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The impact of positive and negative ecstasy-related information on ecstasy use among college students: Results of a longitudinal study

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Abstract

Aims—To: 1) estimate the proportion of students exposed to specific types of information regarding the positive and negative effects of ecstasy, 2) test models that quantified the relationship between exposure to these messages and subsequent ecstasy use, controlling for peer drug use and sensation-seeking.

Methods—As part of the College Life Study, 447 students, ages 17–20, from a university in the mid-Atlantic region of the US completed an in person interview plus three follow-up assessments.

Findings—Individuals who had heard a greater number of negative messages were significantly more likely to use ecstasy, even controlling for positive messages, prior ecstasy use, peer ecstasy use, perceived harm, sensation-seeking, sex, and race. Some messages were significant at the bivariate level.

Conclusions—Ecstasy use may have been influenced more by the content of the messages than by the quantity or diversity of messages. Interventions should be designed to address both positive and negative perceptions about a particular drug, rather than focusing exclusively on the negative information. Future evaluations should focus on the effectiveness of multi-pronged sustainable prevention programs in reducing adolescent drug use risk.

Keywords

ecstasy; MDMA; college students; longitudinal studies

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¹Several unsuccessful attempts were made to learn the viewing numbers of these specials.

Introduction

Adolescents and young adults are exposed to many different kinds of messages about illicit drugs, including favorable information about the pleasurable effects of a given drug, as well as warnings about potential harms associated with drug use. Information about drug effects and drug experiences comes from a variety of sources, including friends, acquaintances, parents, school health classes, and drug education programs. In recent years, the Internet has become a prominent communication vehicle, enabling the transmission of both government-sponsored research findings as well as more anecdotal information via sites such as Erowid, and social networking sites like Facebook® and MySpace,® which provide diary-like accounts of experiences with illicit drugs.

Given the variety of sources from which information is obtained, it is highly challenging to disentangle the impact of drug-related information on drug use behaviors. The likelihood that any one person will initiate drug use varies tremendously from person to person, and is a function of a multitude of personal characteristics and environmental circumstances. One's own prior experiences with drug use as well as perceived harmfulness of the purported effects of particular drugs (Johnston et al., 2005) appear to be strongly associated with drug use. Few longitudinal cohort studies have been conducted regarding the extent to which drug-related information influences drug use in late adolescence and young adulthood. The present study is a first step toward filling that research gap and has a specific focus on ecstasy, given the heavy emphasis on specific ecstasy-related prevention messages that were disseminated through the mass media and other channels during the last decade. The extent to which ecstasy's subsequent decline is attributable to the influence of these prevention messages is unclear. Moreover, few attempts have been made to measure the penetration level of specific prevention messages as well as the saturation level of messages that portrayed ecstasy use in a positive light. This study examines the penetration of information about ecstasy—both favorable and unfavorable—among a sample of college freshmen, and considers whether the amount and/or type of information are prospectively associated with ecstasy use in the future.

Ecstasy, also known as 3,4-Methylenedioxymethamphetamine (MDMA), is a drug with both stimulant and mild hallucinogenic effects. Ecstasy was chosen for investigation in the present study for two reasons. First, there is a wealth of detailed information available to young people from a variety of sources about the ecstasy-using experience (albeit not necessarily accurate or reliable). Second, the prevalence of ecstasy use had an unusual pattern, characterized by a rapid escalation, followed by a fairly dramatic decline. During the 1990s ecstasy use in the United States increased markedly, especially among educated, academically-achieving youths (Battaglia et al., 1988; Johnston et al., 2001; National Institute on Drug Abuse, 1999). Between 1993 and 2000, a ten-fold increase was observed in the annual number of new ecstasy users in the U.S. population, reaching 1.9 million in 2000 (Substance Abuse and Mental Health Services Administration, 2002). Among young adults ages 19–28, the age group with the highest prevalence of ecstasy use, past-year prevalence began increasing sharply around 1995, and peaked at 7.5% in 2001 (Johnston et al., 2005). Simultaneously, ecstasy-related emergency department visits increased more than twenty-fold between 1994 and 2001 (Drug Abuse Warning Network, 2003). After 2001, ecstasy use began a steady decline that continued through 2005, although a slight increase was observed in 2006 (Johnston et al., 2006; Substance Abuse and Mental Health Services Administration, 2003, 2006, 2007). Although there is evidence that dramatic increases in perceived risk preceded the decline in ecstasy use (Johnston et al., 2005), little is known about the reasons behind the drop in ecstasy's popularity and the extent to which any prevention efforts may have influenced this change.

In response to the signs of an emerging ecstasy epidemic, a variety of prevention programs were initiated at national and local levels, starting in the late 1990s. Programs were designed

to publicize information about the harmful effects of ecstasy, which were becoming more evident with the emergence of new research findings. For example, long-term effects on serotonin neural pathways were observed in ecstasy users, supporting a possible link between ecstasy and depression (National Institute on Drug Abuse, 2001). Additional neurological damage was also found to be persistent, suggesting that ecstasy could interfere with learning and memory (Hatzidimitriou et al., 1999). Although their findings were later retracted, Ricaurte and colleagues published work ostensibly demonstrating the deleterious effect of ecstasy on dopamine functioning, and suggested that ecstasy use could cause an increased risk for later development of Parkinson's disease (Ricaurte et al., 2002). These and other studies documenting various "brain damage" effects of ecstasy (see also Bolla et al., 1998; McCann et al., 1999; McCann et al., 1998) influenced the content of prevention messages that were disseminated during the late 1990s and early 2000s.

In 2000, the National Institute on Drug Abuse (NIDA) launched a campaign that featured images of ecstasy-exposed brains superimposed next to images of a healthy brain. These images depicted large black holes in the ecstasy-exposed brains, and they were displayed on a new website designed for teens (www.clubdrugs.org) and on 330,000 postcards distributed in public venues frequented by teens (Zickler, 1999). Subsequently, this theme was disseminated in the popular media, when the television show *48 Hours* collaborated with MTV to produce two specials on ecstasy that aired consecutively on the evening of November 30, 2000. In the MTV special, entitled *True Life: I'm on Ecstasy*, images suggested that using ecstasy could "put holes in your brain." Both specials presented what users felt were the benefits and the deleterious effects of ecstasy.⁵ In addition to the neurological risks from ecstasy use, other research has demonstrated that ecstasy could cause dangerous physiological effects such as acute hypertension, tachycardia, hyperthermia, heat stroke, dehydration, and cardiac arrhythmia (Freese et al., 2002). Some ecstasy-related deaths have been caused by excess fluid intake following dehydration (Joseph, 2000). Prevention messages focusing on these and other physiological risks were spread through public service announcements funded by the Partnership for a Drug Free America and the Office of the National Drug Control Policy (ONDCP). Additionally, beginning in 1998, ONDCP launched a five-year, \$2 billion media campaign aimed at reducing illicit drug use in teens (Palmgreen & Donohew, 2003). Prevention messages also highlighted research findings regarding the widespread presence of adulterants in ecstasy pills, many of which can have dangerous or lethal consequences (Baggott et al., 2000; Community Epidemiology Work Group, 2000).

In addition, the Internet became an important source of information about ecstasy (Falck et al., 2004). Online sites like Erowid.org, DanceSafe.org and Ecstasy.org (Falck et al., 2004) offer a broad scope of material ranging from self-reports of users' experiences while on ecstasy to links and full texts of scientific articles about the deleterious effects of ecstasy. Non-governmental websites are estimated to attract four times as many visitors as government web sites (Falck et al., 2004). While the accuracy of information presented on these sites, as well as government based ones, is debated (Bogenschutz, 2000; Boyer et al., 2001), the Internet remains a widely consulted venue for distributing information about both the positive and negative effects of ecstasy use, especially among young people (Falck et al., 2004).

Given the widespread implementation of anti-drug messages, it is surprising how few studies have attempted to directly assess student exposure to drug-related information and moreover, how little is known about the impact of this information on actual use. Studies show that ecstasy users anticipate a certain degree of health risk associated with their drug use, and in some cases, take measures to protect themselves from these risks (Gamma et al., 2005; Kelly, 2005; Murphy et al., 2006). Carlson and colleagues (2004) found that some users embraced harm-reduction approaches, but prevention messages were largely ignored. In a study done by Murphy et al. (2006), friends were the most popular source of information about ecstasy, followed by drug

leaflets and TV news. Research on ecstasy users by Falck and colleagues (2004) found that friends and non-government web sites were reported as the single most important sources of information by 40.2% and 16.2% of their sample respectively, while friends, drug abuse treatment programs, and physicians were considered the most reliable sources.

While it is tempting to speculate that the increase in dissemination of ecstasy-related information resulted in the observed decline in ecstasy's popularity, it is difficult to draw such a conclusion. The present study, undertaken in the context of a large prospective study of college students, has two aims. The first aim is to estimate the proportion of students who had been exposed to specific messages regarding the positive and negative effects of ecstasy. The second aim is to test models that quantified the relationship between exposure to positive and/or negative information about ecstasy and subsequent ecstasy use, controlling for peer drug use and sensation-seeking characteristics, which have been shown previously to influence other forms of drug use (Kellam & van Horn, 1997; Oetting & Beauvais, 1990; Zuckerman et al., 1964).

Methods

Data for the present analyses were derived from the College Life Study, a longitudinal study of substance use and other health behaviors in a cohort of 1,253 college students. Participants were recruited in two stages from one large, public university in the mid-Atlantic region. First, all incoming first-time freshman students attending new student orientation in 2004 were invited to participate in a brief online screening survey, and the response rate was 89%. Screener participants ($N=3,401$) were representative of the general population of freshman students (Arria et al., In press). Next, a sample of screener participants was selected to participate in the longitudinal study, beginning with a two-hour face-to-face "baseline" interview at some point during their freshman year (2004–2005), with a response rate of 86%. Purposive sampling strategies were employed to obtain a disproportionate number of experienced drug users rather than a representative sample. A supplementary questionnaire was added to the baseline interview approximately two months after the onset of data collection to assess exposure to ecstasy-related information. Participants were followed up at six months with a web-based survey, and then annually at 12 and 24 months with interviews similar to baseline; response rates were 72%, 91% and 88% respectively, based on the original cohort of 1,253 participants eligible for each follow-up. Participants received \$5 for participating in the screener, \$50 for completing each annual interview, and \$20 for completing the Web-based survey.

Although these interviews are referred to as "first-year," "sophomore-year," and "junior-year" interviews, it is important to note that participants were followed up regardless of whether they remained enrolled at the university. Informed consent was obtained for participation in all phases of the longitudinal study, and included permission to use demographic data from university administrative datasets. The study was reviewed and approved by the University Institutional Review Board. A federal Certificate of Confidentiality was also obtained.

The analysis sample for the present study consists of 447 students who completed the supplemental questionnaire on ecstasy information at baseline, participated in all three follow-up assessments, and have non-missing data for all variables in the present analyses. Participants were 17 to 20 years old at the time of their freshman-year interview and diverse with respect to sociodemographics: 59.7% were female, 9.0% were African American/Black, 9.0% were of Asian descent, and 9.2% were from other racial/ethnic minority groups. As a proxy for socioeconomic status, one in four (28.2%) students' mothers had less than a four-year college degree.

Exposure to ecstasy-related information

Exposure to information about ecstasy was assessed in a questionnaire listing six negative statements and four positive statements about ecstasy, as shown in Table I. Because no known scale was available to assess exposure to ecstasy-related information, the negative statements were derived from known prevention campaigns (see Vincent, 2005) and research cited in the Introduction), the positive statements were derived from informant focus groups who had been college students during the height of the ecstasy epidemic (Levy et al., 2005). Respondents indicated whether they had ever heard each of the ten statements. Two indices were computed by summing the number of positive messages and the number of negative messages each student had heard.

Drug use

In each annual interview, students were assessed for use of ecstasy. Separate items captured lifetime consumption (“On how many days in your life have you used ecstasy?”) and past-year consumption (“In the past twelve months, on how many days have you used ecstasy?”). For the present study, we were primarily interested in drug use that occurred subsequent to ecstasy information exposure—that is, after the baseline interview at freshman year and before the junior-year interview, spanning an interval of approximately two years. Therefore, “subsequent ecstasy use” was computed as a dichotomous variable, based on whether past-year ecstasy use was reported at either the sophomore- or junior-year interviews. Ecstasy use that occurred prior to the baseline interview was recoded into a separate dichotomous variable, because it was of interest as a hypothesized predictor of subsequent ecstasy use.

Ecstasy Use by Peers

In the sophomore- and junior-year interviews, participants were asked to estimate the number of their closest friends who had used various types of illicit drugs. For the present study, we included the number of close friends who used ecstasy (“Of all of your close friends, how many do you think used ecstasy in the past 12 months?”). Responses ranged from 0 to 7, with the vast majority (82.8%) having no ecstasy-using friends. Therefore, data were pooled from the two interviews to derive a dichotomous variable to describe peer ecstasy use (“any” vs. “none”).

Impulsive sensation-seeking

The Zuckerman-Kuhlman Personality Questionnaire-short form, which includes a seven-item subscale that measures impulsive sensation-seeking (Zuckerman, 2002) was administered to all participants as part of the first-year interview. Sensation-seeking is regarded as an important predictor of drug use and other risky behaviors (Herman-Stahl et al., 2007; Palmgreen et al., 1991; Reyna & Farley, 2006; Zuckerman et al., 1970). In prior studies, this scale has demonstrated satisfactory reliability among both male and female college students (Cronbach’s $\alpha = .62$ and $.71$, respectively) and good convergent validity with sensation-seeking and risky behaviors (Zuckerman, 2002). In our sample, the mean sensation-seeking score was 3.4 ($SD = 2.2$), and the Cronbach’s α was $.74$.

Perceived harmfulness of ecstasy use

The Web-based survey included the following question modeled after Monitoring the Future surveys, “How much do you think people risk harming themselves (physically or in other ways) if they try ecstasy (MDMA) once or twice (Johnston et al., 2004)?” To preserve power in our regression models and facilitate interpretation of results, responses were dichotomized as moderate or great risk vs. slight or no risk (i.e., high vs. low perceived risk).

Analytic strategy

To describe the sample's overall exposure to positive and negative information about ecstasy, frequencies were computed for the proportion of students reporting exposure to each of the ten statements. Sample means and standard deviations were computed for the indices of positive and negative messages. To test the hypothesis that exposure to negative information about ecstasy would be inversely related to subsequent ecstasy use, a series of logistic regression models were developed, with subsequent ecstasy use as the dependent variable. Explanatory variables were the two indices of exposure to positive and negative ecstasy information, perceived harmfulness of ecstasy use, ecstasy use by peers, past use of ecstasy (i.e., before the baseline interview), impulsive sensation-seeking, sex, and race. Explanatory variables were tested first in a series of bivariate models, followed by a combined model in which all explanatory variables were retained, regardless of statistical significance. Additional models were tested with and without perceived harmfulness and with and without the index of negative information, using a model comparisons approach (MacKinnon et al., 2002) to test for possible evidence of intervening effects. In additional post-hoc models, each of the ten individual ecstasy messages were tested as predictors of ecstasy use, holding constant all the other explanatory variables.

Results

Exposure to ecstasy-related information

Table I provides the sample prevalence for exposure to each of the ten messages about ecstasy. As can be seen, several of the negative messages had been heard by nearly all students, including "ecstasy can cause you to do stupid things" (93.3%), "ecstasy can kill you" (89.3%), and "ecstasy can give you brain damage" (87.7%). Exposure to the positive information about ecstasy appeared less common, although three-quarters had heard that "ecstasy makes you feel wonderful" (79.0%) and "ecstasy lets you enjoy life, parties, and dancing" (74.7%).

Ecstasy use

As of their junior-year interview, 6.7% of the analysis sample had used ecstasy at least once in their lives: 2.5% ($n=11$) had used prior to their freshman baseline interview, and 4.7% ($n=21$) used during the two-year interval between the freshman- and junior-year interviews. Of the 21 individuals who used ecstasy during the freshman-to-junior interval, most (61.9%) used ecstasy just once or twice, although responses ranged as high as 20 times. Also, 17.2% of participants said that one or more of their close friends used ecstasy during the freshman-to-junior interval.

Association between ecstasy information and subsequent use

The bivariate correlations between ecstasy use and its hypothesized predictors are presented in Table II. As can be seen, ecstasy use was weakly but significantly correlated with negative messages and perceived harm ($|r|<.2$), but not with positive messages. Interestingly, positive and negative messages were weakly correlated with each other ($r=.21$).

The results of the logistic regression analyses are presented in Table III. Contrary to our hypothesis, the number of positive messages heard about ecstasy was not related to subsequent ecstasy use, in either the bivariate or multivariate models. However, individuals who had heard a greater number of negative messages were significantly more likely to use ecstasy ($AOR=1.8$; 95% $CI=1.1, 3.0$; $p=.03$), even controlling for positive messages, prior ecstasy use, peer ecstasy use, perceived harm, sensation-seeking, sex, and race as covariates. The finding that negative information was associated with a greater likelihood to use is likely a function of experienced users knowing more about the negative effects, and perhaps seeking out more information. The

first-order interaction of perceived harm and negative information, tested in additional models, was not significant.

At the bivariate level individuals who associated a lower risk of harm with ecstasy use were significantly more likely to use it ($OR=3.5$; 95% $CI=1.4, 8.5$; $p<.01$); however, in models 1 and 3, perceived harm did not remain statistically significant when other explanatory variables were held constant. Comparing the results in Models 2 and 3, we see that the inclusion of perceived harm did not reduce the effect of negative information on ecstasy use. In additional post-hoc models (not shown), negative information did not predict perceived harm. Therefore, our data do not support the conclusion that perceived harm mediates the effect of negative information.

Post-hoc analyses

Additional analyses were conducted to examine the relative influence of each positive and negative message on subsequent ecstasy use. At the bivariate level, none of the positive messages were significantly predictive of ecstasy use, but several of the negative messages were. When each individual message was entered into separate logistic regression models, holding constant the effects of prior ecstasy use, race, and sex, two negative messages significantly predicted ecstasy use: “Ecstasy puts holes in your brain” ($AOR=10.0$; 95% $CI=2.3, 43.6$; $p<.01$) and “Ecstasy can cause Parkinson’s disease” ($AOR=5.8$; 95% $CI=2.3, 14.8$; $p<.01$). Interestingly, only one message was possibly protective against ecstasy use: “Ecstasy causes you to do stupid things” ($AOR=0.4$; 95% $CI=0.1, 1.2$; $p<.10$). When all three of these messages were entered simultaneously in the model, both “holes in your brain” ($AOR=8.1$; 95% $CI=1.8, 35.9$; $p<.01$) and “Parkinson’s disease” ($AOR=4.3$; 95% $CI=1.6, 11.3$; $p<.01$) remained significant.

Discussion

This study of a large sample of college students revealed a high level of exposure to negative messages about ecstasy. Although we do not know where students heard the information, the messages are consistent with many of the prevention messages that were disseminated in informational campaigns during the late 1990s and early 2000s. Therefore, this finding provides evidence that these campaigns may have been successful regarding the penetration of specific messages to the adolescent population. However, in this study, we did not find clear evidence that these negative messages discouraged students from using ecstasy in college. On the contrary, at least two messages were associated with an increased risk for ecstasy use (“ecstasy puts holes in your brain” and “ecstasy can cause Parkinson’s disease”). Moreover, exposure to more negative information about ecstasy had no apparent effect on perceived harm. Nevertheless, individuals in our study with low perceived harm were more likely to use ecstasy, consistent with prior evidence specific to other types of drugs (Bachman et al., 1998; Duistman & Colbry, 1995; Gonzalez & Haney, 1990).

Strengths of this study include the prospective method of data collection and use of a new self-report measure of exposure to ecstasy information. Because students were only asked to indicate whether they had heard the messages, and not whether they believed them, there was less implied pressure to provide “correct” or socially desirable responses, which is an important concern in any interview data. To further reduce the possibility of underreporting, interviewers received extensive training in procedures to maintain confidentiality and build trust and rapport with participants.

The present findings must be tempered by several limitations. Because participants were recruited from a single university, results may not be generalizable to college students in other geographic regions, or to young adults not in college. Also, we did not take into account the

frequency of ecstasy use, and therefore we cannot say whether any prevention messages were associated with lower frequency of use among those who did use ecstasy. In fact, most ecstasy users in our sample used very infrequently, so we cannot rule out the possibility that some of them might have used ecstasy more frequently had they not been exposed to the prevention messages. Moreover, many of the positive and negative messages about ecstasy in this study were derived from qualitative, exploratory research and should be subjected to more rigorous psychometric testing in the future. We did not take into account how many times participants had heard each message, or how much credibility they attributed to the sources of the messages they heard. Although the association between exposure to negative information and subsequent ecstasy use was robust to the inclusion of several other control variables—including prior ecstasy use—our models did not specifically address the possibility that this association might operate differently in deterring incident use among non-users and continued use among experienced users. In addition, another limitation of this study is that only a small portion of the sample used ecstasy (6.7%).

The present findings raise several questions of interest for future research. First, in light of the finding that some negative messages appear to be significantly associated with ecstasy use among college students, other investigators should attempt to replicate these findings, perhaps using a broader variety of messages than were assessed in the present study. Additional focus groups and systematic Internet searches should be conducted to see what other information is being circulated about ecstasy. Furthermore, we found that negative messages were not all associated with ecstasy use in the same way, and therefore we do not recommend the use of summed indices of exposure to prevention messages as a general predictor of ecstasy use behavior. The present findings provide evidence that ecstasy use may have been influenced more by the content of the messages than by the quantity or diversity of messages. Continued research with this cohort will track which of the ecstasy users discontinue their use of ecstasy, and the extent to which that transition might be attributable to earlier exposure to prevention messages.

Another important question for future research is to determine the relative influence of personal experiences with ecstasy, as distinct from information obtained from mass media, friends, teachers, and others. It seems logical that “first-hand” information about ecstasy, derived from personal experiences, would have the greatest influence on future behavior. Perhaps that would account for the present finding that, when positive and negative messages were held constant, prior use of ecstasy was not predictive of future ecstasy use. Even when the information comes second-hand, it is possible that the level of closeness, familiarity, trust, and credibility of the source determines whether the message actually influences future behavior. For instance, a student who hears stories about their friends doing “stupid things” while using ecstasy might be disinclined to use ecstasy in the future, but another student who hears similar stories in the mass media might not be as easily dissuaded. Future research on exposure to ecstasy messages should examine differences in sources of information.

The present study produced the surprising finding that hearing more negative messages about the harms that could result from ecstasy use was actually associated with an increased risk for using the drug. While this finding may seem counterintuitive, it points to the possibility of a self-selection bias in exposure to those negative messages. For example, it is possible that students who are already part of drug-using peer groups are simply exposed to more information about the effects of ecstasy use, both positive and negative, but they remain at high risk for future ecstasy use by virtue of their peer affiliations. Another possibility is that students who are curious about experimenting with ecstasy are more likely to actively seek out information about ecstasy, but they remain at high risk for using ecstasy because of their underlying novelty-seeking traits. The possibility of recall bias also exists; individuals who use ecstasy may be more likely to recall hearing the messages. One implication for prevention,

therefore, is that interventions should be designed to address both positive and negative perceptions about a particular drug, rather than focusing exclusively on the negative information. This type of balanced view may be more likely to be perceived as credible, because it parallels the same information that at-risk students are already hearing from their peers.

We did find limited evidence that one negative message might be protective against ecstasy use, i.e., “doing stupid things.” This finding is intriguing because, unlike the other negative messages, this message implies a negative consequence that is both immediate and socially undesirable. Considering that executive functioning and planning are among the slowest processes to mature in the brain (Chambers et al., 2003), it seems plausible that messages emphasizing near-term consequences might be highly salient to adolescents and young adults. It is also possible that consequences of low severity, such as “doing stupid things,” might be more compelling as deterrents because they sound more credible and likely to occur, unlike the more severe or physically harmful consequences such as brain damage that could be difficult for a young person to imagine.

Although we did not find evidence that exposure to information regarding the harmful effects of ecstasy was associated with reduced risk of use, we are hesitant to suggest that information campaigns do not play an important role in an overall drug prevention strategy, especially given the high degree of information penetration we observed in this study. On the contrary, given that the entertainment industry will continue to show stories about ecstasy use and other risky substance-using behavior, future studies should evaluate whether or not programming that provides a balanced and credible view of the true risks and consequences of drug use is effective in reducing risk. In summary, future evaluations should focus on the effectiveness of multi-pronged sustainable prevention programs in reducing adolescent drug use risk.

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References

- Arria AM, Caldeira KM, O'Grady KE, Vincent KB, Fitzelle DB, Johnson EP, Wish ED. Drug exposure opportunities and use patterns among college students: Results of a longitudinal prospective cohort study. *Substance Abuse* 29(2) In press.
- Bachman JG, Johnston LD, O'Malley PM. Explaining recent increases in students marijuana use: Impacts of perceived risks and disapproval 1976–1996. *American Journal of Public Health* 1998;88:887–892. [PubMed: 9618614]
- Baggott M, Heifets B, Jones RT, Mendelson J, Sferios E, Zehnder J. Chemical analysis of ecstasy pills. *Journal of the American Medical Association* 2000;284(17):2190–2190. [PubMed: 11056589]
- Battaglia G, Yeh SY, De Souza EB. MDMA-induced neurotoxicity: Parameters of degeneration and recovery of brain serotonin neurons. *Pharmacology, Biochemistry, And Behavior* 1988;29(2):269–274.
- Bogenschutz M. Drug information libraries on the internet. *Journal of Psychoactive Drugs* 2000;32:249–258. [PubMed: 11061675]
- Bolla KI, McCann UD, Ricaurte GA. Memory impairment in abstinent MDMA (“ecstasy”) users. *Neurology* 1998;51:1532–1537. [PubMed: 9855498]
- Boyer E, Shannon M, Hibberd P. Web sites with misinformation about illicit drugs. *New England Journal of Medicine* 2001;345:469–471. [PubMed: 11496870]
- Carlson RG, Falck RS, McCaughan JA, Siegal HA. MDMA/Ecstasy use among young people in Ohio: Perceived risk and barriers to intervention. *Journal of Psychoactive Drugs* 2004;36(2):181–189. [PubMed: 15369199]

- Chambers RA, Taylor JR, Potenza MN. Developmental neurocircuitry of motivation in adolescence: A critical period of addiction vulnerability. *American Journal of Psychiatry* 2003;106(6):1041–1052. [PubMed: 12777258]
- Community Epidemiology Work Group. Epidemiologic trends in drug abuse. Highlights & executive summary. 2000 [Retrieved December 2, 2004]. from <http://www.drugabuse.gov/PDF/CEWG/CEWG1200.pdf>
- Drug Abuse Warning Network. Emergency department trends from DAWN: Final estimates 1995 – 2002. 2003 [Retrieved December 22, 2004]. from http://dawninfo.samhsa.gov/old_dawn/pubs_94_02/edpubs/2002final/
- Duistman DM, Colbry SL. Perceived risk and use as predictors of substance use among college students. *Health Values: The Journal of Health Behavior, Education & Promotion* 1995;19(2):44–52.
- Falck RS, Carlson RG, Wang J, Siegal HA. Sources of information about MDMA (3,4-methylenedioxymethamphetamine): Perceived accuracy, importance, and implications for prevention among young adult users. *Drug & Alcohol Dependence* 2004;74(1):45. [PubMed: 15072806]
- Freese TE, Miotto K, Reback CJ. The effects and consequences of selected club drugs. *Journal of Substance Abuse Treatment* 2002;23(2):151. [PubMed: 12220613]
- Gamma A, Jerome L, Liechti ME, Sumnall HR. Is ecstasy perceived to be safe? A critical survey. *Drug & Alcohol Dependence* 2005;77(2):185–193. [PubMed: 15664720]
- Gonzalez GM, Haney ML. Perceptions of risk as predictors of alcohol, marijuana, and cocaine use among college students. *Journal of College Student Development* 1990;31(4):313–318.
- Hatzidimitriou G, McCann UD, Ricaurte GA. Altered serotonin innervation patterns in the forebrain of monkeys treated with (+/-)3,4-methylenedioxymethamphetamine seven years previously: Factors influencing abnormal recovery. *The Journal of Neuroscience* 1999;19(12):5096–5107. [PubMed: 10366642]
- Herman-Stahl MA, Krebs CP, Kroutil LA, Heller DC. Risk and protective factors for methamphetamine use and nonmedical use of prescription stimulants among young adults aged 18 to 25. *Addictive Behaviors* 2007;32(5):1003–1015. [PubMed: 16920275]
- Johnston LD, O'Malley PM, Bachman JG. Monitoring the Future national results on adolescent drug use: Overview of key findings 2001;2000
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, J. Monitoring the Future national survey results on drug use, 1975–2004. College students and adults ages 19–45. 2005 [Retrieved September 26, 2006]. from http://monitoringthefuture.org/pubs/monographs/vol2_2004.pdf
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, J. Monitoring the Future: National results on adolescent drug use: Overview of key findings 2005. 2006 [Retrieved July 5, 2006]. from <http://monitoringthefuture.org/pubs/monographs/overview2005.pdf>
- Johnston, LD.; O'Malley, PM.; Bachman, JG. Monitoring the Future: National results on adolescent drug use. Overview of key findings, 2003. Ann Arbor, MI: University of Michigan Institute for Social Research; 2004.
- Joseph, M. Ecstasy: Its history and lore. London: Carlton Books; 2000.
- Kellam SG, van Horn YV. Life course development, community epidemiology, and preventive trials: A scientific structure. *American Journal of Community Psychology* 1997;25(2):177. [PubMed: 9226862]
- Kelly B. Conceptions of risk in the lives of club drug-using youth. *Substance Use & Misuse* 2005;40:1443–1459. [PubMed: 16048827]
- Levy KB, O'Grady KE, Wish ED, Arria AM. An in-depth qualitative examination of the ecstasy experience: Results of a focus group with ecstasy-using college students. *Substance Use & Misuse* 2005;40(9/10):1427–1441. [PubMed: 16048826]
- MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets VL. A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods* 2002;7(1):83–104. [PubMed: 11928892]
- McCann UD, Mertl M, Eligulashvili V, Ricaurte GA. Cognitive performance in ($\pm$) 3,4-methylenedioxymethamphetamine (MDMA, "ecstasy") users: A controlled study. *Psychopharmacology* 1999;143:417–425. [PubMed: 10367560]

- McCann UD, Szabo Z, Scheffel U, Dannals RF, Ricaurte GA. Positron emission tomographic evidence of toxic effect of MDMA ('Ecstasy') on brain serotonin neurons in human beings. *Lancet* 1998;352(9138):1433–1437. [PubMed: 9807990]
- Murphy PN, Wareing M, Fisk JE. Users' perceptions of the risks and effects of taking ecstasy (MDMA): a questionnaire study. *Journal of Psychopharmacology* 2006;20(3):447–455. [PubMed: 16574719]
- National Institute on Drug Abuse. Cocaine abuse and addiction. Research Report Series. 1999 [Retrieved August 5, 2005]. from <http://www.streetdrugs.org/pdf/RRCocaine.pdf>
- National Institute on Drug Abuse. Ecstasy: What we know and don't know about MDMA: A Scientific Review. Bethesda, MD: 2001.
- Oetting ER, Beauvais F. Adolescent drug use: Findings of national and local surveys. *Journal of Consulting and Clinical Psychology* 1990;58(4):385–394. [PubMed: 2212174]
- Palmgreen, P.; Donohew, L. Effective mass media strategies for drug abuse prevention campaigns. In: Sloboda, Z.; Bukoski, WJ., editors. *Handbook of Drug Abuse Prevention: Theory, Science, & Practice*. New York: Kluwer Academic/Plenum Publishers; 2003. p. 27–43.
- Palmgreen P, Donohew L, Lorch EP, Rogus M. Sensation seeking, message sensation value, and drug use as mediators of PSA effectiveness. *Health Communication* 1991;3(4):217–227.
- Reyna VF, Farley F. Risk and rationality in adolescent decision making: Implications for theory, practice, and public policy. *Psychological Science in the Public Interest* 2006;7(1):1–44.
- Ricaurte GA, Jie Y, Hatzidimitriou G, Cord BJ, McCann UD. Severe dopaminergic neurotoxicity in primates after a common recreational dose regimen of MDMA ('Ecstasy'). *Science* 2002;297(5590):2260. [PubMed: 12351788]
- Substance Abuse and Mental Health Services Administration. Results from the 2001 National Household Survey on Abuse: Volume I Summary of National Findings (Office of Applied Studies, NHSDA Series H-17, DHHS Publication No. SMA 02–3758). 2002 [Retrieved September 26, 2006]. from <http://www.drugabusestatistics.samhsa.gov/nhsda/2k1nhsda/PDF/cover.pdf>
- Substance Abuse and Mental Health Services Administration. 2002 National Survey on Drug Use and Health Questionnaire. 2003 [Retrieved September 26, 2006]. from <http://www.drugabusestatistics.samhsa.gov/nhsda/2k2MRB/2k2CAISpecs.pdf>
- Substance Abuse and Mental Health Services Administration. Results from the 2005 National Survey on Drug Use and Health: National findings (Office of Applied Studies, NSDUH Series H-30, DHHS Publication No. SMA 06–4194). 2006 [Retrieved September 26, 2006]. from <http://www.oas.samhsa.gov/NSDUH/2k5nsduh/tabs/2k5Tabs.pdf>
- Substance Abuse and Mental Health Services Administration. Results from the 2006 National Survey on Drug Use and Health: National Findings. 2007 [Retrieved]. from <http://www.drugabusestatistics.samhsa.gov/nsduh/2k6nsduh/2k6Results.pdf>
- Vincent, KB. The ecstasy and methamphetamine drug epidemics: Implications for policy and control. College Park, MD: Unpublished Thesis, University of Maryland; 2005.
- Zickler P. NIDA launches initiative to combat club drugs. *Nida Notes* 1999;14(6):2p.
- Zuckerman, M. Zuckerman-Kuhlman Personality Questionnaire (ZKPQ): An alternative five-factorial model. In: de Raad, B.; Perugini, M., editors. *Big Five Assessment*. Seattle: Hogrefe & Huber; 2002. p. 377–396.
- Zuckerman M, Kolin EA, Price L, Zoob I. Development of a sensation-seeking scale. *Journal of Consulting Psychology* 1964;28(6):477–482. [PubMed: 14242306]
- Zuckerman M, Neary RS, Brustman BA. Sensation-Seeking Scale correlates in experience (smoking, drugs, alcohol, 'hallucinations,' and sex) and preference for complexity (designs). *Proceedings of the Annual Convention of the American Psychological Association* 1970;5(1):317–318.

Table I

Exposure to Positive and Negative Information About Ecstasy

	% who ever heard this message
<i>Negative Statements</i>	
Ecstasy can cause you to do stupid things.	93.3
Ecstasy can kill you.	89.3
Ecstasy can give you brain damage.	87.7
Ecstasy puts holes in your brain	48.1
Ecstasy costs too much money.	36.2
Ecstasy can cause Parkinson's disease.	12.5
Mean (SD) Number of Negative Statements	3.7 (1.0)
<i>Positive Statements</i>	
Ecstasy makes you feel wonderful.	79.0
Ecstasy lets you enjoy life/ parties/ dancing.	74.7
Ecstasy makes you forget about all of the bad things in life.	45.4
Ecstasy makes you connect with people.	41.6
Mean (SD) Number of Positive Statements	2.4 (1.3)

Pearson correlation coefficients r and p values between ecstasy use and its hypothesized predictors, among $N=447$ participants in the College Life Study.

Table II

	Ecstasy use (freshman-to- junior interval)	Positive messages	Negative messages	SSS-Imp	Peers' ecstasy use	Past ecstasy use
Number of positive ecstasy messages	.05 .28					
Number of negative ecstasy messages	.13 <.01	.21 <.01				
Impulsive sensation seeking (SSS-Imp)	.16 <.01	.08 .11	.07 .14			
Peers' ecstasy use	.29	.12	.08	.15		
(freshman-to-junior interval)	<.01	.01	.08	<.01		
Past ecstasy use	.10	.04	.11	.10	.04	
(before freshman interview)	.03	.42	.02	.03	.37	
Perceived harmfulness of using ecstasy once or twice	-.14 <.01	-.10 .04	<.01 .84	-.07 .16	-.14 <.01	-.06 .24

Table III

Results of logistic regression models predicting ecstasy use in junior year of college, among $n=447$ participants in the College Life Study.

	Bivariate Models		Multivariate Model 1		Multivariate Model 2		Multivariate Model 3	
	OR (95% CI)	p	AOR (95% CI)	p	AOR (95% CI)	p	AOR (95% CI)	p
Race = white	1.6 (0.5, 4.9)	.40	1.6 (0.5, 5.7)	.43	2.0 (0.6, 7.2)	.29	1.9 (0.5, 7.0)	.32
Sex = male	2.0 (0.8, 5.0)	.11	1.7 (0.6, 4.4)	.31	1.7 (0.7, 4.7)	.27	1.4 (0.5, 4.0)	.49
Impulsive sensation-seeking	1.5 (1.2, 1.8)	<.01	1.4 (1.1, 1.8)	.02	1.3 (1.0, 1.7)	.03	1.3 (1.0, 1.7)	.03
Past ecstasy use (before freshman-year interview)	4.9 (1.0, 24.1)	.05	3.9 (0.5, 28.4)	.18	4.3 (0.6, 28.7)	.13	4.0 (0.6, 26.9)	.16
Peers' ecstasy use (freshman-to-junior interval)	11.5 (4.5, 29.7)	<.01	8.2 (3.1, 21.9)	<.01	8.6 (3.2, 23.2)	<.01	7.9 (2.9, 21.5)	<.01
Positive information about ecstasy	1.2 (0.9, 1.7)	.28			1.0 (0.7, 1.6)	.92	1.0 (0.6, 1.5)	.98
Negative information about ecstasy	2.0 (1.2, 3.2)	<.01			1.7 (1.0, 2.8)	.04	1.8 (1.1, 3.0)	.03
Perceived harmfulness of ecstasy	3.5 (1.4, 8.5)	<.01	2.2 (0.8, 6.0)	.11			2.5 (0.9, 6.9)	.08

AOR is the adjusted odds ratio. Results shown in **bold** indicate statistical significance at $p<.05$. The first-order interaction of perceived harm and negative information was also tested and found to be non-significant.