimed to expand upon past research and contribute to the literature by addressing three key aims.

The first aim of the thesis was to model and examine three prominent psychological theories personality, social–cognitive, and social learning, to propose a new conceptual framework that explores how young novice drivers perceive driving risk, and whether they choose to engage, or not engage, in risky driving behaviours. Model testing was conducted using three theoretical frameworks to help aid in understanding young novice driver cognitions and behaviour. Chosen were: i) reinforcement sensitivity theory (RST), ii) protection motivation theory (PMT), and iii) the prototype willingness model (PWM), described in chapters 3, 4, and 5. In Chapter 6, these models were further examined to identify those variables that best predicted young driver reported engagement in risky driving, controlling for demographic factors, variables from the models, and perceived risk. From the results, a new psychosocial–cognitive conceptual model to describe young driver engagement in risky driving behaviours, such as the fatal five, was proposed. Theoretical models and subsequent indicators that provide insight into young drivers’ decision making are needed to assist
in evaluating interventions designed to improve driver safety (Fernandes et al., 2010; Shope, 2006; Shope & Bingham, 2008; Vingilis, 2016). The scales developed and conceptual models proposed in this study may assist in identifying such key indicators, using constructs that can be used to evaluate campaigns to address young driver cognitions as a component of safer driving.

The second aim of the thesis was to examine whether a developed and piloted brief hazard perception training session could improve Provisional 1 licence holders’ (aged 17-25 years) overall hazard perception knowledge, identification, response, and handling of road user related driving hazards using a driving simulator. Studies 5-7 examined the preliminary effectiveness of training methods that sought to improve young driver hazard perception using educational, passive, and active training methods. These methods incorporated a range of behavioural change techniques while elements of a process and product evaluation were used to help evaluate the training components and measures of static and simulator hazard perception tests (HPTs). Development of the training methods and hazard perception outcome measures were explored in Chapter 7. The implementation and effect of training for hazard perception are reported in Chapter 8. Study 6 assessed whether a brief hazard perception training session was sufficient to improve road user hazard perception performance using a developed HPT. Study 6 also sought to examine whether training conditions differed in hazard perception performance compared with the no-training condition, and between training conditions. Also examined was whether any training group differences persisted at 2-3-week follow-up. By investigating these questions, study 6 contributed to the research literature by providing further information about hazard perception, which was measured by hazard knowledge, identification, response, and handling, within this young novice driver sample. The results may also provide preliminary effectiveness data for the impact of three novel brief training sessions on hazard perception.
The third aim of the thesis was to evaluate whether the brief hazard perception training session’s key objectives were met. We used qualitative participant feedback who had completed the training session and were able to identify the factors that emerged from the new conceptual model were associated with hazard perception performance. Therefore, in Chapter 9, the final study evaluated the training session using feedback from participating drivers, and explored initial associations between PMT and PWM for perceived risk, reported risky driving engagement, and hazard perception. First, feedback from participants who engaged in the training session provided important information on their learning, perceived effectiveness of the training session, where improvement was needed, and how their reported confidence in their perception and response to hazards that may appear on the road had changed. We also wanted to know whether participants found the training session helpful, informative, and applicable to real life, and whether they would recommend the training to other P1 drivers. Examining these questions to aid in evaluating the training session is important as it has implications for participant attrition rates. Also, the perceived effectiveness of the training may influence a driver’s ability to internalise knowledge and apply it beyond the training setting (Beanland et al., 2013; Lonero, 2008; Mayhew et al., 1998; Sidani, 2015).

Second, in examining what is related to these three prominent young driver crash risk contributors, the thesis expanded the current literature, addressed a research gap, and possibly enables future research and training programs to take into account influencing relationships (e.g., behavioural willingness and risky driving engagement). The current chapter will describe specific findings relating to each of the aims detailed above, and further discuss key findings, potential implications, applications, and areas for further research.
Contributions to knowledge and theory

Factors associated with risky driving behaviours and their implications.

Chapters 3, 4, and 5, described three studies conducted to help identify which factors from prominent personality, social–cognitive, and social learning theories, and a number of driver demographics were significantly associated with novice driver perceptions of risk and decision making models for engagement in risky driving behaviours. In particular, theoretical frameworks of RST, PMT, and PWM were used to help design and test different models. Variables from these models were then examined to explore which variables best predicted young driver reported engagement in risky driving when controlling for demographic factors and perceived risk. From the results, a new conceptual model to describe young driver engagement in risky driving behaviours, such as the fatal five, was proposed for this young (17-25 years) and inexperienced driver demographic, see Figure 10.1.

For both key dependant variables of perceived risk and reported risky driving engagement, Table 10.1 lists the factors that were found to have a significant association and the relationship (positive or negative) and strength (weak, moderate, strong) found. Factors with moderate to strong relationships found are in bold. Perceived risk was also frequently found to be a mediator between many factors and reported risky driving behaviour, for some completely mediating the relationship (e.g. PMT perceived vulnerability, severity and self-efficacy). As perceived risk has been frequently found to have a moderate negative relationship with reported risky driving (e.g. Harbeck & Glendon, 2013; Harbeck et al., 2017; Machin & Sankey, 2008; Rhodes & Pivik, 2011), further research on whether this construct can be strengthened with young drivers and testing the mediating effects in research that includes a longitudinal design is an avenue for future research to explore.
Figure 10.1. Conceptual framework examined in the thesis to explore significant factors that influenced novice driver decision making and skills when driving (studies 1-3).

Note: * indicates significant unique variance at the final step in the model reported in Chapter 6 study 4.
Table 10.1

Factors explored in conceptual model and the relationships found with perceived risk and reported risky driving engagement.

<table>
<thead>
<tr>
<th>Perceived risk</th>
<th>Risky driving engagement</th>
</tr>
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<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
</tr>
<tr>
<td>Driver age (vw -)</td>
<td>Driver age (vw +)</td>
</tr>
<tr>
<td>Driver sex (male; vw +)</td>
<td>Driver sex (male; vw -)</td>
</tr>
<tr>
<td>P1 Licence (no; vw +)</td>
<td>P1 Licence (no; vw -)</td>
</tr>
<tr>
<td>-</td>
<td>Driving frequency (vw +)</td>
</tr>
<tr>
<td><strong>RST</strong></td>
<td></td>
</tr>
<tr>
<td>Reward sensitivity (vw -)</td>
<td>Reward sensitivity (w +)</td>
</tr>
<tr>
<td>-</td>
<td>Punishment sensitivity (indirect effects only)</td>
</tr>
<tr>
<td><strong>PMT</strong></td>
<td></td>
</tr>
<tr>
<td>Perceived severity (s +)</td>
<td>Perceived severity (mediated by perceived risk)</td>
</tr>
<tr>
<td>Perceived vulnerability (s +)</td>
<td>Perceived vulnerability (mediated by perceived risk)</td>
</tr>
<tr>
<td>Response efficacy (w -)</td>
<td>Response efficacy (w -)</td>
</tr>
<tr>
<td>Reward (vw -)</td>
<td>Reward (w +)</td>
</tr>
<tr>
<td>Self-efficacy (w -)</td>
<td>Self-efficacy (mediated by perceived risk)</td>
</tr>
<tr>
<td><strong>PWM</strong></td>
<td></td>
</tr>
<tr>
<td>Risky driver prototype</td>
<td>Risky driver prototype favourability</td>
</tr>
<tr>
<td>favourability (w -)</td>
<td>(w +)</td>
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</table>
Young novice driver cognitions and behaviour

<table>
<thead>
<tr>
<th>Risky driver prototype similarity</th>
<th>Risky driver prototype similarity</th>
</tr>
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<tbody>
<tr>
<td>(w -)</td>
<td>(m +)</td>
</tr>
<tr>
<td>Behavioural willingness (m -)</td>
<td>Behavioural willingness (m +)</td>
</tr>
</tbody>
</table>

Note: vw= very weak in strength, w = weak in strength, m = moderate in strength, s = strong in strength
(-) = negative relationship, (+) = positive relationship.

In examining the strength of the relationship between factors and dependant variables, demographic variables of driver sex, licence type, age and driving frequency and RST personality factors of sensitivity to reward and punishment, all shared very weak or negligible relationships. The weak relationships indicate that while these factors do contribute, future young driver safety research and initiatives may want to focus on other psychosocial-cognitive factors such as PMT and PWM, which have moderate or strong relationships. This is encouraging as many demographic and personality related variables are enduring or unable to be changed and therefore focusing on what can be more positively influenced in this driver demographic is important for future research.

When all factors from the three models were examined together in a hierarchal regression analysis (Chapter 6), in addition to demographic variables and perceived risk, constructs from RST, PMT, and PWM significantly contributed to substantial explained variance in reported risky driving. The practical implications of using such indicators such as those identified in Chapter 6, highlighted in Figure 10.1 (e.g., perceived vulnerability, response costs, risky driver prototype similarity, behavioural willingness, and perceived risk) provide constructs for future driver training and interventions to target and evaluate.

Results also indicated that similar to previously reported literature that examined older drivers, deterrence due to likelihood of punishment or negative consequences
Young novice driver cognitions and behaviour 276

(e.g., injury, loss of life, fines) may not significantly reduce some young drivers’ engagement in risky driving, even though this remains the primary approach used in Australia (Scott-Parker et al., 2012b; Scott-Parker, Watson et al., 2013). Within the thesis, studies expanded on the effects of driver sex, age, licence type, and experience (length of licence and driving frequency). Results indicated that these variables need to be considered when examining young driver perceived risk and risky driving engagement. However, other factors in the tested models, such as reward sensitivity, coping appraisal, threat appraisal, driver prototypes, behavioural willingness, and perceived risk, had stronger associations with reported engagement in risky driving. Therefore, rather than focusing on factors that are difficult or unable to be changed in a novice driver (e.g., age, sex, personality, cognitive biases), research exploring whether these factors are amendable to change in novice drivers may be a significant next step in supporting road safety initiatives. Furthermore, while all young novice drivers are at higher risk of accident and injury on the road, when compared with older, more experienced drivers, not all young drivers are risky drivers.

As highlighted in Vingilis’s (2016) review of evaluations in road safety, studies have shown that using previously established models and frameworks, theory driven evaluation may improve the interpretation of outcomes, and enhance attribution of road safety initiatives, preventive strategies, and counter measures (e.g., deterrence theory in Meirambayeva et al., 2014). Results from the thesis models (e.g., Chapter 4, PMT; Chapter 5, PWM) indicated preliminary evidence for why some novice drivers may choose not to engage in risky driving, supporting previous literature (e.g., Cathcart & Glendon, 2016, Cestac et al., 2011; Harbeck & Glendon, 2013; Machin & Sankey, 2008; Pearson & Hamilton, 2014; Rhodes & Pivik, 2011; Scott-Parker et al., 2013; Ulleberg & Rundmo, 2003). Reported results may also help road safety initiatives and driver training in targeting maladaptive decision making of young novice drivers.
Effectiveness outcomes for the brief hazard perception training session. In chapters 7 and 8, development and implementation of a brief hazard perception training session were discussed. The training session and methods of training built upon previous research using similar methods (e.g., Crundall et al., 2010; Horswill et al., 2013; Hutton et al., 2002; Isler et al., 2009; Lenné et al., 2011) and numerous behavioural change techniques recommended by Fylan and Stradling (2014). A prominent weakness in the driver training literature highlighted by Beanland et al. (2013) was methodological limitations of the studies cited in their review. Within the thesis, suggestions from Beanland et al. were integrated within the driver training studies (chapters 7, 8, and 9). Implemented was the use of good methodological practices (Sidani, 2015), such as: piloting all training methods and outcome hazard perception performance measures. Differences were found between P1, P2, and Open licence drivers to ensure the validity of measures used, and supported previous research (Isler et al., 2009; Scialfa et al., 2012). Differences between licence types found in study 5 further supported previous literature demonstrating that, when compared with more experienced drivers, differences occur in visual scanning patterns of the road for young novice drivers (e.g., Gugliotta et al., 2017; Pollatsek, Narayanaan, Pradhan, & Fisher, 2006; Scialfa et al., 2011; Underwood et al., 2013; Underwood, Crundall, & Chapman, 2011).

For the training session, participants were randomised to a training or no-training condition, with the use of a control group for comparisons, and having an inter-rater to check the reliability of performance measures blind to training condition (both static and simulator hazard perception). Potential confounding variables that may have influenced driver hazard perception performance were also examined, and the use of a covariate to appropriately adjust for group differences for analyses was applied. Exit testing and having a follow-up for the intervention was also included for evaluation and
examining the effectiveness of the training session, which has been highlighted as components often absent from road safety interventions (Beanland et al., 2013).

In study 6, the effect of hazard perception training using three novel conditions on hazard perception measured by knowledge, identification, response, and handling, using a static HPT and driving simulator HPT were compared with a control, no-training condition. Participants who received no training did not differ significantly from training session participants in hazard perception at a follow-up assessment. However, participants who received some form of training, in either the pamphlet, passive, or active training sessions, displayed a training effect such that significant improvements were found in their overall knowledge, detection, and response to a number of hazards when assessed at 2-3-week follow-up. This major finding indicated that even a brief training session that is focused on building knowledge, situational awareness, and hazard identification, could significantly improve hazard perception amongst P1 drivers. However, differences were evident between the various components of hazard perception performance (knowledge, identification, response, and handling).

Consistent with prior research (e.g., Borowsky, Oron-Gilad, & Parmet, 2009; Fisher et al., 2006; Ventsislavova et al., 2016) examining young novice drivers, participants’ knowledge and identification of hazards within the static measure was poor. Participants identified fewer than half the test hazards (50 hazards). Hazards that were most likely to be identified were vehicles in motion, while the least likely to be reported were stationary (e.g., parked) vehicles, and road-related (e.g., intersections, road changes, crests) hazards. This finding might indicate a relative lack of prior knowledge of certain on-road hazards that drivers typically experience during the early months of their P1 licensure. These results may also suggest that some hazards are more “obvious” (e.g., something moving) than others (e.g., static things), which might be an indicator of where further P1 training might usefully be directed – i.e., at things that
might happen (and how likely this is), as well as the more obvious events that are actually underway.

Additionally, for hazard identification, significant differences were found between conditions after training, with all training conditions (pamphlet, passive, active) showing significantly greater hazard identification than participants in the control condition, who did not receive training. At 2-3-week post-training follow-up assessment, passive and active training condition participants continued to demonstrate significantly greater hazard identification than did those in the control condition. However, at 2-3-week follow-up, pamphlet condition participants’ hazard identification scores no longer significantly differed from those in the no-training condition. Similar to previous research, hazard perception training possessing more interactivity was more effective than was education-based training alone (Horswill et al., 2013; McKenna et al., 2006; Shinar, 2007). Therefore, examining a single component of hazard perception may be insufficient to evaluate young driver hazard perception, as changes in hazard identification may not reflect changes in response to hazards, or how hazards are handled during driving.

These findings from the thesis add to the growing literature on hazard perception and hazard perception driver training (Borowsky, Oron-Gilad, & Parmet, 2009; Crundall et al., 2012; Fisher et al., 2006; Horswill & McKenna, 2004; Isler et al., 2009; Sagberg & Bjørnskau, 2006; Scialfa et al., 2013; Underwood et al., 2013; Ventsislavova et al., 2016; Wang et al., 2010; Wetton et al., 2010, 2011). Training should always be designed for specific driver populations, especially for novice drivers in different stages of licensing (Beanland et al., 2013). The results could also provide preliminary effectiveness data for the impact of the three novel brief training sessions on hazard perception. Overall results indicate that participants involved in training with more interactivity (e.g., watching videos to learn and model an experienced driver’s
situational awareness, receiving a structured commentary while responding to hazards using a driving simulator) out-performed participants in the no-training condition at follow-up. Having high interactivity in training supports previous literature findings (Horswill, 2016a, 2016b; Horswill et al., 2013; Isler et al., 2011; McKenna et al., 2006; Shinar, 2007; Wang et al., 2010). However, while mean differences in hazard perception performance did occur between training groups, these did not reach significance, and consequently, there was no clear superior training method for this driver demographic. Therefore, the study indicated while that some training is better than no training when examining hazard perception performance, perhaps longer training sessions might show greater differences between training methods.

**Participant feedback and areas of development for hazard perception training.** In chapters 7 and 9, using a structured survey to collect quantitative and qualitative data, feedback was collected on the brief training session. Overall three key areas of learning were identified by the P1 participants: improved knowledge of new hazards, higher attentiveness to hazards, and increased awareness of driving laws and rules. Also indicated was that after the training session, participants’ understanding of driving hazard perception and driving-related hazards had improved. This feedback provided initial support for the effectiveness of the training session and addressed primary aims of increasing knowledge of hazards and hazard perception. Feedback also indicated that the training methods and assessment used were particularly effective in targeting hazard awareness and knowledge of new hazard types. Additionally, many participants indicated that they felt the simulator session provided a good opportunity to both test and develop skills in hazard identification, perception and response. Similarly, reasons for recommending this program to other P1 drivers placed a strong focus on its informative nature, an opportunity to test skills and the potential to increase hazard awareness. Feedback from participants also highlighted that use of a driving simulator
was effective in providing realism, and that the simulator assessment session was an
effective gauge of driving and hazard-related skills but also a ‘risk-free’ method of
further developing those skills.

Evaluating the training session from the perspective of the target sample is
important, because if recipients do not perceive the training to be effective in their
learning, or do not find it applicable to their driving experience, then they may not apply
the provided training knowledge or skills to their everyday driving behaviours
(Beanland et al., 2013; Sidani, 2015). As hazard perception is a complex driving skill, to
expand upon the literature on what may influence hazard perception before any training,
correlates were explored. Specifically, having a previous traffic violation penalty,
having a higher coping appraisal and lower risky driver prototype similarity were found
to be related to hazard perception (knowledge and identification). For driver training to
be effective in altering novice drivers’ behaviour, factors that may influence the
outcome measures of hazard perception need to be identified and explored, especially
because hazard perception is assessed in most graduate licensing systems in Australia
and around the world. As research has reported that novice drivers who fail HPTs have
increased crash risk (Beanland et al., 2013; Peck, 2011; Wetton et al., 2013), continuing
research that explores what may influence novice driver hazard perception, and why
these drivers score poorly on HPTs need to be conducted.

Contributions to methods and practical implications

In conjunction with the main findings and models developed and tested, the thesis
also provided a range of methodological contributions to the young driver road safety
literature. Specifically new measures of driving-related perceived risk, PMT coping and
threat appraisal, and PWM risky driver prototypes and behavioural willingness to
engage in the fatal five driving behaviours were created and tested in a young driver
population (see chapters 4 and 5). In the studies described, using item analysis and
exploratory and confirmatory factor analysis, initial support was found for the validity and reliability of these measures. Also, the piloting, training and evaluation methodology implemented for the brief training session (chapters 7, 8, and 9) provided future research with a starting point to build upon. It is intended that these measures will be made available via publication, so as to be available for researchers to use when examining these constructs for a driving-related context.

Finally, the thesis described mixed-method studies, triangulating methodologies of cross-sectional surveys (collecting qualitative and quantitative data), quasi-experimental pilot, experimental, randomised control intervention, with a follow-up, model testing, and evaluation, centred on three specific outcomes: young driver perceived risk, risky driving engagement, and hazard perception. Mixed-method studies are a growing methodological approach relevant to public health, which includes traffic psychology and road safety, particularly concerning complex and highly context-sensitive interventions (Pluye & Hong, 2014). Examining young driver behaviour with multiple methods and statistical approaches, as described within the thesis, is important for research dissemination of empirical findings, as this can assist in translating theory into interventions. Theoretically derived cognitive, social and behavioural determinants may be effectively mapped onto behaviour change techniques (Michie, Johnston, Francis, Hardemann, & Eccles, 2008; Sidani, 2015).

Research context and further research directions

While there were many study strengths in the research outlined, particular areas for overall improvement and directions for future research are recommended. Most of these were outlined in the discussion sections of each of the studies presented in previous chapters. However, summarised here are some key limitations of the research within the thesis and suggestions for future research. For the model testing, measure development and training implementation, results need to be further validated with
larger samples. Particularly for the model testing and measures, more gender-balanced samples are required. However, as driver sex differences were not often found throughout these studies, results from more balanced sex samples might confirm current findings. Additionally, all studies used convenience sampling methods, and primarily drawn from a university population. Scott-Parker and Senserrick (2013, 2017) reported that of young driver research studies published over a 5-year period, 25% sampled from university or school populations, highlighting implications for the generalizability of findings, and comparability of results. Future research using a more general driving population may also validate current findings, and determine whether differences exist between university student drivers and non-university student drivers.

The brief single-session training design and implementation were positively evaluated by the target sample, and learning objectives and improvement in hazard perception performance as measured by hazard knowledge, identification, response and handling were found (see Chapter 7). However, such a brief session may not be comparable to longer or repeated training sessions, which may have stronger or positive results due to training. Still, it is currently unknown what method is superior for training retention and improvement in hazard perception related skills. Our results provide a direction that future research can examine. Hazard perception is a skill that appears to develop naturally over time for drivers due to more time being spent on the road increasing the likelihood of hazardous driving conditions being experienced. For newly P1 licenced drivers, who now drive unsupervised while on the road, is the time during the graduated driver licensing system where road crash risk is greatest. While the use a follow-up session for training to assess performance over a short time, and improvement was found (see Chapter 7), whether the positive influence of training is maintained over time is also not known. It is recommended that future research examine whether this target demographic of young drivers may benefit by brief training implemented as a
‘dose’ (having multiple brief training session over time) or ‘booster’ training sessions over time during the high-risk period (first year of driver-Provisional 1) as training threshold effects are also unknown. Some research has highlighted the need for continued driver training over time to maintain positive training effects and booster sessions have been recommended (Roenker, Cissell, Ball, Wadley, & Edwards, 2003).

Concluding comments

This thesis contributes to the literature by the development of a new conceptual framework of young driver behaviour, which has applied previously established and prominent theories to a young novice driver context. Key factors of these theories and driver demographics were identified to understand important decision-making influences in young novice drivers’ perceived driving-related risk, and why they may engage, or choose not to engage, in risky driving behaviours. This conceptual framework was also applied to an untested driver context, hazard perception.

One of the foremost contributors to young driver crash and injury rates is their poor hazard perception skills. This thesis also contributes to the literature by the creation and implementation of a brief hazard perception training session. This short training session showed initial support for improving hazard perception (knowledge, identification, response, and handling) in a sample of young novice drivers (P1 licence holders). As evaluation should be a key component of any training, the thesis also evaluated the brief training session using responses from training session participants to assess whether key outcomes were met and to obtain feedback for improvement.

A number of implications and directions for future research resulted from the thesis findings, including methods, models and measures used to explore factors related to novice driver perceived risk, reported risky driving engagement and hazard perception. While this thesis represents a unique contribution to the literature, young
driver safety remains a key area of importance, and further work should seek to add to and develop research efforts in both theory-oriented and road safety interventions.

Having a focus on improving driver skills and decision making to reduce their injury and death tolls on our roads are suggestions derived from the results within this thesis.

In summary the conceptual model, developed scales and the brief hazard perception training session from this thesis contributes to the growing body of potentially-seminal work that is increasing for theoretically-guided intervention development, application, and evaluation which targets young driver perceived risk, risky driving engagement and hazard perception. As a part of the decade of action on road safety (ATC, 2011), together may we reach the goal of decreasing road deaths and serious injuries by at least 30 percent by 2020 and in turn stop the over-representation of young drivers in international road injury and death tolls.
References


Bureau of Infrastructure, Transport and Regional Economics. (2012). *Road deaths Australia, 2012 Statistical Summary*. Canberra: BITRE.

Bureau of Infrastructure, Transport and Regional Economics. (2014). *Road deaths Australia, 2013 Statistical Summary*. Canberra, ACT: BITRE.
Young novice driver cognitions and behaviour


Young novice driver cognitions and behaviour


Ferguson, S. A. (2003). Other high-risk factors for young drivers—how graduated licensing does, doesn’t, or could address them. *Journal of Safety Research, 34*(1), 71–77. doi:10.1016/S0022-4375(02)00082-8


generalizability of prediction and countermeasure for risky driving: Different
factors predict different risky driving behaviors. *Journal of Safety Research*,
38(1), 59–70. doi:10.1016/j.jsr.2006.09.003

skill acquisition training and assessment, and their impact on road safety. *The
Centre for Accident Research & Road Safety—Queensland, CARRS-Q.*

scan for information that will reduce their likelihood of a crash? *Injury

simulation for engineering, medicine, and psychology.* Boca Raton, FL: CRC
Press/Taylor and Francis.


A. Baum, C. McManus, S. Newman, K. Wallston, J. Weinman, J., & R. West
(Eds.), *Cambridge handbook of psychology, health and medicine* (pp. 527–529).

French, D., West, R., Elander, J., & Wilding, J. (1993). Decision making style, driving
style and self-reported involvement in road traffic accidents. *Ergonomics, 36*,
627–644. doi:10.1080/00140139308967925

*Ergonomics, 27*(11), 1139–1155. doi:10.1080/00140138408963596


Laapotti, S., Keskinen, E., Hatakka, M., & Katila, A. (2001). Novice drivers’ accidents and violations, a failure on higher or lower hierarchical levels of driving behaviour. *Accident Analysis & Prevention, 33*, 759–769. doi:10.1016/S0001-4575(00)00090-7


Traffic Psychology and Behaviour, 14(6), 447–455.
doi:10.1016/j.trf.2011.08.001


Pradhan, A. K., Pollatsek, A., Knodler, M., & Fisher, D. L. (2009). Can younger drivers be trained to scan for information that will reduce their risk in roadway traffic
scenarios that are hard to identify as hazardous? *Ergonomics*, 52(6), 657–673.
doi:10.1080/00140130802550232

doi:10.1146/annurev-psych-010814-015258


Scott-Parker, B. J., Bates, L., Watson, B. C., King, M. J., & Hyde, M. K. (2011). The impact of changes to the graduated driver licensing program in Queensland,
Young novice driver cognitions and behaviour 309


Young novice driver cognitions and behaviour 310


Appendix A

Ethical clearance to conduct research for studies 1-3

GRIFFITH UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE

20-Dec-2013

Dear Miss Harbeck,

I write further to the additional information provided in relation to the conditional approval granted to your application for ethical clearance for your project "NR: Personality and cognitions affecting behaviours of driver demographics: The development of a young driver risky driving behaviour engagement model." (GU Ref No: PSY/E5/13/HREC).

This is to confirm receipt of the remaining required information, assurances or amendments to this protocol.

Consequently, I reconfirm my earlier advice that you are authorised to immediately commence this research on this basis.

The standard conditions of approval attached to our previous correspondence about this protocol continue to apply.

Regards

Dr Kristie Westerlaken
Policy Officer
Office for Research
Bray Centre, Nathan Campus
Griffith University
ph: +61 (07) 373 58043
fax: +61 (07) 373 57994
email: k.westerlaken@griffith.edu.au

Cc:

Researchers are reminded that the Griffith University Code for the Responsible Conduct of Research provides guidance to researchers in areas such as conflict of interest, authorship, storage of data, & the training of research students. You can find further information, resources and a link to the University's Code by visiting http://policies.griffith.edu.au/pdf/Code%20for%20the%20Responsible%20Conduct%20Research.pdf

PRIVILEGED, PRIVATE AND CONFIDENTIAL
Appendix B

Participant information sheet for online survey

Chief Investigators:
A/Pro Ian Glendon email: i.glendon@griffith.edu.au
Dr. Trevor Hine email: t.hine@griffith.edu.au

Student researcher:
Emma Harbeck email: emma.harbeck@griffithuni.edu.au
School of Applied Psychology, Griffith University, Gold Coast Campus

Why is this research being conducted? This research evaluates factors influencing risk perceptions on driving behaviours that young novice drivers may engage in. This research is a partial requirement for a PhD, supervised by A/Pro Ian Glendon and Dr Trevor Hine, which the researcher is currently undertaking.

Who can participate? Young drivers aged between 17-25 years. Participants will be required to hold an Australian driver’s licence (P1, P2 or Open) and drive a car regularly (not a moped, motorbike, truck, bus, van etc.).

What are you being asked to do? Complete an online survey which contains questions about your perceived risk, driving engagement, personality and cognitions around driving behaviours. You will also be asked general demographic questions such as age, gender and driving experience. The survey will take approx. 30 minutes to complete.

Risks to you: There are no anticipated risks in this research.

Benefit: The research may contribute to the understanding of young adults’ risk perception of driving behaviours. Students enrolled in eligible first year psychology courses may receive 30 minutes of course credit for their participation. All participants can enter a draw for a chance to win 1 of 3 $50 gift vouchers (Coles Myer or JB HI FI). Upon completion of the questionnaire should you wish to view a summary of the results of this study, please email the researcher: emma.harbeck@griffithuni.edu.au.
**Your confidentiality:** The survey is completely anonymous. You do not record your name or any other identifying information in the questionnaire. In order to gain course credit or enter the prize draw, you will be asked to enter your name, student number, and contact details in a second questionnaire. These details cannot be connected to your responses on the main questionnaire. These personal details will be destroyed as soon as course credit is allocated and the prize is drawn at the end of the survey period. No persons other than the researchers involved will have access to the data. All data will be stored on a password-protected university computer. No individual information will be reported. Findings will be conveyed as group data in the PhD thesis or when published in scientific journals.

**Your participation is voluntary:**

Participation in this research is voluntary. You may withdraw at any time by exiting the online survey. However, after the survey is submitted there is no way of withdrawing that survey due to the anonymity of all surveys.

**Questions / further information**

Should you have any questions or require any further information about the project, you can contact Emma Harbeck or any member of the research team.

**The ethical conduct of this research**

Griffith University conducts research in accordance with the *National Statement on Ethical Conduct in Human Research*. If potential participants have any concerns or complaints about the ethical conduct of the research project they should contact the Senior Manager, Research Ethics and Integrity on 3735 5585 or research-ethics@griffith.edu.au.

**Expressing consent.** If, after reading this information and having any questions answered to your satisfaction, you agree to participate in this study please complete and submit the questionnaire. Completion of the questionnaire will be taken as your informed consent to participate in this research.

The researchers and Griffith University acknowledges and thank you for your participation in this research project.

**By clicking "Next" you are consenting to participate in the research project.**
Young novice driver cognitions and behaviour 320
Appendix C

Ethical clearance to conduct research for studies 4-6

GRIFFITH UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE

23-Jul-2014

Dear Miss Harbeck

I write further to the additional information provided in relation to the conditional approval granted to your application for ethical clearance for your project "NR: An evaluation of brief novice driver hazard perception training" (GU Ref No: PSY/38/14/HREC).

This is to confirm receipt of the remaining required information, assurances or amendments to this protocol.

Consequently, I reconfirm my earlier advice that you are authorised to immediately commence this research on this basis.

The standard conditions of approval attached to our previous correspondence about this protocol continue to apply.

Regards

Dr Kristie Westerlaken
Policy Officer
Office for Research
Bray Centre, Nathan Campus
Griffith University
ph: +61 (07) 373 58043
fax: +61 (07) 373 57994
e-mail: k.westerlaken@griffith.edu.au

Cc:

Researchers are reminded that the Griffith University Code for the Responsible Conduct of Research provides guidance to researchers in areas such as conflict of interest, authorship, storage of data, & the training of research students. You can find further information, resources and a link to the University's Code by visiting http://policies.griffith.edu.au/pdf/Code%20for%20the%20Responsible%20Conduct%20of%20Research.pdf

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Appendix D

Research participation information Sheet-Pilot Study 5

Project Title: An evaluation of brief novice driver hazard perception training

Research team

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Trevor Hine</td>
<td>Senior Lecturer</td>
<td><a href="mailto:t.hine@griffith.edu.au">t.hine@griffith.edu.au</a></td>
</tr>
<tr>
<td>A/Pro Ian Glendon</td>
<td>School of Applied Psychology</td>
<td><a href="mailto:i.glendon@griffith.edu.au">i.glendon@griffith.edu.au</a></td>
</tr>
<tr>
<td>School of Applied Psychology</td>
<td>Mount Gravatt Campus</td>
<td></td>
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<tr>
<td>Telephone: +61 7 3735 3357</td>
<td>Gold Coast Campus</td>
<td>Telephone: +61 7 567 88964</td>
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<tr>
<td>Dr Chris Irwin</td>
<td>School of Allied Health Sciences</td>
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</tr>
<tr>
<td>Emma Harbeck PhD Candidate</td>
<td>School of Applied Psychology</td>
<td><a href="mailto:e.harbeck@griffith.edu.au">e.harbeck@griffith.edu.au</a></td>
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<tr>
<td>Gold Coast Campus</td>
<td>Gold Coast Campus</td>
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<tr>
<td>Telephone: +61 7 567 87344</td>
<td>Gold Coast Campus</td>
<td>Telephone: +61 7 567 88119</td>
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</tbody>
</table>

Goal of the study
A driver’s ability to anticipate, judge and respond appropriately to potentially dangerous traffic situations is considered a crucial aspect of driver competence and an important skill that has been found to be associated with crash risk. Additional practice of good hazard perception is associated with better driving performance. The current study examines whether additional hazard perception training can be beneficial in helping young novice drivers to improve their detection and response to potential hazards on the road.

Participation
To be a participant in this study you must have a current Provisional 2 (green P plate) or Open licence.

If eligibility requirements are met, as a participant, you will be asked to:

1. Complete a hazard perception training task.
2. Operate/drive a vehicle in an immersive simulated environment (driving simulator). In the simulation there will be several trials of common on road situations – e.g. turning at T-junctions and traffic light intersections, travelling on both single and dual lane roads, merging with traffic. Simulated situations should be treated as you would normally drive when driving on the road.
3. Complete an online questionnaire that asks questions about your driving perceptions and behaviours.

4. Return after 2 weeks to complete the second component of the hazard perception training task.

Your participation is entirely voluntary and you may withdraw from participation in this research, or any element of it, at any time without penalty or explanation. You are not required to participate in every task or answer every question unless you choose to do so.

Benefits of this research
This research will help to improve the understanding of factors which may influence young drivers’ hazard detection and response while driving a vehicle. The study will also evaluate whether additional hazard perception training for young drivers can improve detection and appropriate response in road traffic scenarios. These results may aid in generating strategic road safety interventions for younger drivers.

Benefits to you
Students enrolled in eligible first year psychology courses (e.g., 1002PSY Introductory Individual and Social Psychology or 1003PSY Research Methods and Statistics 1) at Griffith University may receive an hour of course credit for their participation for each session (max of 2 hours). All participants have the option to enter a prize draw for a chance to win 1 of 8 $50 gift vouchers (Coles Myer or JB HI FI). Upon completion of the research, should you wish to view a summary of the results of this study, please email the researcher: e.harbeck@griffith.edu.au

Risks to you
The risk to you when participating in this study is considered to be low. However, some individuals may experience simulator sickness from the immersive simulated environment. If you know from a past encounter that you may experience simulator or motion sickness in general, please consider this impact upon your health before participating. If sickness occurs while simulation is running, the experimenter will cease the experiment immediately upon notification.

Confidentiality
All data will be completely confidential; no-one will have access to information about you or any other participant. All data will be kept in locked filing cabinets at Griffith University. Only the listed researchers will have access to this data. Findings will be conveyed as group data in the PhD thesis or when published in scientific journals.

Ethical Conduct of this Research
Griffith University conducts research in accordance with the National Statement on Ethical Conduct in Research Involving Humans. If you have any concerns or complaints about the ethical conduct of this research please contact the Manager, Research Ethics on 07 3875 5585 or research-ethics@griffith.edu.au.
Privacy Statement
The conduct of this research involves the collection, access and/or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used to for other research purposes. However, your anonymity will at all times be safeguarded. For further information consult the University’s Privacy Plan at www.gu.edu.au/ua/aa.vc.pp or telephone 07 3875 5585.

Should you choose to participate in this study please complete the accompanying Consent Form.
Appendix E

Research participation information Sheet-Study 7-8

**Project Title:** An evaluation of brief novice driver hazard perception training session

**Research team**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>School of Applied Psychology</th>
<th>Mount Gravatt Campus</th>
<th>Telephone</th>
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<tbody>
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<td>Gold Coast Campus</td>
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**Goal of the study**

A driver’s ability to anticipate, judge and respond appropriately to potentially dangerous traffic situations is considered a crucial aspect of driver competence and an important skill that has been found to be associated with crash risk. Additional practice of good hazard perception is associated with better driving performance. The current study examines whether additional hazard perception training can be beneficial in helping young novice drivers to improve their detection and response to potential hazards on the road.

**Participation**

To be a participant in this study you must be aged between 17-25 years and have a current Provisional 1 (Red P plate).

If eligibility requirements are met, as a participant, you will be asked to:

5. Complete a hazard perception training task.
6. Operate/drive a vehicle in an immersive simulated environment (driving simulator). In the simulation there will be several trials of common on road situations – e.g. traffic light intersections, travelling on dual lane roads, interactions with on road traffic and pedestrians. Simulated situations should be treated as you would normally drive when driving on the road.
7. Complete a questionnaire that asks questions about your driving perceptions, behaviours and experience with the driving simulator.

8. Return after approximately 2 weeks to complete the second component of the hazard perception training task.

Your participation is entirely voluntary and you may withdraw from participation in this research, or any element of it, at any time without penalty or explanation. You are not required to participate in every task or answer every question unless you choose to do so.

**Benefits of this research**
This research will help to improve the understanding of factors which may influence young drivers’ hazard detection and response while driving a vehicle. The study will also evaluate whether additional hazard perception training for young drivers can improve detection and appropriate response in road traffic scenarios. These results may aid in generating strategic road safety interventions for younger drivers.

**Benefits to you**
Students enrolled in eligible first year psychology courses (e.g., 1002PSY Introductory Individual and Social Psychology or 1003PSY Research Methods and Statistics 1) at Griffith University may receive an hour of course credit for their participation for each session (max of 2 hours). All participants have the option to enter a prize draw for a chance to win 1 of 8 $50 gift vouchers (Coles Myer or JB HI FI). Upon completion of the research, should you wish to view a summary of the results of this study, please email the researcher: e.harbeck@griffith.edu.au

**Risks to you**
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**Confidentiality**
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Privacy Statement
The conduct of this research involves the collection, access and/or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used to for other research purposes. However, your anonymity will at all times be safeguarded. For further information consult the University’s Privacy Plan at www.gu.edu.au/ua/aa.vc.pp or telephone 07 3875 5585.

Should you choose to participate in this study please complete the accompanying Consent Form.
Appendix F

Research participation example consent form studies 5-7

Research team

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Mount Gravatt Campus
Telephone: +61 7 3735 3357
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A/Pro Ian Glendon
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Dr Chris Irwin
School of Allied Health Sciences
Gold Coast Campus
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Email: c.irwin@griffith.edu.au

Emma Harbeck PhD Candidate
School of Applied Psychology
Gold Coast Campus
Telephone: +61 7 567 88119
Email: e.harbeck@griffith.edu.au

Project title: An evaluation of brief novice driver hazard perception training

By signing below, I confirm that I have read and understood the information provided to me and in particular have noted that:

- I understand that my involvement in this research will include operating a simulated vehicle in an immersive environment involving several different driving scenarios, and responding to several short questionnaires concerning my perceptions and driving behaviour.
- I understand that my verbal responses during simulator will be recorded for quality and experience purposes and that I have the right to request that this not be recorded for data collection purposes.
- I understand the risks involved.
- I understand that if I feel the effects of simulator sickness I can cease the simulation immediately, however this requires alerting the experimenter.
- I understand that my participation in this research is voluntary.
- I understand that there will be no direct benefit to me from my participation in this research.
- I understand that this study will not determine my own capability to drive, and so I cannot be used to determine driving fitness or lack thereof.
- I understand that while the simulator provides a consequence free environment in regards to driving behaviours, this is not transferable to real life driving. As such I am aware that I cannot operate my own vehicle in the same manner that I may have operated in the simulator vehicle.
• I understand that the results of all individual testing are confidential and these
  will not be communicated to others without my express written consent.
• I understand that if I have any additional questions I can contact the research
  team.
• I understand that I am free to withdraw at any time, without comment or penalty.
• I understand that all information concerning me will be maintained in a locked
  filing cabinet at Griffith University. This information will have been
  deidentified, so that identity remains confidential.
• I understand that I can contact the Manager of Research Ethics, at Griffith
  University Human Research Ethics Committee on 07 3875 5585 (or
  researchethics@griffith.edu.au) if I have any concerns about the ethical conduct
  of the project.
• I can confirm that I am a driver aged 17-25 years, who is currently on a
  Provisional 1 (Red P plate) and that I will not be undertaking my compulsory
  Hazard perception Test to transition to Provisional 2 (Green P plates) in the next
  6 weeks.
• I have had any questions answered to my satisfaction and I agree to participate
  in the project.

**Pre-experiment**

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**Post-experiment**

• I understand that I have left the driving simulator environment.
• I understand that while the simulator provides a consequence free environment
  in regards to driving behaviours, this is not transferable to real life driving. As
  such I am aware that I cannot operate my own vehicle in the same manner that I
  may have operated in the simulator vehicle.

<table>
<thead>
<tr>
<th>Time 1</th>
<th>Time 2</th>
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</thead>
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<td>Name: __________</td>
<td>Name: __________</td>
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<tr>
<td>Signature: _____</td>
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</table>
What is a hazard perception action plan?

Through situational awareness, scanning and hazard perception, drivers can apply these steps:

1. Pedestrian crossing the road
   Detect (See) road hazards (e.g., pedestrian waiting to cross the road ahead).
   Predict (Think) what could happen (e.g., pedestrian might walk in front of your car).
   Consider (Plan) possible solutions (e.g., be prepared to slow down, change lanes, or increase space between your car and other road user, sound horn).
   Respond (Do) to remain safe (e.g., slow down, give another road user more space).

2. Parked car merging into traffic
   Detect (See) road hazards (e.g., parked car ahead has right indicator light on, signalling that the driver wants to enter the lane you are currently in).
   Predict (Think) what might happen (e.g., car could not see you while pulling out into your lane or car could wait until you pass).
   Consider (Plan) possible solutions (e.g., slow down, change lanes, sound horn).
   Respond (Do) to remain safe (e.g., slow down and give the car opportunity to merge into lane).

3. Approaching traffic light intersections
   Detect (See) road hazards (e.g., you are approaching traffic light intersection, the lights are green).
   Predict (Think) what might happen (e.g., the light colour can change amber-slow down, red-stop, another car could be in the intersection, another driver is running a red light).
   Consider (Plan) possible solutions (e.g., slow down, change lanes, sound horn).
   Respond (Do) to remain safe (e.g., always follow traffic light signals, always check side to side, even when the light is green for you in case another driver is running a red light).

Quick Quiz!

1) Good hazard perception requires:
   a) Scanning ahead
   b) An awesome car
   c) Recognising potential traffic conflicts
   d) a and c
   e) All of the above

2) Which of these are considered potential hazards?
   a) Other vehicles on the road
   b) Road users such as pedestrians and motorcyclists
   c) Curves in the road or changing road surfaces
   d) Road works
   e) All of the above

3) Which of the following is not one of the four processes involved in hazard perception?
   a) Accurately detecting the hazard
   b) Implementing decision making
   c) Turning your hazard perception to signal other drivers you have seen a hazard
   d) Assessing the magnitude of the threat
   e) Selecting appropriate actions to avert the hazard

4) What are the steps in the hazard perception action plan?
   a) Detect, Predict, Consider, Respond
   b) Detect, Predict, Consider, Turn off car
   c) Detect, Prevent, Control, Respond
   d) Detect, Respond, Predict, Consider
   e) None of the above

5) You notice there is an object on the road ahead of you, what is your response?
   a) Pretend it doesn’t exist and turn up your radio
   b) Get ready to drive over the object by speeding up
   c) Slow down to give yourself time and space to identify the object ahead
   d) Scan surrounding road to plan safe way to avoid object ahead
   e) c and d
Foreword
The first few months of driving under a Provisional 1 (red P plate) license is when crash risk is highest for novice drivers. However, the level of risk significantly decreases during this time. Research has suggested that this may be due to important driving skills being improved, especially the perception of hazards.

Common crashes for inexperienced drivers include: head-on crashes, rear-end crashes, turning right in the face of oncoming traffic, having a vehicle coming from the right hitting your car, accidentally running off the road on a curve or straight section of a road, and colliding with an object – such as another road user (including pedestrians), and parked vehicles, or foliage (e.g., trees).

These common crash types led researchers and policy makers to propose that inexperienced drivers may have difficulties identifying and responding to various potential traffic hazards. Enabling a driver's ability to anticipate, judge, and respond appropriately to potentially dangerous traffic situations (e.g., merging traffic, poor weather, changing road surfaces etc.) is crucial to developing driver competence, and reducing crash risk.

What is hazard perception?
Good (safe) drivers know how to recognise and respond to hazards. It is important to know how to spot them in time to take actions that will avoid accidents as hazards rarely come one at a time when driving. Accurate and rapid perception of road hazards, which may otherwise result in a traffic conflict, is a vital component of safe driving. Hazards require drivers to potentially change speed and/or direction.

The two unique components of hazard perception are: 1) the degree of perceived danger or crash risk associated with a traffic conflict, and 2) the drivers perception and reaction time (identification and an appropriate response) to the hazard. The four processes involved in hazard perception are:

1. Accurately detecting the hazard
2. Assessing the magnitude of the threat
3. Selecting appropriate actions to avert the hazard
4. Implementing decided actions.

What is a hazard?
A road hazard is any potential danger that might be associated with a traffic accident. Examples include:

- vehicles on the road (e.g., vehicles stopping ahead of you)
- vehicles at intersections, including traffic lights (e.g., other drivers running red lights)
- travelling through roundabouts
- drivers not using their indicators
- vehicles merging or changing lanes
- other traffic when you are turning
- not being aware of motorcyclists or cyclists near you
- sharing the road with trucks, buses and emergency vehicles
- crashes and breakdowns involving other vehicles and/or road users
- travelling through road works and in congested traffic
- pedestrians near buses or trams, crossing the road or stepping out from behind parked cars
- children playing on or near the road edge
- animals, objects (e.g., debris, rubbish) on or near the road
- curvy roads and changing road surfaces
- slippery road shoulders, gravel surfaces or rain/fog
- driving at night (poorer vision).

Need more information?
These government websites provide excellent information, tips, and strategies for improving your hazard perception:


A handbook is available online free to download from NSW, Transport Roads and Maritime Services:


The following Queensland Transport and Main Roads website provides videos on hazard perception: