Continuing to drive while sleepy : the influence of sleepiness countermeasures, motivation for driving sleepy, and risk perception

Continuing to Drive While Sleepy: The Influence of Sleepiness Countermeasures, Motivation for Driving Sleepy, and Risk Perception

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Abstract

Driver sleepiness is a major contributor to road crashes. The current study sought to examine the association between perceptions of effectiveness of six sleepiness countermeasures and their relationship with self-reports of continuing to drive while sleepy among 309 drivers after controlling for the influence of age, sex, motivation for driving sleepy, and risk perception of sleepy driving. The results demonstrate that the variables of age, sex, motivation, and risk perception were significantly associated with self-reports of continuing to drive while sleepy and only one countermeasure was associated with self-reports of continuing to drive while sleepy. Further, it was found that age differences in self-reports of continuing to drive while sleepy was mediated by participants' motivation and risk perception. These findings highlight modifiable factors that could be focused on with interventions that seek to modify drivers' attitudes and behaviours of driving while sleepy.

Highlights

- Age, sex, motivation, and risk perception were related with driving sleepy
- Motivation and risk perception mediated the age effect for driving sleepy
- Motivation and risk perception could be important for behaviour change campaigns

1. Introduction

Driver sleepiness is a major contributor to road crashes. The level of contribution from sleepiness to fatal and severe crashes is estimated from case-control studies to be approximately 20% (Connor et al., 2002; Kecklund, Anund, Wahlström, & Åkerstedt, 2012). Reducing the likelihood of having a sleep-related crash can be accomplished by utilising a sleepiness countermeasure (Cummings, Koepsell, Moffat, & Rivara, 2001). A number of sleepiness countermeasures (e.g., rest and nap breaks, swapping the driving) are recommended by traffic authorities. However, some drivers prefer utilising countermeasures that enable them to continue their journey without stopping (e.g., opening the window down/turning on the air conditioner, turning on the radio). The association between the perceptions of effectiveness of sleepiness countermeasures and self-reports of continuing to drive while sleepy is unknown.

1.1 Driver Sleepiness Countermeasures

There are a number of sleepiness countermeasures used by drivers with varying levels of effectiveness. Primarily, when a sleepy driver stops driving and exits the road environment they remove themselves from the danger of a possible crash. Stopping at the roadside for a short duration is known as a rest break. Rest breaks have a short duration of effectiveness for reducing physiological and subjective sleepiness and can improve simulated driving performance such as lateral positioning (Phipps-Nelson, Redman, & Rajaratnam, 2011). However, the longer term effectiveness of rest breaks have not been demonstrated (Phipps-Nelson et al., 2011; Watling, Smith, & Horswill, 2014).

The effectiveness of a nap break, a short period of sleep of 15-20 mins is suggested as one of the most effective countermeasures to *reduce* sleep drive. Several studies have found nap breaks reduce levels of physiological and subjective sleepiness and improve simulated driving performance levels, such as lateral positioning (Horne & Reyner, 1996; Leger, Philip,

Jarriault, Metlaine, & Choudat, 2009). Swapping drivers is another commonly promoted countermeasure, where the driver and the passenger/s will alternate between driver and passenger/s. While swapping drivers are commonly promoted by traffic authorities (Department of Transport and Main Roads, 2008), the effectiveness of this countermeasure is unknown. Consuming caffeine is another important driver sleepiness countermeasure and has some measure of effectiveness by increasing *arousal*. Specifically, caffeine intake has been shown to reduce physiological and subjective sleepiness and reduce indices of lane drifting (De Valck & Cluydts, 2001; Horne & Reyner, 1996).

Drivers also employ a number of countermeasures without stopping the vehicle. These in-vehicle countermeasures include listening to music and opening the window/turning on the air conditioner. Listening to music has limited effectiveness for reducing sleepiness. Specifically, music has a small effect for reducing subjective sleepiness (Reyner & Horne, 1998; Schwarz et al., 2012); however, the reductions of physiological sleepiness and improvement of driving performance are less pronounced (Reyner & Horne, 1998). The effect from opening the window/turning on the air conditioner has a small, albeit, transient effect on subjective sleepiness; however, the effect on physiological and driving performance indices are negligible to non-existent (Reyner & Horne, 1998; Schwarz et al., 2012). Overall, in-vehicle countermeasures have limited effectiveness for reducing sleepiness.

1.2 Factors influencing driving while sleepy

An individual's motivation for continuing to drive while sleepy is potentially an important factor. Previous research suggests drivers cite factors associated with destination arrival (i.e., time pressures, close to destination) as reasons for continuing to drive while sleepy (Armstrong, Obst, Banks, & Smith, 2010; Nordbakke & Sagberg, 2007). Motivation to reach the destination has been associated with truck drivers self-reported instances of falling asleep at the wheel (McCartt, Rohrbaugh, Hammer, & Fuller, 2000). While previous research

suggests that the motivation of continuing to drive while sleepy is an important factor, the strength or degree of association with instances of continuing to drive while sleepy has not been previously examined.

Risk perceptions are suggested to be a causal factor for the performance of health behaviours (Janz & Becker, 1984) whereby the more risky a behaviour is perceived, the less likely an individual will perform that behaviour (Helweg-Larsen & Shepperd, 2001). That is, drivers who perceive sleepy driving as a risky behaviour are less likely to perform the behaviour. Yet, sleepy driving is not always perceived by drivers as a critical issue for road safety and is typically rated lower than speeding, drink driving, and distracted driving as a crash risk factor (e.g., Pennay, 2008; Vanlaar, Simpson, Mayhew, & Robertson, 2008). To date, no study has examined the influence of risk perception with continuing to drive while sleepy.

1.2.1 Dual Process Model of Decision Making

A rational decision making process should theoretically ensure that risky behaviours would rarely be performed. Recent research has shown the utility of dual process models of decision making in relation to performing risky driving behaviours (e.g., McNally & Titchener, 2012; Rhodes & Pivik, 2011). The dual process model suggests that decision making is the outcome of two different modes of information processing; the cognitive and affective processes. The cognitive process is rational, analytical, and measured with the outcome of decisions following a slow effortful and logical evaluation (Epstein, 1994; Slovic, Finucane, Peters, & MacGregor, 2004). Risk perception is considered as an analogy for the cognitive process.

In contrast, the affective process is experiential, intuitive, and represents decision making based on affect which is typically a fast process (Epstein, 1994; Slovic et al., 2004). In relation to sleepy driving, it could be argued that an antecedent of affective processes

could be the motivation to reach the intended destination – as the affective processes are suggested to be formed from experiential processes (Alhakami & Slovic, 1994; Epstein, 1994). Additionally, several studies have demonstrated that experiential and affective based motivations can influence an individual's driving behaviours (McNally & Titchener, 2012; Reyna & Farley, 2006). Therefore, motivation to drive while sleepy could be a pertinent process for continuing to drive while sleepy.

Previous research demonstrates that the demographic factors of age (being younger) and sex (being male) are associated with greater instances of sleepy driving (Anund, Kecklund, Peters, & Akerstedt, 2008; Vanlaar et al., 2008; Watling, 2014). The risk perceptions of younger drivers and males drivers for several risky driving behaviours are typically lower when compared to older drivers and female drivers respectively (Harré, Brandt, & Dawe, 2001; Hatfield & Fernandes, 2009). Consequently, research demonstrates younger drivers are more likely to drive during times of high levels of sleepiness, even when they perceive their sleepiness levels to be elevated (Smith, Carrington, & Trinder, 2005). Limited research has examined how the dual process model could contribute to driving while sleepy for these two demographic factors. As such, examining the utility of the dual process model for continuing to drive while sleepy is needed.

1.3 The Current Study

The reviewed literature suggests that a number of factors could influence self-reports of continuing to drive while sleepy. The first aim sought to examine how demographic factors, motivation, risk perception, and perceptions of the effectiveness of six sleepiness countermeasures were associated with self-reports of continuing to drive while sleepy. The second aim sought to examine if age and sex differences in self-reports of continuing to drive while sleepy was mediated by participants' motivation and risk perception.

2. Method

2.1 Participants

Potential participants were sourced from the Royal Automobile Club of Queensland (RACQ) membership database. The RACQ is a motoring club, which provides roadside assistance, insurance, and other motoring related services to members. A total of 1,000 randomly selected RACQ members were invited to participate in the study. In total, 309 completed questionnaires were returned to the researchers (30.90% response rate).

The average age of participants was 44.67 years (*SD* = 17.64). The majority of the participants were female (62.62%). Over three quarters of participants were employed (78.17%), which included daytime employment (57.39%), regular nightshift work (2.82%), and variable shift work (17.96%). The largest proportion of participants had a tertiary education (45.75%), the remaining participants reported having a secondary education (44.77%), a trade qualification (5.23%), or a primary education (4.25%).The majority of participants' personal driving occurred in urban areas predominantly during the day (88.36%), or during the night (2.05%). The remaining participants reported driving long distances, during the day and night (9.59%).

2.2 Measures

The questionnaire was developed by the researchers to examine several aspects of sleepy driving behaviours and perceptions. Demographic items include age, sex, employment, education, and personal driving routines. The outcome variable assessed how often the participants had continued to drive after noticing symptoms of sleepiness. The wording of this item was "please rate how often you have continued to drive after noticing symptoms of sleepiness". This item used a 10-point Likert scale scored 1 (never) to 10 (frequently).

The motivation to drive while sleepy was assessed with three items. These items focused on continuing to drive sleepy when “close to home”, “to get to the destination”, and “due to time factors”, with participants responding on a dichotomous scale (yes or no). The three items were summated to produce the motivation scale with a range of 0-3; higher scores indicate greater motivation to drive while sleepy. Risk perception of sleepy driving was assessed on a 10-point Likert scale scored 1 (no risk) to 10 (extremely high risk). The perceived effectiveness of the countermeasures was assessed with six items. Participants indicated the effectiveness of the six countermeasures on a 10-point Likert scale scored 1 (not effective) to 10 (very effective). The six countermeasures were: stop the vehicle, stop and nap, swap drivers, consume a caffeinated drink, open the window/turn on air conditioner, and play loud music.

2.3 Procedure

Following approval by the University Human Research Ethics Committee, a random selection of participants from the RACQ membership database was invited to take part in the research. These potential participants were mailed a consent form, a paper survey, and a reply paid envelope. Upon completing the questionnaire, the participants returned the survey and the signed consent form to the research team via the supplied reply paid envelope.

2.4 Statistical Analyses

The first aim was examined with a hierarchal liner regression analysis. To control for the influence of the demographic variables, age and sex were entered at the first step, with motivation and risk perception entered at the second step. The perceptions of effectiveness of the six sleepiness countermeasures were entered last. The second aim, the mediation models of age and sex were evaluated using the Baron and Kenny (1986) method with the modification for using multiple mediators (i.e., Preacher & Hayes, 2008). The significance of

the indirect pathways (pathways a-b) of the model was assessed with bootstrapping. The two proposed multiple mediator models can be seen in Figure 1.

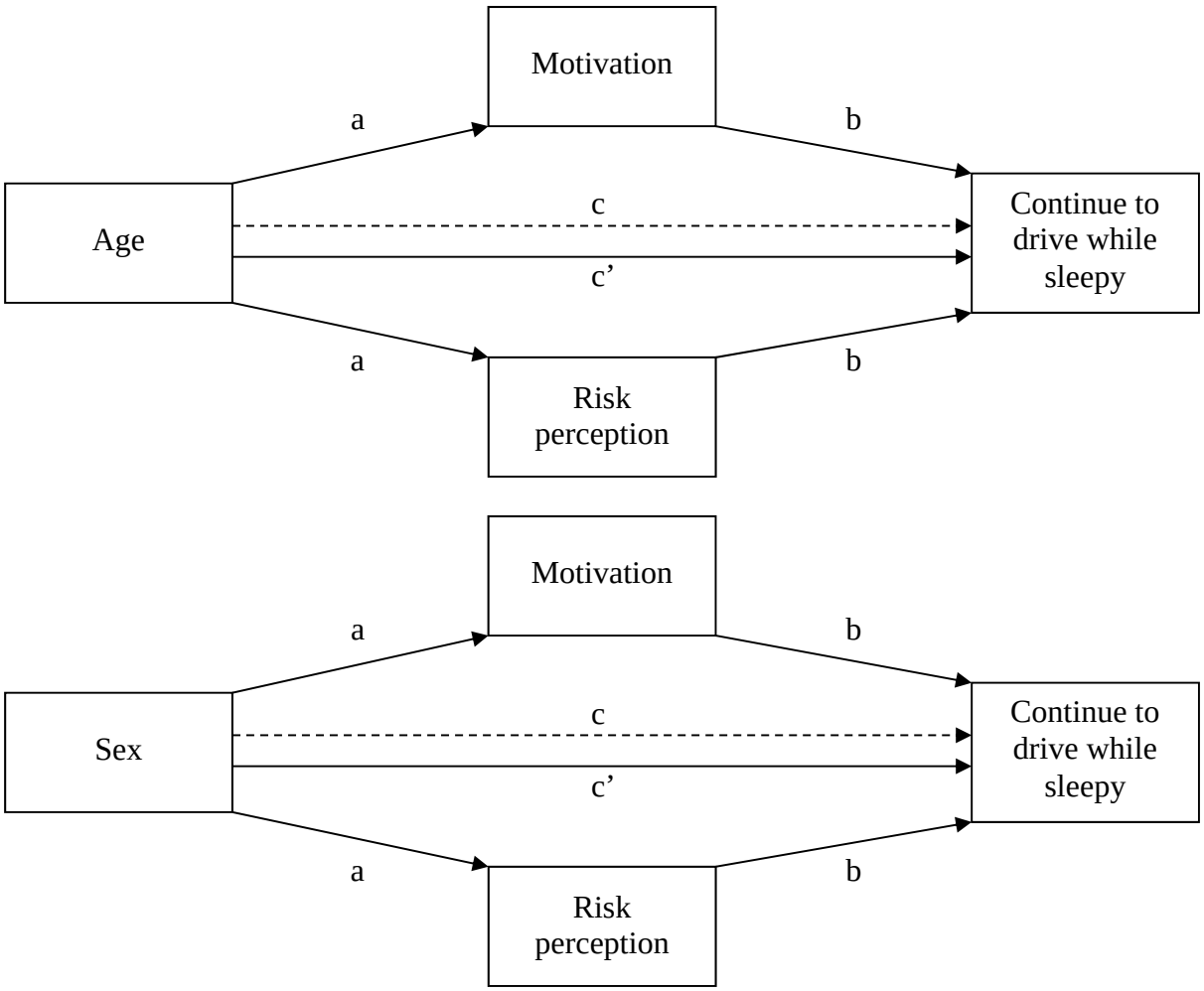

Figure 1. The two proposed multiple mediator models for age and sex.

3. Results

The means, standard deviations, and range of self-reports of continuing to drive while sleepy, motivation, risk perception, and the perceived effectiveness of the sleepy driving countermeasures can be seen in Table 1. On average participants self-reported continuing to drive while sleepy some of the time, there was also a moderate amount of variability. The motivation for sleepy driving was somewhat endorsed by the participants and sleepy driving was perceived as risky. Swapping drivers, stop and nap, and stop the vehicle were rated as

highly effective by participants. Opening the window/turning on the air conditioner was rated as the least effective countermeasure.

Table 1. Means, Standard Deviations (*SD*), and ranges of study variables

Variable	Mean	*SD*	Range
Continuing to drive while sleepy	3.72	2.25	1-10
Motivation	0.85	0.75	0-3
Risk perception	6.27	1.66	1-10
Stop vehicle	7.51	2.55	1-10
Stop and nap	8.18	2.62	1-10
Swap drivers	9.16	1.80	1-10
Caffeinated drink	5.55	2.79	1-10
Play loud music	4.30	2.74	1-10
Open the window/air conditioner	4.97	2.66	1-10

Note: Higher mean scores indicate greater endorsement of the behaviour, perception, or perceived effectiveness of the countermeasure.

3.1 Inter-relationships between study variables

A number of the study variables were significantly correlated with self-reports of continuing to drive while sleepy, as seen in Table 2. The two in-vehicle countermeasures of open the window/turn on air conditioner and play loud music were significantly correlated with self-reports of continuing to drive while sleepy. Age, sex, motivation, and risk perception were all significantly correlated with self-reports of continuing to drive while sleepy. Among the study variables, motivation and risk perception has the largest correlations with the outcome variable of self-reports of continuing to drive while sleepy. The largest correlation was observed between the in-vehicle countermeasures of open the window/turn on air conditioner and play loud music.

Table 2.

Bivariate correlations between the study variables and self-reports of self-reports of continuing to drive while sleepy.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Continuing to drive while sleepy	-										
2. Age	**-.25****	-									
3. Sex (male)[a]	**.18***	**.14***	-								
4. Motivation	**.37****	**-.21****	-.04	-							
5. Risk perception	**-.28****	**.22****	-.01	**-.14***	-						
6. Stop vehicle	-.01	**.12***	-.01	.07	**.13***	-					
7. Stop and nap	-.07	**.11***	.04	-.08	**.18***	**.11****	-				
8. Swap drivers	-.02	-.03	**.16***	-.06	.07	.09	**.36****	-			
9. Caffeinated drink	.09	**-.19***	-.10	**.13***	.01	.05	-.07	.03	-		
10. Play loud music	**.19***	**-.29****	**-.21****	**.22****	-.**15***	**.18****	-.03	.04	**.32****	-	
11. Open the window/air conditioner	**.23****	.07	-.06	**.20****	-.03	**.26****	-.10	.03	**.28****	**.42****	-

$^{**}p < .001$, $^{*}p < .05$; [a] = point bi-serial correlation

3.2 Sleepy Driving and Effectiveness of Countermeasures

A hierarchal linear regression analysis was performed to examine if the perceived effectiveness of the sleepiness countermeasures were associated with self-reports of continuing to drive while sleepy (see Table 3). The variables of age and sex were entered into the regression model at the first step. Both age (β = -.29, p < .001) and sex (being male: β =.22, p < .001) were significantly associated with self-reports of continuing to drive while sleepy. The second set of control variables, motivation, and risk perception were entered into the regression model. Age and sex variables remained significant variables, with motivation (β = .27, p < .001) and risk perception (β = -.18, p < .001) variables also significantly associated with self-reports of continuing to drive while sleepy. This second step of the hierarchal regression accounted for 24.43% of the variance, an increase of 14.25%. The third step included the addition of the perceptions of effectiveness of six sleepiness countermeasures. Age, sex, motivation, risk perception remained significant variables, with perceptions of the effectiveness of open the window/air conditioner (β = .21, p < .001) the only additional significant variable associated with self-reports of continuing to drive while sleepy. Overall, the final model accounted for 28.07% of the variance of self-reports of continuing to drive while sleepy.

Table 3.

Hierarchal regression of the study variables associated with self-reports of continuing to drive while sleepy

Variable	*B*	SE *B*	*β*	$r_{ab.c}$	$r_{a(bc)}$
Step one					
Age	**-.01****	**.01**	**-.29**	**-.29**	**-.28**
Sex (male)	**.13****	**.03**	**.22**	**.23**	**.22**
Constant	**.89****	**.07**			
Adjusted R^2 = .11; $F(2, 266) = 16.97^{**}$					
Step two					
Age	**-.01****	**.01**	**-.17**	**-.19**	**-.16**
Sex (male)	**.12****	**.03**	**.22**	**.24**	**.22**
Motivation	**.10****	**.02**	**.27**	**.29**	**.26**
Risk perception	**-.03****	**.01**	**-.18**	**-.20**	**-.17**
Constant	**.63****	**.13**			
Adjusted R^2 = .24; $F(4, 264) = 22.67^{**}$; R^2 change = .14; $F_{change}(4, 264) = 25.27^{**}$					
Step three					
Age	**-.01****	**.01**	**-.21**	**-.22**	**-.19**
Sex (male)	**.14****	**.03**	**.24**	**.27**	**.23**
Motivation	**.10****	**.02**	**.27**	**.30**	**.26**
Risk perception	**-.03****	**.01**	**-.20**	**-.22**	**-.19**
Stop vehicle	-.01	.01	-.06	-.07	-.06
Stop and nap	.01	.04	.10	.11	-.09
Swap drivers	.01	.01	.03	.04	.03
Caffeinated drink	-.01	.01	-.01	-.01	-.01
Play loud music	.01	.01	.03	.03	.03
Open the window/air conditioner	**.02***	**.01**	**.21**	**.21**	**.18**
Constant	**.60****	**.15**			
Adjusted R^2 = .28; $F(10, 246) = 10.88^{**}$; R^2 change = .05; $F_{change}(6, 246) = 3.01^{*}$					

$^{**}p < .001$, $^{*}p < .05$

3.3 Age Differences for Sleepy Driving

The first step to establish a multiple mediator model for age was to examine the relationships between age and self-reports of continuing to drive while sleepy (c path). Age was significantly associated with self-reports of continuing to drive while sleepy (β = -.25, p < .001). The second step examined the relationship between age and the mediators (a paths). Age was significantly associated with motivation (β = -.21, p < .001) and with risk perception (β = .22, p < .001). The third step was to examine the mediators relationship with self-reports of continuing to drive while sleepy (b paths). Motivation (β = .37, p < .001) and risk perception (β = -.28, p < .001) were both significantly associated with self-reports of continuing to drive while sleepy. The last step re-examined the relationship between age and self-reports of continuing to drive while sleepy, while controlling for the associations from motivation and risk perception (c' path). Age was still significantly associated with self-reports of continuing to drive while sleepy (β = -.14, p < .05), while controlling for the associations from motivation and risk perception.

The significance of the indirect pathways (pathways a-b) were evaluated with a bootstrapping procedure (Preacher & Hayes, 2008). The bootstrapping (2000 bootstrap resamples) with 95% bias corrected and accelerated confidence interval for motivation was -.002 to -.001; for risk perception was -.002 to -.001; and for the total model was -.003 to -.001 which supports the significance of the model. Therefore, age differences in self-reports of continuing to drive while sleepy were associated with age differences in motivation and risk perception, which were associated with self-reports of continuing to drive while sleepy. Overall, the age multiple mediator model accounted for 20.03% of the variance (Adjusted R^2) of self-reports of continuing to drive while sleepy, the model is shown in Figure 2.

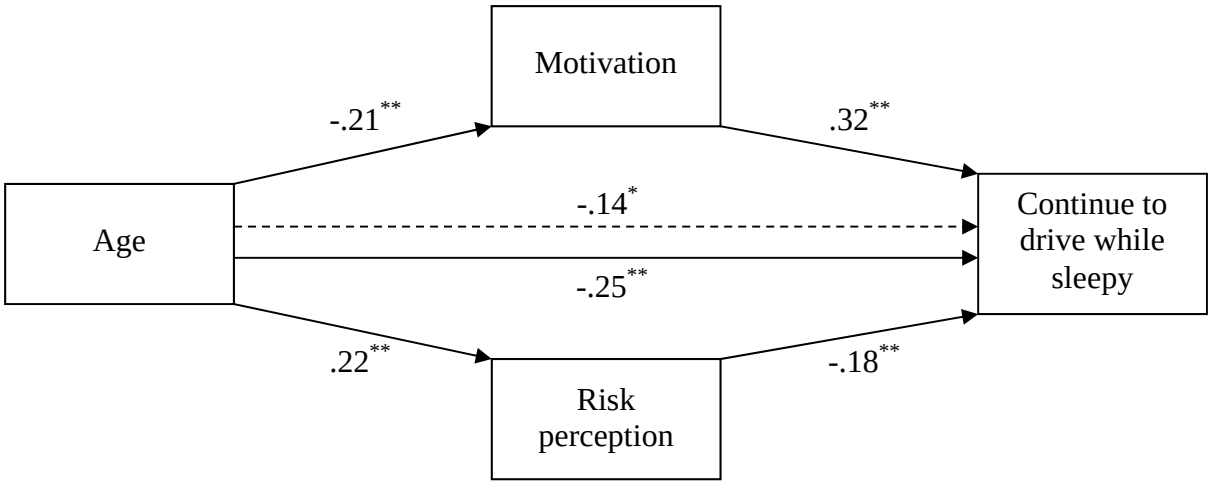

Figure 2.The multiple mediator model of the relationship between age and self-reports of continuing to drive while sleepy, mediated by motivation and risk perception. Standardised beta weights are displayed.** $p < .001$, * $p < .05$

3.4 Sex Differences for Sleepy Driving

The first step of examining a multiple mediator model for sex was to examine the relationships between sex and self-reports of continuing to drive while sleepy. Sex (being male) was significantly associated with self-reports of continuing to drive while sleepy (β = -.18, $p < .05$). The second step examined the relationship between sex and the mediators (a paths). Sex (being male) was not significantly associated with motivation (β = .06, p = .52) or with risk perception (β = .01, p = .95) and the model testing could not proceed any further.

4. Discussion

The current study sought to examine a number of factors that influence drivers' self-reports of continuing to drive while sleepy. Specifically, the first aim sought to examine the association of the perceptions of effectiveness for six sleepiness countermeasures with self-reports of continuing to drive while sleepy, after controlling for age, sex, motivation, and risk perception. The control variables of age, sex, motivation, and risk perception were significantly associated with the dependant variable of self-reports of continuing to drive while sleepy. The perceived effectiveness of opening the window/turning on the air

conditioner was the only countermeasure significantly associated with self-reports of continuing to drive while sleepy. The implications of this outcome are discussed below.

Several studies have described that opening the window and turning on the air conditioner are commonly employed sleepiness countermeasures by drivers (Anund et al., 2008; Armstrong et al., 2010; Vanlaar et al., 2008). The results of the current study further support these findings by demonstrating that opening the window/turning on the air conditioner was significantly associated with self-reports of continuing to drive while sleepy in the multivariate regression analysis. Previous research has demonstrated that turning on the air conditioning has a small, yet transient effect on subjective sleepiness, with no substantive effect on physiological sleepiness during simulated driving (Reyner & Horne, 1998) or on-road driving (Schwarz et al., 2012). Moreover, self-report data suggests that drivers do not perceive opening the window/turning on the air conditioner as a particularly effective sleepiness countermeasure (Armstrong et al., 2010). As such, the potential reasons for the relationship between opening the window/turning on the air conditioner and self-reports of continuing to drive while sleepy are uncertain. Undoubtedly, opening the window/turning on the air conditioner is an easily implemented driver sleepiness countermeasure and allows the driver to continue their journey without any delay – a notion that was supported with the positive bivariate correlation between the variables of motivation to continue driving and opening the window/air conditioner.

Perhaps the most important finding is the lack of association between the countermeasures of stopping, napping, swapping drivers, and caffeine with self-reports of continuing to drive while sleepy at either the bivariate or the multivariate level. Experimental studies have specifically shown that napping and consuming caffeine are effective for reducing sleepiness (De Valck & Cluydts, 2001; Horne & Reyner, 1996; Watling et al., 2014). In addition, survey data also suggests that drivers perceive these countermeasures to

be effective strategies to reduce sleepiness (Anund et al., 2008; Armstrong et al., 2010). Previous research demonstrates that drivers report using these effective countermeasures less so than in-vehicle countermeasures such as opening the window, air conditioning, and turning on the radio (Armstrong et al., 2010; Vanlaar et al., 2008). The disparity between awareness and use of the effective sleepiness countermeasures on the road might have contributed to the obtained results.

The lack of associations between these effective countermeasures and self-reports of continuing to drive while sleepy suggests the perceived effectiveness of stopping driving, napping, swapping drivers, and caffeine have little effect on self-reported sleepy driving behaviours. As such, attitudinal and behaviour change is sorely needed to encourage drivers to utilise the more effective countermeasures. There are a number of factors that can impede the use of roadside sleepiness countermeasures, these include issues of the road environment, such as having no place or no secure place to pull over on the roadside (Gunatillake, Daly, & Anderson, 2003) as well as attitudes that sleepy driving is acceptable (Watling, 2014). Whereas, a factor that facilitates the use of napping or caffeine to counteract driver sleepiness is having previously experienced a sleep-related crash or been involved in a sleep-related close call (Anund et al., 2008). It would be highly beneficial for road safety outcomes if drivers could utilise the more effective countermeasures, without the need of experiencing a sleep-related close call or crash. This could not only reduce the tragic human costs associated with road crashes, but also the substantial financial costs in the form of property damage, infrastructure adjustment, and the rendering of emergency services. As such, efforts focused on modifying factors that facilitate (or impede) a driver's decision to drive while sleepy could be beneficial.

The multivariate analysis revealed two variables that were significantly associated with self-reports of continuing to drive while sleepy which are potentially modifiable factors.

The first modifiable factor, risk perception of the dangerousness of driving while sleepy was found to have a negative relationship with self-reports of continuing to drive while sleepy. The importance of risk perception for the engagement of risky behaviours have been noted previously (Hatfield & Fernandes, 2009). Support for the current findings is found from previous research which has demonstrated that perceived susceptibility to having a sleep-related crash is negatively associated with sleepy driving (Fernandes, Hatfield, & Job, 2010). The second modifiable factor was motivation to continue driving, which was positively associated and had the strongest relationship of all the study variables with self-reports of continuing to drive while sleepy. The construct of time urgency has previously been found to be associated with sleepy driving (Fernandes et al., 2010) and potentially may also be related to motivation to continue driving while sleepy driving. Nonetheless, scant work has been performed examining the motivation to continue driving, particularly relating to any antecedents or related psychological constructs that could facilitate sleepy driving.

The second aim of the study sought to examine the mediation of the demographic factors of age and sex with self-reports of continuing to drive while sleepy by motivation to continue to drive and risk perception. The current data supported a mediated model of the relationship between age and self-reports of continuing to drive while sleepy. Specifically, younger drivers were more likely to continue to drive while sleepy, with this relationship mediated by stronger motivation to continue to drive sleepy and lower risk perception of sleepy driving.

The pattern of results with the age mediation model as well as the other relationships is concerning for younger drivers. At the bivariate level, age was also negatively correlated with the sleepiness countermeasure of turning on the radio, which has limited effectiveness for reducing sleepiness. Previous research suggests that younger drivers are prone to use in-vehicle countermeasures, such as opening the window and turning on the radio (Nordbakke &

Sagberg, 2007). The motives for this could be due to a need to arrive at the intended destination in a timely manner. Hatfield and Fernandes (2009) have demonstrated that getting to the destination quicker was an important factor associated with younger individuals risky driving behaviours. Likewise, individuals scoring higher on the construct of time urgency are more likely to report intentions to drive while sleepy (Fernandes et al., 2010). Age was also negatively related with risk perception of sleepy driving and this relationship is likely to augment or buffer motivation to continue to drive while sleepy or vice versa. Nonetheless, given the obtained results that two modifiable factors of risk perception and motivation were significantly associated with self-reports of continuing to drive while sleepy, it seems appropriate to target these two factors with behaviour change interventions. Previous research has demonstrated that motivation levels and risk perception can be successfully modified (Adamos, Nathanail, & Kapetanopoulou, 2013; Burke, Arkowitz, & Menchola, 2003; Rundmo & Iversen, 2004).

The age mediation model from the current data could potentially be an important framework for behaviour change interventions. Educational campaigns that focus on driver characteristics such as age and sex, typically have a number of impediments to overcome (i.e., peer norms, personality factors: sensation seeking, impulsivity) and thus their effectiveness with behaviour change can be limited (Ulleberg, 2001; Wundersitz, Hutchinson, & Woolley, 2010). Efforts to reduce the over-representation of younger drivers involved in sleep-related crashes could instead focus on the modifiable factors of motivation to continue to drive while sleepy and risk perception of sleepy driving. However, efforts to modify younger drivers' attitudes and behaviours regarding motivation to continue and risk perception will need to consider a number of factors. Specifically, younger drivers are potentially more reliant on an experiential and affective based decision making style when driving, which is likely due to their lower levels of on-road driving experience (Reyna &

Farley, 2006). Moreover, the relationship between risk perception and risk behaviour are bi-directional (Klein, 1997) and suggests that any sleepy driving an individual engages in, which does not result in a sleep-related close call or crash is likely to lower their risk perception of sleepy driving. This bi-directional notion is supported from previous research that demonstrates individuals who have experience with sleep-related incidents and/or crashes are more appreciative of the dangers of sleepy driving (Anund et al., 2008). Notwithstanding, sleepy driving interventions aimed at younger persons could provide important and potentially lasting benefits in the form of attitudinal and behavioural change.

The outcomes from this study need to be interpreted while considering the study limitations. The current data was collected via a self-report measure and recall bias could have influenced the participants' responses, such that their response might not truly reflect their actual on-road behaviours. Additionally, it is unknown whether participants had actual experience with each sleepiness countermeasure – as responses might only represent an educated guess or a vicarious experience. A cross-sectional design was employed and thus directions of causality cannot be inferred with the results. The data was collected at one point in time and as highlighted with the negative correlation between age and motivation as well as age and risk taking, it is likely that these relationships change over time. While on-road experiences with sleepiness might contribute to these changes, there are other factors that could contribute as well (e.g., peer norms, personality influences).

To account for the issues surrounding cross-sectional designs and the likelihood of changing risk perception over time, longitudinal and experimental designs are needed. The issue of generalising self-reported motivation and risk perception to actual on-road driving situations is a ubiquitous problem for risk perception research. As such, future work could begin with examine the relationships between motivation and risk perception and their effect on driving while sleepy in a driving simulator. Although, ultimately future studies are needed

to determine the relationships between motivation, risk perception, and actual on-road driving behaviours. Future studies should be aware of different driver groups (e.g., light and heavy vehicle drivers, shift workers, long distance drivers) which could possibly have different on-road behaviours, risk perceptions, and motivations to continue to drive while sleepy. Future studies could also examine the influence of other types of sleepiness countermeasures that were not examined in the current study (e.g., Armstrong et al., 2010; Oron-Gilad, Ronen, & Shinar, 2008) for their association with sleepy driving.

In conclusion, the current study found the variables of age, sex, motivation, and risk perception were significantly associated with self-reports of continuing to drive while sleepy. The only sleepiness countermeasure that was associated with self-reports of continuing to drive while sleepy was the perceived effectiveness of opening the window/turning on the air conditioner. Additionally, it was found that age differences in self-reports of continuing to drive while sleepy were mediated by differences in motivation and risk perception. As discussed, these findings could prove useful with designing interventions that seek to modify drivers' attitudes and behaviours of driving while sleepy. Driver sleepiness is a major contributor to road crashes with no single individual impervious to the effect of sleepiness. Therefore, endeavours aimed at reducing the instances of sleepy driving are important for all road users.

5. References

Adamos, G., Nathanail, E., & Kapetanopoulou, P. (2013). Do Road Safety Communication Campaigns Work? *Transportation Research Record: Journal of the Transportation Research Board, 2364*(-1), 62-70.

Alhakami, A. S., & Slovic, P. (1994). A Psychological Study of the Inverse Relationship Between Perceived Risk and Perceived Benefit. *Risk Anal, 14*(6), 1085-1096.

Anund, A., Kecklund, G., Peters, B., & Akerstedt, T. (2008). Driver sleepiness and individual differences in preferences for countermeasures. *J Sleep Res, 17*(1), 16-22.

Armstrong, K. A., Obst, P., Banks, T., & Smith, S. S. (2010). Managing driver fatigue: Education or motivation? *Road & Transport Research, 19*(3), 14-20.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol, 51*(6), 1173-1182.

Burke, B. L., Arkowitz, H., & Menchola, M. (2003). The efficacy of motivational interviewing: a meta-analysis of controlled clinical trials. *Journal of Consulting and Clinical Psychology, 71*(5), 843.

Connor, J., Norton, R., Ameratunga, S., Robinson, E., Civil, I., Dunn, R., . . . Jackson, R. (2002). Driver sleepiness and risk of serious injury to car occupants: population based case control study. *BMJ, 324*(7346), 1125.

Cummings, P., Koepsell, T. D., Moffat, J. M., & Rivara, F. P. (2001). Drowsiness, counter-measures to drowsiness, and the risk of a motor vehicle crash. *Inj Prev, 7*(3), 194-199.

De Valck, E., & Cluydts, R. (2001). Slow-release caffeine as a countermeasure to driver sleepiness induced by partial sleep deprivation. *Journal Of Sleep Research, 10*(3), 203-209.

Department of Transport and Main Roads. (2008). *Driving in Queensland - The essential driving companion*. Brisbane, Australia: Depatment of Transport and Main Roads.

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *Am Psychol, 49*(8), 709-724.

Fernandes, R., Hatfield, J., & Job, R. F. S. (2010). A systematic investigation of the differential predictors for speeding, drink-driving, driving while fatigued, and not

wearing a seat belt, among young drivers. *Transp Res Part F Traffic Psychol Behav, 13*(3), 179-196.

Gunatillake, T., Daly, P., & Anderson, N. (2003). *Fatigue and Rest Taking- A Snapshot of Victorian Motorist's Perceptions*. Paper presented at the Australasian Road Safety Research, Policing and Education Conference, 24-26 September 2003, Sydney, New South Wales.

Harré, N., Brandt, T., & Dawe, M. (2001). The development of risky driving in adolescence. *J Safety Res, 31*(4), 185-194.

Hatfield, J., & Fernandes, R. (2009). The role of risk-propensity in the risky driving of younger drivers. *Accid Anal Prev, 41*(1), 25-35.

Helweg-Larsen, M., & Shepperd, J. A. (2001). Do moderators of the optimistic bias affect personal or target risk estimates? A review of the literature. *Pers Soc Psychol Rev, 5*(1), 74-95.

Horne, J. A., & Reyner, L. A. (1996). Counteracting driver sleepiness: effects of napping, caffeine, and placebo. *Psychophysiology, 33*(3), 306-309.

Janz, N. K., & Becker, M. H. (1984). The Health Belief Model: a decade later. *Health Educ Q, 11*(1), 1-47.

Kecklund, G., Anund, A., Wahlström, M. R., & Åkerstedt, T. (2012). *Sleepiness and the risk of car crash: a case-control study*. Paper presented at the 21st Congress of the European Sleep Research Society, Paris, France.

Klein, W. M. (1997). Objective standards are not enough: affective, self-evaluative, and behavioral responses to social comparison information. *J Pers Soc Psychol, 72*(4), 763.

Leger, D., Philip, P., Jarriault, P., Metlaine, A., & Choudat, D. (2009). Effects of a combination of napping and bright light pulses on shift workers' sleepiness at the wheel: A pilot study. *J Sleep Res, 18*(4), 472-479.

McCartt, A. T., Rohrbaugh, J. W., Hammer, M. C., & Fuller, S. Z. (2000). Factors associated with falling asleep at the wheel among long-distance truck drivers. *Accid Anal Prev, 32*(4), 493-504.

McNally, B., & Titchener, K. (2012). The role of affective processes on young drivers' risk perceptions: A dual process model approach. *J Risk Res, 15*(1), 39-51.

Nordbakke, S., & Sagberg, F. (2007). Sleepy at the wheel: Knowledge, symptoms and behaviour among car drivers. *Transp Res Part F Traffic Psychol Behav, 10*(1), 1-10.

Oron-Gilad, T., Ronen, A., & Shinar, D. (2008). Alertness maintaining tasks (AMTs) while driving. *Accident Analysis & Prevention, 40*(3), 851-860.

Pennay, D. (2008). Community Attitudes to Road Safety: 2008 survey report. Canberra, Australia: Australian Government Department of Infrastructure, Transport, Regional Development and Local Government.

Phipps-Nelson, J., Redman, J. R., & Rajaratnam, S. M. (2011). Temporal profile of prolonged, night-time driving performance: breaks from driving temporarily reduce time-on-task fatigue but not sleepiness. *Journal Of Sleep Research, 20*(3), 404-415.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods, 40*(3), 879-891.

Reyna, V. F., & Farley, F. (2006). Risk and rationality in adolescent decision making implications for theory, practice, and public policy. *Psychol Sci Public Interest, 7*(1), 1-44.

Reyner, L. A., & Horne, J. A. (1998). Evaluation "in-car" countermeasures to sleepiness: Cold air and radio. *Sleep, 21*(1), 46-50.

Rhodes, N., & Pivik, K. (2011). Age and gender differences in risky driving: the roles of positive affect and risk perception. *Accid Anal Prev, 43*(3), 923-931.

Rundmo, T., & Iversen, H. (2004). Risk perception and driving behaviour among adolescents in two Norwegian counties before and after a traffic safety campaign. *Safety Science, 42*(1), 1-21.

Schwarz, J. F., Ingre, M., Fors, C., Anund, A., Kecklund, G., Taillard, J., . . . Akerstedt, T. (2012). In-car countermeasures open window and music revisited on the real road: popular but hardly effective against driver sleepiness. *J Sleep Res, 21*(5), 595-599.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Anal, 24*(2), 311-322.

Smith, S. S., Carrington, M., & Trinder, J. (2005). Subjective and predicted sleepiness while driving in young adults. *Accident Analysis & Prevention, 37*(6), 1066-1073.

Ulleberg, P. (2001). Personality subtypes of young drivers. Relationship to risk-taking preferences, accident involvement, and response to a traffic safety campaign. *Transportation Research Part F: Traffic Psychology and Behaviour, 4*(4), 279-297.

Vanlaar, W., Simpson, H., Mayhew, D., & Robertson, R. (2008). Fatigued and drowsy driving: a survey of attitudes, opinions and behaviors. *J Safety Res, 39*(3), 303-309.

Watling, C. N. (2014). Sleepy driving and pulling over for a rest: Investigating individual factors that contribute to these driving behaviours. *Personality and Individual Differences, 56*(0), 105-110.

Watling, C. N., Smith, S. S., & Horswill, M. S. (2014). Stop and revive? The effectiveness of nap and active rest breaks for reducing driver sleepiness. *Psychophysiology*, n/a-n/a.

Wundersitz, L., Hutchinson, T., & Woolley, J. (2010). Best practice in road safety mass media campaigns: A literature review. *Social Psychology, 5,* 119-186.