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Original Papers

Quitting ecstasy: an investigation of why people stop taking the drug and their subsequent mental health

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The regular use of ecstasy (3,4-methylenedioxymethamphetamine, MDMA) has been associated with depressed mood, anxiety and hostility, but it is not known whether such effects persist after people stop using the drug. Furthermore, little is known about what factors might influence the decision to quit using MDMA. The aim of the present study was to examine the reasons why ex-users had stopped using this drug and to assess their current levels of depression, anxiety, anger and aggression. Telephone interviews were conducted with people who used to take MDMA on a regular basis but who no longer used the drug. The participants comprised sixty-six ex-users who used to take MDMA regularly (at least once every 2 months over a period of at least 1 year), but who had not taken MDMA for at least 1 year (average 3 years). Participants were asked about why they had quit MDMA. They also completed questionnaires to assess trait mood. Ex-users could be divided into two groups based on their reason for quitting: (i) those who had quit for mental health reasons and (ii) those who had quit for circumstantial reasons. Approximately half of those in the mental health group scored in the range for clinical depression. In that group, current levels of depression and anxiety correlated significantly with the cumulative amount of MDMA that they had taken several years previously. These findings suggest that some users may either be more vulnerable to the adverse effects of MDMA or have pre-existing mental health problems for which they self-medicate by using ecstasy. The present study shows that some ex-users experience an impairment to mental health that persists for years after they stop using this drug.

Key words: aggression, depression, ecstasy, ex-users, MDMA

Introduction

Although various estimates have been made of how many people use the drug ecstasy (3,4-methylenedioxymethamphetamine, MDMA), the precise incidence is not known. A large-scale survey in the USA (Monitoring the Future; NIDA, 2001) indicates that the use of MDMA increased among eighth- to twelth-grade students from 1999 to 2000; among twelth-graders, lifetime use increased from 8% to 11%. In the UK, Saunders (1995) estimated that 500 000 to 1000 000 young people take this drug each weekend.

Much current debate focuses on the issue of whether MDMA is neurotoxic in humans (Curran, 2000; Grob, 2000; Ricaurte *et al.*, 2000). In animals, MDMA has been associated with neurotoxic damage to both serotonergic and dopaminergic systems (Ricaurte *et al.*, 2000, 2002). However, the vast majority of animal research to date has shown damage only to serotonergic function (Battaglia *et al.*, 1987; McKenna and Peroutka, 1990). In particular, long-lasting damage to serotonergic function has been shown in studies of non-human primates (Hatzidimitriou *et al.*, 1999), where MDMA caused a reduction in serotonin (5-HT) axon density and abnormal reinnervation that was still evident 7 years after administration. However, in animals, no functional consequences of this neurotoxicity have been shown. In humans, neuroimaging studies have demonstrated evidence of decreased 5-HT transporter binding in brains of current MDMA users compared to controls (McCann *et al.*, 1998; Semple *et al.*, 1999). If MDMA alters serotonergic function in humans, then ecstasy users may experience changes in those functions thought to be partially mediated by 5-HT such as the regulation of mood, appetite, sleep, pain and cognition. There has been some evidence of functional changes in MDMA users in terms of impairments to working and episodic memory (Curran, 2000; Morgan, 2000). Ex-users who have not taken MDMA for an average of 2 years were shown to be impaired on tasks tapping episodic and working memory compared to drug naïve controls and polydrug users (Morgan *et al.*, 2002). Mood changes such as increased levels of depression and aggression have been found a few days following MDMA use (Curran and Travill, 1997; Parrott and Lasky, 1998; Verheyden *et al.*, 2002).

If users are experiencing negative consequences of MDMA use, this may have an impact on their decision to continue using the drug. To date, little is known about why people who take MDMA

may eventually stop taking it. Theories of drug addiction such as the transtheoretical model (Prochaska and DiClemente, 1986) have been devised to account for the processes of changing drug use behaviours, but these have focused mainly on behaviours such as quitting smoking or alcohol dependence. Unlike drugs that cause physical dependency, MDMA is predominantly used irregularly, often only at weekends. Whereas there is no evidence to suggest that MDMA is 'addictive', several studies have noted that users report developing tolerance to its effects after repeated use, having to take more to achieve the same effect (Jansen, 1999; Topp *et al.*, 1999). Together with the fact that MDMA is a very 'sociable' drug, predominately used with peers at parties and clubs, it is possible that some users may experience difficulties in quitting use of MDMA.

As there is no previous research on this issue, an exploratory examination of problems related to stopping MDMA was planned.

Several studies (Curran and Travill, 1997; Parrott and Lasky, 1998; Verheyden *et al.*, 2002) have reported that users experience depression, aggression, anxiety and paranoia in the days following MDMA consumption, but it is unknown whether such adverse effects influence a decision to abstain from MDMA. There have been reports of increased levels of depression relative to drug-free controls in those who have recently quit using MDMA or those who are currently using very little (Gerra *et al.*, 2000; MacInnes *et al.*, 2001). However, these studies have not investigated ex-users who have quit MDMA for over 1 year, nor have they investigated whether it is justifiable to conceptualize ex-users as a homogenous group with similar reasons for quitting. To explore these issues, we conducted a study of the current mental health of people who had stopped using the drug for at least 1 year (average 3 years) and of their reasons for quitting.

Methods

Participants

Participants had all previously responded to requests in the media (magazines or a local television programme) for ex-MDMA users to take part in our research programme. Participants were all male, as this was a criterion for participating in the broader programme of research (Curran and Verheyden, 2003). For the present study, we recruited all those volunteers who had been regular MDMA users (using MDMA at least once every 2 months over a period of at least 1 year) but who had stopped using this drug altogether at least 1 year previously. All 66 ex-users who replied to the media requests and who met the recruitment criteria in terms of use of and abstention from MDMA were interviewed on the telephone. Of these, 47 subsequently returned completed postal questionnaires. The participants in this sample (n = 47) had a mean (± SD) age of 30 ± 7.11 years. Participants provided their verbal, informed consent and were not paid for participating in this study. The study was approved by the UCL/UCLH Committees on the Ethics of Human Research.

Procedure

Participants (n = 66) were telephoned, the study was described and they were asked for their informed consent to participate. When their consent had been obtained, demographic data were gathered about participants' past drug use and the reason why they stopped using MDMA. Participants were then sent a set of questionnaires by post and asked to return these when completed in the stamped addressed envelope provided.

Assessments

Telephone interview

This semi-structured interview requested information about participants' drug use patterns. The amount, frequency and length of use of all recreational drugs were recorded, along with the drugs that were used in conjunction with MDMA. Units of alcohol consumed were calculated by the experimenter from the participant's reported drinking. Participants were first asked why they had stopped taking MDMA and the reason they gave was used to define groups in subsequent analyses (see below). They then rated on a scale of 1–10 how important a variety of reasons were in their decision to stop taking MDMA. The reasons provided as choices were based on those used in a survey of 430 current MDMA users (Verheyden *et al.*, in press). Participants were also asked if they had ever received psychological/psychiatric treatment.

Postal questionnaires

Seven standard questionnaires were posted to all participants who had been interviewed. Depression and anxiety were assessed with the Beck Depression Inventory (BDI, Beck, 1978) and the State-Trait Anxiety Inventory (STAI, Spielberger *et al.*, 1970). Anger and aggression were assessed using the Multidimensional Anger Inventory (MAI, Siegel, 1986) and the Aggression Questionnaire (AQ, Buss and Perry, 1992). A measure of self-esteem was included, Self-Esteem Scale (SSES, Heatherton and Polivy, 1991) as well as a measure of impulsiveness, Barratt Impulsiveness Scale (BIS-II, Barratt and Patton, 1983). The BIS-II comprises three subscales to assess non-planning, motor and cognitive impulsiveness. A modified version of the Hospital Anxiety and Depression Scale was used to assess participants' mood over the last 24 h (HADS, Zigmond and Snaith, 1983). This differs from the original scale, which assesses mood over the last week. Participants rated 14 items according to how well each described how they had been feeling over the past 24 h. As with the original scale, our modified version comprised two subscales to assess state anxiety and depression.

Definition of sub-groups and statistical analyses

*Total sample (*n = *66)*

Each participant was assigned to one of two groups according to the reason they gave in the telephone interview for quitting MDMA. Participants assigned to group 1 gave mental health reasons for why they stopped taking MDMA (n = 37); participants assigned to group 2 gave other, 'circumstantial' reasons for why they stopped taking MDMA (n = 29). These two groups were compared in terms of patterns of MDMA use and their answers to the interview questions about why they decided to stop using MDMA, and also how they felt about abstaining. Responses to the telephone interview questions were analysed using chi-square tests.

*Questionnaire group (*n = *47)*

Those who returned the questionnaires were also divided into two groups based on whether they had stopped using MDMA for mental health reasons (n = 29) or for circumstantial reasons (n = 18). As with the total sample, participants were compared on patterns of MDMA use and reasons for stopping. In addition, participants in

this group were compared for scores on trait measures and the adapted state measure of depression and anxiety. Univariate analysis of variance (ANOVA) with age as covariate was used to compare the questionnaire scores of the two groups, except when the Levene test of homogeneity was significant, where Mann–Whitney non-parametric tests were used instead. Pearson product-moment correlations were carried out between measures of mood and patterns of MDMA use in both the mental health and circumstantial groups. Cumulative use of MDMA was a measure of the total number of MDMA tablets ingested by participants in their lifetime (dose × frequency × length of MDMA use). The alpha level was raised to $p < 0.01$ to reduce the likelihood of type I errors resulting from the number of correlations carried out. All data were analysed using SPSS for Windows (release 11.0. SPSS Inc., Chicago, IL, USA).

Results

The results are presented in two parts: (i) telephone interview data for both the total sample ($n = 66$) and those who returned the questionnaires ($n = 47$); and (ii) questionnaire data from the postal questionnaires.

Telephone interview data

Responses to the question 'why did you stop taking ecstasy?' were used for identifying which group participants should be assigned to. These were coded independently by two raters. The inter-rater reliability was computed on the two sets of frequencies recorded by the two raters, using Pearson's correlation coefficient and 100% agreement was found between the two raters ($r = 1.00$, $p < 0.05$). In the total sample, this resulted in 56.1% of participants giving mental health reasons for stopping MDMA and 43.9% of participants giving circumstantial reasons for stopping MDMA. The main reasons given by the mental health group for quitting MDMA were: depression (22%), 'messed my head up' (19%), paranoia (19%), mood changes (13%), anxiety/panic (11%), memory problems (8%) and mental health worries (8%). The main reasons provided by the circumstantial group were: changes of circumstance (65%), boredom (24%) and a fall in the quality of ecstasy (11%).

There were no significant differences between the two groups on any measure of MDMA use in either the total sample or the questionnaire sample (Table 1). Participants had taken MDMA for an average of approximately 4 years and had stopped using the drug 3–4 years before the interview. Patterns of MDMA use were similar in both the total sample and questionnaire group.

The majority of participants took other drugs conjointly with MDMA. For example, in the total sample, 38% of the mental health group and 28% of the circumstantial group reported taking other Class A drugs at the same time as taking MDMA. A similar pattern emerged in the questionnaire group. There were no significant differences between groups in terms of percentage of participants using other drugs with MDMA in either the total sample or the questionnaire group.

Responses to the telephone interview questions about stopping MDMA were coded by the experimenter to create discrete categorical data. The frequency that a response occurred in each category was counted. As shown in Table 2, the only significant

Table 1 Means (± SD) for MDMA use by each group when they were using MDMA

Patterns of use	Total sample ($n = 66$)		Questionnaire group ($n = 47$)	
	Mental health group ($n = 37$)	Circumstantial group ($n = 29$)	Mental health group ($n = 29$)	Circumstantial group ($n = 18$)
Dose of MDMA taken in a typical session (no. tablets)	3.16 (1.80)	3.66 (3.07)	2.84 (1.58)	3.22 (3.13)
Frequency of MDMA use (days/month)	8.49 (6.12)	6.76 (3.87)	7.62 (5.83)	6.64 (3.90)
Years of MDMA use	4.22 (2.73)	3.69 (2.14)	4.41 (2.67)	3.31 (2.16)
Years since quiting MDMA	3.30 (1.83)	3.86 (2.76)	3.43 (1.99)	4.44 (3.12)

Table 2 Percentage of participants responding 'yes' or 'no' to interview questions by each group

Interview question	Total sample ($n = 66$)		Questionnaire group ($n = 47$)	
	Mental health group (%) (MH) ($n = 37$)	Circumstantial group (%) (Ctl) ($n = 29$)	Mental health group (%) (MH) ($n = 29$)	Circumstantial group (%) (Ctl) ($n = 18$)
Were the effects of MDMA the same at the end as at the beginning?	Yes 13.5; No 86.5	Yes 6.9; No 93.1	Yes 13.5; No 86.2	Yes 5.6; No 94.4
How did you feel a few months after stopping?	Better 67.6; Same 24.3; Worse 8.1	Better 51.7; Same 44.8; Worse 3.4	Better 65.5; Same 31.0; Worse 3.4	Better 50.0; Same 44.4; Worse 5.6
What were the down-sides of stopping?	None 40.5; Social 48.6; Other 10.8	None 31.0; Social 55.2; Other 13.8	None 41.4; Social 51.7; Other 6.9	None 33.3; Social 61.1; Other 5.6
What were the benefits of stopping?	None 5.4; MH 73.0; Ctl 21.6	None 10.3; MH 62.1; Ctl 27.6	None 6.9; MH 72.4; Ctl 20.7	None 5.6; MH 77.8; Ctl 16.7
Did you have problems stopping?	Yes 13.5; No 86.5	Yes 10.3; No 89.7	Yes 13.8; No 86.2	Yes 16.7; No 83.3
Did you relapse? If so, why?	Not relapse 86.5; Enjoyment 10.8; Other 2.7	Not relapse 93.1; Enjoyment 6.9; Other 0.0	Not relapse 89.7; Enjoyment 10.3; Other 0.0	Not relapse 100; Enjoyment 0.00; Other 0.0
Have you ever had professional help for mental health problems?	Yes 62.2; No 37.8	Yes 27.6; No 72.4	Yes 62.1; No 37.9	Yes 22.2; No 77.8

Table 3 Hierarchy of reasons for stopping MDMA in the total sample (mean ratings out of 10)

Mental health group (n = 37)	Circumstantial group (n = 29)
Paranoia (7.1)	MDMA quality drop (7.0)
Anxiety (7.0)	Not enjoying drug (5.8)
Long-term mental health (6.9)	Stopped clubbing (5.7)
Depressed (6.8)	Long-term mental health (4.4)
Short-term mental health (6.2)	Work affected (4.4)
Memory (6.2)	Depressed (4.0)
Concentration (5.9)	Concentration (3.7)
MDMA quality drop (5.8)	Memory (3.7)
Not enjoying drug (5.4)	Physical health worries (3.4)
Physical health worries (5.0)	Paranoia (3.3)
Work affected (4.9)	Other's bad experience (3.2)
Stopped clubbing (4.6)	Anxiety (3.1)
Impulsive behaviour (4.4)	Short-term mental health (2.4)
Bad experience (4.2)	Other mentally ill (2.4)
Angry (4.0)	Bad experience (2.3)
Sleeping worries (3.8)	Sleeping worries (2.1)
Eating worries (3.5)	Friends quit (2.1)
Other's bad experience (2.6)	Eating worries (2.0)
Relatives' pressure (2.3)	Impulsive behaviour (2.0)
Relatives find out (2.0)	Relatives find out (2.0)
Other mentally ill (2.0)	Angry (1.8)
Friends quit (1.5)	Criminal record (1.6)
Money problems (1.5)	Money problems (1.3)
Criminal record (0.9)	Relatives' pressure (0.9)

difference between groups was that more participants in the mental health groups reported having received professional help for mental health problems than participants in the groups that gave circumstantial reasons for stopping MDMA use. This was the case for both the total sample (chi squared = 7.80, d.f. = 1, $p < 0.01$) and the questionnaire group (chi squared = 7.08, d.f. = 1, $p < 0.01$). The majority of participants in both groups reported that the effects of MDMA declined over time and that they felt that their mental health had improved after stopping. Only a minority reported experiencing problems in stopping, although approximately half of the sample said that ceasing to use MDMA had a negative effect on their social life.

Participants were asked to rate the extent to which various reasons for stopping MDMA applied to them. Hierarchies for the total sample are presented in Table 3, with the most important reason at the top and the mean ratings presented in brackets. These hierarchies highlight that, for the mental health group, the main reasons for stopping revolved around mental health problems such as paranoia, anxiety and depression. By contrast, the circumstantial group gave highest ratings to non-mental health reasons for stopping MDMA. These included a fall in the quality of MDMA, that they were no longer enjoying the drug and that they were no longer going to clubs. This further supports the creation of groups within the present study.

Questionnaire data

As seen above, the group of participants who returned the questionnaires showed a similar pattern of responses to the interview questions to the total sample. Importantly, 61.7% of participants gave mental health reasons for stopping MDMA whereas 38.3% of participants gave circumstantial reasons. Therefore, they were divided into mental health and circumstantial groups based on their reasons for stopping MDMA use, and a higher percentage of participants in the mental health group had sought help from a mental health professional compared to those in the circumstantial group. Groups also had similar patterns of MDMA use when they were taking the drug regularly.

Table 4 Percentage of participants currently using drugs other than MDMA in a typical month (questionnaire group)

Drug	Mental health group	Circumstantial group
Alcohol	96.4	94.4
Cannabis	67.9	66.7
Tobacco	85.7	66.7
Cocaine	46.4	27.8
Amphetamines	10.7	11.1
LSD	10.7	0
Ketamine	7.1	0
Benzodiazepines	3.6	5.6
GHB*	0	5.6
Heroin	0	0

* Gammahydroxybutyrate

The postal questionnaires provided information about current use of drugs other than MDMA. Self-report of use of drugs other than MDMA is presented in Table 4. Chi-square analysis revealed no significant difference between groups for current drug use. To this end, the majority of participants in both groups reported using alcohol, tobacco and cannabis in a typical month. Participants in the mental health group were more likely to report current use of cocaine than those in the circumstantial group, although this difference was not statistically significant.

Participants were also asked about which drugs they had used in conjunction with MDMA when they were taking it regularly. The two groups were generally matched in terms of drug use. Importantly, there were no group differences in lifetime use of drugs other than MDMA. More specific analysis of drug use patterns showed that there were no significant differences in the amount of drugs other than MDMA used in a typical session. The only difference between groups in frequency and length of use of drugs other than MDMA was that those in the mental health group consumed LSD more often than those in the circumstantial group ($U = 124.00$, $p < 0.005$), and had been using LSD for approximately 2 years longer than those in the circumstantial group ($U = 89.00$, $p < 0.01$).

Because the participants in the mental health group were, on average, 5 years younger than participants in the circumstantial group [$F_{(1,40)} = 6.19$, $p < 0.05$] and also had a younger age of first use of MDMA [$F(1,40) = -2.94$, $p < 0.005$], age was used as a covariate in subsequent analysis because it is possible that younger MDMA users are more susceptible to experiencing adverse psychological effects. Trait mood measures were scored according to standard criteria to yield individual scores for depression, anxiety, anger, aggression, self-esteem and impulsiveness. Univariate ANOVAs, with age as covariate, were used to compare the questionnaire scores of the two groups, except when the Levene test of homogeneity was significant, where Mann–Whitney non-parametric tests were used instead (Table 5).

There was a significant group difference in BDI scores whereby the mental health group had higher depression levels than the circumstantial group [$F(2,39) = 4.40$, $p < 0.05$]. Further examination of the BDI scores revealed that six participants in the mental health group scored in the range for mild clinical depression (14–19), four scored in the range for moderate depression (20–28) and three scored in the range for severe depression (29–63). By

Table 5 Mean (s.d.) questionnaire scores for each group (questionnaire group)

Questionnaire	Mental health group	Circumstantial group
BDI	13.52 (9.79)	7.23 (7.05)*
STAI	47.72 (12.08)	41.24 (12.57)
MAI–frequency	13.96 (4.88)	12.35 (4.64)
MAI–duration	5.88 (1.60)	5.76 (1.68)
MAI–magnitude	12.29 (3.92)	10.65 (3.82)
MAI–hostility	17.04 (5.08)	17.59 (4.24)
AQ–total	80.33 (18.98)	80.00 (20.41)
AQ–physical	25.13 (8.69)	24.35 (7.25)
AQ–verbal	15.79 (4.20)	15.47 (3.00)
AQ–anger	19.88 (6.93)	18.76 (5.97)
AQ–hostility	19.54 (6.84)	21.41 (7.86)*
SSES[a]	2.72 (2.26)	2.59 (2.53)
BIS–total	62.79 (11.47)	56.82 (16.78)
HADS–anxiety[b]	9.36 (5.66)	6.29 (3.70)
HADS–depression	6.52 (4.56)	4.53 (4.54)

[a]A higher score indicates lower self–esteem. [b]Mann–Whitney test used (variances not homogenous). *$p < 0.05$.

contrast, two participants in the circumstantial group scored in the mild range and one scored in the moderate range. The circumstantial group had significantly higher scores on the AQ hostility sub-scale than the mental health group [$F(2,38) = 3.57$, $p < 0.05$]. There was a trend towards a group difference in MAI duration of anger scores [$F(2,38) = 3.07$, $p = 0.06$] whereby participants in the mental health group tended to experience anger for a longer period of time than those in the circumstantial group. There were no significant differences between the two groups on any other trait measure. In terms of state measures, there was a group difference on the HADS anxiety scale with participants in the mental health group having higher anxiety scores than those in the circumstantial group ($U = 173.00$, $p = 0.05$). There was no significant group difference on the HADS depression subscale.

Correlations between measures of mood and lifetime MDMA use

Pearson product-moment correlations revealed significant positive associations in the mental health group between cumulative MDMA use and BDI score ($r = 0.62$, $p < 0.001$), self-esteem ($r = 0.53$, $p < 0.005$) and anxiety (STAI) ($r = 0.49$, $p < 0.01$). Thus, the higher their cumulative use of MDMA, the higher their depression and anxiety and the lower their self-esteem. (The self-esteem scale has reversed scoring so that a positive correlation means that those who had greater lifetime use of MDMA had lower self-esteem.) There were no significant correlations between lifetime use of MDMA and any measure in the circumstantial group.

Further analysis of the significant correlations was conducted to identify whether more specific measures of MDMA use correlated with questionnaire measures. In the mental health group, years of MDMA use was found to correlate significantly with BDI score ($r = 0.58$, $p < 0.001$), aggression (total score) ($r = 0.68$, $p < 0.001$), AQ anger ($r = 0.51$, $p < 0.01$), AQ physical aggression ($r = 0.53$, $p < 0.005$) and MAI frequency of anger ($r = 0.55$, $p < 0.005$). Amount of MDMA taken in a typical session was correlated with STAI anxiety ($r = 0.53$, $p < 0.005$), HADS anxiety ($r = 0.48$, $p < 0.01$) and HADS depression ($r = 0.59$, $p < 0.001$). Frequency of use was not significantly correlated with any trait measure. There were no significant correlations between lifetime use of drugs other than MDMA and any questionnaire measure.

Within the circumstantial group, AQ physical aggression showed a positive correlation with frequency ($r = 0.60$, $p < 0.01$) and amount of MDMA used ($r = 0.64$, $p < 0.01$). Physical aggression was also positively correlated with lifetime use of cocaine in the circumstantial group ($r = 0.68$, $p < 0.005$). Years since last use of MDMA was not correlated with any measure in either group. There were no significant correlations between age or age of first use of MDMA and any questionnaire measure in either the mental health or circumstantial groups.

Discussion

The present study examined the reasons why ex-users had stopped taking MDMA. The findings showed that ex-users can be divided into two groups based on their main reason for choosing to stop using MDMA: (i) those who now abstain from MDMA for mental health reasons and (ii) those who chose to stop using for other, circumstantial reasons. The mental health group cited paranoia, anxiety and depression as the main reasons for quitting MDMA. The circumstantial group gave reasons such as a drop in the quality of MDMA or that they were no longer clubbing as the main explanation for why they stopped using MDMA.

The present study looked at ex-users who had refrained from using MDMA for a significant period of time (average 3–4 years). It therefore builds on the findings of other studies that have reported mild depression in ex-users with much shorter periods of abstinence (Gerra *et al.*, 2000; MacInnes *et al.*, 2001). Importantly, the results of the current study suggest that there are significant differences in levels of depression amongst ex-users that may be related to the reason that they stopped using MDMA and the amount of MDMA consumed when they were using. Those who gave mental health reasons for quitting MDMA had higher trait depression scores than the group that gave circumstantial reasons for stopping. Moreover, approximately a quarter of those in the mental health group scored in the range for mild clinical depression. This is in accordance with the findings of Gerra *et al.* (2000) who found levels of mild depression in former MDMA users who had been abstinent for 12 months. Furthermore, the present study also found that a quarter of ex-users in the mental health group scored in the range for either moderate (14%) or severe depression (10%). The higher levels of depression reported by ex-users may be due to the inclusion of more ex-users who stopped using MDMA because of concerns about their mental health. Therefore, it may be informative if future studies of ex-users include information about the reasons why participants stopped using MDMA.

An association was found between lifetime use of MDMA and BDI score in the mental health group, but not in the circumstantial group. Here, greater cumulative lifetime use of MDMA was correlated with higher depression scores on the BDI. In addition, those participants in the mental health group who had been using MDMA for a longer period of time also had higher BDI scores than those who had been using for fewer years. Similarly, lower self-esteem was associated with greater lifetime use of MDMA in the mental health group. Furthermore, no association was found between use of any other drug and measures related to depression, suggesting that use of MDMA is the key factor in the findings reported above. This is in accordance with the finding of Lieb *et al.* (2002) that MDMA users had higher rates of mental disorder

compared to users of other drugs. Our findings therefore suggest that lifetime amount of MDMA consumed is related to persistent depression in ex-users who report mental health reasons for quitting the drug.

However, it is impossible to determine whether use of MDMA caused the elevated levels of depression reported above, or whether depression pre-dated first use of MDMA. Indeed, it is possible that MDMA was used by those who suffer from depression as a means of 'self-medicating' in an attempt to control their mood. A recent longitudinal study showed that those who had mental disorders at baseline were more likely to go on to use ecstasy than those who did not have a mental disorder at baseline (Lieb *et al.*, 2002). However, the study by Lieb *et al.* (2002) also showed that there is no clear linear relationship between use of MDMA and mental illness because 40% of users were found to develop depression subsequent to using MDMA. Although the present study cannot show a clear causal link between use of MDMA and onset of depression, it does highlight important differences between groups of ex-users that may also be related to the amount of MDMA consumed when using regularly.

It is beyond the remit of the present study to speculate about the mechanisms by which ex-users display signs of depression years after last use of MDMA. Indeed, only two studies to date have used a psychopharmacological challenge to investigate serotonergic function in users who have abstained from MDMA use for 1 year (Gerra *et al.*, 2000; Curran and Verheyden, 2003). Although the study by Gerra *et al.* (2000) did not find a connection between measures of 5-HT function and mood, it did show evidence of persistent depression (HAM-D) and blunted prolactin responses in abstinent MDMA users relative to controls. Similarly, Curran and Verheyden (2003) found no relation between mood and response to tryptophan augmentation or depletion in 32 ex-users who had been abstinent for an average of 2.4 years. However, compared to current ecstasy users and control non-users, the ex-users showed significantly elevated aggression which may indicate reduced 5-HT function. Thus, it is reasonable to hypothesize that recovery from altered serotonergic function may be a long-term process, one consequence of which may be the depression shown by some ex-users in the present study, despite years of abstinence. However, this is only a very tentative hypothesis and does not clarify whether the depression displayed by ex-users in this study is a cause or consequence of MDMA use.

Although there were no group differences in trait anger or aggression, length of use of MDMA was associated with a number of measures of trait anger and aggression in the mental health group. Those who had been using MDMA for a longer period of time had higher scores for total aggression, physical aggression, anger and frequency of anger than those who had not been using for as many years. Thus, those who stopped taking MDMA for mental health reasons may be vulnerable to persisting anger and aggression that is related to the number of years that they had used MDMA. Whereas the circumstantial group also showed positive associations between amount and frequency of MDMA and physical aggression, they also showed highly significant correlations between lifetime use of cocaine and physical aggression. This suggests that, in the circumstantial group, lifetime use of cocaine was as much an influential factor in determining trait aggression as MDMA. Cocaine use and aggression have been associated in previous studies (Davis, 1996; Denison *et al.*, 1997).

The mental health group had significantly higher HADS scores than the circumstantial group. As the modified HADS used in this study is a state measure, it is possible that those in the mental health group were simply more anxious than the circumstantial group about participating in the study. However, in the mental health group, HADS anxiety was significantly correlated with the amount of MDMA taken in a typical session. Those who took more MDMA when they were using regularly had higher anxiety scores than those who took less MDMA. There were no significant group differences on the HADS depression subscale. Although this appears to contradict the significant group difference between scores on the BDI, it should be noted that the modified HADS used in the present study assesses mood over the last 24 h and hence is likely to measure depressive symptomatology rather than depression as an enduring chronic mood state. Furthermore, as the psychometric properties of the modified HADS have not been assessed, questions about its validity and reliability will arise.

The majority of participants reported that the pleasurable, acute psychological effects of taking MDMA declined with time. This suggests that users may become tolerant to the effects of MDMA. The issue of whether regular use of MDMA results in tolerance requires further investigation because the development of tolerance is one of five criteria for drug dependency reported in the World Health Organization Guidelines (1992). However, only 12% of participants reported problems stopping using MDMA and an even smaller proportion used the drug again. This suggests that ceasing to use MDMA is not problematic for most users. At the same time, medical professionals involved in treating depression in ex-MDMA users should note that approximately half of our participants reported feelings of social isolation as a result of abstaining from MDMA. As social support is a key factor in recovery from depression (Brown *et al.*, 1986) and certain ex-users were in the mild-moderate range for clinical depression, then social isolation resulting from quitting MDMA may be one target area for helping ex-users of this drug. It is also possible that the reports of social isolation exacerbated psychiatric symptoms in ex-users. However, as the ex-users in the present study stopped using MDMA over 3 years ago, it seems unlikely that the immediate social isolation resulting from a change of lifestyle contributed to symptomatology at the time of testing.

Approximately two-thirds of those in the mental health group said that they felt better a few months after they had stopped using MDMA. This suggests that cessation of MDMA can be subjectively beneficial. Indeed, participants in both groups reported that they felt that the main benefit of stopping MDMA use was improved mental health. Thus, it seems that even those users who do not stop using MDMA because of mental health problems subjectively benefit from a decision to stop using in terms of their mental health. However, it should be remembered that the high level of media speculation concerning the mental health effects of MDMA might also have influenced these self-reports.

It would also be interesting to know when exactly the mental health group sought professional help; whether it predated their first use of MDMA and whether this was instrumental in their decision to stop using. Further research should also address the accessibility of primary care services to MDMA users. The fact that approximately two-thirds of the mental health group had sought professional help suggests that MDMA users are prepared to seek out support for mental health problems which may be related to their drug use. However, as users who approach mental health services for depression probably do not disclose their

use of MDMA, there may be logistical difficulties in collecting this data.

Methodologically, we were reliant on self-report data and, as participants had not used MDMA for approximately 3–4 years on average, the reliability of their memories could be questioned (Curran, 2000). Participants may have exaggerated the amount of time for which they had been abstinent, or sought to conceal any occasions on which they had used MDMA after quitting. However, the ex-users interviewed in the present study were highly motivated to participate in this research and, as they had made the first contact with researchers about participating, it seems unlikely that they would have deliberately given false information. Only males participated and so findings may not generalize to female ex-MDMA users. However, because (i) females are more prone to depression than males in the general population (Frackiewicz *et al.* 2000) and (ii) female users are more likely than male users to become depressed in the days following MDMA consumption (Verheyden *et al.*, 2002), the current findings may actually underestimate the extent of depression in ex-users. It is also possible that more males who had experienced mental health problems volunteered to participate in the study, and this may mean that our sample was biased.

All research into the effects of MDMA in humans who have taken ecstasy raises issues about purity and the precise dose of MDMA consumed. Ecstasy tablets bought on the street contain varying amounts of the active ingredient (3,4-methylenedioxymethamphetamine). However, there is considerable variation in estimates of the average amount of MDMA in tablets. Whereas some studies state that only 50% of tablets tested contained MDMA, a recent study of tablets seized in the north-west of England reported that 100% of the sample contained MDMA (Cole *et al.*, 2002). Furthermore, a recent study reported that the average amount of MDMA in ecstasy tablets has fallen in recent years (Cole *et al.*, 2002). All of the above factors need to be taken into account when assessing the effects of ecstasy, particularly when considering the type of relationships between amount of use and mood effects reported in the present study. However, the users in this study were predominately taking ecstasy in the early 1990s, at a time when the average MDMA content of Ecstasy tablets was higher than in recent years (Cole *et al.*, 2002). Participants were also regular, experienced users of MDMA, many of whom reported using MDMA powder rather than buying ecstasy tablets in an attempt to get a purer dose of the drug. The difficulties outlined above mean that the present study has obvious limitations compared to a drug trial in which MDMA is directly administered. However, the fact that participants were regular, experienced users over a long period of time may mitigate against some of these methodological difficulties.

In general, participants were matched for lifetime use of drugs other than MDMA and this is clearly important given the possible interactions between MDMA and drugs such as cocaine (Horan *et al.*, 2000), alcohol and cannabis (Croft *et al.*, 2001). However, participants in the mental health group used LSD more frequently and for a longer time than those in the circumstantial group. This is a possible confounding factor as, similar to MDMA, LSD is a 5-HT receptor agonist. LSD could potentiate the effects of MDMA, although little is known about the synergistic effects of such 'candyflipping' (the conjoint use of MDMA and LSD) (Schechter, 1998). However, this seems unlikely because a similar percentage of ex-users in both groups reported using LSD at the same time as MDMA. Ideally, a group of ex-MDMA users who had not used other psychotropic drugs would have been used as a comparison group, although such a group would be difficult, if not impossible, to find. Importantly, there were no statistically significant differences between groups in terms of current drug use.

The mental health group was significantly younger than the circumstantial group. Although age was entered as a covariate to control for this difference, it is possible that the mental health group were more vulnerable to the adverse effects of MDMA because they would have been younger than the circumstantial group when they first started taking MDMA. However, there were no correlations between age of first use and questionnaire measures in either group. Although it would have been desirable to match the groups for age, this would have been difficult because, by definition, the circumstantial group are likely to be older than the mental health group as they chose to stop using because of changes in their life circumstances (e.g. parental responsibilities, career changes, etc.).

As far as the present authors are aware, this is the first study to show long-term depression in a group of people who had not used MDMA for an average of over 3 years. Ex-users who chose to stop taking MDMA for mental health reasons 3 or 4 years previously had elevated levels of depression compared to ex-users who stopped using for circumstantial reasons. One explanation for these findings may be that some users have increased vulnerability to the adverse effects of MDMA, a consequence of which may be vulnerability to depression that persists for some years after they have stopped using this drug. Moreover, for those ex-users who chose to stop taking MDMA for mental health reasons, the adverse effects they experience in the long term are associated with the degree of MDMA use. The present findings suggest that users who experience adverse effects may stop the use of MDMA as a result. Therefore, it may be helpful to consider reasons for quitting MDMA in future studies of ex-users and their mental health.

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