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REGULAR RESEARCH ARTICLE

Motives and Side-Effects of Microdosing With Psychedelics Among Users

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Abstract

Background: Microdosing with psychedelics has gained considerable media attention where it is portrayed as a performance enhancer, especially popular on the work floor. While reports are in general positive, scientific evidence about potential negative effects is lacking aside from the prevalence and motives for use. The present study addressed this gap by surveying psychedelic users about their experience with microdosing including their dosing schedule, motivation, and potential experienced negative effects.
Methods: An online questionnaire was launched on several websites and fora between March and July 2018. Respondents who had consented, were 18 years of age or older, and had experience with microdosing were included in the analyses.
Results: In total, 1116 of the respondents were either currently microdosing (79.5%) or microdosed in the past (20.5%). Lysergic acid diethylamide (10 mcg) and psilocybin (0.5 g) were the most commonly used psychedelics with a microdosing frequency between 2 and 4 times per week. The majority of users, however, were oblivious about the consumed dose. Performance enhancement was the main motive to microdose (37%). The most reported negative effects were of psychological nature and occurred acutely while under the influence.
Conclusion: In line with media reports and anecdotes, the majority of our respondents microdosed to enhance performance. Negative effects occurred mostly acutely after substance consumption. However, the main reason to have stopped microdosing was that it was not effective. Future experimental placebo-controlled studies are needed to test whether performance enhancement can be quantified and to assess potential negative effects after longer term microdosing.

Keywords: psychedelics, microdose, motives, side-effects

Introduction

Recently microdosing, the practice of repeatedly using low doses of psychedelics like lysergic acid diethylamide (LSD) and psilocybin, has gained considerable media attention, where it is portrayed as a performance enhancing activity (Glatter, 2015; Solon, 2016; Dean, 2017; Fadiman, 2017; Reddit, 2018; thethirdwave, 2018; Tomaszewski, 2018). In contrast to a regular dose that is characterized by perceptual changes and hallucinations, a microdose by definition does not induce perceptual alterations (Greiner et al., 1958; Vollenweider and Kometer, 2010; Liechti, 2017; thethirdwave, 2018; Yanakieva et al., 2018; K.P.C. Kuypers et al., unpublished observations). The most widely suggested practice is taking one-tenth of a regular, recreational dose of a psychedelic once every 3 days (Fadiman, 2011; thethirdwave, 2018). There is some early research on using low doses of psychedelics (for review, see Passie, 2019); however, the exact dose along with the practiced dosing schedule people use today is not known.

Anecdotal reports suggest that microdosing is fairly prevalent, particularly in a work environment, with an increasing trend in

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Significance Statement

Microdosing with psychedelics, the practice of taking a low dose of a psychedelic every couple of days, seems to be an increasing trend among science, technology, engineering, and mathematics professionals. Multiple anecdotal reports suggest performance enhancing effects; however, these positive reports may overshadow potential negative experiences. The present study aimed to assess motives to microdose and potential negative effects. Findings show that the majority of the respondents indeed microdose to enhance performance. Only one-fifth experienced negative effects of which most occurred acutely after consumption of the substance. Negative effects were not a reason to stop microdosing whereas absence of self-rated efficacy was.

Silicon Valley among young science, technology, engineering, and mathematics professionals and a spread to other work places and countries (Glatter, 2015; Morrison and Woords, 2016; Solon, 2016; Dean, 2017; Sahakian et al., 2018; Tomaszewski, 2018). The Global Drug Survey 2018 (GDS2018) reported that last year's prevalence of LSD microdosing among their respondents was 28.6% (Winstock et al., 2018). However, scientific data on the prevalence of microdosing with psychedelics other than LSD as well as the prevalence of microdosing in the work environment are lacking.

The most frequently reported motives and effects of microdosing are stimulating productivity, for example, increasing focus, energy levels, and creativity and inducing positive mood (Johnstad, 2018; Prochazkova et al., 2018; Winstock et al., 2018; Polito and Stevenson, 2019). However, the first modern placebo-controlled study reported no significant changes in subjective levels of mental focus when comparing the acute effects of 3 different single microdoses of LSD with a placebo (Yanakieva et al., 2018). Another commonly reported motivation and subsequent outcome is the alleviation of psychological symptoms including depressive mood and anxiety and/or physiological symptoms such as pain (Smith, 2017; Wong, 2017; Johnstad, 2018; Waldman, 2018), though it has not been scientifically tested whether microdoses are effective in combatting diseases. While the latter is beyond the scope of this paper, the current study aimed to provide a detailed insight into individuals' motivations to microdose.

Despite the media's focus on the positive effects of microdosing, users also report negative psychological and physiological effects, such as anxiety and migraines (Fadiman, 2017; Johnstad, 2018). Recently a preclinical study suggested increased anxiety behavior in rats after subchronic intermittent administration of low doses of psilocybin and ketamine, a dissociative agent (Horsley et al., 2018). These findings support the anecdotal reports of symptom intensification in users (Fadiman, 2017). In line with this, an observational study in humans showed an increase in the personality trait neuroticism; a mood trait associated with feelings of anxiety, fear, and frustration, after a period of 6 weeks of microdosing with serotonergic psychedelics (Polito and Stevenson, 2019). In addition, unwanted "trips" were mentioned when using higher doses than intended, along with tolerance to the desired effects after daily use (Fadiman, 2017; Johnstad, 2018). Taken together, these reports and findings suggest that negative effects can occur but may be underrepresented compared with positive effects.

In summary, the aim of the present study was to examine via an online questionnaire the lifetime history of psychedelic use, microdosing practice and dose, motives, and the prevalence rate of negative effects in a sample of psychedelic users.

Methods

Design

An online questionnaire was advertised to psychedelic users on several (psychedelic) websites and fora between March and July 2018. The questionnaire was not targeted to microdosers; moreover, "microdosing" was not mentioned in the advertisement. To be eligible to complete the survey, respondents had to be ≥18 years and have had experience with a psychedelic substance. After having read the study information and having had the opportunity to ask questions about the study, respondents gave their informed consent to continue with the survey. Ethics approval was received from the Ethics Review Committee of Psychology and Neuroscience (ERCPN-177_06_03_2017). Qualtrics was used as the platform to create the survey.

Questionnaires

Demographic Information

Demographic details included age, gender, continent of origin, daily occupation, and the highest level of education. Daily occupation consisted of 6 pre-set options respondents could choose from; learning/studying, physical work, computer/office work, working with people, travelling, and creative work. The level of education was separated into 3 main categories; primary (elementary), secondary (high school, academies, gymnasium, etc.), and tertiary education (university, trade school, college). Furthermore, respondents were asked whether they were diagnosed with a psychiatric, neurological, or physical disorder by a medical doctor or therapist.

Psychedelic Substance Use History

Respondents were asked whether they have had a full psychedelic experience (regular dose) with LSD, 1P-LSD, ALD-52/1A-LSD, psilocybin, ayahuasca, DMT, 5-MeO-DMT, Salvinorin A, Mescaline, 3,4,-methylenedioxymethamphetamine (MDMA)/Ecstasy, N-benzyl Methoxy (NBOMe)s, 2Cs, or any other psychedelic drug. Note: The psychedelic substance psilocybin mentioned throughout this paper refers to psilocybin-containing truffles or mushrooms. If respondents indicated that they have used regular doses of the substance, they were further asked about their use, including whether they currently use the substance or used in it the past and do not intend to use it again, as well as the average amount used. In case the respondent did not know the average dose of the substance s/he used, it was suggested to fill in "999," which signaled this lack of knowledge.

In addition, respondents were asked whether they have microdosed with the listed psychedelic substances, followed by the same questions. Two further microdosing-specific questions were asked, namely the route of administration and the frequency of use. In addition, respondents were asked to indicate where they found their microdosing schedule.

Motivation to Microdose

Respondents were asked to indicate the main reason they microdosed by choosing 1 of the 8 pre-set answers or they had the option to write a different answer in a text box. The answers were clustered afterwards into 5 main categories: performance enhancement (increase energy, to study, increase concentration,

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enhance creativity), symptom alleviation (psychiatric symptom alleviation and physiological symptom alleviation), mood enhancement, curiosity, and other. In addition, respondents were asked whether they microdosed to go to work.

Motivation to Stop Using Psychedelics

When respondents indicated to have used a substance in a regular or microdose in the past and do not intend to use it again, they were asked to indicate the reason why they stopped, with answer options including: negative experience, can no longer find the substance, used the substance for a purpose and no longer need it, lost interest, change in lifestyle, and other. For microdosing an extra answer option, "not effective," was added.

Negative Effects of Microdosing

Respondents were asked if they ever experienced any negative side effects while microdosing and, if yes, to indicate the type of effect: physical, psychological, or both. Respondents were given examples for type of effect: for example, nausea, dizziness, tiredness as physical symptoms; and paranoia, anxiety, depression as psychological symptoms, but respondents did not have the option to specify this type of effect. In addition, they were asked when this effect emerged: acutely, while under the influence of the substance; sub-acutely during the days after the use; or both.

Statistical Analysis

Data were entered into the statistical program SPSS (version 24.0). Respondents who reported to have never microdosed were excluded from analyses. Respondent demographics were categorized into those who currently microdose and those who used to microdose. Frequencies were reported for age, gender, education, continent of origin, daily occupation, psychiatric/neurological/physical diagnoses, and psychedelic use history. Mean (±SD) is given for age.

Outliers, defined as 3 SD away from the mean of the average amount used per psychedelic per route of administration, were calculated using z-scores for regular doses and microdoses. This resulted in a total of 8 and 17 outliers for regular doses and microdoses, respectively. Considering the wide range (min-max) in reported doses (Tables 2 and 3), mode is given for dose per psychedelic.

Frequencies are reported for the route of administration per psychedelic drug and mean (±SD) is given for frequency of use per week.

Motivation to microdose was assessed by summing the total amount of responses for each of the 5 main motivation categories. Responses that were reported in the "other" category were moved into one of the main categories in case of a match; in case there was no fitting category, they remained in the "other" category. Furthermore, frequency is reported for respondents that microdosed to work, followed by the frequency of their daily occupation.

In addition, for those who indicated they stopped using at least one psychedelic substance, frequencies are reported separately for regular and microdoses. Furthermore, frequencies of past use reasons are reported. Chi-square tests of independence were calculated comparing the frequency of reasons to stop per dose (regular/micro).

In addition, frequencies of experienced negative side effects are reported for microdosing. Further chi-square tests of independence were calculated for the frequency of negative side-effects of microdosing, separated by current and past users.

Results

Demographic Information

In total, 3590 of 5681 respondents consented, were 18 years or older, and completed the questionnaire. Two respondents (both aged 117 years old) were removed from further analyses due to untrustworthy answers, and 2472 respondents were removed from further analyses because they did not have any experience with microdosing, resulting in a total sample of 1116 (20%) respondents. It took respondents about 16 minutes to complete the questionnaire, depending on the number of substances a person had ever used before and whether they microdosed. The demographic details of the microdosers are presented in Table 1.

Psychedelic Substance Use History of Microdosers

Regular Doses of a Psychedelic

—All microdosers indicated experience with at least 1 regular dose (full psychedelic experience) of a psychedelic substance. Psychedelic substance use history details regarding a regular dose are presented in Table 2; it is shown that the 3 most used substances in descending order were: psilocybin (n = 954; 85.5%), LSD (n = 910; 81.5%), and MDMA/ecstasy (n = 746; 66.8%); the 3 least frequently used substances in ascending order are 5-MeO-DMT (n = 66; 5.9%), ALD-52/1A-LSD (n = 99; 8.9%), and ayahuasca (n = 113; 10.1%).

Microdoses of a Psychedelic

—Microdose use history details are presented in Table 3. It is shown that the 3 most used substances for microdosing in descending order were: LSD (n = 666; 59.7%), psilocybin (n = 645; 57.8%), and 1P-LSD (n = 129; 11.6%); the 3 least used substances in ascending order were 5-MeO-DMT (n = 5; 0.4%), NBOMes (n = 9; 0.8%), and ayahuasca (n = 15; 1.3%).

Almost one-half of the respondents who microdosed (n = 546; 48.9%) indicated that they designed their own microdosing schedule. Other respondents found their schedule on the internet (n = 371; 33.2%), received from a friend (n = 96; 8.6%), read in a book (n = 38; 3.4%), via a retreat (n = 13; 1.2%), or via another way (n = 42; 3.8%) such as podcasts, a combination of resources, or a conference. Some (n = 10; <1%) indicated to not have a microdosing schedule at all.

An overview of route of administration and frequency of use per psychedelic for microdosing is presented in Table 4, which shows that the frequency of microdosing ranges between 2 and 7 times per week, depending on the substance. For instance, 57% up to 78% of the respondents that microdosed with LSD and psilocybin reported to use microdosing several times per week, ranging between 2 and 4 times per week.

Motivation to Microdose

The majority of the respondents reported to have microdosed for performance enhancement (n = 409; 36.6%). Other reasons were mood enhancement (n = 325; 29.1), symptom relief (n = 156; 14.0%), curiosity (n = 170; 15.2%), and other reasons such as enhancing empathy and spirituality (n = 56; 5.0%) (Figure 1). Almost one-half (n = 531; 47.6%) indicated to have microdosed to go to work, of which the most frequent occurring daily occupation in descending order was studying (31.8%) and computer/office work (29.9%), working with people (14.3%), creative work (11.3%), physical work (11.1%), and travelling (0.9%), whereas some did not fill in their daily occupation (0.6%).

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Table 1. Demographic information of respondents divided in those who currently microdose and stopped microdosing

	Current microdosing (n = 887; 79.5%)	Stopped microdosing (n = 229; 20.5%)
Mean age (SD)	28.6 (10.0)	27.4 (9.7)
N (%)		
Gender		
Male	747 (84.2)	198 (86.5)
Female	126 (14.2)	29 (12.7)
Other	14 (1.6)	2 (0.9)
Level of education		
Primary	9 (1.0)	2 (0.9)
Secondary	252 (28,4)	71 (31.0)
Tertiary	626 (70.6)	156 (68.1)
Continent of origin		
North America	554 (62.5)	154 (67.2)
Europe	264 (29.8)	61 (26.6)
Australia	34 (3.8)	8 (3.5)
Asia	13 (1.5)	4 (1.7)
South America	16 (1.8)	1 (0.4)
Africa	6 (0.7)	1 (0.4)
Antarctica	–	–
Daily occupation		
Learning/studying	283 (31.9)	74 (32.3)
Physical work	116 (13.1)	38 (16.6)
Computer/office work	232 (26.2)	53 (23.1)
Working with people	138 (15.6)	36 (15.7)
Travelling	7 (0.8)	1 (0.4)
Creative work	106 (12.0)	24 (10.5)
Missing	5 (0.6)	3 (1.3)
Diagnosed	324 (36.5)	86 (37.6)

Table 2. Number (percentage) of respondents in the microdosing sample who indicated use of one of the listed substances in a regular dose, with the self-reported dose in mode and the percentage of respondents who did not know the dose or failed to complete this item

	Psychedelic users per substance	Regular dose details		Users who do not know the dose or did not fill out this question	
Substance	n (%)	Amount, mg	Dose range, mg (min–max)	Do not know, n (%)	Missing, n (%)
1P-LSD	200 (17.9)	0.1	0.001–300	20 (10.0)	31 (15.5)
2Cs	281 (25.2)	20	0.03–500	78 (27.8)	71 (25.3)
5-MeO-DMT	66 (5.9)	20	0.05–1,000	23 (34.8)	19 (28.8)
ALD-52/1A-LSD	99 (8.9)	0.2	0.001–300	15 (15.2)	20 (20.2)
Ayahuasca	113 (10.1)	50	25–60,000	74 (65.5)	28 (24.8)
DMT	398 (35.7)	50	0.01–1,000	122 (30.7)	63 (15.8)
LSD	910 (81.5)	0.2	0.00025–1,500	218 (24.0)	75 (8.2)
MDMA/ecstasy	746 (66.8)	100	0.1–800	181 (24.3)	161 (21.6)
Mescaline	187 (16.8)	400	1–30,000	76 (40.6)	71 (38.0)
NBOMes	132 (11.8)	1	0.02–1,000	44 (33.3)	53 (40.2)
Other	350 (31.4)	50	0.02–15,000	71 (20.3)	228 (65.1)
Psilocybin	954 (85.5)	3500	0.05–3,000,000	236 (24.7)	105 (11.0)
Salvinorin A	312 (28.0)	100	0.2–8,000	159 (51.0)	113 (36.2)

Abbreviations: 1P-LSD, 1-propionyl-lysergic acid diethylamide; 2C, 2-ethylamine; 5-MeO-DMT, 5-methoxy-N,N-dimethyltryptamine; ALD-52/1A-LSD, 1-Acetyl-N,N-diethyllysergamide; DMT, N,N-dimethyltryptamine; LSD, lysergic acid diethylamide; MDMA, 3,4,-methylenedioxymethamphetamine; NBOMe, N-benzyl Methoxy.

Reasons to Stop Using Psychedelics

Around one-fifth of all microdosers (n = 229; 20.5%) indicated to have stopped microdosing completely. One-half of the respondents (n = 636; 57.0%) indicated to have stopped using at least 1 psychedelic substance in regular doses, and around one-third (n = 336; 30.1%) indicated to have stopped microdosing with at least 1 psychedelic substance, of which the past use reasons are presented in Figure 2A.

Separate chi-square tests of independence per reason to stop revealed a significant effect of dose (regular/micro) on negative experiences (x^2 (1) = 40.86, $P < .01$) and on the loss of interest in the substance (x^2 (1) = 50.77, $P < .01$), indicating that negative experiences and loss of interest were more frequently reported as a reason to have stopped regular dosing compared with microdosing. No statistically significant differences were shown between types of dose (regular/micro) for the other past use reasons: can no longer find the substance (x^2 (1) = 0.94, $P = .33$), used the substance for a purpose and no longer need it (x^2 (1) = 0.73, $P = .39$), change in lifestyle (x^2 (1) = 0.04, $P = .85$), and other (x^2 (1) = 1.47, $P = .23$).

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Table 3. Number (percentage) of respondents who indicated use of one of the listed substances as a microdose, with the self-reported dose in mode and the percentage of respondents who did not know the dose or failed to complete this item

	Psychedelic users per substance	Microdose details		Users who do not know the dose or did not fill out this question	
Substance	n (%)	Amount, mg	Dose range, mg (min–max)	Do not know, n (%)	Missing, n (%)
1P-LSD	129 (11.6)	0.01	0.0005–75	9 (7.0)	9 (7.0)
2Cs	22 (2.0)	3–4	0.75–25	3 (13.6)	3 (13.6)
5-MeO-DMT	5 (0.4)	0.005	0.005–7	–	2 (40.0)
ALD-52/1A-LSD	41 (3.7)	0.01	0.0005–75	3 (7.3)	6 (14.6)
Ayahuasca	15 (1.3)	14	14–500	10 (66.7)	2 (13.3)
DMT	64 (5.7)	10	00.5–25	19 (29.7)	15 (23.4)
LSD	666 (59.7)	0.01	0.00001–500	113 (17.0)	60 (9.0)
MDMA/ecstasy	71 (6.4)	50	0.02–100	18 (25.4)	21 (29.6)
Mescaline	26 (2.3)	50	0.3–1000	14 (53.8)	4 (15.4)
NBOMes	9 (0.8)	0.5–50	0.5–50	3 (33.3)	4 (44.4)
Other	60 (5.4)	5	0.01–1000	15 (25.0)	24 (40.0)
Psilocybin	645 (57.8)	500	0.025–8000	146 (22.6)	93 (14.4)
Salvinorin A	31 (2.8)	0.2	0.2–200	16 (51.6)	10 (32.3)

Abbreviations: 1P-LSD, 1-propionyl-lysergic acid diethylamide; 2C, 2-ethylamine; 5-MeO-DMT, 5-methoxy-N,N-dimethyltryptamine; ALD-52/1A-LSD, 1-Acetyl-N,N-diethyllysergamide; DMT, N,N-dimethyltryptamine; LSD, lysergic acid diethylamide; MDMA, 3,4,-methylenedioxymethamphetamine; NBOMe, N-benzyl Methoxy.

Negative Effects of Microdosing

About one-fifth (n = 225; 20.2%) of the responders that microdosed experienced negative effects. Both current and past microdosers reported to have experienced psychological side effects, which in general occurred acutely, that is, while under the influence of the substance. A chi-square test of independence revealed that the co-occurrence of psychological and physical effects differed statistically between past and current microdose use (x^2 (1) = 7.52, $P < .01$), with these effects being reported more frequently among respondents who stopped microdosing with psychedelics compared with those who are still microdosing. Analysis did not reveal statistically significant differences between current and past users with respect to only psychological effects (x^2 (1) = 0.27, $P = .61$) and only physical effects (x^2 (1) < 0.01, $P = .98$) (Figure 2B). The duration or occurrence of the negative effect relative to intake (e.g., long term, acute, or both) did not differ between past and current use: acute (x^2 (1) = 0.77, $P = .38$), long term (x^2 (1) = 2.31, $P = .13$), and both acute and long term (x^2 (1) = 0.85, $P = .36$) (Figure 2C).

Discussion

The present study aimed to investigate, by means of an online questionnaire, the history of psychedelic use among microdosers, the dose and schedule they use, the prevalence of microdosing in the work environment, their motivation to microdose, and the potential negative effects. The survey was not specifically advertised as a microdosing survey but rather a psychedelic survey in general. Detailed questions about motives to use were only presented for microdosing since the study was not set up to test differences in motivations for use of regular doses and microdoses.

Findings showed that all respondents in the present survey had at least used 1 regular dose of a psychedelic, which was expected as the survey was advertised for psychedelic users. The most frequently reported psychedelics used, both in regular and microdoses, were LSD and psilocybin. The most reported regular and microdose for LSD was 200 mcg and 10 mcg, and for psilocybin 3.5 g and 0.5 g, respectively. However, most respondents (up to 67%) indicated not knowing the dosage they normally consume. In addition, one-half of the respondents (48.9%) that microdosed followed their own microdosing schedule. The majority of respondents who microdosed with LSD and psilocybin (57–78%) reported using microdosing several times per week, ranging between 2 and 4 times per week, respectively. One-half of the microdosers (47.6%) indicated to have microdosed while working, of which studying and computer/office work were the most prevalent daily occupations. The motives to microdose in descending order were for performance enhancement (37%), mood enhancement (29%), out of curiosity (15%), and for self-medication (14%). The most reported side effects while microdosing were psychological in nature and occurred acutely.

The present study demonstrated that the majority (58–78%) of our microdosing respondents (using LSD and psilocybin) reported to have microdosed on a regular basis, while this was only 2% in the GDS of 2017 (Winstock et al., 2018). While both surveys included respondents from all continents, the majority of respondents in our survey were from North America (62–67%) while the majority of respondents of the GDS2017 were from Europe (70%) (Winstock et al., 2017). In addition, the male to female ratio in the GDS2017 was 2:1, while our survey this ratio was around 5:1. Furthermore, our survey specifically addressed psychedelic users while the GDS is known to assess the prevalence of a broader range of substances including alcohol, not exclusively focusing on psychedelics. Overall both surveys included a slightly different sample, which could indicate that these differences in demographics play a role in whether people microdosed on regular basis. Future studies might focus on these demographical differences. However, it cannot be excluded that the prevalence of microdosing has increased over the last year, which might be due to the enhanced media attention and the extensive information available on the internet about the effects and methods of use (Andersson et al., 2009).

The most reported microdoses of LSD (10 mcg) and psilocybin (0.5 g) are comparable with the doses reported in previous studies (Johnstad, 2018; Winstock et al., 2018; Polito and Stevenson, 2019) and in line with the reported one-tenth of a regular dose (Chandler, 2018; thethirdwave, 2018). The limitation here is that people might have reported the dose they were told to have bought or that they simply report one-tenth of the

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Table 4. Number (percentage) of respondents who indicated to (have) use(d) the listed psychedelic substance to microdose via the listed route of administration[a] and the corresponding frequency of use (Mean (SD), range

	Route of administration, n (%)									Frequency of microdosing per week		
Substance	Number of respondents who answered, n (%)	Oral	Sublingual	Inspiration	Intranasal	Ocular	Cutaneous	Rectal	Other	Number of respondents who answered N (%)	Frequency of dosing per week M (SD)	Range of dosing per week (min–max)
1P-LSD	120 (77.5)	71 (55.0)	28 (21.7)	–	–	–	–	1 (0.8)	–	76 (58.9)	2.13 (2.23)	0.001–14
2Cs	13 (59.1)	11 (50.0)	–	–	1 (4.5)	–	–	1 (4.5)	–	10 (45.5)	2.89 (4.11)	0.2–14
5-MeO-DMT	2 (30.0)	1 (20.0)	–	–	–	–	–	1 (20.0)	–	2 (40.0)	7.5 (9.19)	1–14
ALD-52/ 1A-LSD	28 (68.3)	18 (43.9)	9 (22.0)	–	–	–	–	1 (2.4)	–	22 (53.7)	2.23 (2.82)	0.005–14
Ayahuasca	7 (46.7)	5 (33.3)	–	1 (6.7)	–	–	–	1 (6.7)	–	6 (40.0)	4.37 (5.16)	0.25–14
DMT	35 (54.7)	2 (3.1)	–	32 (50.0)	–	–	–	1 (1.6)	–	25 (39.1)	2.26 (3.17)	0.002–14
LSD	491 (73.7)	387 (58.1)	99 (14.9)	–	1 (0.2)	1 (0.2)	–	1 (0.2)	2 (0.3)	384 (57.7)	2.02 (1.89)	0.0001–15
MDMA/ ecstasy	34 (47.9)	24 (33.8)	2 (2.8)	–	7 (9.9)	–	–	1 (1.4)	–	19 (26.8)	2.08 (3.46)	0.005–14
Mescaline	12 (46.2)	11 (42.3)	–	–	–	–	–	1 (3.8)	–	6 (23.1)	3.46 (5.26)	0.25–14
NBOMes	3 (33.3)	–	2 (22.2)	–	–	–	–	1 (11.1)	–	3 (33.3)	5.67 (7.23)	1–14
Other	26 (43.3)	16 (26.7)	–	6 (10.0)	2 (3.3)	–	1 (1.7)	1 (1.7)	–	21 (35.0)	6.78 (6.98)	0.5–30
Psilocybin	416 (64.5)	415 (64.3)	–	–	–	–	–	1 (0.2)	–	325 (78.3)	3.74 (3.35)	0.001–30
Salvinorin A	15 (45.4)	3 (9.7)	2 (6.5)	8 (25.8)	–	–	–	1 (3.2)	1 (3.2)	8 (25.8)	2.63 (4.65)	0.01–14

Abbreviations: 1P-LSD, 1-propionyl-lysergic acid diethylamide; 2C, 2-ethylamine; 5-MeO-DMT, 5-methoxy-N,N-dimethyltryptamine; ALD-52/1A-LSD, 1-Acetyl-N,N-diethyllysergamide; DMT, N,N-dimethyltryptamine; LSD, lysergic acid diethylamide; MDMA, 3,4,-methylenedioxymethamphetamine; NBOMe, N-benzyl Methoxy.
*a*Route of administration: "injection" is not shown, as no respondent reported injection as route of administration.

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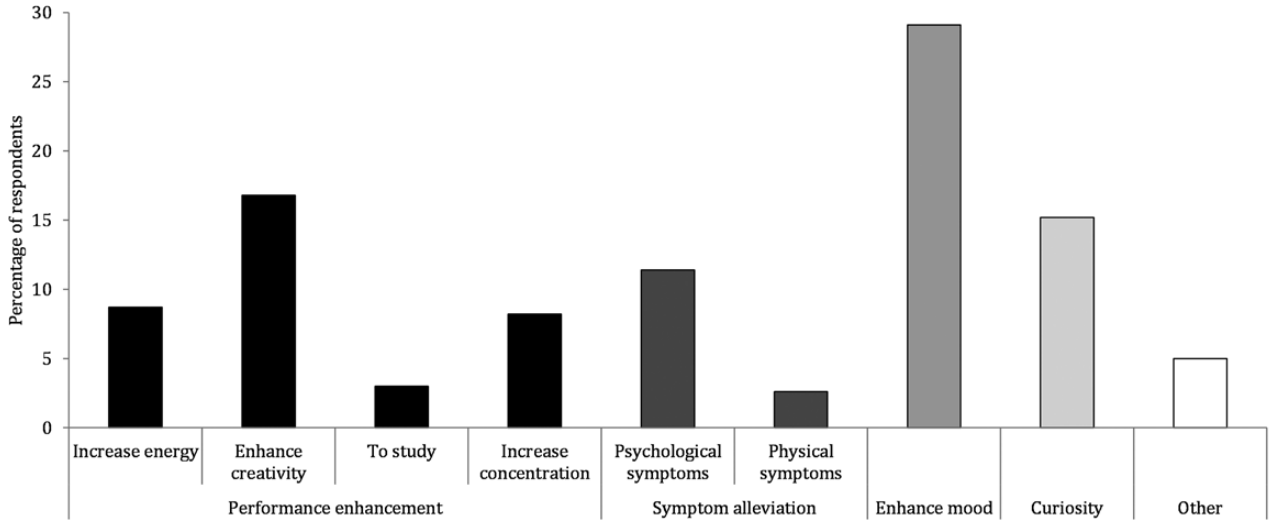


Figure 1. Percentage of respondents who indicated their main motivation to microdose, presented per category (performance enhancement: black bars; symptom alleviation: dark grey bars; mood enhancement: grey bar; curiosity: light grey bar; and other: white bar).

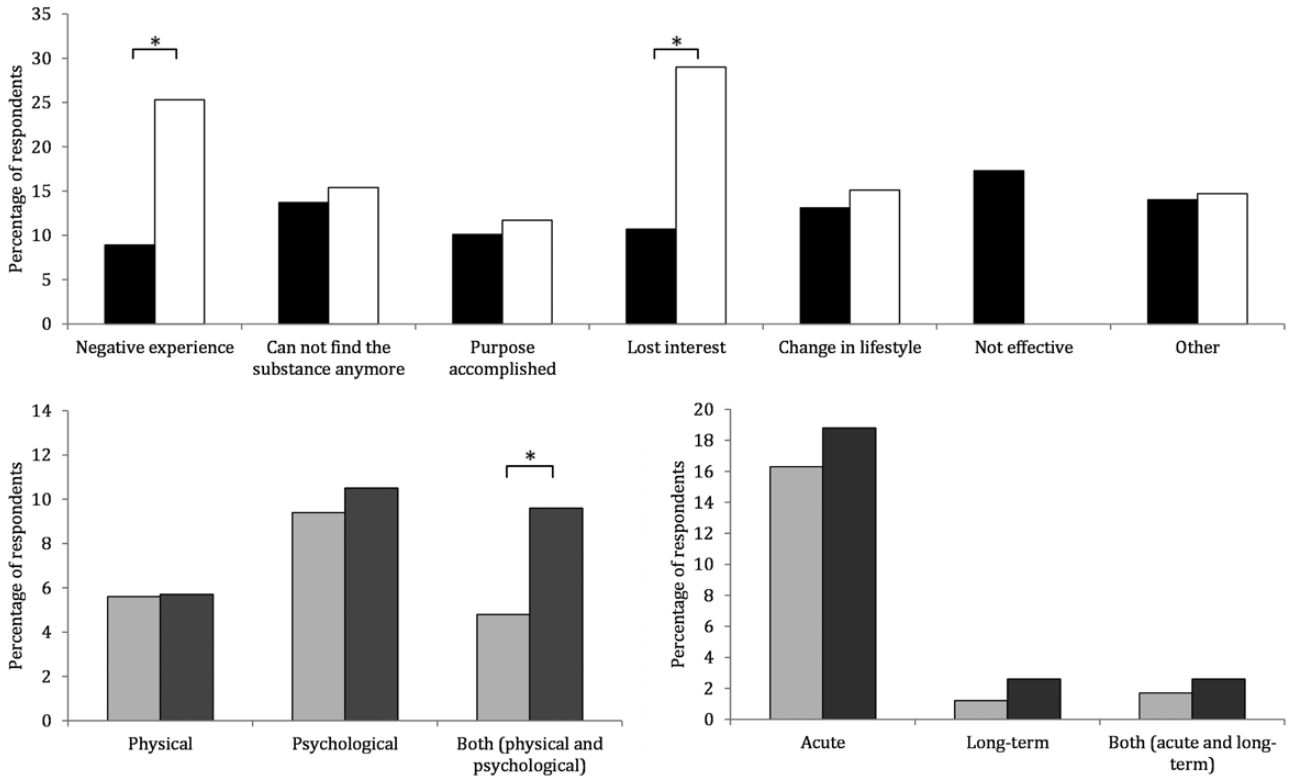


Figure 2. (A) Percentage of respondents who stopped using at least 1 psychedelic substance in a regular dose (white bar) or a microdose (black bar) depicted per reason. (B) Percentage of respondents who experienced negative side effects and currently microdose (light grey bar) or who experience negative side effects and stopped microdosing (dark grey bar) depicted per type effect. (C) Percentage of respondents who experienced negative side effects and currently microdose (light grey bar) or who experienced negative side effects and stopped microdosing (dark grey bar) depicted per effect onset.

regular dose they take. Nonetheless, it is concerning that up to 67% of the respondents reported to not know the dose they were consuming. Our proportion of microdosers unaware of the dose is higher than the 46% reported by the GDS2018 (Winstock et al., 2018); however, the latter survey only included numbers on LSD microdosers in contrast to our survey, which included a broad range of psychedelics. Nevertheless, LSD was one of the most prevalent psychedelic substance to microdose with in the current survey as well as in previous studies (Johnstad, 2018; Polito and Stevenson, 2019). The preference to microdose with LSD may be due to feasibility, as users can measure the amount with a pipet or cut the blotter paper into smaller tabs. Accordingly, the GDS2018 reported that 52.5% use the cutting method to dose LSD (Winstock et al., 2018), despite the fact that LSD can be

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unevenly distributed on the blotter paper and is therefore not the most precise way of dosing (thethirdwave, 2018). Nevertheless, specifying the exact dose is difficult for respondents (Johnstad, 2018), which might be due to not knowing its purity and/or not having the right equipment to adequately dose when using such small amounts (thethirdwave, 2018). With regard to microdosing motives, the majority of the respondents (37%) indicated they microdosed for performance enhancement, such as to increase energy, creativity, and concentration. Accordingly, the majority of the microdosers did so at the workplace, of which computer/office work and studying was their main daily occupation. The use of enhancing substances to improve performance at work or while studying gives rise to some ethical questions, which are extensively discussed in the literature (Bostrom and Sandberg, 2009; Maslen et al., 2014; Santoni de Sio et al., 2014; Garasic and Lavazza, 2015). For instance, the use of cognition enhancing substances to pass exams or to get a promotion at work can be seen as cheating (Savulich et al., 2017; Colzato, 2018) and may not be fair to those who choose not to use it. Furthermore, observing others engaging in these practices could in some people create the idea that it might be necessary to use substances to keep up in a competitive environment, such as school or a workplace (Academy of Medical Sciences et al., 2012). However, despite these practices and attention by the media there is no scientific support for this to date (Glatter, 2015; Solon, 2016; Dean, 2017; Tomaszewski, 2018; Yanakieva et al., 2018). Placebo-controlled experimental studies are needed to quantify the alleged effects of microdosing with psychedelics.

Importantly, one-fifth (20%) of all microdosers reported to have experienced some kind of psychological or physical negative effects. Furthermore, experiencing the co-occurrence of psychological and physical negative effects was a significant reason for users to stop microdosing. Conversely, results demonstrate that when users experienced only psychological or only physical negative effects, they continued to microdose. Overall, the most reported negative side effects were psychological (current microdosing: 9.4%, and stopped microdosing: 10.5%). In general these effects occurred acutely, while under the influence of the substance. This is in line with previous anecdotal reports that reflect the intensification of symptoms, such as anxiety (Fadiman, 2017; Johnstad, 2018). Nonetheless, in 2 placebo-controlled studies no psychological changes were noted after LSD doses <20 mcg (Greiner et al., 1958; Yanakieva et al., 2018); however, the lack of effects in both studies might be due to low power. Nonetheless, only a small proportion of the microdosers (1–3%) in the present study indicated that the negative effects lasted for days after dosing. Interestingly, the main reason for users to have stopped microdosing was not due to negative side effects but rather because they deemed it to not be effective. This perceived lack of efficacy can be related to the expectations people have developed of microdosing, for instance by anecdotal reports in the media. A recent follow-up study found a mismatch between expected effects and the perceived psychological changes when microdosing for 6 weeks (Polito and Stevenson, 2019). Accordingly, the expected changes were the ones most reported in the media. It is possible that due to these positive reports, people feel attracted to microdosing and start with high hopes and expectations. When no changes are experienced or they are smaller or other than expected, users could become disappointed and stop using. Subsequently, future studies still need to examine the efficacy of microdosing.

To have a more generalizable sample, the present survey was not limited to only healthy respondents, which is in contrast to previous studies (Prochazkova et al., 2018; Polito and Stevenson, 2019). Nevertheless, results need to be interpreted with caution since this survey was advertised on fora focusing on psychedelics, and therefore it specifically targeted the psychedelic community. Consequently, we may not have reached the population that has experience with microdosing without having experienced a regular dose. These individuals' motives to microdose may be different from our sample and perhaps more related to curiosity. In addition, people who might have stopped using psychedelics because of negative experiences will be less likely to fill in the survey, as they might not be visiting these internet fora. Furthermore, the range of reported microdoses in the present survey was very broad; for instance for LSD this was 0.00001 to 500 mg. This wide range could indicate that more respondents than reported did not realize the actual dose they are taking. However, this might also be a result of typing errors or misreading the dosing units in which they needed to report (e.g., reading mcg instead of mg). Future studies might use multiple-choice options and may inquire as to how respondents measure their dose(s). Furthermore, the survey did not allow responders to specify different kinds of negative effects, so it could not be evaluated whether, for instance, "anxiety" or "depression" was a more common (psychological) side effect. In addition, the cause of negative effects is unknown. Specifically, negative effects could be due to taking higher doses than intended due to the mental state of the respondents, because of the set and setting and/or the impurity of the substance (Smith, 1969; Carbonaro et al., 2016; Carhart-Harris et al., 2018). Therefore, future clinical studies should focus on investigating potential acute and long-term side-effects, as this question cannot be reliably answered in an online survey.

To conclude, this study demonstrates that microdosing is mostly used to enhance performance. Furthermore, the majority of microdosers are unaware of the dose they are actually taking. Importantly, psychological and physical negative effects were reported but in general do not outlast the "acute" phase. To clarify whether effects of microdosing on performance are restricted to a subjective level or are quantifiable with performance measures, placebo-controlled studies are needed. In addition, it will be important in these studies to assess the acute and long-term positive and negative effects to capture the full consequence of microdosing with psychedelics.

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Statement of Interest

None.

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