



# Individual differences in distress, impulsivity, and coping motives for use as predictors of problematic ecstasy use



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## HIGHLIGHTS

- Trait impulsivity and psychological distress both predict problem ecstasy use.
- These effects are independent of amount of ecstasy use.
- Effect of distress on problem use is partially mediated by using ecstasy to cope.
- No sex differences in problem ecstasy use were observed.

## ARTICLE INFO

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Problematic use  
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## ABSTRACT

**Background:** Ecstasy users who report problematic use of ecstasy experience adverse social, psychological, and health-related consequences not reported by non-problem users. Relatively little is known about the risk factors for the development of problematic ecstasy use. Such information would be valuable for targeted intervention, prevention, and education

**Aims:** The current study aimed to fill this gap by investigating several hypothesised risk factors for problematic use and the relationships between them.

**Methods:** Self-reported impulsivity, psychological distress, sex, and coping motives for ecstasy use were investigated as predictors of problematic ecstasy use in a cross-sectional online survey.

**Results:** The sample consisted of 483 individuals (60.5% male, 38.3% female, 1.2% other) aged 18–62 years, reporting ecstasy use on an average of 59.7 occasions ( $SD = 167.8$ ). Both higher self-reported impulsivity and psychological distress predicted problem ecstasy use, and both these relationships were partially mediated by coping motives. When these variables were examined in a combined mediation model accounting for their covariance, psychological distress still predicted problematic use partially via an effect on coping motives, while impulsivity showed only a direct effect on problem use. No sex differences in problem ecstasy use were observed.

**Conclusions:** Increased trait impulsivity and psychological distress appear to confer greater risk of problematic ecstasy use. Targeting these factors, as well as coping motives for ecstasy use, may be useful in efforts to prevent and reduce problematic ecstasy use among those who use the drug.

## 1. Introduction

‘Ecstasy’ continues to be popular recreationally, with recent estimates indicating that 18.7% of 20–29 year old people in Australia (Australian Institute of Health and Welfare, 2017), and 11.3% of 16–24 year olds in England and Wales (National Health Service, 2018) have used ecstasy at least once. Most people who use ecstasy do so infrequently, naturally decreasing their use over time (Smirnov et al., 2013), and experiencing minimal associated harm (Australian Institute

of Health and Welfare, 2017; Baylen & Rosenberg, 2006). A minority of ecstasy users, however, do report problems associated with their ecstasy use, with some seeking treatment (Substance Abuse and Mental Health Services Administration, 2014).

It has been estimated that 3.6% of users experience ‘dependence’ each year (Wu, Ringwalt, Mannelli, & Patkar, 2008), however, estimates vary widely depending on the sample and diagnostic criteria used (Degenhardt, Bruno, & Topp, 2010). Ecstasy dependence, and more recently ecstasy use disorder, continue to be the subject of debate, with

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unresolved questions including whether a unified categorical construct such as a substance use disorder exists with respect to ecstasy, and if it does, what are appropriate criteria for such a construct (Bruno, Matthews, & Topp, 2009; Degenhardt et al., 2010; McKetin et al., 2014; Uosukainen, Tacke, & Winstock, 2015). A broader term such as 'problematic use' can be used to bypass these issues as it can be conceptualised as a spectrum rather than a category. Here we use problematic ecstasy use to refer to recurrent ecstasy use despite adverse consequences or concern about use (Degenhardt, Hall, Warner-Smith, & Lynskey, 2001; United Nations Office for Drug Control and Crime Prevention, 2000). Problematic use does not necessarily imply heavy or frequent use, or vice versa (Bruno et al., 2009). Importantly, those who report symptoms of problematic use experience significant adverse social, psychological and health-related consequences that are not seen in other users (Bruno et al., 2009; Medina & Shear, 2007).

Identification of variables associated with problematic ecstasy use would enable them to be investigated as targets for prevention and intervention efforts, consistent with harm reduction frameworks (Marlatt & Witkiewitz, 2010; Stockings, Hall, & Lynskey, 2016). Several candidate variables predict problem use of a range of other substances, as well as frequent or heavy ecstasy use, but their relationship to problematic ecstasy use has not been investigated.

One such variable is impulsivity; the tendency for rash decision-making and action with a lack of forethought (Dalley, Everitt, & Robbins, 2011; Schelling, 1978). Impulsivity is a multidimensional construct with distinct traits that serve as pathways to impulsive behaviour (Whiteside & Lynam, 2001) and relate to substance use in a variety of ways (Coskunpinar, Dir, & Cyders, 2013; VanderVeen, Hershberger, & Cyders, 2016). In general, impulsivity is a strong predictor of substance use problems (Hanson, Luciana, & Sullwold, 2008; Magid, MacLean, & Colder, 2007). For instance, in a sample of adolescents, baseline trait impulsivity prospectively predicted substance-related problems 18 months later (Castellanos-Ryan, O'Leary-Barrett, Sully, & Conrod, 2013). Regarding ecstasy use, trait impulsivity is positively correlated with the occasions of use, as well as the lifetime number of pills taken (Hanson et al., 2008; Taurah, Chandler, & Sanders, 2014).

Psychological distress is also implicated in substance use problems with a high comorbidity between mood disorders and substance use disorders (Lai, Cleary, Sitharthan, & Hunt, 2015). While relationships between these disorders are complex and likely bidirectional, mood disorders often precede and predict the onset of substance use disorders (Falk, H-y, & Hilton, 2008; Swendsen et al., 2010; Wolitzky-Taylor, Bobova, Zinbarg, Mineka, & Craske, 2012). One prior study has found an association between symptoms of ecstasy dependence and depression inventory scores (Scheier, Abdallah, Inciardi, Copeland, & Cottler, 2008).

At the demographic level, there are clear sex differences in substance use (Chen & Jacobson, 2012), with differences between male and female drug users in developing problem use varying by substance (Fattore, Altea, & Fratta, 2008). Sex differences in the transition from non-problem to problem ecstasy use have not yet been established, although some evidence points towards an increased risk for males, who report greater symptoms of problematic ecstasy use than females (Scheier et al., 2008; Yacoubian, Deutsch, & Schumacher, 2004).

Motives for use have been shown to be useful predictors of drug use behaviours, including problematic use (Cooper, Kuntsche, Levitt, Barber, & Wolf, 2016; White, Anderson, Ray, & Mun, 2016). In particular, using a drug to cope with distress has been strongly associated with drug use problems across a variety of substances (Kuntsche, Knibbe, Gmel, & Engels, 2005; Lyvers, Hasking, Hani, Rhodes, & Trew, 2010; Patrick, Schulenberg, O'malley, Johnston, & Bachman, 2011; Simons, Gaher, Correia, Hansen, & Christopher, 2005; Van Der Pol et al., 2013). Regarding ecstasy use, coping motives are associated with the frequency and intensity of ecstasy use (Boys & Marsden, 2003; Boys et al., 1999).

Beyond individual risk factors, it is important to understand relationships between predictors (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). For instance, the relationship between distress and problem use of substances like alcohol and marijuana appears to be at least partially mediated by use of drugs to cope (Bujarski, Norberg, & Copeland, 2012; Chinneck et al., 2018; Farris, Metrik, & Bonn-Miller, 2016), as does the relationship between impulsivity and drug use problems (Adams, Kaiser, & Lynam, 2012; Magid et al., 2007). While no such mediation effects have been investigated for problem ecstasy use, studies have reported that both increased symptoms of depression and impulsivity are associated with coping motives for use (Egan, Kambouropoulos, & Staiger, 2010; Scott, Hides, Allen, & Lubman, 2013).

Relationships between sex, coping motives and problematic drug use are less clear. Studies have found conflicting results regarding any difference between males and females in coping motives for substance use (Mezquita, Stewart, & Ruipérez, 2010; Norberg, Norton, Olivier, & Zvolensky, 2010; Thornton et al., 2012), and such differences may vary by substance (Terry-McElrath, O'Malley, & Johnston, 2009). To date, only one study has examined sex differences in motives for ecstasy use, finding no difference in coping motives as a function of sex (Ter Bogt & Engels, 2005). However, this study sampled 'rave' attendees who were acutely intoxicated by ecstasy and it is unclear whether this influenced outcomes.

The current study investigated each of the potential predictors discussed above, hypothesising that increased trait impulsivity, psychological distress, and being male, would all predict problematic ecstasy use. We further hypothesised that coping motives for ecstasy use would mediate the effect of both impulsivity and psychological distress on problematic ecstasy use (Fig. 1a, b). On an exploratory basis, we examined the potential for coping motives to mediate the relationship between sex and problematic ecstasy use, and the influence of shared variation between predictors on the relationships identified (Fig. 1c, d), as well as the effects of other motives for use on problematic ecstasy use.

## 2. Materials and methods

### 2.1. Participants

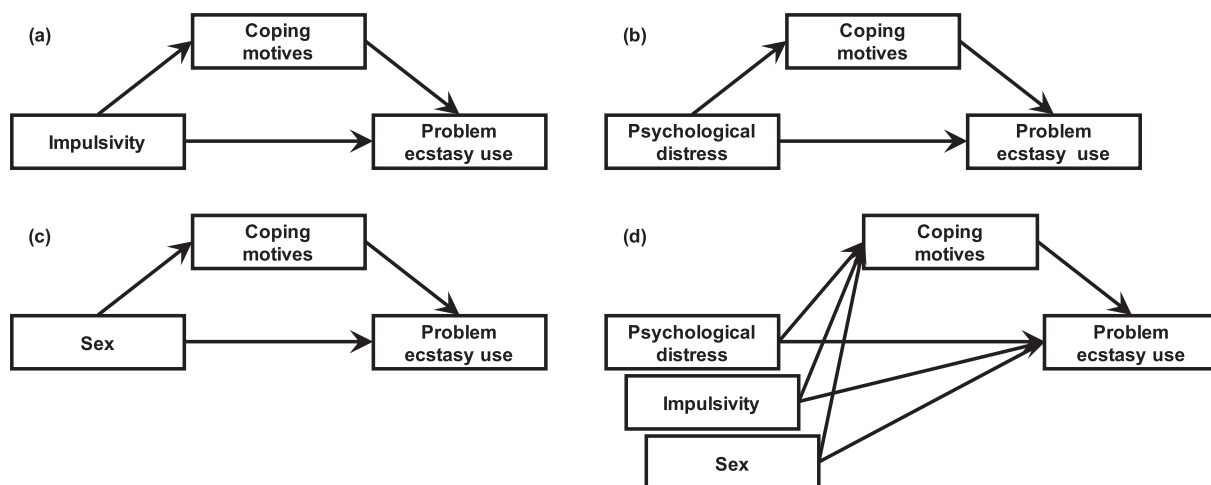
Participants were 600 adults recruited via snowballing techniques (Baltar & Brunet, 2012), using online advertisements distributed by drug research institutes, advocacy groups and online communities through social media platforms and mailing lists. Inclusion criteria were 1) being at least 18 years old, and 2) reporting use of ecstasy on at least one occasion. All data were collected in accordance with approvals obtained from The University of Melbourne Human Research Ethics Committee (#1852141).

### 2.2. Procedure

Data were collected via an anonymous online questionnaire programmed in Qualtrics (Qualtrics International Inc., Washington, USA). Candidates receiving the online study advertisements were provided a link to click through to the plain language statement and the online consent form. Participants provided online consent by checking a box and were then taken to the secure online survey.

### 2.3. Measures

*Demographic and drug use information* was collected via a series of forced-response questions. Demographic variables included age, sex, education and employment. Drug use was recorded using free-choice and multiple-choice questions, with the content based on the *Monitoring the Future* questionnaire (Bachman, Johnston, O'Malley, Schulenberg, & Miech, 2015). Cut-off values of 15 and 120 were used for the 'usual



**Fig. 1.** Mediation models tested: (a) hypothesised mediation model for the predictor, impulsivity, (b) hypothesised mediation model for the predictor, psychological distress, (c) exploratory mediation model for the predictor, sex, and (d) exploratory combined mediation model. Note, only significant predictors will be included in the combined model.

number of pills taken per occasion of ecstasy use' and 'occasions of cannabis use per month' variables respectively. Responses falling above these cut-offs were considered typographical errors and excluded from descriptive statistical calculations only. Participants who selected 'other' as their sex were excluded from analyses of sex effects only.

The *Severity of Dependence Scale* (SDS) was employed to measure problematic ecstasy use in the last 12 months (Gossop et al., 1995). This self-report measure consists of five items addressing psychological aspects of problematic use. Responses are made on a 4-point Likert scale from 'never/almost never' to 'always/nearly always'. Total scores range from 0 to 15, with higher scores indicative of more problematic use. This scale was validated for measurement of problematic ecstasy use by Bruno et al. (2009). Internal consistency was 0.78 in the current sample.

The *Kessler Psychological Distress Scale* (K10) was used to measure generalised psychological distress in the month prior to participation (Kessler & Mroczek, 1994). The K10 is a self-report measure, consisting of 10 items with responses coded on a 5-point Likert scale. Total scores range from 10 to 50, with higher scores indicating greater distress (Australian Bureau of Statistics, 2001). Internal consistency was 0.92 in the current sample.

The *Zuckerman-Kuhlman Personality Questionnaire* (ZKPQ) was used to measure trait impulsivity (Zuckerman, 2002). This questionnaire consists of 99 statements rated as either 'true' or 'false'. The impulsivity subscale is comprised of 8 items and scores can range from 0 to 8; internal consistency was 0.73 in the current sample. The questionnaire also contains an infrequency subscale, the constituent items of which are unlikely to be completely true for anyone; accordingly, 'true' responses are taken to indicate careless responding. Participants with infrequency scores greater than 4 were excluded from all analyses (Gomà-i-Freixanet, Valero, Puntí, & Zuckerman, 2004).

*Motives for Ecstasy Use Questionnaire* (MEUQ) was used to measure coping motives (Ter Bogt & Engels, 2005). This questionnaire is based on a model of alcohol drinking motives (Cox & Klinger, 1988) which was adapted and extended to measure the motives for ecstasy use with the guide of Van de Wijngaart et al. (1997) reports of recreational ecstasy users' motives for use. The MEUQ contains seven subscales measuring the motives of energy, euphoria, self-insight, sociability/flirtatiousness, sexiness, coping and conformism, measured with 28 items rated on a 5-point Likert scale. The coping motives subscale consists of 3 items, and scores range from 3 to 15. Internal consistency of the coping subscale was 0.78 in the current sample.

*Additional screening questions* asked whether participants were 'high', answering with a friend, or in a distracting environment. Participants

who responded 'yes' to any of these questions were considered to likely be providing compromised data and were excluded from all analyses.

#### 2.4. Data analysis

All analyses were conducted in SPSS 25 with the SPSS PROCESS v3.1 script used to run mediation analyses (Hayes, 2013). Individual mediation analyses were conducted, and the total effects were examined to test the hypotheses that impulsivity, psychological distress, and sex would predict problematic ecstasy use. The direct and indirect effects were then examined in order to test the mediation hypotheses and establish whether full, partial or no mediation effects were present. In an additional exploratory analysis, variables for which there was a statistically significant mediation effect were combined into one mediation model to re-test the effects of these predictors on SDS scores while accounting for any shared variance. All mediation analyses statistically controlled for the influence of age, education and level of ecstasy use (lifetime number of pills consumed). See Hayes (2018) for definitions of the direct, indirect, and total effects. All indirect effects were tested using bootstrapping procedures with 5000 bootstrap samples. Multiple linear regression was used to examine whether any of the other motives for ecstasy use predicted problematic use. An alpha criterion of  $\alpha = 0.05$  was used for all tests.

### 3. Results

*Sample characteristics.* Fifty-nine participants were excluded due to scores above 4 on ZKPQ Infrequency, and 58 were excluded based on responses to the screening questions. The final sample comprised of 483 participants (60.5% male, 38.3% female, 1.2% other), ranging from 18 to 62 years old ( $M = 27.8$ ,  $SD = 7.7$ ). Participants came from 34 different countries; predominantly Australia, the UK and USA. Most were either employed (65.2%) and/or studying (36.7%) and were educated at a tertiary level (77.0%). Descriptive statistics for ecstasy and other drug use are provided in Table 1. Additionally, 60% of the sample reported usually taking other drugs with ecstasy, the most common being alcohol at 48.9%.

The mean SDS score was 0.87 ( $SD = 1.71$ ), with a positively skewed distribution (see Fig. 2); 9.73% of the sample scoring above the cut-off for possible 'dependence' (Bruno, Gomez, & Matthews, 2011). The mean ZKPQ impulsivity score was 2.71 ( $SD = 2.19$ ) and the mean MEUQ coping motives score was 6.86 ( $SD = 2.92$ ). The mean K10 score was 20.67 ( $SD = 8.27$ ), which is marginally past the threshold for 'likely to have a mild mental disorder' (Australian Bureau of Statistics,

**Table 1**  
Drug use descriptive statistics and percentages of the sample reporting different levels of lifetime recreational use of drug classes.

Variable	M	SD	Range	n <sup>a</sup>
Lifetime occasions of ecstasy use	59.7	167.8	1–3000	483
Age of first ecstasy use	20.8	5.2	13–55	483
Usual number of pills taken per occasion of ecstasy use	1.9	1.8	0.25–15	480
Cigarettes per week	13.4	31.3	0–250	483
Standard alcoholic drinks per week <sup>b</sup>	5.5	7.0	0–50	483
Occasions of cannabis use per month <sup>c</sup>	9.7	15.7	0–100	480
Drug class	Never used (%)	1–10 times (%)	11–50 times (%)	51 + times (%)
Hallucinogens/dissociatives (e.g. LSD, psilocybin mushrooms, ketamine)	10.1	32.9	37.7	19.3
Stimulants (e.g. cocaine, methamphetamine, methylphenidate)	15.1	31.5	28.6	24.8
Inhalants (e.g. nitrous oxide, nitrates, solvents)	37.5	30.8	20.9	10.8
Sedatives (e.g. benzodiazepines, barbiturates)	42.4	30.6	15.7	11.1
Opiates (e.g. heroin, oxycodone, fentanyl)	58.0	27.1	7.0	7.9

<sup>a</sup>Some participants were excluded from calculation of certain descriptive statistics due to responses that were likely invalid (see methods). <sup>b</sup>Standard drink refers to Australian standard. Participants were shown a diagram displaying how many standard drinks there are in common beverages. <sup>c</sup>If an individual reports using multiple times per day, each use is counted as a separate occasion.

2001).

Univariate outliers were detected and substituted for values 3.29 standard deviations from the mean, and as these changes did not affect the outcome of any of the statistical tests, original data are reported (Tabachnick & Fidell, 2013). There were no consequential violations of linearity between predictors and the outcome variable, independence of errors, or multicollinearity. There was evidence of mild heteroscedasticity and non-normality of residuals. No adjustments were made as simulation studies suggest mild violations of these assumptions do not affect the validity of statistical inferences (Duncan & Layard, 1973; Edgell & Noon, 1984; Havlicek & Peterson, 1977; Hayes, 1996).

Individual mediation analyses revealed significant total effects on SDS scores for both ZKPQ impulsivity and K10 distress but not sex, while controlling for age, education and level of ecstasy use. Significant direct effects on SDS scores and indirect effects through MEUQ coping motive scores were observed for impulsivity and distress, thus partial mediation effects were present. There was no mediation effect for sex. See Table 2 and Fig. 3 for pathway coefficients.

In a combined mediation model, the effects of ZKPQ impulsivity and K10 distress were computed while accounting for their covariance, and controlling for age, education and level of ecstasy use. The total and direct effects of impulsivity and distress remained significant. The indirect effect only remained significant for distress, not impulsivity. See Table 3 and Fig. 3 for pathway coefficients.

An exploratory multiple linear regression analysis revealed that only

euphoria and coping motives significantly predicted SDS scores (model:  $F = 5.74, p < .001, \text{adjusted } R^2 = 0.06$ ; euphoria:  $\beta = 0.09, t(482) = 2.33, p = .02$ ; coping:  $\beta = 0.11, t(482) = 4.00, p < .001$ ).

**4. Discussion**

This study aimed to identify potential risk factors for problematic ecstasy use among recreational users, extending on previous research by examining several factors simultaneously, allowing for analysis of potential relationships between them. In a novel finding, self-reported trait impulsivity predicted problematic ecstasy use, as did psychological distress, consistent with prior research (Scheier et al., 2008). Both effects were partially mediated by coping motives, and these effects persisted when controlling for age, education and level of ecstasy use. Further exploratory analyses indicated that when combined into a single mediation model, a mediation effect for impulsivity was no longer present; only a direct effect remained. Conversely, the partial mediation of psychological distress remained after accounting for covariance with impulsivity. Contrary to hypotheses, sex did not predict problematic ecstasy use, and no mediation effect of sex on problem ecstasy use through coping motives was observed. Exploratory analyses revealed that in addition to coping motives for use, using ecstasy to induce euphoria also predicted problematic ecstasy use. Given this finding conflicts with prior results (Boys & Marsden, 2003) and the exploratory nature of the analysis, further research is needed to clarify

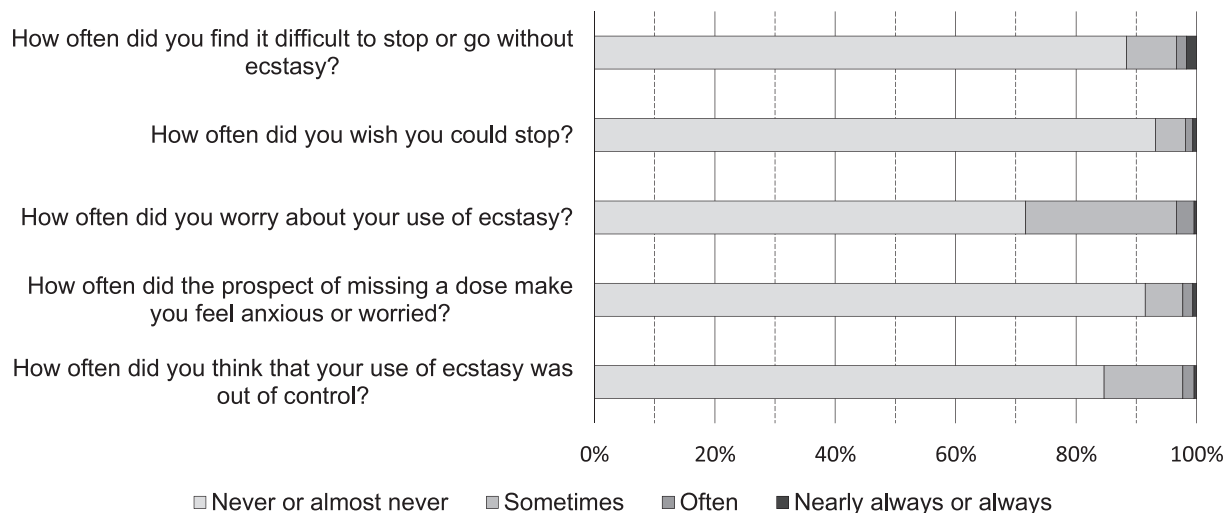


Fig. 2. Participant responses to the Severity of Dependence Scale for ecstasy.

**Table 2**  
Standardised Coefficients for Individual Mediation Models.

Variable	Total effects $c$ [p-value]	Direct effects $c'$ [p-value]	Indirect effect $b$ [95% CI]
ZKPQ Impulsivity	0.172 [0.0002]	0.152 [0.0008]	0.020 [0.002, 0.043]
K10 Distress	0.194 [ $< 0.0001$ ]	0.138 [0.0039]	0.056 [0.020, 0.093]
Sex	0.041 [0.6609]	0.013 [0.8868]	0.028 [−0.012, 0.073]

Note: Coefficients for sex are partially standardised as it is a dichotomous variable. Coefficients for impulsivity and distress are completely standardised.

this relationship.

Findings suggest that those with high impulsivity may be at a greater risk of problematic use partially via an increased tendency to use ecstasy to cope, but only if they are also experiencing higher levels of distress. This finding is consistent with theoretical explanations for a link between impulsivity and problem use through coping motives. Specifically, when distressed, impulsive individuals are proposed to act rashly and choose coping mechanisms that provide immediate relief regardless of the potential for long-term adverse outcomes (Hull & Slone, 2004; Vohs & Baumeister, 2016), with use of drugs to cope leading to problem use through a process of negative reinforcement (Baker, Piper, & McCarthy, 2004). The primary pathway between impulsivity and problem use however, is direct and independent of psychological distress. This can be understood in terms of a general disregard for future negative outcomes among those with high impulsivity, resulting in use of ecstasy in contexts that lead to problems (Magid et al., 2007).

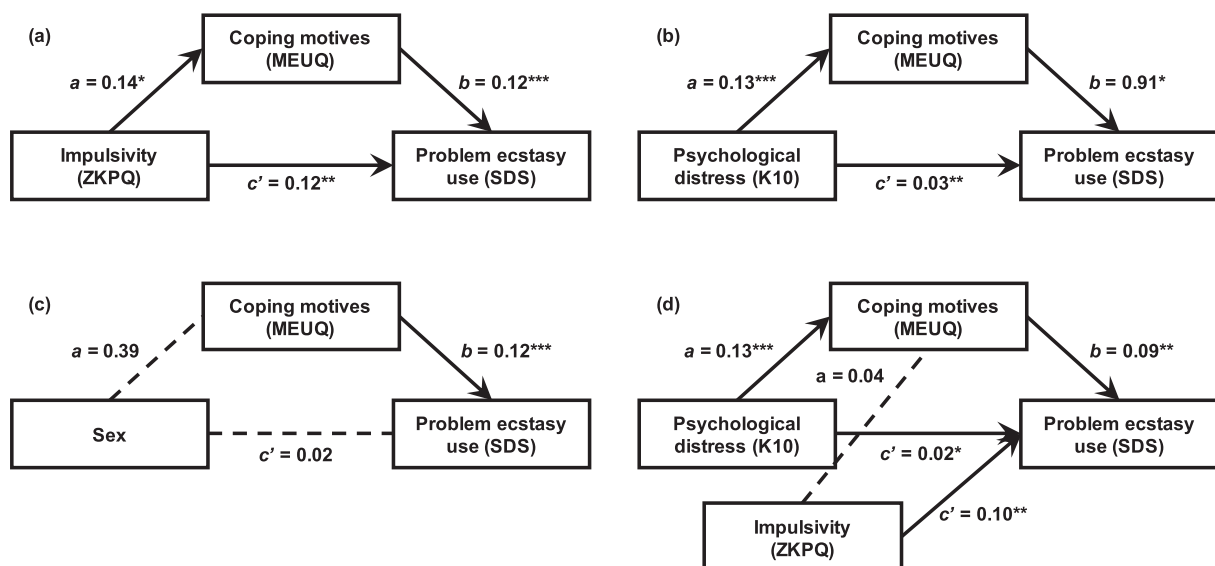
Results also suggest that individuals experiencing higher levels of psychological distress may be at a greater risk of problematic ecstasy use, partially via an increased tendency to use ecstasy to cope with that distress, regardless of their level of impulsivity. These findings broadly fit with the self-medication theory of problem drug use (Smith et al., 2017). However, results indicate that most of the effect of psychological distress on problem use was accounted for by the direct effect, suggesting that there are other mechanisms involved.

Findings support a focus on trait impulsivity and psychological distress in research concerning prevention efforts for problematic ecstasy use. While the current results indicate these factors are similarly strong predictors of problem ecstasy use, psychological distress may be a particularly important target as recent research shows a 48% increase

in ecstasy users reporting high levels of psychological distress, from 18% in 2013 to 27% in 2016 (Australian Institute of Health and Welfare, 2017). Other potential practical implications of findings include acknowledgement of individual motivations for ecstasy use in the development and evaluation of harm reduction education programs.

The current study provides no evidence for sex differences in problematic ecstasy use, contrary to previous findings (Scheier et al., 2008; Yacoubian et al., 2004). This discrepancy may be explained by the methodological differences from earlier studies. For instance, participants in one study were intoxicated (Yacoubian et al., 2004), while the second used a measure of problematic ecstasy use including withdrawal (Scheier et al., 2008), a symptom not yet well characterised in ecstasy users (Degenhardt et al., 2010; McKetin et al., 2014). Current results may also represent a change in sex differences since these previous studies were conducted, forming part of a broader emerging trend of narrowing gender gaps in problem drug use (Degenhardt et al., 2008; Kerridge, Chou, & Pickering, 2019; White et al., 2015).

A general limitation of mediation analyses is the possibility for epiphenomenal or spurious associations. Education and age are both associated with impulsivity, psychological distress and problematic ecstasy use, making them potential confounders (Bruno et al., 2009; Jorm, 2000; Kessler, 1982; Scheier et al., 2008; Swann, Lijffijt, Lane, Steinberg, & Moeller, 2009). Level of ecstasy use is correlated with coping motives (Boys & Marsden, 2003), impulsivity and psychological distress (Taurah et al., 2014), and predicts problem use (Bruno et al., 2009); therefore posing the threat of an epiphenomenal association. We addressed this issue by measuring these variables and statistically controlling for their influence in the current analysis, thereby limiting their potential influence. Controlling for the level of ecstasy use also allowed for the identification of factors that are specifically associated



**Fig. 3.** Mediation models with pathway coefficients: (a) partial mediation of impulsivity on problem ecstasy use through coping motives, (b) partial mediation of psychological distress on problem ecstasy use through coping motives, (c) non-significant direct effect and mediation effect of sex on problem ecstasy use through coping motives, and (d) combined mediation model. Note, models also included statistical control for age, education and lifetime number of ecstasy pills taken, not shown here. Coefficients are unstandardised. \* Coefficient is significant at the .05 level (2-tailed). \*\* Coefficient is significant at the .005 level (2-tailed). \*\*\* Coefficient is significant at the .0001 level (2-tailed).

**Table 3**  
Standardised Coefficients for Combined Mediation Model.

Variable	Total effects <i>c</i> [p-value]	Direct effects <i>c'</i> [p-value]	Indirect effect <i>ab</i> [95% CI]
ZKPQ Impulsivity	0.138 [0.0030]	0.133 [0.0038]	0.005 [−0.009, 0.021]
K10 Distress	0.167 [0.0003]	0.114 [0.0185]	0.054 [0.019, 0.089]

with problematic use, rather than high-level consumption, which has been the focus of much of the previous research in this area.

The use of observational and cross-sectional data in mediation analyses opens up the possibility for alternative directions of causation, such that any sequence of causal ordering of predictor, mediator and outcome variable is possible (Hayes, 2018). While most causal orderings in the current study can be discounted due to logical implausibility, it could be argued that problematic ecstasy use could lead to increased impulsivity and psychological distress through the putative neurotoxic effects of high dose 3,4-methylenedioxyamphetamine (MDMA; the most common psychoactive constituent of ecstasy) on serotonergic functioning (Parrott, 2013). However, the inclusion of statistical control over level of ecstasy use diminishes the possibility that this is the true underlying relationship in the current results, given that dose rather than problem use is most plausibly associated with any neurotoxic effect from a biological perspective. While this strengthens the interpretations presented here, the exact causal direction of relationships reported here cannot be determined definitively without prospective data.

Future research would benefit from a more detailed analysis of the risk factors examined. For instance, the use of a dimensional model of impulsivity (such as the UPPS; Whiteside & Lynam, 2001) to examine whether different components of impulsivity preferentially lead to problematic ecstasy use. Further, while the current study controlled for lifetime ecstasy use, future studies could valuably assess the impact of a broader spectrum of use variables, including recent use/abstinence.

The current study presents novel findings on psychological and motivational factors implicated in problematic ecstasy use and substantially extends on prior research in this area. Impulsivity and psychological distress were identified as potential risk factors and the use of ecstasy to cope with distress was found to be a key pathway to problem use for those with increased impulsivity and psychological distress. These results indicate that attempts to curb problematic ecstasy use should acknowledge the diversity of users and their reasons for use. Targeting ecstasy users with high impulsivity or psychological distress may improve the efficacy of such efforts.

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## 6. Contributors

G. Bedi and S. Meikle designed the study. S. Meikle conducted the statistical analyses and wrote the first draft of the manuscript, all authors contributed to and have approved the final manuscript.

## CRedit authorship contribution statement

**Sally Meikle:** Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Olivia Carter:** Conceptualization, Methodology, Writing - review & editing, Supervision. **Gillinder Bedi:** Conceptualization, Methodology, Writing - review & editing, Supervision.

## Declaration of Competing Interest

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

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