



## Factors associated with driving under the influence of alcohol and drugs among an Australian sample of regular ecstasy users

Allison Matthews<sup>a,\*</sup>, Raimondo Bruno<sup>a</sup>, Jennifer Johnston<sup>b</sup>, Emma Black<sup>c</sup>,  
Louisa Degenhardt<sup>c</sup>, Matthew Dunn<sup>c</sup>

<sup>a</sup> School of Psychology, University of Tasmania, Private Bag 30, Hobart, TAS 7000, Australia

<sup>b</sup> Turning Point Alcohol and Drug Centre, 54–62 Gertrude Street, Fitzroy, VIC 3065, Australia

<sup>c</sup> National Drug and Alcohol Research Centre, University of New South Wales, NSW 2052, Australia

### ARTICLE INFO

#### Article history:

Received 14 January 2008

Received in revised form 26 August 2008

Accepted 28 August 2008

Available online 14 November 2008

#### Keywords:

Ecstasy

Alcohol

Cannabis

Methamphetamine

Drug driving

Drink driving

### ABSTRACT

The aim of the present study was to investigate factors associated with driving under the influence (DUI) of alcohol and other drugs (ecstasy, cannabis and methamphetamine) among a group of regular ecstasy users. Participants were those who participated in the Australian Ecstasy and related Drug Reporting System (EDRS) in 2007 and had recently driven a motor vehicle ( $n = 573$ ). Participants were administered a semi-structured face-to-face interview which included questions about ecstasy and other drug use, associated health-related issues, and risk behaviours. Close to half of those who were current consumers of ecstasy, cannabis, and methamphetamine had recently driven under the influence of these drugs, while two-fifths of current alcohol users reported recent drink driving. Frequency of use for each substance was the most significant correlate of DUI of alcohol, cannabis, and methamphetamine, suggesting that interventions targeting high frequency and problematic drug use may be useful in reducing the occurrence of DUI for these substances. Low perception of the likelihood of having an accident was the most significant correlate of DUI of ecstasy and also related significantly to DUI of other substances. Perceptions of low likelihood of being apprehended by police and demographic characteristics such as younger age and male sex were also weakly associated with DUI. Together these findings have important implications for targeted interventions aimed at reducing the occurrence of DUI among regular drug users.

© 2008 Elsevier Ireland Ltd. All rights reserved.

### 1. Introduction

Driving under the influence (DUI) of alcohol and other drugs is a serious road safety concern due to the potentially impairing effects of these substances on driving ability and the associated increased likelihood of motor vehicle accidents (MVA). Internationally, alcohol and other drugs have been implicated in 10%–50% and 5%–25% of MVA cases respectively, with poly-drug use and alcohol/drug combinations common (see Kelly et al., 2004). For example, among MVA fatalities in Australia (1990–1999), cannabis, opioids, benzodiazepines and amphetamines were the most common drugs detected other than alcohol, with ecstasy (3,4-methylenedioxyamphetamine, or MDMA) rarely detected (Drummer et al., 2003). Drivers under the influence of alcohol or other drugs are often found to be more likely to be culpable (responsible) for accidents than alcohol- or drug-free drivers, particularly

those cases in which both cannabis and alcohol were detected (Drummer et al., 2004; Longo et al., 2000a,b).

Research employing driving simulation, on-road driving, and other cognitive tasks has also aimed to determine the nature of driving-related impairment associated with specific drugs (see Kelly et al., 2004). While alcohol has consistently been found to produce a marked and dose-dependent impairment in the performance of driving simulation tasks and other driving-related cognitive tasks, evidence in relation to other drugs (e.g., cannabis, methamphetamine and ecstasy) has been less decisive (see Kelly et al., 2004) and there is a clear need for further research in this area. For example, low doses of MDMA have been shown to affect some (e.g., accident involvement; risk taking behaviours, accuracy of speed adaptation) but not other (e.g., vehicle control, road tracking, reaction time of speed adaptation) aspects of driving performance (Brookhuis et al., 2004; Ramaekers et al., 2006). Moreover, the complexity of real-life situations, such as driving under the influence of multiple drugs, after extended periods of use or without sleep, is often beyond the methodological scope of such controlled investigations. In summary, however, the bulk of evidence indicates that

\* Corresponding author. Tel.: +61 3 6226 7664; fax: +61 3 6226 2883.  
E-mail address: [Allison.Matthews@utas.edu.au](mailto:Allison.Matthews@utas.edu.au) (A. Matthews).

DUI of alcohol and illicit drugs is a serious road safety concern and thus it is pertinent to identify characteristics associated with DUI among regular drug using populations.

DUI of alcohol and other drugs has often been associated with demographic characteristics such as age and sex, patterns of substance use, risk perceptions towards DUI, and personality factors such as risk taking and impulsivity (Kelly et al., 2004). An overall higher prevalence of drug driving has been reported among those aged less than 35 years (Kelly et al., 2004). While some research findings indicate that males are more likely to DUI of drugs in comparison to females (e.g., Davey et al., 2005b; Walsh and Mann, 1999), other studies have reported no gender differences (Alvarez et al., 1991; Longo et al., 2000a). However, males are also more likely to be illicit drug users and to be involved in risky driving practices more generally (see Kelly et al., 2004), which may account for this discrepancy in the literature. A relationship has consistently been observed between DUI of alcohol and high alcohol consumption and/or alcohol-related problems (see Kelly et al., 2004). DUI of drugs has also been associated with higher dependence levels, frequency of drug use, polydrug use, and binge drug use among regular drug users (Darke et al., 2004; Duff and Rowland, 2006; Mallick et al., 2007; Matthews and Bruno, 2007). However, Albery et al. (2000) found no association between DUI and frequency of drug use or levels of dependence among out-of-treatment drug users.

Risk perceptions and attitudes also contribute to risky driving behaviour. Drug drivers often perceive that their driving skills are unaffected by drugs, and that alcohol impairs performance and increases accident risk more than drugs such as cannabis, and stimulants (Albery et al., 2000; Darke et al., 2004). Positive attitudes towards DUI of alcohol and drugs (Davey et al., 2005b), and perceptions of low likelihood of an accident (Jones et al., 2007) are also significant correlates of DUI. Individuals are also less likely to drink drive if they perceive that there is a high risk of being detected by police, but this association is less clear for drug driving and the chances of being apprehended while DUI of drugs are typically perceived to be lower (Darke et al., 2004; Davey et al., 2005a; Degenhardt et al., 2004). For example, Davey et al. (2005b) found that attitudes towards law and detection were associated with drink driving but not drug driving among a sample of university students.

The aim of the present research is to examine the extent of DUI of alcohol and other drugs, and perceptions of impairment and risk while DUI among a cohort of participants reporting at least monthly ecstasy use in the preceding 6 months. DUI is an issue of interest among this cohort due to high levels of DUI reported in previous studies (Black et al., 2008). Whereas previous research has identified several correlates of DUI, few previous studies have investigated the relative contribution of these factors to DUI among regular ecstasy users. Thus, a further aim of the present research was to investigate the association of factors such as age, sex, perceptions of risk (both accident and legal), and frequency of use to DUI of alcohol and other drugs (ecstasy, cannabis, and methamphetamine) among this cohort. The identification of factors associated with DUI has important implications for the development of targeted interventions to reduce the prevalence of DUI and improve road safety among this population.

## 2. Method

### 2.1. Participants and procedure

Interviews were conducted as part of the Australian Ecstasy and Related Drug Reporting System (EDRS; formerly the Party Drugs Initiative, PDI), a study designed to monitor trends in the markets for ecstasy and other related drugs. The structured questionnaire was based on an instrument devised during the initial feasibility study for the project (Topp et al., 2004). Participants included in the current analysis ( $n = 573$ ) were those interviewed for the 2007 EDRS ( $N = 741$ ) who reported driv-

ing a vehicle during the 6 months preceding interview. Participants were recruited through a purposive sampling strategy (Kerlinger, 1986), which included the distribution of posters and flyers at various locations (e.g., cafes, bars, nightclubs, clothing stores, music stores, universities), posting on internet forums, and through 'snowball' methods (word of mouth). Potential participants contacted the researchers and were screened for eligibility. Inclusion criteria required that participants be at least 16 years of age, to have used ecstasy at least once a month during the preceding 6 months, and have been a resident of the jurisdiction in question for the past year. Ethics approval was granted by relevant ethics committees in each jurisdiction. Participants gave written informed consent prior to the interview and all information provided was confidential and anonymous.

Interviews took between 45 and 60 min to complete and were administered by trained interviewers at locations that were mutually acceptable to respondent and interviewer (e.g., coffee shops, university campuses). All participants were reimbursed \$30AUD to cover travel and out of pocket expenses. A structured interview was administered including questions on demographic characteristics, patterns of ecstasy and other drug use, criminal activity, problems attributed to ecstasy and other drugs, and risk behaviours such as intravenous drug use, sexual risk taking, and driving under the influence of alcohol and other drugs.

For the present study, participants were asked if they had used each substance (ecstasy, alcohol, cannabis, and methamphetamine) during the 6 months preceding the interview, and if so, how many days they had used the substance, and whether they had driven under the influence of the substance during this time. DUI of alcohol was defined as driving while self-perceived to be over the legal limit (blood alcohol content, BAC, greater than 0.05), DUI of illicit substances was defined as driving a vehicle within an hour of taking a given substance. Those who had driven under the influence of illicit drugs in the last 6 months were asked the last drug they had DUI under, and to rate how impaired they perceived their driving to have been on this occasion, on a Likert scale ranging from 1 (quite impaired) to 5 (quite improved). All participants were asked to rate their perception of both the likelihood of having an accident (risk perception: accident) and the likelihood of being apprehended by police (risk perception: legal) if they were DUI of alcohol (over the legal limit), ecstasy, cannabis, and methamphetamine on a 5 point Likert scale ranging from 1 (very unlikely) to 5 (very likely).

### 2.2. Design and data analysis

All statistical analyses were conducted using SPSS 12.0.1 for Windows (SPSS Inc., 2003). The  $\chi^2$  test and 95% confidence intervals were used to compare categorical data and the non-parametric Mann-Whitney  $U$  test was used to compare continuous data. Based on variables known to be associated with risky driving behaviour, a series of regression analyses were conducted to examine the correlates of DUI of alcohol, ecstasy, cannabis, and methamphetamine for those who had used each drug in the last 6 months. Logistic regression with stepwise removal was performed, in order to avoid the erroneous exclusion of variables involved in suppressor effects, using significant change ( $p < 0.10$ ) in the likelihood statistic as criterion (due to the exploratory nature of the analyses). However, to provide an estimate of the influence of each factor, the change in Nagelkerke  $R^2$  values on entry, using a forward stepwise entry approach, are provided. For all analyses, the following variables were assessed: age (in years), sex (male = 0, female = 1), frequency of target drug use in the preceding 6 months (days), risk perception (accident) and risk perception (legal) for each target drug (ranging from 1 to 5, where higher scores reflect increased risk). For each regression analysis, those who had not used the target drug in the preceding 6 months, those with 'don't know' responses for risk perception variables, and those with missing data on other variables were excluded.

## 3. Results

### 3.1. Demographic characteristics of regular ecstasy users

The 573 participants had a median age of 23 years (range 17–54) and were predominantly male (60%, 95% CI 56–65). The majority of participants were heterosexual (82%, 95% CI 79–86) and all spoke English as their main language. Three-quarters of the sample (75%, 95% CI 72–79) had completed secondary education (year 12), and the majority were either employed (61%, 95% CI 54–69) or students (23%, 95% CI 19–26). Only a minority had ever received a custodial sentence (5%, 95% CI 3–7) or were currently in drug treatment (2%, 95% CI 1–4).

### 3.2. Recent drug use and DUI among regular ecstasy users

Table 1 shows recent drug use, frequency of drug use, and prevalence of DUI of alcohol and drugs during the 6 months preceding

**Table 1**  
Recent drug use and occurrence of DUI of alcohol and illicit drugs among regular ecstasy users.

N = 573	
<b>Alcohol</b>	
% Used alcohol in last 6 months (95% CI)	97 (96–98)
% Driven over legal alcohol limit in last 6 months <sup>a</sup> (95% CI)	39 (34–43)
<b>Ecstasy</b>	
% Used ecstasy in last 6 months	100
Median days used ecstasy (range)	12 (4–104)
% Driven under the influence of ecstasy in last 6 months <sup>a</sup> (95% CI)	53 (48–57)
<b>Cannabis</b>	
% Used cannabis in last 6 months (95% CI)	82 (79–85)
Days used cannabis (range) <sup>a</sup>	25 (1–180)
% Driven under the influence of cannabis in last 6 months <sup>a</sup> (95% CI)	53 (48–57)
<b>Methamphetamine</b>	
% Used methamphetamine in last 6 months (95% CI)	70 (66–74)
Median days used methamphetamine (range) <sup>a</sup>	6 (1–180)
% Driven under the influence of methamphetamine in last 6 months <sup>a</sup> (95% CI)	49 (44–54)

<sup>a</sup>Of those who had used the drug in the last 6 months.

the interview. Due to the inclusion criteria for the study, all participants had used ecstasy during the 6 months preceding the interview. Ecstasy had been used on a median frequency of 12 days during this time, or approximately fortnightly. The majority had also used alcohol (97%), cannabis (82%), or methamphetamine (70%) during this time. Alcohol had been used on a median of 48 days, or approximately twice a week, cannabis on a median of 25 days, or approximately once a week, and methamphetamine used on a median 6 days, or approximately monthly in the preceding 6 months.

Among those that had used alcohol during the 6 months preceding the interview, almost two-fifths (39%) had driven when they perceived themselves to have been over the legal BAC limit (0.05% in Australia), doing so on a median of 4 days (range 1–90) during this time. Almost half (43%) of those who had driven under the influence of alcohol reported that they had been random breath tested during this time and one-fifth (20%) of these participants reported that they were over the legal BAC limit on at least one occasion. Almost three-quarters (72%) of the sample reported DUI of illicit drugs during the 6 months prior to interview. Those that

reported DUI of illicit drugs had done so on a median of 5 occasions (range 1–180) during this time, or slightly less than once a month. A very small proportion (2%) of those who had driven under the influence of drugs had been roadside drug tested during this time.

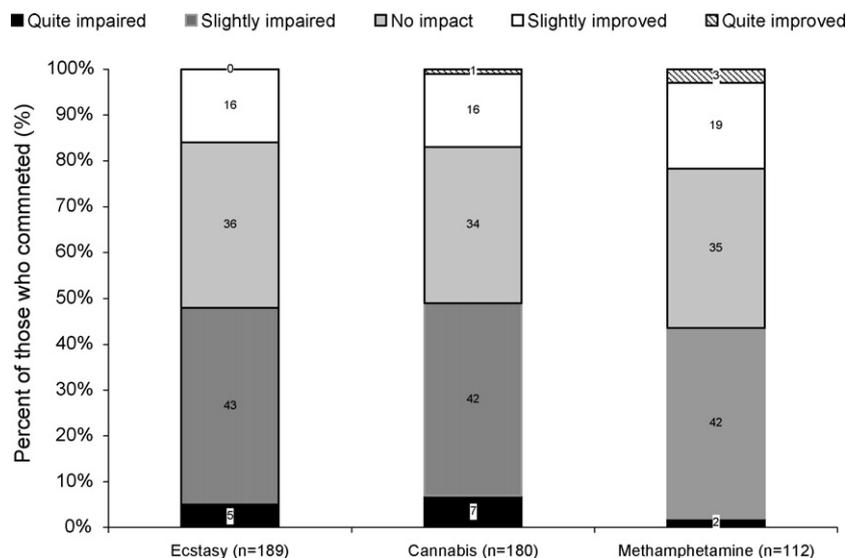
Just over half (53%) of participants had driven under the influence of ecstasy during the 6 months preceding the interview. Similarly, close to half of those that had recently used cannabis (53%) or methamphetamine (49%) had also recently driven under the influence of these drugs during this time. There was considerable overlap between those that had recently DUI alcohol and drugs, with those who had recently driven while over the legal BAC limit significantly more likely to have driven under the influence of any illicit drug compared to those who had not (86% vs. 62%,  $\chi^2 = 35.68$ ,  $p < .001$ ).

### 3.3. Perceptions of driving impairment

Fig. 1 shows that there were no differences in the perception of driving impairment due to drugs for those who had last driven under the influence of ecstasy, cannabis, or methamphetamine. For all drugs, two-fifths (42%–43%) indicated that their driving ability had been 'slightly impaired' and less than one-tenth (2%–7%) indicated that their driving ability had been 'quite impaired' the last time that they had driven under the influence of the drug. Approximately one-third (34%–36%) indicated that drug use had 'no impact' on driving ability the last time that they had driven under the influence of the drug. The remainder of those who commented indicated that their driving ability was 'slightly improved' (16%–19%), or 'quite improved' (1%–3%).

### 3.4. Perceptions of driving risk

Among the full sample, examination of the perceived likelihood of having an accident while DUI revealed that over three-quarters (76%) of those who commented on alcohol perceived that having an accident while driving over the legal BAC limit was 'likely' or 'very likely', and smaller proportions considered it to be 'no more or less likely' (23%), 'unlikely' (6%), or 'very unlikely' (1%). In contrast, approximately two-fifths or less (35%–44%) perceived that having an accident while DUI of other substances (ecstasy, cannabis, methamphetamine) was 'likely' or 'very likely', with over



**Fig. 1.** Perceptions of driving impairment of those who had driven under the influence of ecstasy, methamphetamine, and cannabis in the last 6 months.

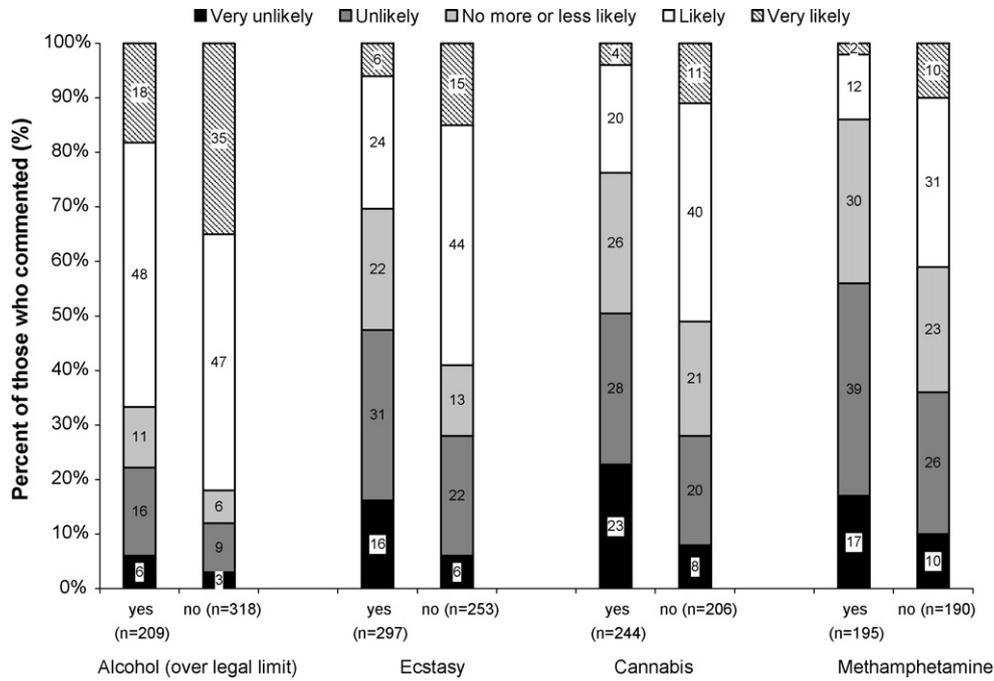


Fig. 2. Perceived likelihood of having an accident while DUI of alcohol, ecstasy, cannabis, and methamphetamine among those who had or had not DUI in the last 6 months.

half (65%–56%) indicating that the risk of having an accident was ‘no more or less likely’, ‘unlikely’ or ‘very unlikely’. The proportion who perceived that having an accident while DUI was ‘likely’ or ‘very likely’ was significantly higher for alcohol (76%, 95% CI 72–80%,  $n = 553$ ) relative to all other substances, and significantly lower for methamphetamine (35%, 95% CI 31–39%,  $n = 524$ ) in comparison to ecstasy (44%, 95% CI 40–48%,  $n = 550$ ), with cannabis falling in between (40%, 95% CI 36–44%,  $n = 535$ ).

Fig. 2 shows the risk of accident perceptions among those who had used each substance in the preceding 6 months as a function of whether they had DUI of these substances during this time. A

significantly greater proportion of those who had not driven under the influence of alcohol perceived that having an accident while DUI of alcohol was ‘likely’ or ‘very likely’ in comparison to those who had recently driven under the influence of alcohol (82% vs. 67%,  $\chi^2 = 16.71, p < .001$ ). Similarly, for each of the illicit drug types under consideration, those who had not driven under the influence were significantly more likely to rate the likelihood of having an accident as ‘likely’ or ‘very likely’ than those who had recently driven under the influence: for ecstasy (59% vs. 30%,  $\chi^2 = 46.67, p < .001$ ), cannabis (51% vs. 23%,  $\chi^2 = 36.96, p < .001$ ), and methamphetamine (41% vs. 14%,  $\chi^2 = 35.91, p < .001$ ).

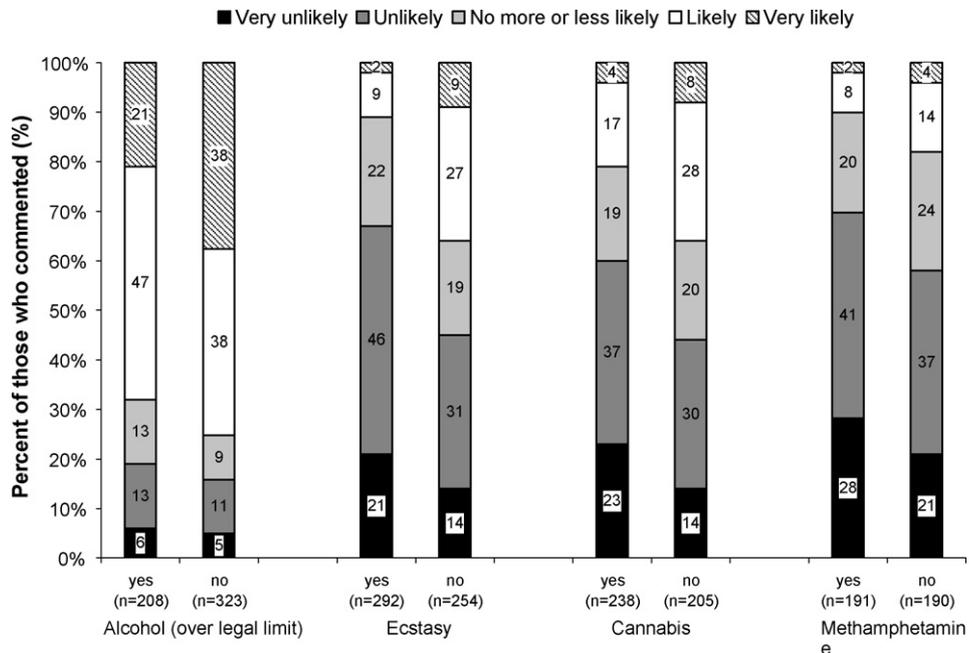


Fig. 3. Perceived likelihood of being caught by police while DUI of alcohol, ecstasy, cannabis, and methamphetamine among those who had or had not DUI in the last 6 months.

Among the whole sample, almost three-quarters (73%) of those who commented on alcohol, perceived that being caught by police while driving over the legal BAC limit was 'likely' or 'very likely', and smaller proportions considered it to be 'no more or less likely' (10%), 'unlikely' (11%), or 'very unlikely' (6%). In contrast, approximately one-third or less (29%–19%) perceived that being caught by police while DUI of other substances (ecstasy, cannabis, methamphetamine) was 'likely' or 'very likely', with over two-thirds (71%–81%) indicating that the risk of being caught by police was either 'no more or less likely', 'unlikely' or 'very unlikely'. The proportion who perceived that being caught by police while DUI was 'likely' or 'very likely' was significantly lower for methamphetamine (19%, 95% CI 16–22%,  $n = 521$ ) in comparison to cannabis (29%, 95% CI 25–33%,  $n = 530$ ), with the perception for ecstasy not differing from either drug (23%, 95% CI 20–27%,  $n = 546$ ).

Fig. 3 shows perceptions of the risk of being apprehended by police among those who had used each substance in the preceding 6 months as a function of whether they had DUI of this substance during this time. There was a trend for a greater proportion of those who had not driven under the influence of alcohol to rate the likelihood of being caught by police while DUI of alcohol as 'likely' or 'very likely' in comparison to those who had recently driven under the influence of alcohol (76% vs. 68%,  $\chi^2 = 3.37$ ,  $p = .066$ ). Similarly, for each of the illicit drug types under consideration, those who had not driven under the influence were significantly more likely to rate the likelihood of being caught by the police as 'likely' or 'very likely' than those who had recently driven under the influence: for ecstasy (36% vs. 12%,  $\chi^2 = 46.22$ ,  $p < .001$ ), cannabis (36% vs. 21%,  $\chi^2 = 12.44$ ,  $p < .001$ ), and methamphetamine (18% vs. 11%,  $\chi^2 = 35.91$ ,  $p < .001$ ).

### 3.5. Factors associated with driving under the influence of alcohol and drugs

Logistic regression analyses were performed to identify the correlates of DUI of alcohol (over the legal BAC limit), ecstasy, cannabis, and methamphetamine (Table 2). After the exclusion of those who had not used alcohol in the last 6 months ( $n = 20$ ) and those with missing data on continuous variables ( $n = 32$ ), data from 521 participants were available for analysis of DUI of alcohol. The significant

regression model accounted for 17% of variance and correctly classified 68% of all cases, but just 41% of those who had recently driven under the influence of alcohol,  $\chi^2(4, n = 521) = 70.01$ ,  $p < 0.001$  (Cox and Snell  $R^2 = 0.13$ , Nagelkerke  $R^2 = 0.17$ ). Of the variables examined, frequency of alcohol use had the strongest independent association with DUI of alcohol, accounting for 10.2% of variance in the model, followed by risk perception of having an accident (3.3%), sex (1.9%) and age (1.6%). Risk perception (legal) did not contribute unique variance to the model. Thus, more frequent alcohol use, lower perceptions of accident risk, male sex, and younger age were associated with increased risk of DUI of alcohol.

After the exclusion of those with missing data on continuous variables ( $n = 40$ ), data from 533 cases were available for analysis of DUI of ecstasy. Lower perceptions of the likelihood of having an accident or being apprehended by police, a greater frequency of ecstasy use, and male sex contributed to an increased risk of DUI of ecstasy (Table 2),  $\chi^2(4, n = 533) = 71.16$ ,  $p < 0.001$  (Cox and Snell  $R^2 = 0.13$ , Nagelkerke  $R^2 = 0.17$ ). This model accounted for 17% of variance, correctly classifying 68% of all cases, and a substantial 75% of those who had recently driven under the influence of ecstasy. Risk perception (accident) had the strongest independent association with DUI of ecstasy (10.2%) and risk perception (legal), frequency of ecstasy use, and sex made small but significant contributions (3.8%, 1.7%, and 1% of unique variance respectively). Age was not associated with DUI of ecstasy.

Data from 434 participants were available for analysis of DUI of cannabis, after the exclusion of those who had not recently used cannabis ( $n = 105$ ) and those with missing data ( $n = 34$ ). More frequent cannabis use and lower perceptions of accident risk were associated with DUI of cannabis. The regression model accounted for 28% of variance and correctly classified 72% of all cases and 69% of those who had DUI of cannabis in the 6 months preceding the interview (Table 2),  $\chi^2(4, n = 434) = 103.48$ ,  $p < 0.001$  (Cox and Snell  $R^2 = 0.21$ , Nagelkerke  $R^2 = 0.28$ ). Frequency of cannabis use had the strongest independent association with DUI of cannabis, accounting for over one-quarter (25.9%) of unique variance. Risk perception (accident) also contributed significantly to DUI of cannabis (2.5%). Age, sex, and risk perception (legal) did not contribute to the model.

**Table 2**  
Logistic regression models for identifying the correlates of DUI of alcohol (over legal BAC limit), and driving within 1 h of using ecstasy, cannabis or methamphetamine.

	B (SE)	Wald	$\Delta R^2$ <sup>~</sup>	OR	95% CI
<b>DUI of alcohol (<math>n = 521</math>)</b>					
Constant	1.43 (0.58)	6.12 <sup>*</sup>	–	–	–
Days used alcohol in last 6 months	0.01 (0.01 <sup>#</sup> )	30.05 <sup>***</sup>	0.102	1.01	1.01–1.02
Risk perception (Accident)	–0.33 (0.09)	13.34 <sup>**</sup>	0.033	0.72	0.60–0.86
Age (range 17–54 years)	–0.05 (0.02)	8.13 <sup>**</sup>	0.016	0.96	0.93–0.99
Sex (female)	–0.57 (0.20)	8.12 <sup>**</sup>	0.019	0.56	0.38–0.84
<b>DUI of ecstasy (<math>n = 533</math>)</b>					
Constant	1.98 (0.34)	34.55 <sup>***</sup>	–	–	–
Risk perception (Accident)	–0.37 (0.08)	19.88 <sup>***</sup>	0.102	0.69	0.59–0.87
Risk perception (Legal)	–0.32 (0.09)	12.40 <sup>***</sup>	0.038	0.73	0.61–0.87
Frequency of ecstasy use	0.02 (0.01)	6.26 <sup>*</sup>	0.017	1.02	1.01 <sup>#</sup> –1.03
Sex (female)	–0.40 (0.19)	4.36 <sup>*</sup>	0.010	0.67	0.46–0.98
<b>DUI of cannabis (<math>n = 434</math>)</b>					
Constant	0.24 (0.34)	.50	–	–	–
Days used cannabis in last 6 months	0.14 (0.01)	50.50 <sup>***</sup>	0.259	1.01	1.01–1.02
Risk perception (Accident)	–0.30 (0.10)	9.79 <sup>**</sup>	0.025	0.74	0.61–0.89
<b>DUI of methamphetamine (<math>n = 376</math>)</b>					
Constant	1.11 (0.38)	8.78	–	–	–
Days used methamphetamine last 6 months	0.03 (0.01)	22.30 <sup>***</sup>	0.150	1.03	1.02–1.05
Risk perception (Accident)	–0.42 (0.11)	14.94 <sup>***</sup>	0.064	0.66	0.53–0.81
Risk perception (Legal)	–0.20 (0.11)	2.94 <sup>†</sup>	0.009	0.82	0.66–1.03

Note: Less than three percent of cases had normalized residuals  $>|2|$ . <sup>~</sup>Nagelkerke  $R^2$  value change calculated using forward stepwise entry of factors into the model. <sup>†</sup> $p < 0.1$ , <sup>\*</sup> $p < 0.05$ , <sup>\*\*</sup> $p < 0.01$ , <sup>\*\*\*</sup> $p < .001$ . <sup>#</sup>value rounded up to nearest two decimal places. The categorical values for Sex were defined as 1 for females and 0 for males. Numbers per analysis varies as those that had not used a target drug were necessarily excluded from the associated analysis.

For the analysis of DUI of methamphetamine, data from 376 participants were available after the exclusion of those who had not used methamphetamine in the last 6 months ( $n=173$ ) and those with missing data ( $n=24$ ). More frequent methamphetamine use and lower perceptions of the likelihood of having an accident or being apprehended by police while DUI of methamphetamine were associated with increased the risk of DUI of methamphetamine (Table 2). This model accounted for 22% of variance and correctly classified 68% of all cases and 65% of those who had recently driven under the influence of methamphetamine,  $\chi^2(3, n=376)=68.57$ ,  $p<0.001$  (Cox and Snell  $R^2=0.17$ , Nagelkerke  $R^2=0.22$ ). Out of the variables examined, frequency of methamphetamine use had the strongest independent association with DUI of methamphetamine, accounting for 15% of unique variance in the model. Risk perception (accident) and risk perception (legal) also accounted for small but significant amounts of unique variance (6.4% and 0.9% respectively). Sex and age did not contribute unique variance to the model.

To examine any demographic differences between those included in the logistic regression analyses and those excluded due to missing data, further non-parametric (Mann–Whitney  $U$ ) and  $\chi^2$  analyses were used to investigate age and sex differences respectively. There were no significant differences in age or sex between those included and those excluded for alcohol, ecstasy, and methamphetamine. There was no significant difference in terms of sex for cannabis; however, those excluded from analyses ( $n=34$ ) were significantly older than those included ( $n=434$ ), Mann–Whitney  $U=5750.5$ ,  $p<.05$ . Thus older participants were more likely to respond that they did not know about the risks (legal and accident) associated with DUI of cannabis and were therefore more likely to be excluded.

#### 4. Discussion

Few previous studies have investigated DUI and associated correlates among people who regularly consume ecstasy. In the present study, a large majority of the regular ecstasy users interviewed also reported use of alcohol (97%), cannabis (82%), and methamphetamine (70%) during the 6 months preceding the interview, and a substantial proportion (39%–53%) of these participants reported DUI of these substances during this time. DUI was most strongly associated with frequency of use and risk perceptions (both accident and legal), and to a lesser extent demographic characteristics such as age and sex. These findings have important implications for targeted interventions aimed at reducing the prevalence of DUI among this population.

Two-fifths of those who had recently used alcohol had driven under the influence of alcohol (over the legal BAC limit) during the 6 months preceding the interview, and close to half of those who had recently used ecstasy, cannabis, and methamphetamine had driven under the influence of these substances during this time. Whereas these estimates of the prevalence of DUI are considerably higher than Australian population estimates of DUI provided by the 2004 National Drug Strategy Household Survey (Australian Institute of Health and Welfare, AIHW, 2005), they are largely consistent with the high rate of DUI of drugs among other samples selected on the basis of regular drug use, and research investigating DUI among night club and dance party attendees (Darke et al., 2004; Degenhardt et al., 2004; Duff and Rowland, 2006; Lenton and Davidson, 1999; Mallick et al., 2007).

The EDRS uses a purposive sampling framework to investigate drug use among a sentinel group of regular ecstasy users, and is therefore not representative of all ecstasy users; however, the high frequency of drug use and DUI among the present sample is a significant strength of the study, as it allows for a detailed exploration of

associations between different drug use and risk perception variables. DUI of illicit drugs was perceived as less risky in terms of having an accident and in terms of being apprehended by police than DUI of alcohol. Furthermore, those who had recently DUI had lower perceptions of both accident and legal risk compared to those that had not, suggesting that risk perceptions may play a role in the decision to drive under the influence. These findings are broadly consistent with previous research in this area (Albery et al., 2000; Darke et al., 2004; Davey et al., 2005a,b; Degenhardt et al., 2004; Mallick et al., 2007).

Investigation of the correlates of DUI of alcohol, ecstasy, cannabis, and methamphetamine revealed significant logistic regression models that correctly classified between 40% and 72% of risk cases. Frequency of recent use was the most significant correlate of DUI of cannabis, methamphetamine and alcohol. Frequency of ecstasy use was only weakly associated with DUI of ecstasy, which may be a reflection of the selection criteria employed in the current study (i.e., selection on the basis of regular ecstasy use may have reduced the variability on this measure). These findings are consistent with previous research (e.g., Darke et al., 2004; Duff and Rowland, 2006; Mallick et al., 2007; Matthews and Bruno, 2007) and suggest an association between DUI and the frequency or extent of drug and alcohol use. Thus interventions designed to reduce levels of drug use or dependence in an individual may also have follow-on effects for the wider community in terms of reducing DUI (see Jones et al., 2007; Mallick et al., 2007). Examples of such targeted interventions include diversionary programs within the judicial system which aim to address drug use.

In contrast to other substances, perception of the likelihood of having an accident was the strongest correlate of DUI of ecstasy. Accident risk was also weakly associated with DUI of alcohol, cannabis, and methamphetamine. Thus interventions which provide clear information about the level of risk associated with DUI of drugs (e.g., advertising and education campaigns) may be useful in decreasing levels of DUI, particularly among regular ecstasy consumers. It has been reported that a television advertising campaign outlining the risks of driving under the influence of cannabis would deter 30% of regular cannabis users from DUI (Terry and Wright, 2005). However, other research suggests that an increase in the certainty of punishment would produce greater potential reductions in DUI of cannabis than providing information about potential risks (Jones et al., 2006). Furthermore, considering the mixed findings in relation to the effects of drugs such as ecstasy, methamphetamine, and cannabis on driving ability (Brookhuis et al., 2006; Kelly et al., 2004; Ramaekers et al., 2006; Silber et al., 2006), further research is required in order for such interventions to be accurately informed and evidence-based.

Perception of the likelihood of being apprehended by police was associated with DUI of methamphetamine and to a lesser extent ecstasy, but was not a significant correlate of DUI of alcohol and cannabis. Although roadside drug testing had been introduced in four out of the eight Australian capital city jurisdictions at the time of data collection for the present study, legislation has since been implemented (or is on the process of being implemented) in most Australian jurisdictions. This provides a unique opportunity for future investigation into the effectiveness of drug driving campaigns in changing the occurrence of and attitudes towards DUI among regular drug users.

Previous research has indicated that DUI is more common among younger individuals (<35) (Kelly et al., 2004) and that males are overrepresented among those who drive over the influence of alcohol and illicit drugs (e.g., Davey et al., 2005b; Walsh and Mann, 1999). Among this relatively young sample of regular ecstasy users (typically in early to mid 20s), these factors accounted for very small amounts of variance, such that being younger and male was asso-

ciated with DUI of alcohol and being male was associated with DUI of ecstasy. Several other factors that were not investigated in the present study may also be associated with DUI. For example, it is likely that participants were under the influence of more than one substance on the occasion that they had driven under the influence, and it is possible that polydrug use plays a role in DUI. Furthermore, personality factors such as impulsivity and low constraint have also been found to be associated with DUI (Begg et al., 2003; Fernandes et al., 2007; Jonah, 1997). Access to public transport is also an important factor in the decision to drive under the influence (Duff and Rowland, 2006) and therefore interventions which aim to increase access to public transport may also be suitable for targeting this population.

In summary, DUI of alcohol and other drugs was relatively common among this 'at-risk' sample of regular ecstasy users. Consistent with previous literature, those who reported DUI typically perceived that their driving was not impaired by drugs, and they perceived that there was less risk of having an accident or being apprehended by police relative to those who had not. Frequency of drug use was the most significant correlate of DUI of alcohol, cannabis and methamphetamine, and more weakly, for ecstasy. Perception of accident risk was the most significant correlate of DUI of ecstasy and was also associated with DUI of alcohol, cannabis, and methamphetamine. Perceptions of the risk of being apprehended by police and demographic factors were less strongly associated with the likelihood of DUI. These findings have implications for the development of appropriately targeted interventions aimed at reducing risky driving practices among regular drug users. Interventions that aim to increase awareness of the accident risk of DUI as well as indirect interventions that aim to reduce the frequency of drug use, may be particularly useful in this population.

### Role of funding source

The Ecstasy and Related Drugs Reporting System (EDRS) is funded by the Australian Government Department of Health and Aging (AGDH&A) and coordinated by the National Drug and Alcohol Research Centre, University of New South Wales. AGDH&A had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the paper for publication.

### Contributors

The study reported here is based on a module added to the Ecstasy and Related Drug Reporting System (EDRS). The EDRS is an ongoing study and multiple researchers at the National Drug and Alcohol Research Centre and collaborating teams have contributed to its development. Details of the development of the EDRS study are described in Topp et al. (2004).

All authors of this manuscript (Matthews, Bruno, Johnston, Black, Dunn, Degenhardt) have contributed to the development of the EDRS study and specifically to the module discussed in the current manuscript.

Author 1 (Matthews) managed the literature searches and summaries of previous related work. Authors 1 and 2 (Matthews & Bruno) undertook the statistical analysis, and author 1 (Matthews) wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

### Conflict of interest

All authors declare that they have no conflicts of interest.

### Acknowledgements

In addition to the authors, the following researchers and research institutions contributed to the data collected for this study: Prof Louisa Degenhardt, Emma Black, Jennifer Stafford, Dr Matthew Dunn and Gabrielle Campbell, National Drug and Alcohol Research Centre; Brendan Quinn, Heidi Strickland, Dr Jennifer Johnston and Rebecca Jenkinson, Turning Point Alcohol and Drug Centre Inc. Dr Allison Matthews and Dr Raimondo Bruno, University of Tasmania; Robyn Vial, Dr Nancy White and A/Prof Robert Ali, Drug and Alcohol Services South Australia; Jessica George, Tanja L'Veena and A/Prof Simon Lenton, National Drug Research Institute; Ana Urbancic-Kenny and Dr Stuart Kinner, Queensland Alcohol and Drug Research and Education Centre. We would also like to extend our thanks to the agencies and individuals who assisted with recruitment and interviewing and finally the regular ecstasy users who were willing to be interviewed and share their experience.

### References

- AIIHW, 2005. 2004 National Drug Strategy Household Survey. Australian Institute of Health and Welfare, Canberra.
- Albery, I.P., Strang, J., Gossop, M., Griffiths, 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.
- Alvarez, F.J., Prada, R., Del Rio, M.C., 1991. 'Illegal' drugs and driving in Spain. *Accid. Anal. Prev.* 19, 491–492.
- Begg, D.J., Langley, J.D., Stephenson, S., 2003. Identifying factors that predict persistent driving after drinking, unsafe driving after drinking, and driving after using cannabis among young adults. *Accid. Anal. Prev.* 35, 669–675.
- Black, E., Dunn, M., Degenhardt, L., Campbell, G., George, J., Kinner, S., Matthews, A., Quinn, B., Newman, J., White, N. (2008). Australian drug trends 2007: findings from the Ecstasy and Related Drugs Reporting System (EDRS). Sydney: Australian Drug Trends Series No. 10. National Drug and Alcohol Research Centre, University of New South Wales, Sydney.
- Brookhuis, K.A., de Waard, D., Samyn, N., 2004. Effects of MDMA (ecstasy), and multiple drugs use on (simulated) driving performance and traffic safety. *Psychopharmacology* 173, 440–445.
- 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.
- Davey, J., Davies, A., French, N., Williams, C., Lang, C.P., 2005a. Drug driving from a users perspective. *Drugs: Education, Prevention and Policy*, vol. 12, pp. 61–70.
- Davey, J.D., Davey, T., Obst, P.L., 2005b. Drug and drink driving by university students: an exploration of the influence of attitudes. *Traffic Inj. Prev.* 6, 44–52.
- Degenhardt, L., Dillon, P., Duff, C., Ross, J., 2004. Driving, drug use behaviour and risk perceptions of nightclub attendees in Victoria. *Int. J. Drug Policy* 17, 41–46.
- Drummer, O.H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J., Robertson, M.D., Swann, P., 2003. The incidence of drugs in drivers killed in Australian road traffic crashes. *For. Sci. Int.* 134, 154–162.
- Drummer, O.H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J., Robertson, M.D., Swann, P., 2004. The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes. *Accid. Anal. Prev.* 36, 239–248.
- Duff, C., Rowland, B., 2006. 'Rushing behind the wheel': investigating the prevalence of 'drug driving' among club and rave patrons in Melbourne, Australia. *Drugs: Education, Prevention and Policy*, vol. 13, pp. 299–312.
- Fernandes, R., Soames Job, R.F., Hatfield, J., 2007. A challenge to the assumed generalizability of prediction and countermeasure for risky driving: different factors predict different risky driving behaviors. *J. Safety Res.* 38, 59–70.
- Jonah, B.A., 1997. Sensation seeking and risky driving: a review and synthesis of the literature. *Accid. Anal. Prev.* 33, 651–665.
- Jones, C., Donnelly, N.J., Swift, W., Weatherburn, D.J., 2006. Preventing cannabis users from driving under the influence of cannabis. *Accid. Anal. Prev.* 38, 854–861.
- Jones, C.G.A., Swift, W., Donnelly, N.J., Weatherburn, D.J., 2007. Correlates of driving under the influence of cannabis. *Drug Alcohol Depend.* 88, 83–86.
- 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.
- Kerlinger, F.N., 1986. *Foundations of Behavioral Research*. CBS Publishing Limited, Japan.
- Lenton, S., Davidson, P., 1999. Raves, drugs, dealing and driving: qualitative data from a West Australian sample. *Drug Alcohol Rev.* 18, 153–161.
- Longo, M.C., Hunter, C.E., Lokan, R.J., White, J.M., White, M.A., 2000a. The prevalence of alcohol, cannabinoids, benzodiazepines and stimulants amongst injured drivers and their role in driver culpability. Part I: the prevalence of drug use in drivers, and characteristics of the drug-positive group. *Accid. Anal. Prev.* 32, 613–622.

- Longo, M.C., Hunter, C.E., Lokan, R.J., White, J.M., White, M.A., 2000b. The prevalence of alcohol, cannabinoids, benzodiazepines, and stimulants amongst injured drivers and their role in driver culpability. Part II: the relationship between drug prevalence and drug concentration, and driver culpability. *Accid. Anal. Prev.* 32, 623–632.
- Mallick, J., Johnston, J., Netzach, G., Kennedy, V., 2007. *Drugs and Driving in Australia: A Survey of Community Attitudes, Experience and Understanding*. Australian Drug Foundation, Melbourne.
- Matthews, A., Bruno, R. (2007). *Tasmanian Trends in Ecstasy and Related Drug Markets 2006: Findings from the Ecstasy and Related Drugs Reporting System (EDRS)*. National Drug and Alcohol Research Centre Technical Report No. 281. University of New South Wales, Sydney.
- Ramaekers, J.G., Kuypers, K.P.C., Samyn, N., 2006. Stimulant effects of 3, 4-methylenedioxymethamphetamine (MDMA) 75 mg and methylphenidate 20 mg on actual driving during intoxication and withdrawal. *Addiction* 101, 1614–1621.
- Silber, B.Y., Croft, R.J., Papafotiou, K., Stough, C., 2006. The acute effects of d-amphetamine and methamphetamine on attention and psychomotor performance. *Psychopharmacology* 187, 154–169.
- 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, 619–626.
- Topp, L., Breen, C., Kaye, S., Darke, S., 2004. Adapting the Illicit Drug Reporting System (IDRS) methodology to examine the feasibility of monitoring trends in party drug markets. *Drug Alcohol Depend.* 73, 189–197.
- Walsh, G.W., Mann, R.E., 1999. On the high road: driving under the influence of cannabis in Ontario. *Can. J. Public Health* 90, 260–263.