ELSEVIER

Accident Analysis and Prevention 38 (2006) 854–861

ACCIDENT ANALYSIS & PREVENTION

www.elsevier.com/locate/aap

Preventing cannabis users from driving under the influence of cannabis

Craig Jones [a,*], Neil Donnelly [a], Wendy Swift [b], Don Weatherburn [a]

[a] *New South Wales Bureau of Crime Statistics and Research, GPO Box 6, Sydney, NSW 2000, Australia*
[b] *National Drug and Alcohol Research Centre, University of New South Wales, Sydney, NSW 2052, Australia*

Received 11 November 2005; received in revised form 13 February 2006; accepted 17 February 2006

Abstract

Face-to-face, structured interviews were conducted with 320 recent cannabis users in New South Wales, Australia to assess the likely deterrent effects of (a) increasing the certainty of apprehension for driving under the influence of cannabis (DUIC) and (b) doubling the severity of penalties for DUIC. Participants were presented with a drug-driving scenario and asked to indicate their likelihood of driving given that scenario. The perceived risk of apprehension and severity of punishment were manipulated in each scenario to create four different certainty/severity conditions and participants were randomly allocated to one of these four groups. A subsidiary aim was to assess the likely impact of providing factual information about the accident risk associated with DUIC. Recent drug drivers who felt at low risk of accident when DUIC were asked to rate their willingness to drive if convinced that it was dangerous. The results suggested that increasing the certainty but not severity of punishment would produce reductions in cannabis-intoxicated driving among recent cannabis users. Providing factual information about the risks associated with DUIC would appear to have little impact on drug-driving rates among this population.

Keywords: Cannabis; Driving; Roadside drug testing; Penalty severity; Deterrence; Education

1. Introduction

Although each State and Territory in Australia has implemented some form of criminal justice diversion scheme for minor cannabis offences, use and possession of the drug is still legally prohibited across the country. Irrespective of this prohibition, Australia continues to have one of the highest rates of cannabis use in the world (United Nations Office on Drugs and Crime, 2005). The most recent National Drug Strategy household survey revealed that 34% of people aged 14 years or older had used cannabis in their lifetime and 11% had used it in the previous year (Australian Institute of Health and Welfare, 2005).

This high prevalence of use is concerning because cannabis is not an altogether harmless drug. One emerging injury prevention concern is the potential risk associated with driving under the influence of cannabis (DUIC). Cannabis certainly impairs performance on some driving-related psychomotor tasks (Kelly et al., 2004; Moskowitz, 1985; Smiley, 1999; Walsh et al., 2004) and these impairments appear to be most pronounced when cannabis is consumed at higher doses (Ramaekers et al., 2004). Although the precise nature of the relationship between cannabis use and accident involvement is more ambiguous, recent evidence suggests that cannabis-positive drivers may be more likely to be involved in and responsible for accidents than drug-free drivers (e.g. Drummer et al., 2004; Blows et al., 2005; Fergusson and Horwood, 2001). It is unclear whether this reflects an actual increase in accident risk associated with DUIC, or whether cannabis use merely serves as a marker for general driving-related deviance (Fergusson and Horwood, 2001; Fergusson, 2005). At this point, though, extant evidence certainly provides cause for concern.

Whatever the precise effect DUIC has on accident risk, DUIC itself is widespread among some populations of road users. For example, injecting drug users (Albery et al., 2000; Darke et al., 2004) and young drivers (Adlaf et al., 2003; Stevenson et al., 2001) both report DUIC at relatively high rates. As might be expected, the likelihood of reporting DUIC is also very high among recent or frequent cannabis users (e.g., Aitken et al., 2000; Lenne et al., 2001; Reilly et al., 1998; Terry and Wright, 2005). Secondary analysis of the Australian National Drug Strategy household survey found that 28% of driving-age residents in the state of New South Wales (NSW) who had used cannabis in 2004 had also driven after using one or more illicit drugs in

* Corresponding author. Tel.: +61 292319176; fax: +61 292319187.
E-mail addresses: craig_jones@agd.nsw.gov.au (C. Jones), neil_donnelly@agd.nsw.gov.au (N. Donnelly), w.swift@unsw.edu.au (W. Swift), don_j_weatherburn@agd.nsw.gov.au (D. Weatherburn).

0001-4575/$ – see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2006.02.010

that year. Given that 80% of drug drivers in that state report using cannabis on their last occasion of drug driving (Hawkins et al., 2004), it is likely that most people reporting drug driving in 2004 had driven after using cannabis.

The high rates of DUIC and the harm potentially caused by the behaviour have led researchers, clinicians and policy makers in many countries to closely examine strategies for preventing DUIC. Because random breath testing for alcohol intoxication has been very successful in reducing the incidence of drink-driving and alcohol-related road fatalities (e.g. Chisholm et al., 2004; Dunbar et al., 1987; Homel et al., 1988; Peek-Asa, 1999), many have been drawn to the idea of using random drug testing as a deterrent. However while most Western nations prohibit DUIC and many have legislative provisions that allow police to stop and drug-test drivers, few actually conduct random roadside drug tests (European Monitoring Centre for Drugs and Drug Addiction, 2003). Moreover, where roadside drug testing has been implemented (e.g. in some German and Australian states) there have, to date, been no peer-reviewed evaluations of their deterrent effect on drug-driving behaviours.

Random roadside drug testing is not the only possible policy response to the problem of DUIC. As already noted, most countries impose criminal sanctions on those who engage in DUIC and, in doing so implicitly assume that these penalties act as a deterrent. Once again, however, the deterrent effectiveness of imposing harsher penalties on convicted drug drivers is not immediately clear. Educational approaches to risky drug-using behaviours also exhibit some promise, even though they have not received much attention from policy makers. A recent UK study found that approximately 30% of regular cannabis users would be deterred by a "good TV advertising campaign" detailing the risks associated with DUIC (Terry and Wright, 2005). Unfortunately, little can be gleaned from the literature on drink driving because education campaigns generally aim to inform potential offenders about the risk of apprehension, not about their risk of having an accident (Babor et al., 2003). Where such information has been conveyed, it has usually been combined with enforcement activity which makes it impossible to partial out the independent contribution of education to reductions in offending behaviour (e.g. Hingson et al., 1996).

This lack of information on the likely impact of drug testing, severe penalties and the provision of educational information on rates of drug driving provided the motivation for the current study. The primary aim was to investigate the potential deterrent effects of random roadside drug testing and the likely deterrent impact of doubling the severity of existing penalties for DUIC among a sample of recent cannabis users. A subsidiary – though perhaps no less important – goal was to assess the likely impact of providing factual information about the accident risks associated with DUIC.

2. Method

2.1. Participants

A purposive sample of 320 recent cannabis users was recruited from the greater Sydney ($n = 200$) and Newcastle ($n = 120$) areas of NSW, Australia. All participants were volunteers who were reimbursed $30 for travel expenses immediately after the interview. To be eligible, participants had to be aged 18 years or older, have used cannabis in the previous 12 months and have driven a motor vehicle in the prior 12 months (although not necessarily driven after using cannabis). The mean age of participants was 29 years (median = 26; range = 18–73); two-thirds were male and only 6% identified as indigenous. Three quarters of the sample were born in Australia and all but one participant spoke English as their first language. Forty-six percent of the participants were in paid employment at the time of interview and 29% had not completed their year-12 higher school certificate.

2.2. Design

To assess the likely deterrent effect of introducing random drug testing and doubling the severity of penalties for DUIC, an experimental deterrence paradigm developed by Nagin and Paternoster (1993) was employed. Participants were presented with a hypothetical scenario in which they had the option to drive within a short time of using cannabis (see Appendix A). They were then asked to rate their likelihood of driving under the conditions portrayed in that scenario. Aspects of each scenario were varied to create four different groups based on the certainty (high/low) or severity (high/low) of sanctions for DUIC. Participants were block-randomised to one of these four conditions before the interview began (using block sizes of either four or eight). All participants were blinded to the scenario condition to which they had been assigned. In the high certainty conditions, participants were informed that police could randomly drug-test drivers at the roadside. In the low certainty conditions, which were designed to reflect the current situation in NSW, participants were told that police could not randomly drug-test drivers at the roadside. In the high severity conditions participants were informed that, if they were to get caught DUIC, they would get a fine of about $1000 and have their licence disqualified for a minimum of 12 months. In the lower severity conditions, which were again designed to approximate the current sanctions for DUIC in NSW, participants were led to believe that they would get a fine of about $500 and have their licence disqualified for a minimum of 6 months.

2.3. Measures

2.3.1. Punishment certainty and severity

Visual analogue scales (VAS) were used to measure participants' willingness to drive under the scenario conditions to which they had been randomised. The VAS consisted of a 100 mm line drawn on the page and marked with 'not at all' at the left extreme of the line and 'definitely' at the right extreme. Participants were asked to mark a cross on the line to indicate how likely they would be to drive under the conditions in the scenario. The experimenter later coded each response as a numerical score by measuring the number of millimetres from the left end-point of the scale to the centre of the 'x'.

Other potential predictors of driving likelihood were also examined to check the adequacy of the randomisation process.

The factors considered in this analysis were age, gender, prior convictions for driving and non-driving offences, participants' dependence on cannabis (as indicated by a score of three or greater on the severity of dependence scale, see Swift et al., 1998), participants' use of other drug types and whether they had a history of injecting drugs, their perceived risk of having an accident and their perceived risk of apprehension when driving after using cannabis, and whether they reported driving within 1 h of using cannabis in the previous year. One hour was chosen to measure cannabis-intoxicated driving because psychomotor impairment is most pronounced within the first hour of consumption (Ramaekers et al., 2004). Measures were also collected as independent checks on the effectiveness of the scenarios in generating variations in perceived certainty and severity of punishment. Participants were asked to rate on a VAS: (1) their chances of being caught by the police given the scenario, and (2) how big a problem the penalties for the offence would create for them if they decided to drive and were caught and convicted. To assess the absolute deterrent effect of sanctions, participants were also asked to indicate on a VAS how likely they would be to drive home under the circumstances in the scenario if there was no possibility of being caught, convicted and punished. Scores ranged from 0 (not at all likely) to 100 (definitely).

2.3.2. *Likely effect of providing factual information about accident risk*

Participants were asked to indicate (on a VAS) their likelihood of driving if they could be convinced that cannabis-intoxicated drivers were "about three to seven times more likely to be responsible for their crash [than] drivers [who] have not used drugs or alcohol". The quote was taken from Ramaekers et al. (2004) review of the evidence for cannabis use and accident risk. The analysis focussed only on those participants who had driven within 1 h of using cannabis in the previous year (while not simultaneously under the influence of alcohol or other drugs) and who believed that driving under the influence of cannabis on its own either reduced or did not affect their risk of accident ($n = 133$).

2.4. *Analyses for effect of punishment certainty and severity*

Non-parametric Kruskal–Wallis tests were employed to assess whether there were any significant differences in likelihood ratings between the four certainty and severity of punishment conditions. However the Kruskal–Wallis test is bivariate and does not detect whether perceptions of punishment certainty and severity interact to determine driving likelihood scores. The scores were therefore collapsed into a six-category ordinal scale (0–9, 10–29, 30–49, 50–69, 70–89, 90–100) and ordinal logistic regression models including terms for certainty, severity and an interaction between the two were fitted to the data (Agresti, 1990). A model was then fitted which included these terms as well as other measured variables that could potentially predict driving likelihood scores. A manual backward elimination modelling approach was adopted to reach the final regression model.

2.5. *Procedure*

Participants were primarily recruited by advertising on radio, in mainstream newspapers and in popular music magazines. Some participants were also recruited through snowballing, whereby the initial base of participants used informal social networks to refer the interviewer on to other potential participants. Advertisements were placed in the various media sources and participants were invited to call a toll-free phone number if they were interested in taking part in the study. If the participant met the selection criteria a time and place was decided upon to meet and conduct the interview. This usually took place within 1 week of the participant contacting the interviewers. New recruitment advertisements were placed in each media source as the number of interested participants from the previous round began to decline. An initial two-stage pilot, with 20 participants in each stage, was conducted in August 2004 and the final 320 interviews were conducted between October 2004 and March 2005. Trained interviewers administered all interviews face-to-face with the participant and the mean interview time was 35 min. All questions were first read aloud to the participant and their answers were coded on a paper copy of the questionnaire. The respondents marked the questionnaire themselves for questions where VAS were used and the interviewer coded all other responses.

3. Results

Overall, 28.4% (95% confidence interval [CI] = 23.6–33.8) of the sample reported using cannabis every day in the previous 12 months and a further 41.9% (95% CI = 36.4–47.5) reported using cannabis at least weekly in that time period. More than three-quarters (77.8%, 95% CI = 72.8–82.2) of the sample reported having driven within 1 h of using cannabis in the previous 12 months and 26.9% (95% CI = 22.2–32.1) reported doing so weekly or more often in that year.

3.1. *Potential impact of random drug testing and more severe penalties for DUIC*

The participants' characteristics are shown in Table 1 according to the scenario condition to which they had been assigned. There were no significant differences between any of the four groups in terms of mean age, gender composition, offending behaviour, cannabis dependence, previous injecting behaviour, other-drug use, past-year drug driving behaviour, or in participants' beliefs about their accident and apprehension risks when DUIC. These similarities between groups suggest that the randomisation procedures were successful.

The mean and median driving likelihood scores are presented in Table 2 by the scenario condition to which participants had been assigned and by their past-year drug-driving behaviour. Kruskal–Wallis chi-squares revealed a significant difference in driving scores among the total sample (Kruskal–Wallis $\chi^2_3 = 41.3$, $p < 0.001$) and among those who reported DUIC in the previous 12 months (Kruskal–Wallis $\chi^2_3 = 42.7$, $p < 0.001$). There was no significant difference in driving likelihood scores among the sub-group of participants who did not report DUIC in the pre-

Table 1
Check on whether participants were successfully randomised to scenario conditions

Participant Characteristic	Scenario condition[a] HC/HS	HC/LS	LC/HS	LC/LS	Sign.
Mean age	26.8	28.7	28.8	30.2	KW $\chi^2_3 = 3.8, p = 0.28$
% Male	71	65	66	69	$\chi^2_3 = 0.8, p = 0.84$
% Convicted any offence	29	23	30	31	$\chi^2_3 = 1.8, p = 0.62$
% Convicted driving offence	66	60	64	60	$\chi^2_3 = 1.0, p = 0.81$
% Cannabis dependent	51	41	35	51	$\chi^2_3 = 6.2, p = 0.10$
% Ever injected any drug	24	26	25	26	$\chi^2_3 = 0.2, p = 0.98$
# Drugs types ever used					$\chi^2_6 = 5.5, p = 0.48$
% ≤3	26	25	30	25	
% 4–5	30	40	24	30	
% ≥6	44	35	46	45	
% Believe accident risk increases when DUIC	53	53	50	59	$\chi^2_3 = 1.3, p = 0.72$
% Believe low apprehension risk when DUIC	81	79	74	85	$\chi^2_3 = 3.3, p = 0.35$
% DUIC previous year	79	74	78	81	$\chi^2_3 = 1.4, p = 0.72$

[a] HC: high certainty, LC: low certainty, HS: high severity, LS: low severity.

vious year (Kruskal–Wallis $\chi^2_3 = 2.3$, $p = 0.52$). It is important to note, however, that the smaller numbers in this sub-group ($n = 71$) may have power implications for this result. In fact, the mean and median values shown in Table 2 for participants who did not report DUIC in the previous year clearly indicate that the direction of the effect was the same as for those who did report DUIC in the prior 12 months.

Table 3 shows the regression model with terms for punishment certainty, severity and the interaction between the two (model 1) as well as the final model with other predictors of driving likelihood included (model 2). The interaction term in model 1 suggests that there was no significant interaction between punishment certainty and punishment severity ($\chi^2_1 = 1.9$, $p = 0.16$). Because the terms for certainty and severity of punishment cease to be main effects when the interaction term is included in the model, the more important model to focus on is model 2. The main effect term for certainty of punishment shown in model 2 indicates that participants in the high certainty condition were less likely to indicate a willingness to drive given the scenario than those in the lower certainty condition (odds ratio [OR] = 0.2, $\chi^2_1 = 48.6$, $p < 0.001$). This effect was independent of gender (OR = 1.7, $\chi^2_1 = 5.2$, $p = 0.023$), cannabis dependence (OR = 1.6, $\chi^2_1 = 4.9$, $p = 0.026$), whether participants reported using six or more (compared with three or fewer) drug types in their lifetime (OR = 1.7, $\chi^2_1 = 4.2$, $p = 0.040$), participants' perceptions of accident vulnerability when DUIC (OR = 0.6, $\chi^2_1 = 6.3$, $p = 0.012$) and whether participants reported DUIC in the past year (OR = 2.8, $\chi^2_1 = 13.2$, $p < 0.001$). The main effect terms for punishment severity (OR = 0.9 [0.5–1.6], $\chi^2_1 = 0.2$, $p = 0.68$), age (OR = 0.9 [0.6–1.5], $\chi^2_1 = 0.1$, $p = 0.76$), prior convictions for driving offences (OR = 1.1 [0.7–1.7], $\chi^2_1 =$

Table 2
Mean and median driving likelihood scores (out of 100), by scenario condition and past-year drug driving behaviour

Scenario	*N*	Mean score (95% C.I.)	Median score
Total sample			
High certainty/high severity	80	32 (25–39)	19
High certainty/low severity	80	27 (21–34)	14
Low certainty/high severity	80	54 (46–63)	54
Low certainty/low severity	80	59 (52–67)	69
Reported DUIC in past year			
High certainty/high severity	63	36 (28–44)	27
High certainty/low severity	59	31 (23–40)	19
Low certainty/high severity	62	62 (52–71)	73
Low certainty/low severity	65	67 (59–75)	75
Did not report DUIC in past year			
High certainty/high severity	17	16 (4–29)	5
High certainty/low severity	21	16 (5–26)	7
Low certainty/high severity	18	29 (13–46)	11
Low certainty/low severity	15	27 (12–42)	16

Table 3
Ordinal logistic regression models predicting driving likelihood scores

Covariate	Parameter estimate	S.E.	*p*-value	Cumulative odds ratio	95% C.I.
Model 1					
Apprehension certainty	−1.64	0.29	0.00		
Apprehension severity	−0.24	0.28	0.39		
Certainty × severity interaction	0.56	0.40	0.16		
Model 2					
Apprehension certainty	−1.51	0.22	0.00	0.2	0.1–0.3
Male	0.52	0.23	0.02	1.7	1.1–2.6
Cannabis-dependent	0.47	0.21	0.03	1.6	1.1–2.4
4–5 drug types ever	0.27	0.28	0.33	1.3	0.8–2.3
6+ drug types ever	0.54	0.26	0.04	1.7	1.0–2.9
Accident risk increase	−0.54	0.21	0.01	0.6	0.4–0.9
Reported DUIC in past year	1.02	0.28	0.00	2.8	1.6–4.8

0.1, $p = 0.82$), prior convictions for other offending (OR = 1.2 [0.7–2.1], $\chi^2_1 = 0.4$, $p = 0.55$) and injecting history (OR = 1.2 [0.7–2.0], $\chi^2_1 = 0.5$, $p = 0.50$) were not significant and were dropped from the final model.

3.1.1. Checks on scenarios

Participants assigned to the high certainty scenario conditions rated their likelihood of apprehension given that scenario as significantly higher than those in the low certainty conditions (median scores were 49 and 26 out of 100, respectively; Mann–Whitney *U*-test, $p < 0.001$). However, there was no significant difference between the high and low severity groups in their ratings of how problematic the penalties would be for them if they were to be caught and convicted (median scores were 92 and 87 out of 100, respectively; Mann–Whitney U-test, $p = 0.11$). This suggests that the introduction of random drug testing would successfully increase the perceived certainty of apprehension among this group of cannabis users but that there would be no marginal difference in perceived sanction severity should fines and licence disqualification periods be doubled.

3.1.2. Absolute deterrent effect of sanctions

Fig. 1 shows the distributions of driving likelihood scores under the scenario conditions if there were no possibility of being caught and punished for DUIC, by current drug-driving behaviour. Overall, three-quarters of the sample rated their chances of driving as 50% or greater (i.e. scored greater than 50 on the VAS). Nearly half suggested that they would be highly likely to drive (i.e. scored between 91 and 100 on the VAS) if there were no chance of being caught and punished. Participants who reported DUIC in the past 12 months were significantly more likely than those who did not report DUIC in the past year to report a willingness to drive if there was no chance of being caught and punished (median scores were 94 and 42 out of 100, respectively; Mann–Whitney U-test, $p < 0.001$).

3.2. Potential impact of providing factual information about accident risk

Fig. 2 shows the distribution of participants' stated driving likelihood scores (out of 100) if they could be convinced that DUIC increased their risk of accident. There are three important points to make about this distribution of scores. First, a significant proportion (26.3%) indicated that they would be highly likely to continue to DUIC in the future (i.e. they had scores between 91 and 100 on the VAS), even if they could be convinced that DUIC increased their risk of accident. Second, because the majority of participants had scores on the right side of the distribution, it is clear that most participants would be more likely than not to continue to DUIC even if they were convinced that it increased their accident risk. Finally, very few participants (7.5%) indicated that they would be unlikely to drive if they could be convinced that cannabis increased their accident risk (i.e. 7.5% of participants had scores between 0 and 10). There was no relationship between driving likelihood scores and age, gender, prior convictions for driving and non-driving offences, cannabis dependence, history of drug injecting or the total number of drug types participants reported ever using.

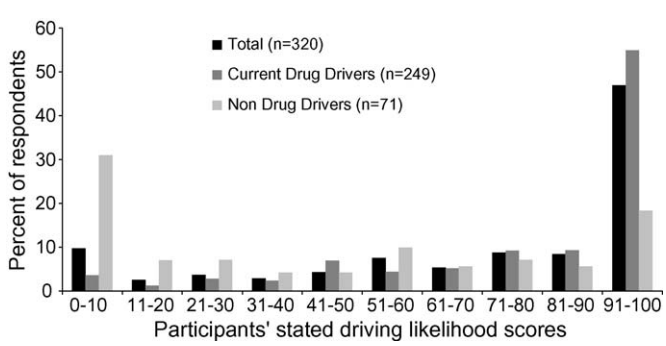

Fig. 1. Likelihood of driving if there were no possibility of being caught and punished, by past-year drug driving behaviour.

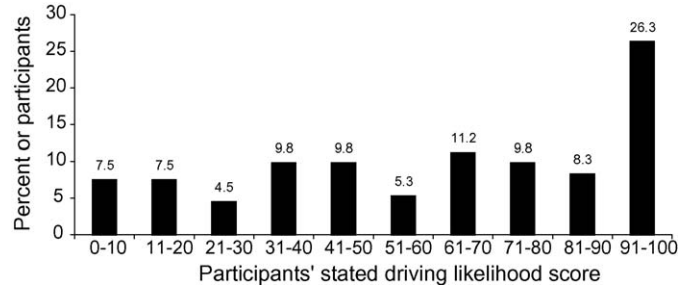

Fig. 2. Likelihood of driving if participants could be convinced that cannabis increased their accident risk.

4. Discussion

These results provide strong support for the potential deterrent effects of measures that increase the perceived risk of apprehension among populations of road users who are at high risk of DUIC. Recent cannabis users who were asked how willing they would be to drive in a scenario where police could randomly test for drugs at the roadside indicated far less willingness than participants presented with scenarios in which there was a lower possibility of apprehension. As was expected if the randomisation to conditions was successful, this finding was independent of a number of other predictors of driving likelihood such as cannabis dependence, number of types of other drugs participants reported ever using, perceived accident risks associated with DUIC and past year drug-driving behaviour.

Bivariate analyses indicated that there was no certainty of punishment effect for participants who reported that they had not driven after using cannabis in the previous year. This should be treated with some caution due to the small number of participants who had not driven after using cannabis in the previous 12 months ($n = 71$). Nevertheless, it would be unsurprising if the deterrent effect of roadside drug testing were stronger for current offenders than non-offenders. Deterrent effects have in the past been shown to be stronger among offending populations than non-offending populations (Wright et al., 2004). The theory is that non-offenders are sufficiently deterred by extra-legal factors

– such as their moral opposition to breaking the law – and the threat of legal sanctions adds little deterrent value (Burkett and Ward, 1993).

These results provide no evidence to suggest that DUIC would be discouraged by doubling the magnitude of existing fines or licence disqualification periods for DUIC. This finding complements a large body of literature showing that increases in sanction severity have much smaller effects on criminal outcomes than increases in penalty certainty (see Nagin, 1998 for a review). In a local context, these findings are also supportive of Briscoe's (2004) discovery that re-offending rates among drink drivers were only very slightly affected following a doubling of the penalties for the offence in NSW, Australia in 1998. While some studies have found that increases in penalty severity exert their greatest impact when the perceived risk of apprehension is high (Grasmick and Bryjak, 1980; Howe and Brandau, 1988; Howe and Loftus, 1996), there was no evidence of any interaction between sanction certainty and severity in the current study.

The lack of any punishment severity effect in the current study should not be interpreted as evidence that penalties per se exert no effect on DUIC. On the contrary, most of the participants – and recent drug drivers in particular – indicated that they would be highly likely to drive if there was no possibility of being caught and punished. Moreover, most participants felt the penalties associated with even the low severity condition (which approximated existing penalties in NSW) would have quite major ramifications for them. When asked how problematic being caught drug driving would be, the median scores were 92 and 87 out of a possible 100 for high and low severity groups, respectively. It is unclear whether deterrent effects may have been observed had participants felt that the low severity sanctions were more moderate (say, for example, a $100 fine and 1 month licence disqualification). This is an interesting question from a theoretical standpoint but only future research will bear this out. The current findings simply suggest that doubling the severity of existing penalties is unlikely to return any marginal deterrent benefit.

The findings in relation to the potential effectiveness of providing factual information about accident risk are also not particularly encouraging. A majority of respondents indicated that they would probably continue to drive irrespective of whether they could be convinced that DUIC increases their accident risk. It is possible that these more pessimistic results reflect a self-serving bias among cannabis users, whereby they overestimate their own abilities relative to others. For example, people generally tend to think that they are above-average drivers (Svenson, 1981). While participants in this study might believe that other people are at increased risk of accident if they drive while intoxicated by cannabis, they might believe that their own risk would not increase because they are better than the average driver. Alternatively, they might think that they have an above-average tolerance to the effects of cannabis and would therefore be at less risk of accident than the average cannabis user.

While it appears that roadside testing may provide considerable leverage over drug-driving behaviour, the feasibility of this enforcement relies entirely on the accuracy of the tests themselves. Several studies have reported that the use of saliva tests for detecting the main psycho-active ingredient in cannabis (delta-9-tetrahydrocannibinol, or THC) can be problematic (e.g. Samyn et al., 2002; Samyn and van Haeren, 2000). One problem with oral fluid tests is that THC is almost incapable of being secreted from blood into saliva at levels that are detectable by roadside equipment (Rouen et al., 2001). Anyone who is detected, then, would have to have residual traces of THC in the oral cavity from very recent use of the drug, or have an extraordinarily high concentration of THC in their blood (Skopp and Potsch, 1999). This, of course, increases the chances of producing a high number of false negatives, thereby lowering the sensitivity of the tests (Bierman et al., 2004) and eroding the specific deterrent effect of the roadside testing program.

Even if tests for drug driving do not prove feasible in the short-run, there are other ways of increasing the perceived risk of apprehension for this offence. Standardised Field Sobriety Assessments, where drivers are examined for behavioural signs of drug impairment, may be useful ways of increasing the perceived certainty of apprehension among potential drug drivers (Brookoff et al., 1994). Of course, more targeted approaches to behaviour change may also be useful among drivers who are at risk of drug driving. Motivational enhancement approaches, for example, are designed to encourage engagement and behaviour change by helping clients explore and resolve ambivalence. Monti et al. (2001) have successfully used this approach to provide an opportunistic intervention among young drink-drivers in accident and emergency settings. Compared to those receiving standard care, those who received a brief motivational intervention showed significant reductions in drink driving behaviour and alcohol-related injuries up to 12 months later.

As with any purposive sampling framework, the current results cannot be generalized to the broader population of cannabis users. In fact, participants in the current sample were somewhat atypical of Australian cannabis users; at least insofar as their patterns of cannabis consumption is concerned. For example, in the most recent Australian National Drug Strategy household survey, 16% of past year cannabis users reported using cannabis daily while a further 23% reported using at least weekly but less than daily (Australian Institute of Health and Welfare, 2005). The corresponding proportions in this study were 28% and 42%, respectively, which suggests that the present sample consisted of a high proportion of frequent cannabis users. It is important to note, however, that it was not the authors' intention to draw a random sample of Australian cannabis users. It is well known that young people who use cannabis frequently are more at risk of DUIC (e.g. Adlaf et al., 2003; Terry and Wright, 2005) and it is this at-risk population who should be the focus of law enforcement and other prevention campaigns. This targeted approach would contribute not only to more effective prevention efforts but also to more cost-effective prevention policies. Whichever program policy-makers choose to adopt, the results of the current study suggest that including program components that effectively increase the perceived certainty of apprehension among those who engage in the behaviour would be paramount.

Acknowledgements

The authors would like to thank the Office of Drug and Alcohol Policy, NSW Ministry of Health (formerly with NSW Cabinet Office) for funding this research and all of the participants for their invaluable contribution to the research. We would also like to thank Suzanne Briscoe for her many helpful comments throughout and particularly for her assistance with survey design.

Appendix A

Example of the high certainty/high severity condition:

"Suppose you are at a friend's house one night and you've just smoked some cannabis. You suddenly remember that you have to be home in 10 min because you are meeting another friend there. You've seen police in the area recently and have heard that they've begun conducting random roadside tests using saliva swabs to detect recent cannabis use. If you get caught, you know that you will get a fine of about $1000 and have your licence disqualified for a minimum of 12 months. You can either drive the 10 km home or find some other way home but if you leave your car at your friend's house, you will have to return early the next morning to pick it up for work. How likely is it that you would drive home under the circumstances provided in the scenario above?"

References

Adlaf, E.M., Mann, R.E., Paglia, A., 2003. Drinking, cannabis use and driving among Ontario students. Can. Med. Assoc. J. 168 (5), 565–566.

Agresti, A., 1990. Categorical Data Analysis. John Wiley and Sons, New York.

Aitken, C., Kerger, M., Crofts, N., 2000. Drivers who use illicit drugs: behaviour and perceived risks. Drugs Ed. Prev. Pol. 7 (1), 39–50.

Albery, I.P., Strang, J., Gossop, M., Griffeths, P., 2000. Illicit drugs and driving: Prevalence, beliefs and accident involvement among a cohort of current out-of-treatment drug users. Drug Alcohol Depend. 58, 197–204.

Australian Institute of Health and Welfare, 2005. 2004 National Drug Strategy Household Survey: Detailed Findings. Drug Statistics Series no. 16. Australian Institute of Health and Welfare, Canberra.

Babor, T., Caetano, R., Casswell, S., Edwards, G., Giesbrecht, N., Graham, K., Grube, J., Gruenewald, P.J., Hill, L., Holder, H.D., Homel, R., Osterberg, E., Rehm, J., Room, R., Rossow, I., 2003. Alcohol: No Ordinary Commodity. Oxford University Press, New York.

Bierman, T., Schwarze, B., Zedler, B., Betz, P., 2004. On-site testing of illicit drugs: the use of the drug-testing device "Toxiquick". Forens. Sci. Int. 143, 21–25.

Blows, S., Ivers, R.Q., Connor, J., Ameratunga, S., Woodward, M., Norton, R., 2005. Marijuana use and car crash injury. Addiction 100, 605–611.

Briscoe, S., 2004. The impact of increased drink-driving penalties on recidivism rates in NSW. Alcohol Studies Bulletin 5. NSW Bureau of Crime Statistics and Research, Sydney.

Brookoff, D., Cook, C.S., Williams, C., Mann, C.S., 1994. Testing reckless drivers for cocaine and marijuana. NE J. Med. 331, 518–522.

Burkett, S.R., Ward, D.A., 1993. A note on perceptual deterrence, religiously based moral condemnation, and social control. Criminal 31 (1), 119–135.

Chisholm, D., Rehm, J., Van Ommeren, M., Monteiro, M., 2004. Reducing the global burden of hazardous alcohol use: a comparative cost-effectiveness analysis. J. Stud. Alcohol 65 (6), 782–793.

Darke, S., Kelly, E., Ross, J., 2004. Drug driving among injecting drug users in Sydney, Australia: prevalence, risk factors and risk perceptions. Addiction 99, 175–185.

Drummer, O.H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J.R.M., Robertson, M.D., Swann, P., 2004. The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes. Acc. Anal. Prev. 36, 239–248.

Dunbar, J.A., Penttila, A., Pikkarainen, J., 1987. Drinking and driving: Success of random breath testing in Finland. Brit. Med. J. (Clin. Res. Ed.) 295 (6590), 101–103.

European Monitoring Centre for Drugs and Drug Addiction, 2003. Drugs and Driving. European Monitoring Centre for Drugs and Drug Addiction, Lisbon.

Fergusson, D.M., 2005. Marijuana use and driver risks: the role of epidemiology and experimentation. Addiction 100, 577–578.

Fergusson, D.M., Horwood, L.J., 2001. Cannabis use and traffic accidents in a birth cohort of young adults. Acc. Anal. Prev. 33, 703–711.

Grasmick, H.G., Bryjak, G.J., 1980. The deterrent effect of perceived severity of punishment. Soc. Forces 59 (2), 471–491.

Hawkins, A., Bryant, P., Zipparo, L., 2004. Drug users' attitudes to drugs and driving. Paper presented at the Road Safety Research, Policing and Education Coonference, Perth, Western Australia, 14–16 November.

Hingson, R., McGovern, T., Howland, J., Heeren, T., Winter, M., Zakocs, R., 1996. Reduced alcohol-impaired driving in Massachusetts: The Saving Lives Program. Am. J. Public Health 86 (6), 791–797.

Homel, R., Carseldine, D., Kearns, I., 1988. Drink-driving countermeasures in Australia. Alcohol Drug Driv. 4 (2), 113–143.

Howe, E.S., Brandau, C.J., 1988. Additive effects of certainty, severity and celerity of punishment on judgements of crime deterrence scale value. J. Appl. Soc. Psychol. 18 (9), 796–812.

Howe, E.S., Loftus, T.C., 1996. Integration of certainty, severity, and celerity information in judged deterrence value: further evidence and methodological equivalence. J. Appl. Soc. Psychol. 26 (3), 226–242.

Kelly, E., Darke, S., Ross, J., 2004. A review of drug use and driving: epidemiology, impairment, risk factors and risk perceptions. Drug Alcohol Rev. 23, 319–344.

Lenne, M.G., Fry, C., Dietze, P., Rumbold, G., 2001. Attitudes and experiences of people who use cannabis and drive: Implications for drugs and driving legislation in Victoria, Australia. Drugs Ed. Prev. Pol. 8 (4), 307–313.

Monti, P.M., Barnett, N.P., O'Leary, T.A., Colby, S.M., 2001. Motivational enhancement for alcohol-involved adolescents. In: Monti, P.M., Colby, S.M., O'Leary, T.A. (Eds.), Adolescents, Alcohol, and Substance Abuse: Reaching Teens Through Brief Interventions. The Guilford Press, New York, pp. 145–182.

Moskowitz, H., 1985. Marihuana and driving. Acc. Anal. Prev. 17 (4), 323–345.

Nagin, D.S., 1998. Criminal deterrence research at the outset of the twenty-first century. In: Tonry, M. (Ed.), In: Crime and Justice: A Review of Research, 23. University of Chicago Press, Chicago, pp. 1–42.

Nagin, D.S., Paternoster, R., 1993. Enduring individual differences and rational choice theories of crime. Law Soc. Rev. 27 (3), 467–496.

Peek-Asa, C., 1999. The effect of random alcohol screening in reducing motor vehicle crash injuries. Am. J. Prev. Med. 16 (Suppl 1), 57–67.

Ramaekers, J.G., Berghaus, G., van Laar, M., Drummer, O.H., 2004. Dose related risk of motor vehicle crashes after cannabis use. Drug Alcohol Depend. 73, 109–119.

Reilly, D., Didcott, P., Swift, W., Hall, W., 1998. Long-term cannabis use: Characteristics of users in an Australian rural area. Addiction 93 (6), 837–846.

Rouen, D., Dolan, K., Kimber, J., 2001. A review of drug detection testing and an examination of urine, hair, saliva and sweat, NDARC Technical Report no. 120, National Drug and Alcohol Research Centre, Sydney.

Samyn, N., Boeck, G.D., Verstraete, A.G., 2002. The use of oral fluid and sweat wipes for the detection of drugs of abuse in drivers. J. Forens. Sci. 47 (6), 1380–1387.

Samyn, N., van Haeren, C., 2000. On-site testing of saliva and sweat with drugwipe and determination of concentrations of drugs of abuse in saliva, plasma and urine of suspected users. Int. J. Legal Med. 113, 150–154.

Skopp, G., Potsch, L., 1999. Perspiration versus saliva—basic aspects concerning their use in roadside drug testing. Int. J. Legal Med. 112, 213–221.

Smiley, A., 1999. Marijuana: on-road and driving simulator studies. In: Kalant, H., Corrigall, W., Hall, W., Smart, R.G. (Eds.), The Health Effects of Cannabis. Centre for Addiction and Mental Health, Toronto, pp. 173–191.

Stevenson, M., Palamara, P., Rooke, M., Richardson, K., Baker, M., Baumwol, J., 2001. Drink and drug driving: What's the skipper up to? Aust. NZ J. Public Health 25 (6), 511–513.

Svenson, O., 1981. Are we all less risky and more skillful than our fellow drivers? Acta Psychol. (Amst) 97, 143–148.

Swift, W., Copeland, J., Hall, W., 1998. Choosing a diagnostic cut-off for cannabis dependence. Addiction 93 (11), 1681–1692.

Terry, P., Wright, K., 2005. Self-reported driving behaviour and attitudes towards driving under the influence of cannabis among three different user groups in England. Addict. Behav. 30 (3), 619–626.

United Nations Office on Drugs and Crime, 2005. 2005 World Drug Report. United Nations Office on Drugs and Crime, Vienna.

Walsh, J.M., de Gier, J.J., Christophersen, A.S., Verstraete, A.G., 2004. Drugs and driving. Traffic Injury Prevent. 5, 241–253.

Wright, B.R.E., Caspi, A., Moffitt, T.E., Paternoster, R., 2004. Does the perceived risk of punishment deter criminally prone individuals? Rational choice, self-control, and crime. J. Res. Crime Delinq. 41 (2), 180–213.