



The influence of the revised reinforcement sensitivity theory on risk perception and intentions to speed in young male and female drivers

Emily Logan, Sherrie-Anne Kaye*, Ioni Lewis

Queensland University of Technology (QUT), Centre for Accident Research and Road Safety – Queensland (CARRS-Q), Institute of Health and Biomedical Innovation (IHBI), 130 Victoria Park Road, Kelvin Grove, Queensland, 4059, Australia



ARTICLE INFO

Keywords:

Speeding
Gender
Young drivers
Risk perception
Behavioural activation system
Impulsivity

ABSTRACT

This study applied the revised-Reinforcement Sensitivity Theory (r-RST) to assess the influence of individual differences in young male and female drivers' risk perceptions and intentions to exceed the posted speed limit in a 60 km/hr zone. Relevant to the current study was the Behavioural Activation System (BAS; sensitive to reward), with a specific focus on the BAS processes: Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity, and the Fight-Flight-Freeze System (FFFS; sensitive to punishment). It was hypothesised that young male and female drivers with stronger BAS traits would report lower risk perceptions towards speeding behaviour than those with weaker BAS traits and this risk perception would predict greater intentions to exceed the posted speed limit in 60 km/hr zones. It was further hypothesised that young male and female drivers with stronger FFFS traits would report higher risk perceptions towards speeding behaviour than those with weaker FFFS traits and this risk perception would predict lower intentions to exceed the posted speed limit in 60 km/h zones. Participants were 367 young licensed Australian drivers aged between 17 and 25 years. The results of a mediation analyses showed that females with stronger Impulsivity had low perceptions of risk and higher intentions to speed than participants with weaker Impulsivity. Further, males with stronger Goal-Drive Persistence and reported higher perceptions of risk and lower intentions to speed than participants with weaker Goal-Drive Persistence. Contrary to expectations, the BAS processes of Reward Interest and Reward Reactivity, and the FFFS were not significant. The findings contribute to the theoretical understanding of how the r-RST traits, specifically Goal-Drive Persistence and Impulsivity may influence speeding behaviour as well as the understanding of the unique influence of the four underlying BAS processes.

1. Introduction

Speeding behaviour is a major contributing factor to fatal traffic crashes with around 60 speeding-related deaths occurring in Queensland, Australia each year and hundreds of other road users seriously injured as a result of this behaviour (Department of Transport and Main Roads, 2018). Low level speeding, defined as driving less than 10 km/hr over the posted speed limit, is cited as a contributing factor in half of these speed related crashes in Queensland (Department of Transport and Main Roads, 2018). Previous research has shown that in a 60 km/hr speed zone, driving 5 km/hr over the speed limit doubles the driver's chance of having a serious crash (Kloeden and McLean, 1998). Even though speeding is known to be a major contributor to road crashes, many drivers do not think their speeding is dangerous (Fleiter and Watson, 2005). One particular group of drivers at high risk of traffic crashes due to speeding are young drivers aged 17–25 years

(Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2018). Out of the 1266 crash related deaths throughout Australia in 2017, 18.7% of these deaths were young drivers, this population making up only 12.17% of the Australian population (Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2018). These statistics indicate the need for further research to help reduce the number of young drivers involved in crashes.

One factor which influences young drivers' risky driving behaviours is gender. Previous research has shown that young males engage in more speeding behaviour and are at a higher risk of being involved in a crash than females (e.g., Constantinou et al., 2011). Compared to female drivers, males report speeding in a wide range of situations and do not consider that travelling 5–10 km/hr over the posted speed limit increases their chances of being involved in a crash (Department of Transport and Main Roads, 2015). Further, a study conducted by Horvath et al. (2012) found that young male drivers who reported high

* Corresponding author.

E-mail addresses: loganel@qut.edu.au (E. Logan), s1.kaye@qut.edu.au (S.-A. Kaye), i.lewis@qut.edu.au (I. Lewis).

<https://doi.org/10.1016/j.aap.2019.105291>

Received 13 February 2019; Received in revised form 24 July 2019; Accepted 3 September 2019

Available online 10 September 2019

0001-4575/ © 2019 Elsevier Ltd. All rights reserved.

intention to speed perceived more social support to speed and had higher intentions to speed on familiar and on roads that they considered had inappropriately assigned speed zones. Collectively, these findings suggest that males are more likely to engage in speeding behaviour than females. It follows that it is important to understand more about the factors influencing the speeding behaviour of males and females and, as such, the findings for males and females are presented separately herein.

Previous research has also indicated that differences in personality may assist with explaining the differences in males' and females' engagement in speeding behaviour (Constantinou et al., 2011; Harbeck et al., 2017). For example, Constantinou et al (2011) found that young males under 25 years tended to drive in a more aggressive and riskier manner than females. Constantinou et al (2011) argued that this tendency may be due to males generally possessing stronger Impulsivity and weaker punishment sensitivity traits which, in turn, leads them to underestimate the risks and overestimate their ability. In contrast, Constantinou et al. (2011) found that females tended to be stronger in punishment sensitivity. This latter finding may in part explain why females are less likely to engage in speeding and lower crash involvement (relative to males) given that they are more highly motivated to avoid the negative consequences of speeding such as a traffic infringement or crash (Constantinou et al., 2011). The current study sought to further examine the influence that personality may have on young male and females' intentions to speed.

1.1. Revised reinforcement sensitivity theory

By applying Gray and McNaughton (2000) revised Reinforcement Sensitivity Theory (r-RST), the current study will assess the influence that personality and, in particular, differences in reward and punishment sensitivities, may have on risk perception and intentions towards speeding behaviour. The r-RST holds that personality and behaviour are brought about through the activation of underlying neurological systems: the Behavioural Activation System (BAS), the Fight-Flight-Freeze System (FFFS), and the Behavioural Inhibition System (BIS; Corr, 2008). Given that the BIS requires simultaneous activation of the BAS and the FFFS or goal conflict between these two systems, the focus of this research was on the BAS and the FFFS.¹

The BAS is sensitive to reward cues and is responsive to all appetitive stimuli (Smillie et al., 2006). The BAS is a positive feedback loop aimed at moving individuals towards the final goal and a biological reinforcer thus reducing the distance between the current state and the desired biological reinforcer (Gray and McNaughton, 2000). Further, the BAS motivates individuals to respond positively to reward cues and engage more in goal-directed behaviours in order to obtain a reward (Gray and McNaughton, 2000). Corr and Cooper (2016) proposed that the revised BAS comprises four underlying processes, including Reward Interest, Goal-Drive Persistence, Reward Reactivity, and Impulsivity. The first process, *Reward Interest*, encompasses an openness to new opportunities that could have potential rewards. For this process, individuals are activated to approach new experiences independent of the presence of an actual reward (Krupić et al., 2016). The second process is *Goal-Drive Persistence*. This process consists of the goals and sub-goals that are put in place to obtain the final reward, as well as the motivation to continue working towards the goal, especially when the reward is not immediate (Krupić et al., 2016). The third process is *Reward Reactivity*. Reward Reactivity involves the experience of reward pleasure which acts as a positive reinforcer. Individuals with stronger Reward Reactivity tend to maintain their safety through threat avoidance compared to individuals weaker on Reward Reactivity (Krupić et al., 2016). The final process is *Impulsivity*. This component can often be

detrimental to the earlier stages of BAS behaviour as it involves automatic action, although it is important in the final stages when thorough planning is not suitable and fast approach action is needed to reach the reward (Corr and Cooper, 2016). These processes are thought to be organised hierarchically with Reward Interest and Goal-Drive Persistence making up the early stages of approach and Reward Reactivity and Impulsivity making up the later stages of approach (Corr and Cooper, 2016). Due to the different roles each process plays, they are sometimes in opposition such that Goal-Drive Persistence involves thinking through sub-goals that will lead to attaining a reward whereas Impulsivity involves simply acting immediately without thinking through a plan. (Corr and Cooper, 2016).

In the r-RST, the FFFS is sensitive to punishment cues and mediates reactions to all aversive stimuli, both conditioned and unconditioned; the conditioned stimulus is stimulus that was once neutral but has become associated with a certain response and the unconditioned stimulus is a stimulus that automatically triggers a response (Corr, 2008; Smillie et al., 2006). The FFFS is a negative feedback loop which aims to resolve inconsistencies between a threat and the desired goal and is responsible for the escape response of fear (Corr, 2008). Further, the FFFS is associated with fear-proneness and avoidance aspects of personality (Gray and McNaughton, 2000).

1.2. RST and risky driving behaviour

The majority of previous research has relied upon the original Gray (1970) conceptualisation of the RST. In the original RST, the BIS was activated by conditioned aversive stimuli. In the revised RST, the BIS is now only activated when conflict occurs between the BAS and FFFS (or within either system) and the FFFS is now proposed to be activated by all aversive stimuli. The BAS remains relatively unchanged from the original RST and is still sensitive to reward. Previous research which has utilised Gray (1970) original RST has provided support for the notion that individuals with stronger BAS traits are more likely to engage in traffic violations, for example driving under the influence of alcohol and using a mobile phone whilst driving, compared to drivers who report being weaker in BAS traits (e.g., Constantinou et al., 2011). An additional study by Castellà and Pérez (2004) using the original RST, found that drivers who were more sensitive to punishment and less sensitive to reward reported lower levels of speeding; while those drivers more sensitive to reward and less sensitive to punishment reported engaging in more speeding behaviour. Castellà and Pérez (2004) also found that being sensitive to reward was a stronger predictor of reported risky driving behaviour than sensitivity to punishment. Similar results were also found by Scott-Parker, Watson, King, and Hyde (2012) who reported strong positive associations between both reward sensitivity and sensation seeking and higher rates of engagement in risky driving behaviours. In addition, reward sensitivity and sensation seeking were found to be significantly related, but were also significant independent predictors of young drivers' risky driving behaviours, including speeding behaviour (Scott-Parker et al., 2012). Collectively, these results highlight that drivers who report higher sensitivity to reward are also likely to report higher rates of engagement in risky driving behaviours compared to those drivers who report higher levels of sensitivity to punishment. The results from these previous studies also support the notion that the RST personality traits play a role in influencing risky driving behaviours.

1.3. Risk perception and risky driving behaviour

Risk perception, defined as ones' judgement about the severity of risk when driving (Deery, 1999), has also been shown to be associated with risky driving behaviours (e.g., Harbeck and Glendon, 2013; Machin and Sankey, 2008). For example, Harbeck and Glendon (2013) reported a significant negative relationship between risk perception and young drivers' self-reported engagement in risky driving behaviours

¹ Interested readers should refer to Gary and McNaughton (2000) for a more detailed overview of the BIS.

(i.e., higher levels of perceived risk were associated with lower self-report ratings of engagement in unsafe driving behaviours). Similarly, Machin and Sankey (2008) reported a significant negative relationship between aversion to risk taking and self-report speeding behaviour in a sample of young Australian drivers. Rhodes and Pivik (2011) also found that risk perception was an independent predictor of risky driving behaviour in a sample of US drivers aged between 16–20 years and between 25–45 years. Taken together, this research highlights the importance of considering risk perceptions when assessing young drivers' engagement in risky driving behaviours.

1.4. RST, risk perception, and risky driving behaviour

Previous research has applied the original RST to predict risk perception and risky driving behaviour (Harbeck and Glendon, 2013; Harbeck et al., 2017). Harbeck and Glendon (2013) examined whether the original RST and perceived risk were associated with 10 different forms of risky driving, including speeding behaviour. Their sample comprised 165 young Australian drivers aged between 17–25 years. They found that the RST aspect of BAS Fun Seeking accounted for lower risk perception and higher engagement in risky driving behaviours and that individuals stronger in BAS Reward Responsiveness and BIS also reported higher risk perception (Harbeck and Glendon, 2013)². Their results also indicated that drivers who were more concerned with the legal consequences of being caught engaging in risky driving behaviours had higher risk perceptions and were stronger in BIS³ (Harbeck and Glendon, 2013). The results also suggested that drivers who reported more frequent engagement in risky driving behaviours were stronger in BAS and, in particular, stronger on Reward Responsiveness and Fun Seeking (Harbeck and Glendon, 2013).

A more recent study by Harbeck et al. (2017) explored the role of the original RST and perceived risk on engagement in risky driving behaviours and found that reward sensitivity (BAS) accounted for higher reported engagement in risky driving behaviours as well as low risk perception of the danger of engaging in risky driving behaviour. Further, the authors found no significant effect between punishment sensitivity and engagement in risky driving and risk perception (Harbeck et al., 2017). These results indicate that the original BIS has no significant influence over a driver's risk perception and engagement in risky driving behaviour compared to the BAS, which has a significant and direct impact on producing lower risk perceptions and higher engagement in risky driving.

Given that previous research has applied the original RST to examine risk perception and risky driving behaviours, there is a need to evaluate the r-RST and its influence on risky driving to establish the role the adjusted systems may have on risky driving behaviour. Previous research in the road safety context has focused on assessing the BAS trait in its entirety (e.g., Scott-Parker et al., 2012) or assessed Carver and White (1994) Reward Responsiveness, Drive, and Fun Seeking; underlying processes which were conceptualised based on the original BAS (e.g., Harbeck and Glendon, 2013). As highlighted above, Harbeck and Glendon (2013) found that Carver and White (1994) three BAS processes had different effects on perceived risk and self-reported engagement in risky driving behaviours. Specifically, Reward Responsiveness was shown to have both a direct effect on engagement in risky driving behaviours as well as an indirect effect on engagement via perceived risk of risky driving behaviours. Fun Seeking was only shown to have an indirect effect in engagement in risky driving behaviours through perceived risk. In contrast, Drive was not a predictor of perceived risk or risky driving behaviours. Overall, these findings

² Reward Responsiveness is similar to Corr and Cooper's (2016) Reward Reactivity subscale and Fun Seeking is similar to Corr and Cooper's (2016) Impulsivity subscale.

³ The original BIS is similar in nature to the revised FFFS.

demonstrate that Carver and White (1994) three BAS processes had different effects on perceived risk and engagement in risky driving behaviours.

To date, no published research has assessed Corr and Cooper (2016) revised underlying BAS factors of Reward Interest, Goal-Drive Persistence, Reward Reactivity, or Impulsivity on speeding behaviour. Given that young drivers are more susceptible to speeding behaviour compared to older adults (Fleiter et al., 2006), it is important that research continue to investigate factors which may influence engagement in speeding. Therefore, the current study assessed the unique impact that the BAS processes of Reward Interest, Goal-Drive Persistence, Reward Reactivity, Impulsivity and FFFS have on risk perception and intentions to engage in speeding behaviour.

Previous research has found that self-reported intentions to speed are an accurate predictor of future speed behaviour (Haglund and Åberg, 2000). One study conducted by Haglund and Åberg (2000) found a strong positive relationship between a driver's self-reported speed intentions and their observed speed. This finding is further supported by Ajzen (1991) Theory of Planned Behaviour which suggests that intentions are the most proximal determinant of behaviour and, as such, intentions may be considered an appropriate proxy measure of speeding behaviour.

1.5. The current research

This research extends upon previous work by Harbeck and colleagues (2013, 2017) and examines the impact that the revised BAS and FFFS traits have on young male and female drivers' risk perceptions and intentions to exceed the posted speed limit in a 60 km/hr zone. A 60 km/hr speed zone was used because of the high rates of crashes and the risk associated with even small increases in speeds in these areas (Department of Transport and Main Roads, 2018; Kloeden and McLean, 1998). To further understand the unique impact of the four BAS processes of Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity, the current research investigated the role of the separate BAS processes rather than the BAS as a whole. Given that previous research has shown that the original BAS traits had direct and indirect (via perceived risk) effects on self-reported engagement in risky driving behaviours (e.g., Harbeck and Glendon, 2013; Harbeck et al., 2017), the current study conducted mediation analyses to examine the effects of the revised BAS and FFFS traits on risk perceptions and intentions to speed. This research offers an important contribution to the literature and addresses a gap in knowledge regarding factors that may influence young males and females drivers' speeding intentions. The aim of the current study was to examine the impact that the BAS and FFFS traits have on young male and female drivers' risk perceptions and intentions to exceed the posted speed limit in a 60 km/hr zone. The following hypotheses were proposed:

Hypothesis 1. It was predicted that young male and female drivers with stronger BAS traits (i.e., Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity) would report lower risk perceptions towards speeding behaviour than those with weaker BAS traits and this risk perception would predict greater intentions to exceed the posted speed limit in 60 km/hr zones.

Hypothesis 2. It was predicted that young male and female drivers with stronger FFFS traits would report higher risk perceptions towards speeding behaviour than those with weaker FFFS traits and this risk perception would predict lower intentions to exceed the posted speed limit in 60 km/hr zones.

Hypothesis 3. It was predicted that males would have stronger BAS traits and would report lower risk perceptions and greater intentions to speed than females. In turn, it was predicted that females would have stronger FFFS traits and would report higher risk perceptions and lower intentions to speed than males.

2. Method

2.1. Participants

Participants were 367 Australian drivers (159 females) aged between 17 and 25 years ($M = 19.40$, $SD = 2.30$). Of those participants, 274 reported holding a Provisional driver licence and the remaining 93 participants reported holding an open/unrestricted driver licence. In Australia, there is a graded licencing system, with drivers receiving a provisional drivers' licence upon passing a driving test. Young drivers are eligible for an open/unrestricted driver licence after holding a provisional licence for two years (Queensland Government, 2019). Individuals were ineligible to participate in the research if they were over 25 years and did not hold a current provisional or open Australian driver licence. Individuals holding a learners permit were excluded from this study given that driving while on a learner's permit involves a different driving experience given all driving occurs in the presence of a supervising driver (Bates et al., 2009). Participants reported driving for an average of 9.70 h ($SD = 8.10$) per week.

2.2. Measures and materials

Participants completed an online survey which included demographics, the Reinforcement Sensitivity Theory-Personality Questionnaire (RST-PQ), past engagement in speeding, risk perceptions towards speeding behaviour and speeding intentions. Initially, participants were asked to define what they considered speeding by indicating on a scale what they regard as speeding in a 60 km/hr zone. Participants were also asked to indicate the speed that they would be willing to drive at whilst still feeling in full control in a 60 km/hr zone. These items were kept as separate items for analysis to provide some indication of what level of speeding someone defines as 'speeding'. Previous research has shown that males and females differ on their respective definitions of speeding (Lewis et al., 2012).

2.2.1. Past engagement

Three items were used to measure past behaviour; the first item asked "In the past 12 months: 'How often did you engage in speeding behaviour on urban roads (60 km/hr zones)?" which was measured using a 5-point Likert scale ranging from 'Never' to 'Very Often'. The next two questions asked participants about their history of having received speeding infringements (i.e., 'Have you ever received a speeding ticket?', 'If yes, have you received a speeding ticket in the last 12 months?').

2.2.2. Revised reinforcement sensitivity theory

Corr and Cooper's (2016) Reinforcement Sensitivity Theory – Personality Questionnaire (RST-PQ) was used to assess BAS/FFFS traits. The RST-PQ is a 74-item scale using a 4-point Likert scale ranging from 'Not at all' to 'Highly'. The RST-PQ measures FFFS (10 items, e.g., 'I would be frozen to the spot by the sight of a snake or spider'); BIS (23 items, e.g., 'I am often preoccupied with unpleasant thoughts'); Defensive Fight (8 items, e.g., 'I usually react immediately if I am criticized at work') and includes four BAS subscales, Reward Interest (7 items, e.g., 'I regularly try new activities just to see if I enjoy them'); Goal-Drive Persistence (7 items, e.g., 'I put in a big effort to accomplish important goals in my life'); Reward Reactivity (10 items, e.g., 'Sometimes even little things in life can give me great pleasure'); and Impulsivity (8 items, e.g., 'I think I should stop and think more instead of jumping into things too quickly'). Higher scores on these measures reflected higher BAS, FFFS, and BIS traits. All subscales in the current sample were internally reliable with all alpha levels above $\alpha = .70$ (FFFS $\alpha = .85$; BIS $\alpha = .92$; DF $\alpha = .81$; Reward Interest $\alpha = .79$; Goal-Drive Persistence $\alpha = .84$; Reward Reactivity $\alpha = .78$; Impulsivity $\alpha = .73$)⁴. As the BIS scales were not relevant to the current study, only FFFS and BAS subscales

were used in the analyses.

2.2.3. Risk perception

Participants were asked, "To what extent do you consider the following behaviour to be risky: 'Speeding on an urban road (60 km/hr zone)?" reporting their response on a 5-point Likert scale ranging from 'Not at all risky' to 'Extremely risky' (Harbeck and Glendon, 2013). Higher scores indicated higher levels of perceived risk.

2.2.4. Intention

Participant's intention to speed in the future was measured using two items, 'How likely are you to speed on an urban road (60 km/hr)?' and, 'How willing are you to speed on an urban road (60 km/hr)?', on a 6-point Likert scale ranging from 'Very Unlikely/Unwilling' to 'Very Likely/Willing' (Elliott et al., 2007). Higher scores reflected higher intentions to exceed the posted speed limit in urban areas. The intention items showed a strong positive significant relationship ($r = .793$, $p < .001$) and were thus combined to form a measure of intentions.

2.3. Procedure

The current study obtained ethical approval from the QUT University Human Research Ethics Committee (Approval Number 1800000301). Participants were recruited from the first year undergraduate students at QUT and through paid Facebook advertising as well as by word-of-mouth. Participants were offered the chance to enter a prize draw to win 1 of 7 \$20 Coles/Myer gift cards for completing the survey. Eligible first year undergraduate participants were offered the choice to enter the prize draw or receive partial course credit (i.e., credit of 0.5%). Participants accessed the survey online via KeySurvey and were provided detailed information about the study before they commenced. The information participants received included a brief description of the research and the types of questions to be asked as well as an explanation about the potential risks and they were informed about the voluntary and anonymous nature of their participation. Participants were able to complete the online survey in their own time and notified that by submitting the survey they were indicating their informed consent. Participants were also made aware that any partially completed surveys may be used in analyses. On average, participants took 30 min to complete the survey.

2.4. Design and analysis

The independent variables were the BAS subscales (Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity) and FFFS. The dependent variable was intentions to speed and the mediator variable was risk perception towards speeding. First, an independent groups *t*-test was run to determine if there was any difference in intentions to speed between males and females. Next bivariate correlations were conducted to determine the relationships between personality, risk perception, and intentions. Finally, a series of mediations were conducted to assess whether risk perception mediated the relationship between the BAS/FFFS subscales and intentions to exceed the posted speed limit in 60 km/h speed zones. The mediation analysis was conducted in SPSS using Hayes' (2013) PROCESS procedure for SPSS 2.10. A separate mediation analysis was run for each predictor variable with the mediator variable of risk perception and dependent variable of intentions to speed in a 60 km/hr zone. Further, a non-parametric bootstrapping procedure was used for each mediation. There were no covariates included in the models.

3. Results

3.1. Data cleaning and assumptions checks

All analyses were conducted using statistics software IBM SPSS

⁴ Interested readers can refer to Corr and Cooper (2016) for further information on the development and validation of the RST-PQ.

Statistics version 25. A missing data analysis was conducted with the Little's MCAR test indicating that missing data were less than 5% and that values were missing at random, $\chi^2 = 3.05$ ($df = 5$; $p = .692$). All assumptions were met and significance testing was assessed at $p < .05$.

3.2. Descriptives

In regards to defining speeding, participants reported a mean speed of 65.68 km/hr ($SD = 3.84$ km/hr) as representing speeding behaviour in a 60 km/hr zone. Participants also reported that they would be willing to drive at a mean speed of 68.43 km/hr ($SD = 7.15$ km/hr) in a 60 km/hr zone and still feel in full control. Out of the 367 participants, 104 reported receiving a speeding infringement with 50 receiving a speeding ticket in the past 12 months. These findings indicate that participants in the current sample were willing to drive over 60 km/hr and feel in full control while also not considering it speeding unless driving over 65 km/hr.

3.3. Independent groups *t*-Test

As expected, an independent groups *t*-test showed that males had significantly higher intentions to speed ($M = 3.66$, $SD = 1.41$) than females ($M = 2.97$, $SD = 1.19$), $t(341) = 4.86$, $p < .001$. As such, this finding further supports presenting the results separately for males and females⁵.

3.4. Bivariate correlations

Bivariate correlations were undertaken to assess the relationships between the four BAS processes (i.e., Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity), FFFS, risk perception and intention for males (see Table 1) and for females (see Table 2). For males, there was a significant negative correlation between Goal-Drive Persistence and Impulsivity. There was also a small significant positive correlation between FFFS and Reward Reactivity for males. In addition, there was a small significant, positive correlation between FFFS and risk perception and a small, negative correlation between FFFS and intention. These results suggest that, higher FFFS was associated with higher risk perception towards speeding and lower intentions to exceed the posted speed limit. Additionally, the relationships between Goal-Drive Persistence and risk perception and Goal-Drive Persistence and intentions were not in the expected direction, with a significant small positive correlation between Goal-Drive Persistence and risk perception and a significant small negative correlation between Goal-Drive Persistence and intentions. These findings suggest that higher Goal-Drive Persistence was associated with higher reported levels of risk perceptions towards speeding behaviour and lower intentions to engage in this behaviour. Further, the results for males showed only a small positive correlation between Impulsivity and intentions indicating that stronger Impulsivity is associated with higher intentions to exceed the speed limit in a 60 km/hr zone. Additionally, there was no significant correlation between Reward Interest and risk perception and Reward Interest and intentions for males. There were also no significant relationships found between Reward Reactivity and risk perception or between Reward Reactivity and intentions.

For females, each of the BAS processes were significantly, positively correlated. Similar to the males, females showed a small significant positive correlation between FFFS and Reward Reactivity. Further there was a significant small negative relationship between Impulsivity and risk perception and a significant small positive correlation between Impulsivity and intentions to speed. These correlations suggest that,

⁵ For completeness, the results from the mediation analyses at the whole sample level are provided in the online Supplement.

higher Impulsivity is associated with lower risk perception towards speeding and higher intentions to engage in speeding. Similar to males there was no significant correlation between Reward Interest and risk perception and Reward Interest and intentions for females. Additionally, there was no significant relationships between Reward Reactivity and risk perception or between Reward Reactivity and intentions.

3.5. Mediation

A series of mediation analyses were conducted to assess whether risk perception mediated the relationship between the r-RST systems (i.e., FFFS, Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity) and intentions to speed in a 60 km/hr zone. The indirect effects (*ab*) were checked using a re-sampling of 5000 bootstrap samples and an effect was considered significant if zero was excluded from the 95% confidence interval. The unstandardized betas are reported. The direct pathway between r-RST and intention and the indirect pathway between r-RST and intention through the mediator risk perception are shown in Fig. 1.

3.5.1. BAS: reward interest, risk perception, and intentions

The results for the mediation analysis of male and female participants are shown in Tables 3 and 4, respectively. For both males and females, Reward Interest did not significantly predict risk perception (path a) or intentions (path c). However, the results showed that risk perception had a significant negative effect on intentions (path b), indicating that higher risk perception was associated with lower intentions to speed. The bootstrap results for indirect effects were not significant.

3.5.2. BAS: goal-drive persistence, risk perception, and intentions

For Goal-Drive Persistence, the findings showed that Goal-Drive Persistence had a significant positive effect on risk perception (path a) indicating that males higher on Goal-Drive Persistence perceived higher amounts of perceived risk towards speeding behaviour. A significant negative relationship was found between risk perception and intention (path b), indicating that young male drivers reporting higher risk perceptions reported less intentions to speed. A significant negative direct effect was found between Goal-Drive Persistence and intention (path c), suggesting that males who reported stronger Goal-Drive Persistence traits also reported lower intentions to speed. However, the direct effect of Goal-Drive Persistence on intentions was not significant (path c'). The bootstrap results for indirect effects were significant, $p < .05$, suggesting that risk perception mediated the relationship between Goal-Drive Persistence and intentions.

For females, Goal-Drive Persistence did not significantly predict risk perception (path a) or intentions (path c). However, the results showed that risk perception had a significant negative effect on intentions (path b), indicating that higher risk perception was associated with lower intentions to speed in females. The bootstrap results for indirect effects were not significant.

3.5.3. BAS: reward reactivity, risk perception, and intentions

For both males and females, Reward Reactivity did not significantly predict risk perception (path a) or intentions (path c). The results showed that risk perception had a significant negative effect on intentions (path b), indicating that higher risk perception was associated with lower intentions to speed in both males and females. The bootstrap results for indirect effects were not significant.

3.5.4. BAS: impulsivity, risk perception, and intentions

For males, the results showed that Impulsivity did not significantly predict risk perception (path a). However, there was a significant negative effect of risk perception on intentions (path b) as well as significant positive effect of Impulsivity on intentions (path c) and a

Table 1
Bivariate correlations for males between r-RST traits, risk perception and intention.

	Mean	SD	1	2	3	4	5	6	7
1. BAS-Reward Interest	2.84	0.51	–						
2. BAS-Goal-Drive Persistence	3.00	0.58	.424**	–					
3. BAS-Reward Reactivity	2.67	0.47	.340**	.247**	–				
4. BAS-Impulsivity	2.44	0.56	.276**	–.183**	.398**	–			
5. FFFS	1.90	0.59	–.107	.066	.301**	.133	–		
6. Risk Perception (60 km/hr)	3.15	1.03	.094	.251**	–.002	–.029	.159*	–	
7. Intention (60 km/hr)	3.63	1.39	.069	–.210**	.079	.165*	–.210**	–.565**	–

Note. BAS = Behavioural Activation System; FFFS = Fight-Flight-Freeze System.

* $p < .05$.

** $p < .001$.

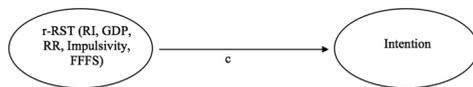
Table 2
Bivariate correlations for females between r-RST traits, risk perception and intention.

	Mean	SD	1	2	3	4	5	6	7
1. BAS-Reward Interest	2.59	0.61	–						
2. BAS-Goal-Drive Persistence	2.98	0.58	.550**	–					
3. BAS-Reward Reactivity	2.82	0.47	.525**	.436**	–				
4. BAS-Impulsivity	2.54	0.57	.504**	.142	.429**	–			
5. FFFS	2.56	0.55	–.155	.034	.164*	.004	–		
6. Risk Perception (60 km/hr)	3.60	1.01	–.092	.021	–.032	–.223**	.090	–	
7. Intention (60 km/hr)	3.01	1.15	.069	.091	.036	.236**	–.152	–.548**	–

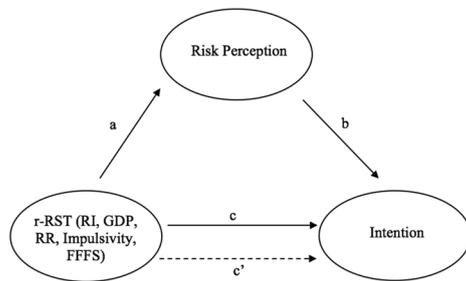
Note. BAS = Behavioural Activation System; FFFS = Fight-Flight-Freeze System.

* $p < .05$.

** $p < .001$.



a) Direct Pathway



b) Indirect Pathway

Fig. 1. Mediation model testing the (a) direct pathway between r-RST traits and intention and (b) the indirect pathway of the r-RST traits, risk perception and intention.

Note. RI = Reward Interest; GDP = Goal-Drive Persistence; RR = Reward Reactivity; RP = risk perception.

significant positive effect of Impulsivity on intentions (path c'). Examination of the bootstrapped indirect effects revealed that risk perception did not have a significant indirect effect on the relationship between Impulsivity and intentions.

For females, Impulsivity had a significant negative effect on risk perception (path a), indicating that individuals with stronger Impulsivity traits perceived lower risk towards speeding. The results also indicated a significant and strong negative effect of risk perception on intentions (path b), indicating that individuals with higher risk perceptions had lower intentions to speed. A significant positive relationship was found between Impulsivity and intentions (path c), suggesting that individuals with stronger Impulsivity traits reported greater intentions to speed. However, the direct effect of Impulsivity on

intentions was not significant (path c'). The bootstrap results for indirect effects were significant, $p < .05$, suggesting that risk perception mediated the relationship between Impulsivity and intentions.

3.5.5. FFFS, risk perception, and intentions

For males a significant positive relationship was found between FFFS and risk perception (path a), indicating that participants stronger on FFFS reported higher levels of perceived risk. A significant negative relationship was found between risk perceptions and intentions (path b), indicating that participants with higher perceived risk had lower intentions to speed. Further, FFFS had a significant negative effect on intention (path c) indicating that participants with a stronger FFFS trait reported lower intentions to speed. There was also a significant negative relationship between FFFS and intention when controlling for risk perception (path c'). However, the bootstrap results for indirect effects failed to reach significance ($p = .053$), indicating that risk perception did not mediate the relationship between FFFS and intentions to speed.

For females, the FFFS did not significantly predict risk perception (path a) or intentions (path c). The results showed that risk perception had a significant negative effect on intentions (path b), indicating that higher risk perception was associated with lower intentions to speed. The bootstrap results for indirect effects were not significant.

4. Discussion

The aim of the current study was to examine the impact that the BAS and FFFS traits have on young male and female drivers' risk perceptions and intentions to exceed the posted speed limit in a 60 km/hr zone. First, it was predicted that young male and female drivers with stronger BAS traits (i.e., Reward Interest, Goal-Drive Persistence, Reward Reactivity and Impulsivity) would report lower risk perceptions towards speeding behaviour than those with weaker BAS traits and this risk perception would predict greater intentions to exceed the posted speed limit in 60 km/hr zones. The two BAS processes that showed significant results were Goal-Drive Persistence and Impulsivity. Goal-Drive Persistence did not influence risk perception and intentions in the expected direction, rather the results showed that young male drivers

Table 3
Mediation results for males: BAS subscales, FFFS, risk perception and intention.

Path/effect	Bootstrapping				R ² Med
	β	SE	95% CI	p	
RI-risk perception-intention					
a (RI-risk perception)	0.20	0.15	-0.10, 0.49	.196	
b (risk perception-intention)	-0.78	0.08	-0.94, -0.61	< .001	
c (RI-intention)	0.19	0.21	-0.21, 0.60	.352	
c'	0.34	0.17	0.01, 0.68	.045	
ab	-0.15	0.11	-0.38, 0.07	.201	-0.01
GDP-risk perception-intention					
a (GDP-risk perception)	0.42	0.13	0.17, 0.67	.001	
b (risk perception-intention)	-0.73	0.09	-0.90, -0.56	< .001	
c (GDP-intention)	-0.50	0.17	-0.85, -0.16	.004	
c'	-0.20	0.15	-0.49, 0.10	.195	
ab	-0.31	0.10	-0.51, -0.12	.002	0.04
RR-risk perception-intention					
a (RR-risk perception)	-0.04	0.16	-0.35, 0.27	.792	
b (risk perception-intention)	-0.76	0.08	-0.92, -0.59	< .001	
c (RR-intention)	0.23	0.21	-0.19, 0.65	.281	
c'	0.20	0.18	-0.15, 0.55	.263	
ab	0.03	0.12	-0.19, 0.27	.793	0.00
Impulsivity-risk perception-intention					
a (Impulsivity-risk perception)	-0.06	0.13	-0.33, 0.20	.646	
b (risk perception-intention)	-0.74	0.08	-0.90, -0.57	< .001	
c (Impulsivity-intention)	0.40	0.18	0.05, 0.76	.025	
c'	0.36	0.15	0.06, 0.65	.018	
ab	0.05	0.10	-0.15, 0.25	.648	0.01
FFFS-risk perception-intention					
a (FFFS-risk perception)	0.27	0.13	0.00, 0.53	< .001	
b (risk perception-intention)	-0.72	0.08	-0.89, -0.56	< .001	
c (FFFS-intention)	-0.52	0.18	-0.88, -0.17	.004	
c'	-0.33	0.15	-0.63, -0.02	.035	
ab	-0.19	0.11	-0.42, 0.01	.053	0.03

Note. RI = Reward Interest; GDP = Goal-Drive Persistence; RR = Reward Reactivity; FFFS = Fight-Flight-Freeze System. R² Med = R-squared mediation effect size.

stronger in Goal-Drive Persistence reported higher risk perceptions and lower intentions to speed compared to those weaker in Goal-Drive Persistence. However, and providing some support for hypothesis 1, young female drivers with stronger Impulsivity reported lower risk perceptions and higher intentions to speed than those weaker in Impulsivity. Hypothesis 2 predicted that young male and female drivers with stronger FFFS traits would report higher risk perceptions towards speeding behaviour than those with weaker FFFS traits and this risk perception would predict lower intentions to exceed the posted speed limit in 60 km/h zones. This hypothesis was not supported with the findings showing the risk perception did not mediate the relationship between FFFS and intentions to speed for both males and females. It was further anticipated that males would have stronger BAS traits and would report lower risk perceptions and greater intentions to exceed the speed limit than females. In turn, it was predicted that females would have stronger FFFS traits and would report higher risk perceptions and lower intentions to exceed the speed limit than males. In support of hypothesis 3, males reported higher intentions to speed than females. However, the results also indicated that for females, risk perception mediated the relationship between Impulsivity and intentions to speed.

Table 4
Mediation results for females: BAS subscales, FFFS, risk perception and intention.

Path/effect	Bootstrapping				R ² Med
	β	SE	95% CI	p	
RI-risk perception-intention					
a (RI-risk perception)	-0.15	0.14	-0.42, 0.12	.267	
b (risk perception-intention)	-0.65	0.08	-0.80, -0.49	< .001	
c (RI-intention)	0.14	0.16	-0.18, 0.45	.391	
c'	0.04	0.13	-0.23, 0.30	.774	
ab	0.10	0.09	-0.06, 0.28	.273	0.00
GDP-risk perception-intention					
a (GDP-risk perception)	0.25	0.44	-0.26, 0.31	.865	
b (risk perception-intention)	-0.64	0.08	-0.79, -0.48	< .001	
c (GDP-intention)	0.19	0.17	-0.14, 0.52	.256	
c'	0.21	0.14	-0.07, 0.48	.143	
ab	-0.02	0.09	-0.20, 0.15	.865	0.00
RR-risk perception-intention					
a (RR-risk perception)	-0.04	0.17	-0.38, 0.30	.822	
b (risk perception-intention)	-0.65	0.08	-0.80, -0.49	< .001	
c (RR-intention)	0.09	0.20	-0.31, 0.49	.656	
c'	0.06	0.17	-0.27, 0.39	.701	
ab	0.03	0.11	-0.18, 0.24	.823	0.00
Impulsivity-risk perception-intention					
a (Impulsivity-risk perception)	-0.37	0.14	-0.65, -0.02	.010	
b (risk perception-intention)	-0.62	0.08	-0.78, -0.46	< .001	
c (Impulsivity-intention)	0.50	0.17	0.17, 0.82	.003	
c'	0.26	0.14	-0.02, 0.55	.068	
ab	0.23	0.09	0.08, 0.41	.014	0.04
FFFS-risk perception-intention					
a (FFFS-risk perception)	0.16	0.14	-0.13, 0.44	.279	
b (risk perception-intention)	-0.62	0.08	-0.78, -0.47	< .001	
c (FFFS-intention)	-0.32	0.17	-0.64, 0.01	.058	
c'	-0.22	0.14	-0.49, 0.06	.121	
ab	-0.10	0.09	-0.29, 0.09	.285	0.01

Note. RI = Reward Interest; GDP = Goal-Drive Persistence; RR = Reward Reactivity; FFFS = Fight-Flight-Freeze System. R² Med = R-squared mediation effect size.

4.1. Relationship between the BAS processes, risk perception, and intentions to speed

The current findings support previous research which has found that young drivers who reported stronger Impulsivity and low response inhibition also reported higher rates of speeding and other risky driving behaviours during a simulated driving experiment (Hatfield et al., 2017). However, previous research has indicated that females are generally more highly motivated to avoid punishment compared to males who drive in a riskier manner and are more strongly motivated by rewards associated with speeding. Therefore, it was expected that Impulsivity would show a significant influence for males. This disparity in the influence of Impulsivity on male and female drivers may be explained by the way in which this personality trait influences males' and females' processing of risk. Impulsivity has been reported by Corr and Cooper (2016) as being a later approach behaviour, therefore, it could be speculated that Impulsivity could lead to higher levels of speeding when the driver perceives that they will obtain a reward immediately. It is possible that when females are stronger on Impulsivity they perceive the risks of speeding to be low and the benefits of speeding to obtain the reinforcer as outweighing any risk. These drivers may perceive the rewards associated with speeding (e.g., arriving at a destination sooner) as outweighing the slight potential of any risks of speeding, such as being fined or being involved in a crash. In comparison, male drivers who are stronger on Impulsivity may not analyse risk and instead immediately act, which would result in higher levels of speeding. This suggestion is consistent with the notion that Impulsivity influences behaviour in the later stages of reward acquisition where planning is not needed and quick action is taken to obtain the reward. One

potential motivator identified in previous research is that drivers perceive that speeding will save them time, however, research has shown that this is not the case (Fleiter et al., 2016). Therefore, in order to reduce speeding in drivers with stronger Impulsivity traits, interventions may need to take into consideration a driver's tendency to act with Impulsivity. Consequently, potential interventions may include a skills training program to help individuals with impulse control and, in particular, helping males who evidence suggests have higher levels of risk taking to take the time to consider the risks associated with speeding before immediately acting (Eensoo et al., 2018).

As this is one of the first studies to examine the independent BAS processes of the r-RST, there is no similar studies focusing on Goal-Drive Persistence and speeding behaviour with which to compare and contrast these findings. However, it could be speculated that for males with stronger Goal-Drive Persistence, not speeding to get somewhere earlier and risking having a crash may be a sub-goal which leads to sustained positive reinforcement. An individual might perceive higher risks of speeding as something that may potentially get in the way of obtaining the final reward such as being pulled over by the police or crashing. This higher risk perception may then lead to lower intentions to speed helping the driver move into the final stages of the goal acquisition phase aimed at reaching the reward. The differences seen in the way each BAS subscale influences risk perception and intention may be related to the stages as proposed by Corr and Cooper (2016). Specifically, Corr and Cooper posited that the early stage consisted of Reward Interest and Goal-Drive Persistence and the later stage included Reward Reactivity and Impulsivity. As seen with Impulsivity, moving from the early stage where individuals strong on Goal-Drive Persistence will be less likely to speed, this may change in the late stage if the individual is strong on Impulsivity, which may, in turn, increase the likelihood that they will speed. Further, due to the direction of this relationship seen in males it would be assumed that Goal-Drive Persistence would have a similar influence on females who generally report lower intentions to speed. However, this was not the case in the current sample and given the lack of research for the Goal-Drive Persistence process, more research is required to further investigate the role of this process in risky driving behaviours, such as speeding behaviour in both males and females.

Further, the results indicated that risk perception did not mediate the relationship between Reward Reactivity and intentions to speed or between Reward Interest and intentions to speed. The non-significant relationships between Reward Reactivity, Reward Interest, risk perception and intention may be explained by the role that these processes play in the goal acquisition process. As found by Krupić, Gračanin, and Corr (2016), individuals stronger in Reward Reactivity tend to avoid threat to maintain their safety, while individuals stronger in Reward Interest tend to act pro-socially. Given that BAS processes reflect safety and pro-social behaviours, this may explain these non-significant findings. Although there is no previous research focusing on the role of Reward Reactivity and Reward Interest on speeding behaviour it has been proposed that Reward Reactivity is similar to Carver and White (1994) Reward Responsiveness (Corr and Cooper, 2016). However, and inconsistent with the current findings, Harbeck and Glendon (2013) found that Reward Responsiveness had both a direct and indirect (via perceived risk) effects on self-reported engagement in risky driving behaviours (including exceeding the posted speed limit). These further highlight the differences between the original and revised RST traits and the need for further research to examine the role of the revised BAS processes on risky driving behaviours, such as speeding behaviour.

The current results provide support for previous research which has suggested that the BAS is a multidimensional system (e.g., Corr and Cooper, 2016; Dino and Philip, 2017; Krupić et al., 2016). The current results suggest that speeding behaviour may be influenced by both early and late stage BAS processes and may differ in male and female drivers. These findings indicate that a different BAS process may be responsible for influencing behaviour depending on the type of reward as well as

how far away the individual is from obtaining the final reward. This suggestion seems to be supported by the fact that late stage processes often work in opposition to the early processes (Corr and Cooper, 2016). Therefore, as there were significant results for Goal-Drive Persistence, an early stage BAS process, and Impulsivity, a late stage BAS process, the current findings may suggest that the function speeding plays in the individuals stronger on BAS may alter in different circumstances. For example, when the final reward is not immediate, the early process of Goal-Drive Persistence is influencing behaviour and this may occur because speeding may hinder the attainment of the final reward or it is not required to reach the reward, resulting in less speeding. In comparison, if the reward for speeding is immediate and planning or impulse control are not required if the driver is stronger on Impulsivity than they may be more likely to speed in order to obtain the reward, or in the case of young males, may not even engage in a risk analysis before speeding. These explanations are speculative, however, and future research should continue to examine the influence of the independent BAS processes on speeding behaviour.

4.2. Relationship between FFFS, risk perception, and intentions to speed

The current findings showed that risk perception did not mediate the relationship between FFFS and intentions to speed for both males and females. Previous research on the influence of the original BIS on risk perceptions and engagement in risky driving behaviours has been mixed (Castellà and Pérez, 2004; Harbeck and Glendon, 2013, 2017). For instance, Harbeck and Glendon (2013) found that the original BIS significantly predicted perceived risk (i.e., higher scores on the original BIS were associated with higher scores on perceived risk of risky driving behaviours). Further, Harbeck and Glendon (2013) found that the original BIS had no significant direct effects on engagement in risky driving behaviours; rather the original BIS had only an indirect on engagement in risky driving behaviours via risk perception. However, and in a later study, Harbeck and Glendon (2017) found that punishment sensitivity was not associated with perceived risk (nor reported engagement in risky driving behaviours). In contrast, Castellà and Pérez (2004) found that drivers who were higher in sensitivity to punishment were less likely to speed than those lower in punishment sensitivity, however these results were only significant in young male drivers. Collectively, these findings highlight the need to examine the role of the punishment sensitivity system on risk perceptions and intentions/engagement in risky driving behaviour. More specifically, and with the number of significant changes which have occurred between the original BIS and revised FFFS, future research should focus on assessing the role of the FFFS rather than continue to rely upon assessing the role of the BIS. Given that the FFFS is theoretically linked to the emotion of fear, while the original BIS was theoretically linked to the emotion of anxiety (Corr, 2008), the FFFS may react differently to risk perception and intentions to engage in risky driving behaviours compared to the original BIS.

4.3. Strengths and limitations

This study has a number of strengths. Firstly, the use of the well validated r-RST model allowed for an in-depth understanding of the factors influencing young drivers' perception of risk and intentions to speed. Further, the current study extended upon previous research in the area of risky driving behaviours which have relied upon assessing Gray (1970) original definition of BAS, BIS and FFS and applied the r-RST to assess speeding-related risk perceptions and intentions to speed. Thus, this research advances the theory by focusing on the revised BAS and FFFS and highlighting the unique contribution that the BAS processes may have on influencing speeding behaviour. Further, by using an online anonymous survey format this should have allowed participants to respond in regards to the illegal behaviour honestly without fear of repercussions, thus enhancing the reliability and validity of the

data by minimising potential reporting biases (Ramsey et al., 2016). However, and in order to further validate these findings based on self-report measures, future research could consider using objective measures to further assess actual speeding behaviour (e.g., in-vehicle devices).

Despite these strengths, the current study also had some limitations which need to be acknowledged. First, there were a number of factors that may influence risk perception and intentions to speed that were not controlled for. These factors included road conditions (e.g., traffic and whether), peer pressure from passengers in the vehicle, and differences that occur because of situational factors (i.e., running late). Further, the current sample comprised participants with different licence types in terms of both provisional and open licence holders. In Queensland, Australia, there are a number of restrictions for drivers who hold a provisional licence, including restrictions in relation to the use of high powered vehicles, the number of passengers, as well as night time driving (Queensland Government, 2017). We acknowledge that these and other factors not assessed in the current study could influence risk perceptions and intentions to speed. However, as with any study, it is not possible to explore all potential factors. Therefore, the decision was made to scope the current study to look at the unique influence the r-RST traits have on risk perception and intentions towards speeding. Further, regarding the theoretical framework, and as identified by Harbeck et al. (2017), by offering a potential reward to participate in the survey, the study's incentives (i.e., incentive was course credit or prize draw entry) may have attracted individuals who are more sensitive to rewards. However, the incentive was commensurate with the effort involved in participating so it is not expected that the incentive would have been an overly strong influence in attracting more individuals who are sensitive to rewards compared to those sensitive to punishment.

4.4. Implications

4.4.1. Theoretical implications

This study extended upon previous research (Harbeck and Glendon, 2013; Harbeck et al., 2017) by applying the r-RST to further understand risk perceptions towards speeding and intentions to exceed the posted speed limit in a 60 km/hr zone. The current study has provided support for previous research which has argued that the BAS is a multi-dimensional system (Dino and Philip, 2017; Krupić et al., 2016), indicating that each of the BAS processes should be assessed individually in order to gain a full understanding of the role of the underlying BAS processes. Currently, this approach is lacking in evidence to support the unique impact each BAS subscale has.

4.4.2. Practical implications

Previous research has identified the benefits of utilising the RST/r-RST models to help inform intervention and prevention strategies (Harbeck & Glendon, 2017; Kaye et al., 2013, 2018; Scott-Parker and Weston, 2017). Devising interventions in accordance with the r-RST personality traits provides a potentially important way to better target risky behaviours through targeting the underlying motivations of such behaviours. Due to the underlying and enduring nature of the r-RST traits, interventions that specifically target these processes may have particular benefits in reducing rates of speeding in young drivers. Specifically, interventions that target young drivers need to take into consideration those drivers with stronger Impulsivity traits; a subset of drivers' who have previously been shown to report greater intentions to speed (e.g., Hatfield et al., 2017). To target individuals with stronger Impulsivity traits, policy makers could introduce road safety messages which are designed to challenge the perceived rewards associated with speeding behaviour. For example, road messages could dispel the myth that speeding saves a large amount of time or could focus on increasing drivers' awareness of speed enforcement activities (i.e., you will eventually be caught and fined if you continue to speed and thus the

perceived reward is minimised/ challenged). While it is acknowledged that not everyone will be persuaded by the same road safety messages, a range of messages could be designed to target different groups of young drivers.

5. Conclusion

Young drivers are over represented in speeding related crashes which result in a high number of young drivers' deaths in Australia each year. Young males, in particular, are heightened risk of engaging in speeding and for being involved in road trauma (BITRE, 2017). The current study adds to the literature on young drivers' speeding behaviour and may be helpful in identifying the personality factors which influence speeding which may be used to help design intervention to reduce speeding and speed related crashes. The findings suggest that the r-RST factors may influence young drivers' risk perception and intentions to speed and provide important initial support for the need to assess the impact of each BAS process individually. The findings also suggest that different personality traits influence males and females in varying ways. Further, the current research contributes to the theoretical understanding of the r-RST traits and the influence they have on young drivers' speeding. This research also has important potential practical applications in terms of helping identify personality factors which can be further targeted in interventions such as advertising messages.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

A Manuscript Completion Assistance grant was awarded to the first author by CARRS-Q, QUT to assist with the write-up of this publication. We would also like to acknowledge Drs' Janine Lurie and Patricia Obst for providing statistical advice.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.aap.2019.105291>.

References

- Ajzen, I., 1991. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50 (2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T).
- Bates, L., Watson, B., King, M., 2009. Factors influencing learner driver experiences. Department of Infrastructure, Transport, Regional Development and Local Government. Retrieved from. https://eprints.qut.edu.au/19498/2/Grant_report.pdf.
- Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2018. Road Trauma Australia 2017 Statistical Summary. Retrieved from. https://bitre.gov.au/publications/ongoing/files/Road_Trauma_Australia_2017.pdf.
- Carver, C.S., White, T.L., 1994. Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. *J. Pers. Soc. Psychol.* 67 (2), 319–333. <https://doi.org/10.1037/0022-3514.67.2.319>.
- Castellà, J., Pérez, J., 2004. Sensitivity to punishment and sensitivity to reward and traffic violations. *Accid. Anal. Prev.* 36 (6), 947–952. <https://doi.org/10.1016/j.aap.2003.10.003>.
- Constantinou, E., Panayiotou, G., Konstantinou, N., Loutsiou-Ladd, A., Kapardis, A., 2011. Risky and aggressive driving in young adults: personality matters. *Accid. Anal. Prev.* 43, 1323–1331. <https://doi.org/10.1016/j.aap.2011.02.002>.
- Corr, P.J., 2008. *The Reinforcement Sensitivity Theory of Personality*. Cambridge University Press, Cambridge.
- Corr, P.J., Cooper, A.J., 2016. The reinforcement sensitivity theory of personality questionnaire (RST-PQ): development and validation. *Psychol. Assess.* 28 (11), 1427–1440. <https://doi.org/10.1037/pas0000273>.
- Deery, H.A., 1999. Hazard and risk perception among young novice drivers. *J. Safety Res.* 30 (4), 225–236. [https://doi.org/10.1016/S0022-4375\(99\)00018-3](https://doi.org/10.1016/S0022-4375(99)00018-3).
- Department of Transport and Main Roads, 2015. Report A: Speed, Alcohol, Drugs, Road User Behaviour (Report No. 151456). Retrieved from. <https://www.tmr.qld.gov.au/Safety/Road-safety/Road-safety-research-reports>.
- Department of Transport and Main Roads, 2018. Speeding – Get the Facts. Retrieved

- from. <https://jointhdrive.qld.gov.au/speeding/factsheet>.
- Dino, K., Philip, J.C., 2017. Moving forward with the BAS: towards a neurobiology of multidimensional model of approach motivation. *Psychol. Topics* 26 (1), 25–45. Retrieved from. <http://pt.ffri.hr/index.php/pt/article/view/391/209>.
- Eensoo, D., Paaver, M., Vaht, M., Loit, H., Harro, J., 2018. Risky driving and the persistent effect of a randomized intervention focusing on impulsivity: the role of the serotonin transporter promoter polymorphism. *Accid. Anal. Prev.* 113, 19–24. <https://doi.org/10.1016/j.aap.2018.01.021>.
- Elliott, M., Armitage, C., Baughan, C., 2007. Using the theory of planned behaviour to predict observed driving behaviour. *Br. J. Soc. Psychol.* 46 (1), 69–90. <https://doi.org/10.1348/014466605X90801>.
- Fleiter, J.J., Watson, B.C., 2005. The speed paradox: the misalignment between driver attitudes and speeding behaviour. In: Paper Presented at the Australasian Road Safety Research, Policing and Education Conference. Wellington, New Zealand. Retrieved from. <https://eprints.qut.edu.au/3892/>.
- Fleiter, J., Watson, B., Lennon, A., Lewis, I., 2006. Significant others, who are they? Examining normative influences on speeding. In: In Proceeding of 2006 Australasian Road Safety Research Policing and Education Conference. Gold Coast, Australia.
- Gray, J.A., 1970. The psychophysiological basis of introversion-extraversion. *Behav. Res. Ther.* 8 (3), 249–266. [https://doi.org/10.1016/0005-7967\(70\)90069-0](https://doi.org/10.1016/0005-7967(70)90069-0).
- Gray, J., McNaughton, N., 2000. *The Neuropsychology of Anxiety an Enquiry Into the Functions of the Septo-hippocampal System*, 2nd ed. Oxford University Press, Oxford.
- Haglund, M., Åberg, L., 2000. Speed choice in relation to speed limit and influences from other drivers. *Transp. Res. Part F Traffic Psychol. Behav.* 3 (1), 39–51. [https://doi.org/10.1016/S1369-8478\(00\)00014-0](https://doi.org/10.1016/S1369-8478(00)00014-0).
- Harbeck, E.L., Glendon, A.I., 2013. How reinforcement sensitivity and perceived risk influence young drivers' reported engagement in risky driving behaviours. *Accid. Anal. Prev.* 54, 73–80. <https://doi.org/10.1016/j.aap.2013.02.011>.
- Harbeck, E.L., Glendon, A.I., Hine, T.J., 2017. Reward versus punishment: reinforcement sensitivity theory, young novice drivers' perceived risk, and risky driving. *Transp. Res. Part F Traffic Psychol. Behav.* 47, 13–22. <https://doi.org/10.1016/j.trf.2017.04.001>.
- Hatfield, J., Williamson, A., Kehoe, E.J., Prabhakaran, P., 2017. An examination of the relationship between measures of impulsivity and risky simulated driving amongst young drivers. *Accid. Anal. Prev.* 103, 37–43. <https://doi.org/10.1016/j.aap.2017.03.019>.
- Horvath, C., Lewis, I., Watson, B., 2012. The beliefs which motivate young male and female drivers to speed: a comparison of low and high intenders. *Accid. Anal. Prev.* 45, 334–341. <https://doi.org/10.1016/j.aap.2011.07.023>.
- Kaye, S., White, M.J., Lewis, I.M., 2013. Individual differences in drivers' cognitive processing of road safety messages. *Accid. Anal. Prev.* 50, 272–281. <https://doi.org/10.1016/j.aap.2012.04.018>.
- Kaye, S., White, M.J., Lewis, I.M., 2018. Young females' attention toward road safety images: an ERP study of the revised reinforcement sensitivity theory. *Traffic Inj. Prev.* 19 (2), 201–206. <https://doi.org/10.1080/15389588.2017.1369531>.
- Kloeden, C., McLean, J., 1998. How traveling speed relates to the risk of crash involvement. *Inst. Transp. Eng. ITE J.* 68 (9), 16. Retrieved from. <https://gateway.library.qut.edu.au/login?url=https://search-proquest-com.ezp01.library.qut.edu.au/docview/224893091?accountid=13380>.
- Krupić, D., Gračanin, A., Corr, P.J., 2016. The evolution of the Behavioural Approach System (BAS): cooperative and competitive resource acquisition strategies. *Pers. Individ. Dif.* 94, 223–227. <https://doi.org/10.1016/j.paid.2016.01.044>.
- Lewis, I.M., Watson, B.C., White, K.M., Elliott, B., Thompson, J., Cockfield, S., 2012. How males and females define speeding and how they'd feel getting caught for it: some implications for anti-speeding message development. In: Paper Presented at the Australasian Road Safety Research, Policing and Education Conference. Wellington, New Zealand. Retrieved from. https://eprints.qut.edu.au/54601/1/Lewis_et_al_FINAL_RS2012.pdf.
- Machin, M.A., Sankey, K.S., 2008. Relationships between young drivers' personality characteristics, risk perception, and driving behaviour. *Accid. Anal. Prev.* 40, 541–547. <https://doi.org/10.1016/j.aap.2007.08.010>.
- Queensland Government, 2017. Provisional Licence Restrictions. Retrieved from. <https://www.qld.gov.au/transport/licensing/driver-licensing/applying/provisional/restrictions>.
- Queensland Government, 2019. Licence Types, Classes and Conditions. Retrieved from. <https://www.qld.gov.au/transport/licensing/driver-licensing/types>.
- Ramsey, S., Thompson, K., Mckenzie, M., Rosenbaum, A., 2016. Psychological research in the internet age: the quality of web-based data. *Comput. Hum. Behav.* 58, 354–360. <https://doi.org/10.1016/j.chb.2015.12.049>.
- Rhodes, N., Pivik, K., 2011. Age and gender differences in risky driving: the roles of positive affect and risk perception. *Accid. Anal. Prev.* 43, 923–931. <https://doi.org/10.1016/j.aap.2010.11.015>.
- Scott-Parker, B., Weston, L., 2017. Sensitivity to reward and risky driving, risky decision making, and risky health behaviour: a literature review. *Transp. Res. Part F Traffic Psychol. Behav.* 49, 93–109. <https://doi.org/10.1016/j.trf.2017.05.008>.
- Scott-Parker, B., Watson, B., King, M.J., Hyde, M.K., 2012. The influence of sensitivity to reward and punishment, propensity for sensation seeking, depression, and anxiety on the risky behaviour of novice drivers: a path model. *Br. J. Psychol.* 103 (2), 248–267. <https://doi.org/10.1111/j.2044-8295.2011.02069.x>.
- Smillie, L.D., Pickering, A.D., Jackson, C.J., 2006. The new reinforcement sensitivity theory: implications for personality measurement. *Personal. Soc. Psychol. Rev.* 10 (4), 320–335. https://doi.org/10.1207/s15327957pspr1004_3.