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Modifiable risk factors of ecstasy use: risk perception, current dependence, perceived control, and depression

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Abstract

Risk perception, perceived behavioral control of obtaining ecstasy (PBC-obtaining), current ecstasy dependence, and recent depression have been associated with past ecstasy use, however, their utility in predicting ecstasy use has not been demonstrated. This study aimed to determine whether these four modifiable risk factors could predict ecstasy use after controlling for socio-demographic covariates and recent polydrug use. Data from 601 ecstasy users in the National Institute on Drug Abuse funded TriCity Study of Club Drug Use, Abuse and Dependence were analyzed using multivariate logistic regression. Participants were interviewed twice within a 2-week period using standardized instruments. Thirteen percent (n=80) of the participants reported using ecstasy between the two interviews. Low risk perception, high PBC-obtaining (an estimated ecstasy procurement time < 24 hours), and current ecstasy dependence were statistically associated with ecstasy use between the two interviews. Recent depression was not a significant predictor. Despite not being a target predictor, recent polydrug use was also statistically associated with ecstasy use. The present findings may inform the development of interventions targeting ecstasy users.

Keywords

Ecstasy; MDMA; “Risk perception”; dependence; “perceived control”; depression

1. Introduction

Ecstasy (3,4-methylenedioxy-N-methamphetamine or MDMA) is one of the major illicit drugs used by young people. The US National Survey on Drug Abuse and Health showed that, after a stable decline in the rates of use for a few years (2002–2005), an upward trend emerged in 2006, with over 12 million individuals 12 years or older reported using ecstasy at least once in their lifetime (Substance Abuse and Mental Health Services Administration, 2007). The persistent popularity of ecstasy among young people continues to be a public health concern and a major challenge to the field. Previous research showed that ecstasy use is a multifactorial behavior regulated by modifiable and non-modifiable risk factors (Parrott, 2001). Although

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non-modifiable risk factors (such as gender, ethnicity, measures of lifetime consumption at a single time point, and age of onset) are important to the understanding of the course of addiction and the identification of the at-risk populations, the utility of non-modifiable risk factors in the development of interventions is limited because these factors are not subject to change. Interventions are more likely to be effective if the target risk factors are modifiable. Identification of modifiable risk factors that predict ecstasy use not only improves our understanding of the phenomenon, but also provides valuable information that guides the development of intervention programs.

Research on health behaviors suggests that some modifiable risk factors, such as risk perception, perceived behavioral control, current dependence, and depression, may have utility in predicting continued ecstasy use (Conner, Sherlock, & Orbell, 1998; Mogan, 2000; Orbell, Blair, Sherlock, & Conner, 2001; Peters, Kok, & Schaalma, 2008; Parrott, 2001). Risk perception is a type of attitude representing a summarized evaluation of an object along the favorable-unfavorable attribute dimensions (Ajzen, 1991; Brewer, Chapman, Gibbons, Gerrard, McCaul, & Weinstein, 2007; Brewer, Weinstein, Cuite, & Herrington, 2004). Levels of risk perception, or perceived risk, are considered to be major determinants of risk actions (Gonzalez & Haney, 1990; Brewer et al., 2007). Health behavior theories, such as Theory of Planned Behaviors (TPB: Ajzen, 1991) and the Health Belief Model (HBM: Rosenstock, 1974), posit that a high level of perceived risk is associated with a low likelihood of performing risk behaviors, including drug use and unprotected sex. Although ecstasy users in a qualitative study expressed that they did not believe there were risks associated with ecstasy use (Carlson, Falck, McCaughan, & Siegal, 2004); the risk perception-drug use association has been demonstrated in a number of cross-sectional quantitative studies. It has been shown that risk perception was statistically associated with lifetime ecstasy use and ecstasy consumption (Yacoubian, Boyle, Harding, & Loftus, 2003; Yacoubian, Deutsch, & Schumacher, 2004; Topp, Hando, Dillon, Roche, & Solowij, 1999; White, Degenhardt, Breen, Bruno, Newman, & Proudfoot, 2006), and users generally perceived at least some risk associated with the use of ecstasy (Gamma, Jerome, Liechti, & Sumnall, 2005; Leung, Li, Tsay, Callahan, Liu, Hsu, et al., 2008; Murphy, Wareing, & Fisk, 2006). However, these studies focused on the associations between risk perception and past ecstasy use, where the predictive validity of risk perception has yet to be determined.

Another potentially modifiable risk factor is perceived behavioral control (PBC). In the Theory of Planned Behaviors, PBC is defined as the `perceived ease or difficulty of performing the behavior' (Ajzen, 2002, p.1). PBC has been found to have direct influence on a range of behaviors (see Ajzen, 2005). In a prospective study on attitude and ecstasy use, when perceived behavioral control of obtaining ecstasy (PBC-obtaining) was operationalized as the perceived ease or difficulty of obtaining ecstasy; use of ecstasy within a 2-month follow-up period was found to be associated with a higher level of PBC-obtaining (e.g., To obtain ecstasy is easy; Orbell et al., 2001). The effects of the PBC-obtaining on ecstasy use were also documented in a cross-sectional study (Umeh & Patel, 2004). However, these studies aimed to test specifically whether TPB was applicable to ecstasy use and did not control for other potential covariates such as gender, ethnicity, socio-economic status, past ecstasy use, and polydrug use.

Additionally, ecstasy use has been hypothesized to be associated with the perceived ease or difficulty of using the drug (Conner et al., 1998; Orbell et al., 2001; Peters, Kok, & Abraham, 2008). The notion of perceived control over using (PBC-using) is closely related to the clinical construct of `substance dependence'. In the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV), substance dependence is defined as `a cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues use of the substance despite significant substance related problems' [American Psychiatric Association (APA), 2000, p.192]. According to Ajzen (2002), PBC is predictive of behavior only if it

reflects actual volitional control[1]. In this regard, PBC-using is a proxy of impaired volitional control, and current ecstasy dependence should be a better predictor of continued use of ecstasy. Current dependence has been shown to have predictive validity regarding continued use and treatment outcomes in other drug classes (Kidorf, Brooner, King, Stoller, & Wertz, 1998; Kosten, Bianchi, & Kosten, 1992). Using the DSM-IV adopted criteria for MDMA dependence developed by Cottler and colleagues (Cottler, Womack, Compton, & Ben Abdallah, 2001), Ben Abdallah, Scheier, Inciardi, Copeland, & Cottler (2007) showed that lifetime ecstasy dependence was statistically associated with ecstasy use in a structural equation model.

Ecstasy use has also been hypothesized to be associated with depression because of its effects on the 5-HT system (Morgan, 2000; Parrott, 2001). Although an increased level of depression has been found to be associated with ecstasy use in cross-sectional studies (Gamma, Buck, Berthold, & Vollenweider, 2001; Gamma, Frei, Lehmann, Pascual-Marqui, Hell, & Vollenweider, 2000; Gerra et al., 1998), the effect size of this association is small and may have little clinical significance (Sumnall & Cole, 2005). Furthermore, a longitudinal study showed that ecstasy use was not associated with clinically significant depressive symptoms (Falck, Wang, & Carlson, 2008). Other prospective studies of the temporal relationship between depression and ecstasy use showed mixed results. Lieb, Schuetz, Pfister, von Sydow, & Wittchen (2002) found that depression preceded the first use of ecstasy; however, in a later study, De Win et al. (2006) showed that depression was not a significant predictor. Additionally, these two prospective studies focused on the initiation of ecstasy use; the utility of depression in predicting ecstasy use remains unclear.

The purpose of this study was to examine the predictive validity of risk perception, perceived behavioral control of obtaining ecstasy (PBC-obtaining), current ecstasy dependence, and recent depression. Specifically, this study determined whether these modifiable risk factors could predict ecstasy use after controlling for socio-demographic covariates and recent polydrug use. We hypothesized that a low risk perception, high PBC-obtaining, current ecstasy dependence, and recent depression were all independently associated with an increased risk of ecstasy use.

2. Method

2.1 Study design

Data were collected as part of the National Institute on Drug Abuse (NIDA)-funded TriCity Study of Club Drug Use, Abuse and Dependence (TriCity Study) which examined club drug use behaviors and test-re-test reliability of DSM-IV criteria for drug use disorders in St. Louis, Miami, and Sydney from 2002 to 2005 (PI: Dr. Cottler [LBC]). Target sampling procedures were employed for participant recruitment (Watters and Biernacki, 1989). An important feature of targeted sampling is the continued revision of sampling plans during implementation to meet social conditions and enrollment rates (Watters and Biernacki, 1989, p.423). Unlike the asystematic recruitment procedures in convenience sampling, targeted sampling emphasizes flexibility of recruitment approaches which maximizes the circulation of study information among the target population. In the TriCity Study, Ecstasy users who used ecstasy more than five times lifetime with the most recent use occurring within a 12 month interval prior to the

[1]In the present paper, the use of the term `actual volitional control' is consistent with that in the Theory of Planned Behavior (TPB: Ajzen, 1991), which refers to the volitional control of the target behavior, but not the `control factors' (or determinants) of perceived behavioral control (PBC). Since PBC is a perception, it may, or may not be congruent with actual volitional control. However, the TPB states that prediction of behavior is more accurate when PBC realistically reflect actual volitional control (Ajzen, 1991; Armitage and Conner, 2001). Cognition-behavior consistency (including the TPB) is an entirely different area of research. The TPB alone has been cited for more than five thousand times since its publication in 1991. Due to the objectives of our paper, it is not possible for us to provide detailed discussions on various theories and empirical findings on the cognition-behavior relationships. Interested readers are encouraged to read Ajzen's and other publications on this topic (e.g., Ajzen, 1991; 2005).

interview were systematically recruited from the three communities through advertising flyers, internet postings, posters in universities and high-schools, street and club outreach, and public announcements in local newspapers. These recruitment methods may enhance the circulation of study information among our target population (club drug users) as well as improving the diversity in the final sample. The TriCity Study consisted of two waves (Time1 and Time2). The eligible age range was 15 to 50 years. Participants were invited to attend the second interview about seven days after the Time 1 interview. It should be noted that the target sample of the TriCity Study was out-of-treatment, community club drug users who were a part of the hard-to-reach, illicit drug use population. It is known that illicit drug users have a high drop-out rate; it requires tremendous effort, patience, and persistence to achieve a high completion rate in a prospective study involving this specific population (Cottler, Compton, Ben-Abdallah, Horne, & Claverie, 1996; Scott, 2004; Walton, Ramanathan, & Reischl, 1998). Due to the difficulties of recruiting illicit drug users in a prospective study, we did not reject participants even when they were not able to attend the second interview on the seventh day. Study protocols and procedures were approved by the Washington University School of Medicine Institutional Review Board (IRB), and the IRB at each of the participating institutes. Informed consent was obtained from all participants. Parental permission was obtained for non-emancipated minors. Participants were remunerated US $55 in total for their time and effort.

2.2 Participants

Six hundred and forty participants were enrolled in the study. Among them, two participants who had used ecstasy fewer than six times lifetime and 33 who had only one interview were excluded. Among the remaining 605, three participants with missing values on risk perception and one outside the eligible age range were excluded. The final sample consisted of 601 participants (59% male) which constituted 94% of the sample enrolled in Time1. The median age of the entire sample was 22 [mean=23.28 (SD 4.98), range 16 – 47 years]. This finding was consistent with other studies of ecstasy use (Topp, Hall, & Hando, 1997: mean age =22.1; range 15–42). In our study, over 90% of participants were 16–30 years old, and over 1/3 of the entire sample were 19 to 21 years of age (mode = 20 years for the entire sample). National data showed that people 18–29 years of age have a higher prevalence of lifetime and past year ecstasy use compared to other age groups (SAMHSA, 2008; Stafford, Sindicich, & Burns, 2008). Due to a higher prevalence of ecstasy use among this age group, it is possible that we have recruited more users from this particular age group (16–30 years) than from the other age groups. No gender or age differences were noted between sites. The sample was 62% White, 18% Hispanic, and 8% Black. While the majority of the participants in St. Louis and Sydney were White (>73%), 56% in Miami were Hispanic [χ^2 (6, N=601) = 284.02, p<0.001]. In Miami, all participants endorsed being comfortable conducting an interview in English. More than half of the sample (60%) did not have a high school diploma. Educational status varied across sites [χ^2 (2, N=601) = 7.92, p<0.05], with Miami having the highest percentage with a high school diploma (49% vs. 36%). The median total income in the past 12 months was US $13 000. Participants from Sydney reported a significantly higher income than their US counterparts [Kruskal-Wallis test (2, N=601) = 13.51, p<0.01]. Using an annual income of US $10 000 as the poverty threshold (US Census Bureau, 2007), it was found that 47% of the sample were below the poverty threshold (Table 1).

2.3 Measures

Items in the present analyses were selected from the three main assessment instruments utilized in the TriCity Study [Washington University Risk Behavior Assessment for Club Drugs (WU-RBA-CD), Substance Abuse Module for Club Drugs (CD-SAM), and the Center for Epidemiological Studies Depression Scale (CES-D)]. The WU-RBA-CD was used to assess risk perception and PBC-obtaining; CD-SAM was used to determined current ecstasy dependence and recent use of ecstasy. Recent depression was determined by CES-D. Both

WU-RBA-CD and CD-SAM employed structured interview format, where interviews were conducted by interviewers who have undergone intensive training provided by the PI (LBC). In the present analysis, except for the outcome variable (continued ecstasy use), which was assessed at Time 2, all predictor variables (risk perception, PBC-obtaining, current ecstasy dependence, and recent depression) and other covariates were assessed at Time1.

Ecstasy use—All eligible participants in this study have used ecstasy more than five times lifetime and used at least once in the past 12 months prior to the Time 1 interview. Ecstasy use between Time 1 and Time 2 (a dichotomous outcome variable: 1-used, 0-not used) was indicated by the self-reported use of ecstasy between the two interviews. In the Time 2 CD-SAM, participants were asked: `When was the last time you used ecstasy?' Participants were identified as having used ecstasy if the time of the last use fell within the time interval between Time1 and Time 2. In the present analysis, participants who have used ecstasy between Time 1 and Time 2 were labeled as the `Used' group and those who have not used ecstasy during this time interval were label as the `Not Used' group.

The time interval between the two interviews was predetermined by the TriCity Study and was relatively short (7 days). Nevertheless, the use of such a short time interval was crucial to the prediction of behaviors because of the concern with the predictors' stability over time. In the assessment of cognition-behavior correspondence, temporal stability of the target predictors is the major determinant of the validity and accuracy of the prediction (Ajzen, 1996; Cooke and Sheeran, 2004; Glasman and Albarracin, 2006; Schwartz, 1978). In other words, to predict behavior accurately, target predictors must remain reasonably stable over time until the behavior is performed (Ajzen, 1996). Since the target predictors in this study might change over time depending on other events occurred within this time interval, it is reasonable to assume that the target predictors were less likely to change in a short time interval than in a long time interval.

Risk perception of ecstasy use—To assess risk perception associated with ecstasy use, the following WU-RBA-CD item was used: `I'd like you to rate the following situation on a scale of 1 to 5 in terms of how dangerous you think [it] is – Taking 1 pill of ecstasy once a week for at least a month'. Participants indicated how dangerous they felt this activity was on a 5-point scale ranging from `1-Not dangerous at all' to `5-Extremely dangerous'. The test-retest reliability of this item was good [Intraclass correlation coefficient (ICC): 0.72, 95%CI: 0.69–0.76; Washington University (WU), 2006]. In the present analysis, risk perception was reverse-coded with the higher rating indicating a lower level of risk perception to reflect the relative increase in the likelihood of ecstasy use as risk perception decreased.

Perceived behavioral control of obtaining ecstasy (PBC-obtaining)—Participants were asked how long it would take them to get ecstasy if they wanted it. Responses were dichotomized (1-high control vs. 0-low control). Since communication and transportation systems in the US and Australia are well developed, it is reasonable to assume that it is more difficult for an individual to get the drug when the procuring time is long than when the procuring time is short, given the intention to use the drug. The PBC-obtaining was considered `high' if the participant could get it within 24 hours. An estimated ecstasy procuring time of 24 hours or fewer has been shown to be statistically associated with the use of ecstasy (Ben Abdallah et al., 2007). The assessment of PBC-obtaining related to ecstasy shows good test-retest reliability (kappa: 0.71, 95%CI: 0.64–0.77; WU, 2006).

Current ecstasy dependence—The computerized CD-SAM was used to assess current dependence on ecstasy. The CD-SAM is an expanded version of the Composite International Diagnostic Interview – Substance Abuse Module (CIDI-SAM). Good test-retest reliability has been established for the original SAM (Compton, Cottler, Dorsey, & Spitznagel, 1996; Horton,

Compton, & Cottler, 2000). An important feature of the CD-SAM is the separate assessment of each club drug, including MDMA, ketamine, gamma-hydroxybutyric acid (GHB), and flunitrazepam (rohypnol). To determine current ecstasy dependence, the DSM based diagnostic algorithm used by Cottler et al. (2001) included meeting at least three of the seven dependence criteria in the past 12-month period. To determine withdrawal for ecstasy, a list of 19 withdrawal symptoms was compiled from all drug specific withdrawal symptoms in DSM. A positive diagnosis of ecstasy withdrawal required at least 3 of the 19 withdrawal symptoms or withdrawal relief to have occurred. Although the examination of the psychometric property of current ecstasy dependence is ongoing, the diagnosis of lifetime ecstasy use disorder using the same scoring algorithm showed good test-retest reliability (kappa=0.69; Cottler, Leung, & Ben Abdallah, in press).

Recent depression—The Center for Epidemiological Studies Depression Scale (CES-D) was developed by Radloff (1977). This instrument is one of the most widely used self-report tools for assessing depressive symptoms and likelihood for depression. Several branches at the National Institute of Health (NIH) have selected the CES-D for their large, multi-site studies of diverse populations due to its excellent psychometric properties among different ethnic groups (Roberts, 1980). The CES-D has high sensitivity and specificity among youth and young adults (Garrison, Addy, Jackson, & McKeown, 1991). In the present analyses, the CES-D was used to assess symptoms of depression in the past seven days; participants were classified as having recent depression if they had a CES-D score of 16 and above.

Socio-demographic covariates—The final logistic regression would be adjusted for several covariates, including gender, education-poverty status, and ethnicity. Due to the significant association between having a high school diploma and poverty [$\chi^2(601,1) = 46.21$, $p < 0.0001$], the two levels of educational status (Have a high school diploma [HDip] and No high school diploma [NDip]) were crossed with the two levels of poverty status (above poverty threshold-US$10 000 [Not poor] and below poverty threshold [Poor]) to form a new 4-category new variable (education-poverty status): HDip-Not poor, HDip-Poor, NDip-Not poor, and NDip-Poor.

Polydrug use in the past 30 days—To control for the confounding effects of polydrug use, the total number of other drugs used in the past 30 days was included in the multivariate logistic regression. Polydrug use in the past 30 days was obtained by summing up the use of all other classes of drugs listed in CD-SAM, including marijuana, stimulants, sedatives, cocaine, opioids, phencyclidine (PCP), ketamine, hallucinogens, inhalants, anabolic steroids, and gamma-Hydroxybutyric acid (GHB).

2.4 Analysis

Odds ratios(OR), adjusted odds ratios (aOR) and 95% confidence interval (95% CIs) for the associations between ecstasy use between the two interviews and the four modifiable risk factors (risk perception, PBC-obtaining, current ecstasy dependence, and recent depression) were estimated using logistic regression models. Results of univariate analysis and multivariate analysis adjusting for socio-demographic covariate and polydrug use were presented.

Effects of the four predictors would be adjusted for gender, education-poverty status, ethnicity, and the number of other drug used in the past 30 days (polydrug use). Additionally, current ecstasy dependence was statistically associated with lifetime time ecstasy consumption (Spearman $\rho=0.25$, $p<0.0001$). Thus, in the multivariate logistic model, current ecstasy dependence was also used as a statistical control for the confounding effects of past behavior on the outcome measure when the effects of other predictors were examined. Due to the theoretical importance of the selected predictors, all four predictors were kept in the

multivariate model regardless of their level of statistical significance. All statistical tests were two-sided, with alpha = 0.05 considered statistical significant. Statistical analyses were conducted using SAS 9.1.

3. Results

3.1 Characteristics of participants

Findings on the patterns of ecstasy and other drug use were based on the data collected at Time 1 (Table 1). The median of the lifetime ecstasy consumption was 50 pills (mean=211.67, SD=499.96). Sydney showed a significantly higher lifetime consumption and frequency of ecstasy use compared to the other sites [Kruskal-Wallis test: consumption (2, N=601) = 28.64, $p<0.0001$; frequency (2, N=601) = 31.42, $p<0.0001$, results not shown]. Consistent with a previous large scale study in the US (N=402), people tended to have started using ecstasy during the later stage of adolescence (Carlson, Wang, Falsk, & Siegal, 2005). The median age of first use of ecstasy was 18 years (mean= 19.02, SD=4.08) with 10% beginning ecstasy use before their 16th birthday. No significant site difference was noted for the age of first use of ecstasy.

Lifetime alcohol and marijuana use were reported by most of the participants (99.7% and 97.5% respectively). A majority of the participants reported using hallucinogens (64%), stimulants (62%), and cocaine (61%) and about half of them reported sedatives (52%), inhalants (50%), and opioids (47%). While a majority of the participants started using marijuana before ecstasy (86%); over two-thirds started using sedatives, rohypnol, cocaine, ketamine, anabolic steroids, and GHB after or within the same year of starting ecstasy use. In addition to ecstasy, the sample reported an average of six other drugs in lifetime. Sydney had the lowest number of other drugs used compared to St. Louis and Miami [Kruskal-Wallis test (2, N=601) = 25.23, $p<0.0001$, results not shown]. Participants reported using a median of two other drugs in the past 30 days; lifetime other drug use was not statistically different between sites.

The lower half of Table 1 shows the characteristics of the sample regarding the four modifiable risk factors. It has been found that 39% of the participants met the DSM-IV adopted criteria for current ecstasy dependence, 76% claimed that they could obtain ecstasy within 24 hours (high PBC-obtaining), and 36% experienced depression recently (CES-D score ≥ 16). Consistent with previous studies (Gamma et al., 2005;Topp et al., 1999), ecstasy use was generally considered `Dangerous' by ecstasy users (risk perception of ecstasy: median=3, mean=2.95). Sydney had the highest proportion of continued use, current dependent users, and the lowest risk perception compared to the US sites (continued use: 37% vs. ≅7%; current dependence: 54% vs. ≅34%; mean risk perception: 3.58 vs. ≅2.75, $p<0.0001$, results not shown).

3.2 Comparisons between `Used' and `Not Used' groups

The mean duration between Time 1 and Time 2 interviews of the 601 participants was 7.73 days (range, 3 – 51 days). Thirteen percent (n=80) of the participants reported using ecstasy between the two interviews. Nearly 80% of the participants were interviewed 7 to 14 days after the first interview, and over 96% were interviewed within 5 to 14 days. Participants who reported using ecstasy between Time 1 and Time 2 (the `Use' group) reported a higher lifetime ecstasy pill consumption and used more drugs in the past 30 days compared to those who did not use ecstasy (the `Not Used' group) during this time interval ($p<0.05$, Table 1). There was no statistical difference between `Used' and `Not Used' groups regarding age, gender, education, poverty status, education-poverty status, the number of other drugs used lifetime, onset age of ecstasy, and recent depression.

The proportions of current ecstasy dependence, high PBC-obtaining, and recent depression for the `Used' group were 64%, 90%, and 41%, respectively. Participants in the `Used' group had a higher proportion of current dependence, a higher proportion of high PBC-obtaining, and a lower mean risk perception compared to those in the `Not Used' group' ($p<0.05$, Table 2). However, the proportion of recent depression did not vary significantly between the two groups.

3.3 Modifiable risk factors and ecstasy use

Results of univariate analysis showed that, except for recent depression, all other modifiable risk factors were statistically associated with ecstasy use between Time 1 and Time 2 (Table 2). Low risk perception, current ecstasy dependence, and high PBC-obtaining were all significantly associated with an increase in the likelihood of ecstasy use between the two interviews (unadjusted ORs ranged from 1.44 to 3.28). Although recent depression was not a significant predictor, it was retained in the multivariate logistic model because of its important association with ecstasy in the literature.

The associations between the four modifiable risk factors and ecstasy use between Time 1 and Time 2 were further examined using multivariate logistic regression, with all predictors and covariates entering the model simultaneously. Results of initial analysis showed that site was significantly associated with three of the four target predictors [current ecstasy dependence and PBC-obtaining (χ^2 tests, $p<0.0001$), and risk perception (Spearman ρ, $p<0.0001$)] and two covariates [ethnicity and education-poverty status (χ^2 tests, $p<0.0001$)], suggesting collinearity between the effects of site and other variables. Although site was statistically associated with ecstasy use between the two interviews ($p<0.0001$), we found that the inclusion of site in the multivariate model would suppress the effects of the target predictors and other covariates. The primary interest of this study was the predictive validity of the target predictors, but not the effects of site; thus, site was not included in the multivariate analysis[2]. Nevertheless, the potential confounding effect of site was statistically controlled by three socio-demographic covariates: ethnicity, education-poverty status, and gender[3].

Table 2 shows the aORs and the 95% CI for ecstasy use between Time 1 and Time 2 with adjustment for gender, ethnicity, education-poverty status, and the total number of other drugs used in the past 30 days. Results of multivariate logistic regression showed that, after taking into account the effects of other variables, there was an independent association between risk perception measured at Time 1 and use of ecstasy between the two interviews (aOR : 1.35; 95% CI: 1.08 – 1.69). Furthermore, participants who perceived `Taking 1 pill of ecstasy once a week for at least a month' as `Not dangerous at all' were more than three times more likely

[2]Multivariate logistic regression analysis was conducted separately for each study site. Results showed that the effects of risk perception, PBC-obtaining, and current ecstasy dependence were not statistically significant when site was analyzed separately. Since risk perception, PBC-obtaining, and current ecstasy dependence were statistically associated with ecstasy use between Time 1 and Time 2 when data from all three sites were combined, the non-significant findings within each site suggest that the significant effects of the three predictors on the outcome measure came from the variability between sites, and not necessarily from within sites.

[3]Results of logistic regression analysis showed that the likelihood chi-square in the original model, model controlling for frequency, model controlling for consumption, and model controlling for both frequency and consumption were 61.45 (12 df), 61.51 (13 df), 61.69 (13 df), and 62.04 (14 df), respectively. Model comparisons based on the differences in the likelihood chi-square indicated that no significant difference between the models with or without the two control variables. Furthermore, the effects of frequency of use and consumption were not statistically significant after controlling for all other variables (frequency: Wald chi-sq [1 df]=0.06, p=0.81; consumption: Wald chi-sq [1 df]=0.23, p=0.63). The inclusion of frequency, consumption, or both did not change the statistical significance of the four predictors. For instance, there were only small changes in the adjusted ORs for the three significant predictors (risk perception [perception], current ecstasy dependence [dependence], and PBC-obtaining [PBC]) in the model adjusting for frequency of use (model without adjusting for frequency of use - perception: 1.35; dependence: 2.54; PBC: 2.70; model adjusting for frequency of use - perception: 1.35; dependence: 2.53; PBC: 2.69). Frequency of use and consumption were also strongly associated with three target predictors (risk perception, current ecstasy dependence, and PBC-obtaining; $p<0.0001$) and some other covariates (e.g., education-poverty status and total number of other drug use in the past 30 days; $p<0.0001$); thus, we decided not to include them in the final logistic regression model in this paper.

to use ecstasy after the Time 1 interview compared to those who perceived the behaviors as `Extremely dangerous' (aOR: 3.30; 95% CI: 1.35 – 8.08, result not shown).

Current ecstasy dependence and high PBC-obtaining also increased the odds of ecstasy use between Time 1 and Time 2 after adjusting for other variables. Participants who met the DSM-IV adopted criteria for current ecstasy dependence were more than two times more likely to use ecstasy between the interviews compared to non-dependent users (aOR: 2.54; 95% CI: 1.51 – 4.26); and those who reported high PBC-obtaining were almost three times more likely to report use compared to those who reported low PBC-obtaining (aOR: 2.70; 95% CI: 1.23 – 5.92). Consistent with the result of univariate analysis, recent depression remained statistically non-significant in the multivariate model. Although the number of other drugs used in the past 30 days prior to the Time 1 interview was treated as a covariate in the multivariate model, this effect was significantly associated with ecstasy use between the two interviews. An increase in the number of other drugs used in the past 30 days significantly increased the likelihood of using ecstasy between the two interviews (aOR: 1.23; 95% CI: 1.03 – 1.47).

4. Discussion

Previous cross-sectional studies showed that some modifiable risk factors were statistically associated with ecstasy use; however, the predictive validity of these factors has not been adequately demonstrated. This study is among the first to examine the predictive validity of risk perception, current dependence, perceived behavioral control, and recent depression regarding ecstasy use. The sample in the TriCity Study consisted of over 600 ecstasy users, which is the one of the largest user samples in the field.

In the present study, when ecstasy users were asked to rate how dangerous they felt about using ecstasy once a week for at least a month, they considered this behavior dangerous. This result is in line with Gamma et al.'s (2005) and Topp et al.'s (1999) findings that users generally were aware of the risks associated with ecstasy and perceived its use as having `at least some risk'. More importantly, the present study extends the investigation into the risk perception-ecstasy use association by determining whether risk perception predicts ecstasy use after adjusting for other potential confounding variables. In this study, although ecstasy was considered dangerous in general, the mean level of risk perception among users in the `Used' group was significantly lower than that in the `Not Used' group. Specifically, results of logistic regression showed that users who reported `Not dangerous at all' were more than three times more likely to use ecstasy after the first interview compared to those reporting `Extremely dangerous'. The finding that risk perception is statistically associated with actual ecstasy use appears to refute the claim that increased risk perception toward ecstasy `neither deters curious non-users, nor causes cessation in users' (Peters, Kok, & Schaalam, 2008, p.7), and provides some support for the intervention approaches aiming to increase risk perception, at least for ecstasy.

This study also demonstrates the predictive validity of the DSM-IV adopted criteria for MDMA dependence. Using the diagnostic algorithm developed by Cottler et al., (2001), 39% of the participants were found to have current ecstasy dependence. The proportion of current ecstasy dependence in the `Used' group was significantly higher than in the `Not Used' group (64% vs. 35%). Current dependent users were also significantly more likely than non-dependent users to report ecstasy use between Time 1 and Time 2 (aOR = 2.54) after adjusting for other variables. This finding is not unexpected since dependence implicates a certain degree of impaired behavioral control over its use. According to the Theory of Planned Behavior, volitional control is a causal determinant of behavior (Ajzen, 2001). It is assumed that an individual should have the ability to decide at will whether to act or not to act if the behavior in question is under volitional control. In the case of ecstasy dependence, it is possible that the user may not be able to stop using the drug even if he/she wants to because volitional control

over the use of ecstasy is impaired. However, the extent to which volitional control influences ecstasy use is unclear since current dependence also includes physiological symptoms resulting from a repeated use of the drug. Future studies that examine the differential contribution of individual criterion to continued ecstasy use may clarify this issue.

Consistent with previous prospective studies (Orbell et al. 2001), high PBC-obtaining (an estimated ecstasy procurement time < 24 hours) was associated with an increase in the likelihood of ecstasy use between Time 1 and Time 2. In our study, high PBC-obtaining users were almost three times more likely than low PBC-obtaining users to report use between the two interviews (aOR = 2.70). It has been suggested that drug use, like other consumer behaviors, is a goal-directed behavior governed by effortful cognitive processes (e.g., rational choices), and it is part of a solution to the users' expected lifetime utility maximization (Ben Abdallah et al., 2007). Since users want to obtain quality drugs at affordable prices, therefore, drug use behaviors are constrained by factors like PBC-obtaining (i.e., opportunity cost in Ben Abdallah et al.'s psycho-economic model). In the present study, high PBC-obtaining users were found to be more likely than low PBC-obtaining users to use ecstasy, suggesting that the time a user spent acquiring ecstasy may have had a direct influence on the decision to purchase and use ecstasy.

The relationships between recent depression and ecstasy use were also examined. Although people reported using ecstasy to alleviate depressive mood (Boys, Marsden, & Strang, 2001), and depression was found to precede the first use of ecstasy (Lieb et al., 2002), recent depression was not a significant predictor of ecstasy use in the present study. It has been suggested that the effect of depression is not directly related to ecstasy consumption but rather generated through other factors that motivate ecstasy use (Ben Abdallah et al, 2007). The hypothesis that depression may not be directly related to ecstasy use is partly supported by the present study and a previous prospective study (De Win et al., 2006), where depression did not predict either the initiation or the continuation of ecstasy use. However, whether depression serves as a catalyst that motivates ecstasy use requires further investigation.

While our findings are encouraging, several limitations should be noted. First, this study aimed to examine the predictive validity of some modifiable risk factors, but not to test the validity of a particular health theory. Second, since the interval between the two interviews was relatively brief (less than two weeks on average), the utility of these factors in predicting long-term behavior is unclear. Another disadvantage for using such a short time interval is that we may not have enough events (who used the drug between the two interviews) to obtain a statistical significant association in the analysis even when these modifiable risk factors are indeed associated with the behavior in question. In order to delineate the associations between the target predictors and ecstasy use over time, a different study design which permits the collection of other information is needed. For example, if participants will be interviewed twice and a dichotomous outcome variable is used, it will be more useful if the time-to-event information is collected at the second interview in addition to the assessment of the behavioral outcome. These data can be analyzed with survival analysis techniques. A longer time interval is also desirable in order to have enough cases (events) in the analysis. Third, this study demonstrates the predictive validity of the target risk factors, but not the causality between these predictors and the actual behavioral outcome. Nevertheless, the findings in this study help to indentify modifiable risk factors for control studies. Fourth, polydrug use (number of other drugs used in the past 30 days) had been found to contribute independently to the prediction of ecstasy use between the two interviews, over and above the effects of other variables. This finding underscores the importance of controlling for the confounding effects of polydrug use in ecstasy research. Cautions should be taken when interpreting research findings involving a large proportion of polydrug users. Fifth, although targeted sampling is not convenience sampling (Watters and Biernacki, 1989), and the sample obtained from

targeted sampling has been shown to be similar to Census and HIV surveillance data in terms of many demographic characteristics (Robinson, Risser, McGoy, Becker, Rehman, Jefferson, et al., 2006), it is possible that our sample may not be representative of the ecstasy user population because of the potential biases in such a sampling method (Magnani, Sabin, Saidel, & Heckathorn, 2005). Furthermore, despite the same sampling method was used in all three sites, there were significant site differences in terms of socio-demographic characteristics, risk perception, PBC-obtaining, and drug use patterns. Specifically, Sydney showed a higher lifetime ecstasy consumption and frequency of use; had a higher proportion of use between the two interviews, current dependent users, and a lower risk perception compared to the US cities. In a recent cross-national study on drug use and drug dependence, Teesson and colleagues suggested that the differences between the US and Australia in drug use could be due to the differences in legal and policy approaches towards the reduction of drug use and the avoidance of drug related harm between the two countries (Teesson, Baillie, Lynskey, Manor, & Degenhardt, 2006). Future studies which include the information about drug policies and other cultural factors may help clarify this issue. Finally, the data were collected from three different study sites; however, despite our attempt, we were unable to test the effects of site because of its suppressing effects on the target predictors.

To conclude, this study demonstrated that three modifiable risk factors, risk perception, current ecstasy dependence, and perceived behavioral control of obtaining, are independently associated with ecstasy use. Educational programs aim to reduce ecstasy use among younger people should target risk perception and PBC-obtaining. Although PBC-obtaining is unlikely to be changed by behavioral interventions at the micro-level (individual level), it is possible to modify PBC-obtaining by intervening at the macro-level (including social network interventions and community interventions). Assessment of current dependence may help identify those who need clinical interventions. Progress and effectiveness of interventions can also be monitored via the changes in these factors. Finally, Control studies which permit the manipulation of the independent variables may help clarify the causal relationship between these risk factors and ecstasy use.

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Abbreviations

PBC-obtaining	Perceived behavioral control of obtaining ecstasy
WU-RBA-CD	Washington University Risk Behavior Assessment for Club Drugs
CD-SAM	Substance Abuse Module for Club Drugs
CES-D	Center for Epidemiological Studies Depression Scale

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Table 1

Characteristics of participants[a]

	Total (N=601)			`Used' group'[g] (n=80)			`Not Used' group'[g] (n=521)		
	%	Median	Mean (SD)	%	Median	Mean (SD)	%	Median	Mean (SD)
Age		22	23.28 (4.98)		22	22.63 (4.03)		22	23.38 (5.11)
Gender									
male	59%			55%			60%		
Female	41%			45%			40%		
Ethnicity/Race									
White	62%			71%			60%		
Black	8%			3%			9%		
Hispanic	19%			10%			20%		
Other[b]	12%			16%			11%		
Education									
Have a high school diploma (HDip)	40%			66%			59%		
No high school diploma (NDip)	60%			34%			41%		
Poverty status									
Above poverty threshold (Not poor)	53%			58%			52%		
Below poverty threshold (Poor)	47%			42%			48%		
Education-poverty status[c]									
HDip-Not poor	28%			36%			35%		
HDip-Poor	12%			30%			24%		
NDip-Not poor	25%			6%			13%		
NDip-Poor	35%			28%			28%		
Number of other drugs used (lifetime)		6	6.17 (2.75)		5	5.70 (2.69)		6	624 (2.76)
Number of other drugs used (30 days)[d]		2	234 (1.32)		3	2.78 (1.42)		2	2.27 (1.29)
Lifetime ecstasy use (pills)[d]		50	211.67 (499.96)		100	271.14 (374.62)		47	202.54 (516.21)
Lifetime frequency of ecstasy use (days)[d]		40	124.11 (289.20)		62	162.59 (320.64)		30	118.20 (283.94)
Onset age of ecstasy use		18	19.02 (4.08)		18	18.84 (3.08)		18	19.05 (4.21)

	Total (N=601)			`Used' group'[g] (n=80)			`Not Used' group'[g] (n=521)		
	%	Median	Mean (SD)	%	Median	Mean (SD)	%	Median	Mean (SD)
Current ecstasy dependence[d]									
Dependence	39%			64%			35%		
No dependence	61%			36%			65%		
Perceived behavioral control of obtaining ecstasy (PBC-obtaining)[d]									
High (≥24 hours)	76%			90%			73%		
Low (> 24 hours)	24%			10%			27%		
Risk perception of ecstasy use[e,f]		3	2.95 (1.23)		4	3.40 (1.04)		3	2.88 (1.24)
Recent depression									
Yes	36%			41%			35%		
No	64%			59%			65%		
Ecstasy use between Time 1 and Time 2									
Yes (`Used' group)	13%			100%			-		
No (`Not Used' group)	87%			-			100%		

[a] Except for ecstasy use between Time 1 and Time 2, all other data were collected it Time 1.

[b] `Other' included Alaskan native, American Indian, Asian, Middle-Eastern, Pacific Islander, and Biracial.

[c] Education and poverty status were combined to form Education-poverty stasis. HDip-Not poor: Have a high school diploma and an annual income above the poverty threshold (US$10000); HDip-Poor: Have a high school diploma and an annual income below tne poverty threshold; NDip-Not poor: No high school diploma and an annual income above the poverty threshold; NDip-Poor: No high school diploma and an annual income below the poverty threshold.

[d] χ^2 or Wilcoxon tests: $p<0.05$.

[e] t-test: $p<0.05$.

[f] Risk perception ranging from 1 (Extremely dangerous) to 5 (Not dangerous at all).

[g] `Used' group : Having used ecstasy between the two interviews; `Not Used' group: No ecstasy use between the two interviews.

Table 2

Associations between modifiable risk factors and ecstasy use (N=601)

	Univariate analysis		Multivariate analysis[a]	
Predictors and Covariares	**Odds Ratio**	**95% Confidence Interval**	**Adjusted Odds Ratio**	**95% Confidence Interval**
Risk perception of ecstasy use[b]	1.44	1.17 – 1.76	1.35	1.08 – 1.69
Current ecstasy dependence				
Yes	3.25	1.99 – 5.30	2.54	1.51 – 4.26
No	1.00	Referent	1.00	Referent
Perceived behavioral control of obtaining ecstasy (PBC-obtaining)				
High (≥ 24 hours)	3.28	1.54 – 6.97	2.70	1.23 – 5.92
Low (> 24 hours)	1.00	Referent	1.00	Referent
Recent depression				
Yes	1.30	0.80 – 2.10	1.07	0.64 – 1.79
No	1.00	Referent	1.00	Referent
Gender				
Male	-	-	0.77	0.46 – 1.28
Female	-	-	1.00	Referent
Ethnicity/Race				
Black	-	-	0.29	0.07 – 1.30
Hispanic	-	-	0.42	0.19 – 0.94
Other	-	-	1.38	0.68 – 2.80
White	-	-		Referent
Education - Poverty Status				
High Dip - Not poor	-	-	0.76	0.40 – 1.45
High Dip - Poor	-	-	0.40	0.14 – 1.11
No High Dip - Not poor	-	-	0.89	0.47 – 1.67
No High Dip - Poor	-	-	1.00	Referent
Total number of other drugs used in the past 30 days	-	-	1.23	1.03 – 1.47

[a] Multivariate model was adjusted for site, gender, education-poverty status, ethnicity, and the total number of other drugs, used in the past 30 days. Model fitting statistic: Likelihood ratio χ^2=61.45, df=12, p<0.0001.

[b] Risk perception was treated as a continuous measure ranging from 1 (Extremely dangerous) to 5 (Not dangerous, at all). The odds ratio denoted the corresponding increase in the likelihood of continued ecstasy use as the level of risk perception decreased by one unit (e.g., from `Dangerous' to `A little bit dangerous').