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Research Paper

Microdosing psychedelics: Motivations, subjective effects and harm reduction

Toby Lea[a,b,*], Nicole Amada[c], Henrik Jungaberle[d], Henrike Schecke[e], Michael Klein[a]

[a] German Institute for Addiction and Prevention Research, Catholic University of Applied Sciences, Wörthstr. 10, 50668 Cologne, Germany
[b] Centre for Social Research in Health, UNSW, Sydney, NSW 2052, Australia
[c] The Graduate Center, City University of New York, 365 5th Ave, New York, NY 10016, USA
[d] MIND Foundation, Betahaus Berlin, Rudi-Dutschke-Straße 23, 10969 Berlin, Germany
[e] Department of Psychiatry and Psychotherapy, Faculty of Medicine, University of Duisburg-Essen, LVR-Klinikum Essen, Virchowstr. 174, 45147 Essen, Germany

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ABSTRACT

Background: In recent years there has been growing media attention on microdosing psychedelics (e.g., LSD, psilocybin). This refers to people routinely taking small doses of psychedelic substances to improve mental health and wellbeing, or to enhance cognitive performance. Research evidence is currently limited. This paper examines microdosing motivations, dosing practices, perceived short-term benefits, unwanted effects, and harm reduction practices.

Methods: An international online survey was conducted in 2018 examining people's experiences of using psychedelics. Eligible participants were aged 16 years or older, had used psychedelics and could comprehend written English. This paper focuses on 525 participants who were microdosing psychedelics at the time of the survey.

Results: Participants were primarily motivated to microdose to improve mental health (40%), for personal development (31%) and cognitive enhancement (18%). Most were microdosing with psilocybin (55%) or LSD/1P-LSD (48%). Principal components analysis generated three factors examining perceived short-term benefits of microdosing: improved mood and anxiety, enhanced connection to others and environment, and cognitive enhancement; and three factors examining negative and potentially unwanted effects: stronger-than-expected psychedelic effects, anxiety-related effects, and physical adverse effects. Most participants (78%) reported at least one harm reduction practice they routinely performed while microdosing.

Conclusion: Our findings suggest that people microdosing are commonly doing so as a self-managed therapy for mental health, either as an alternative or adjunct to conventional treatments. This is despite psychedelics remaining prohibited substances in most jurisdictions. Recent findings from clinical trials with standard psychedelic doses for depression and anxiety suggest that a neurobiological effect beyond placebo is not unreasonable. Randomised controlled trials are needed, complemented by mixed methods social science research and the development of novel resources on microdosing harm reduction.

Introduction

Over the past decade, there has been renewed interest in the use of psychedelics to treat mental and substance use disorders, leading to clinical trials of psilocybin and ayahuasca for treatment-resistant depression (Carhart-Harris et al., 2018; Palhano-Fontes et al., 2019), psilocybin for alcohol dependence (Bogenschutz et al., 2015) and nicotine dependence (Johnson, Garcia-Romeu & Griffiths, 2017), and psilocybin and lysergic acid diethylamide (LSD) for end-of-life anxiety in terminally ill patients (Gasser et al., 2014; Griffiths et al., 2016; Liechti, 2017). Administered on a small number of occasions in a therapeutic setting, phase II studies have shown positive results and few adverse effects (Nichols, 2016; Reiche et al., 2018). The US Food and Drug Administration has recently granted psilocybin "breakthrough therapy" designation to expedite its clinical development and review, which could lead to psychedelic therapy as a legally available treatment for some mental disorders in the next decade (COMPASS Pathways, 2018).

* Corresponding author at: German Institute for Addiction and Prevention Research, Catholic University of Applied Sciences, Wörthstr. 10, 50668 Cologne, Germany.
E-mail address: toby.lea@unsw.edu.au (T. Lea).

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Coinciding with the resurgence of clinical psychedelic research, "microdosing" has gained considerable media attention in recent years. Microdosing refers to the ingestion of low to very low doses of psychedelics (typically between 5 and 10 percent of a standard dose) on a routine schedule (e.g., every third day) without the intention of experiencing noticeable drug effects (Fadiman, 2011; Kuypers et al., 2019; Liechti, 2019). Although a recent randomised controlled trial reported 13mcg of LSD as a threshold microdose (Bershad, Schepers, Bremmer, Lee, & de Wit, 2019), there is currently no scientific consensus about what dose ranges constitute LSD and psilocybin microdoses (Kuypers et al., 2019; Passie, 2019). News and popular media articles have described it as a workplace trend, first reported among technology professionals in Silicon Valley who microdosed as a cognitive "biohack" to enhance productivity, focus and creative problem-solving (Dean, 2017; Glatter, 2015). Perhaps driven to some extent by the promising findings of clinical research with larger doses, there have also been increasing reports of people microdosing as a self-managed treatment for depression, anxiety and other mental disorders (Hutten, Mason, Dolder & Kuypers, 2019; Waldman, 2017).

While some research on small LSD doses was conducted before psychedelics were banned in the USA in 1970 (Passie, 2019), contemporary research on microdosing is in its infancy. Two recent randomised controlled trials of LSD microdosing have shown changes in time perception following LSD administration (Yanakieva et al., 2019), and dose-related increases in ratings of "vigor" (Bershad, Schepers, Bremmer, Lee, & de Wit, 2019). A naturalistic experimental study found improved performance on problem-solving tasks after taking a non-blinded microdose of psilocybin truffles (Prochazkova et al., 2018). In addition, observational online studies have reported improved mood, wellbeing and cognitive performance on days when a microdose is ingested (Anderson et al., 2019; Fadiman & Korb, 2019; Politi & Stevenson, 2019), and fewer symptoms of depression and stress after six weeks of microdosing (Politi & Stevenson, 2019). An online interview study reported perceived improvements in mood and creativity with few adverse effects (Johnstad, 2018), while another qualitative study reported that interviewees rationalised microdosing as a functional form of drug use akin to taking a supplement, in order to be "the best possible version of themselves" (Webb, Copes & Hendricks, 2019, p. 35).

People are motivated to use psychedelics at standard doses for a range of reasons including to enhance pleasure, as treatments for mental and physical health concerns, for self-exploration and development, and spiritual growth (Móró, Simon, Bárd & Racz, 2011; Prepeliczay, 2002). At standard doses, LSD and psilocybin induce enduring improvements in mood and well-being, positive attitudes towards life, social connectedness and empathy, according to self-report, irrespective of their motivations for use (Carhart-Harris et al., 2016; Lerner & Lyvers, 2006; Schmid & Liechti, 2018; Watts, Day, Krzanowski, Nutt & Carhart-Harris, 2017). While much has been published about harm reduction practices among MDMA users – with MDMA categorised as a stimulant or entactogen – relatively little has been published about psychedelic harm reduction (Allott & Redman, 2006; Bøhling, 2017; Global Drug Survey, 2015; Van Schipstal, Mishra, Berning & Murray, 2016).

This paper aims to describe the motivations, dosing practices, short-term perceived benefits and unwanted effects, and harm reduction practices of people microdosing psychedelics. A secondary aim was to determine whether different microdosing motivations and microdosed substances were associated with perceived benefits and unwanted effects.

Methods

Sample and recruitment

The Psychedelic Experiences Survey is an international online survey examining practices and subjective experiences of using psychedelic substances at standard doses and microdoses. Recruitment was conducted in late 2018 via email lists of psychedelic communities and non-profit organisations (e.g., The Third Wave, microdosing.nl), posts on online discussion forums (e.g., microdosing subreddit, shroomery.org), shared Facebook posts via these organisations and psychedelic societies in different countries, and paid Facebook advertisements. People were eligible to participate in the study if they were 16 years or older, had used psychedelics for any purpose and could comprehend written English. Participants received no remuneration. This research was approved by the Faculty of Medicine Ethics Committee, University of Duisburg-Essen, Germany (Ref: 18-8215-BO).

We recruited 2674 participants, including 1533 who had microdosed psychedelics and completed questions on microdosing practices and motivations. This paper is focused on participants who were microdosing at the time of the survey ($n = 525$; 34.2% of those who reported microdosing).

Measures

Participants were asked about the substances they had microdosed, dosing schedules, duration of microdosing, dose adjustment, obtaining psychedelics, knowledge sources and disclosure of microdosing to different groups (e.g., friends, health professionals). Some items about microdosing practices were asked separately for psilocybin, LSD and 1P-LSD (an LSD analogue), and N,N-Dimethyltryptamine (DMT), including dose, preparation and administration.

The Severity of Dependence Scale (SDS) measured potential adverse consequences of psychedelic use (Gossop et al., 1995), acknowledging that psychedelic use is generally not associated with dependence (Nichols, 2016; Nutt, King & Phillips, 2010). The SDS includes 5 items and the total score ranges from 0 to 15. We reported mean scores and used a cut-off score of ≥ 4 to indicate potential problems with use (Bruno et al., 2009).

Short-term perceived benefits of microdosing were examined with 22 items (yes, no). Participants were asked to select items that they usually experienced when microdosing (i.e., on more than 50% of days that they microdosed). Negative and other potentially unwanted effects experienced on days when participants microdosed in the past 12 months were examined with 23 items using a 5-point Likert scale (never, rarely, sometimes, often, always). Harm reduction and other practices usually performed or avoided when microdosing (on more than 50% of microdosing days) were examined with 20 items (yes, no). For each of these three sections, items were designed by the researchers based on previous psychedelic and harm reduction research and a content analysis of online microdosing discussion forums (Lea, Amada & Jungaberle, 2019). Items in each section were presented in random order.

Statistical analyses

Data were analysed using Stata (v13.0) and statistical significance was set at $p < 0.05$. We compared participants who were currently microdosing exclusively using LSD/1P-LSD with those exclusively using psilocybin using t-tests and chi-square tests for sociodemographic characteristics, psychedelic use history, microdosing motivations, dosing practices, perceived benefits, unwanted effects, and harm reduction practices.

A proportion of respondents did not complete items on unwanted effects and harm reduction practices. We conducted a sensitivity analysis to compare the sociodemographic characteristics of respondents who completed these questions ($n = 467$) with those who did not ($n = 58$). No significant differences were detected.

We conducted two principal component analyses using polychoric correlation matrices to determine whether items about (1) short-term benefits from microdosing and (2) unwanted effects of microdosing

formed reliable scales. Polychoric methods are appropriate when conducting factor analyses with binary and ordinal scales (Flora & Curran, 2004). The minimum loading for inclusion on a factor was 0.4. If an item loaded on two factors, a difference of at least 0.2 between loadings was required to include the higher loading item. For scales generated from factors for short-term benefits, scale scores ranged from 0 (no items endorsed) to 1 (all items endorsed), and for unwanted effects, scale scores ranged from 0 (never) to 4 (always). We used multivariate linear regression to examine differences in mean scores on each scale between participants microdosing LSD/1P-LSD only and participants microdosing psilocybin only, and according to participants primary motivation for microdosing, controlling for potentially confounding variables (age, gender, education, employment, country of residence, taken standard psychedelic dose in past year). Regression results report standardised betas. Harm reduction practices were not examined via principal component analysis as several items were not applicable to all participants (e.g., avoiding antidepressants on microdosing days).

Results

Sample characteristics

The mean age of the 525 participants was 34.5 years (SD = 12.7). The majority of participants were men (73.5%), identified as heterosexual (78.3%), had completed a university degree (52.8%) and were in a relationship (55.4%). Half of participants were in full-time employment (49.3%), 15.4% were in part-time employment and 17.3% were students. Almost half of participants resided in the United States (48.2%), with smaller numbers from the United Kingdom (7.4%), Canada (6.7%), Germany (5.0%), Australia and New Zealand (4.6%), and the Netherlands (3.8%). Remaining participants resided in Southern/Eastern Europe (12.0%), other parts of Western/Northern Europe (8.8%), Middle East or Africa (1.7%), Central and South America (1.3%), and Asia (0.6%). Compared to participants microdosing with LSD/1P-LSD, participants microdosing with psilocybin were older (M = =36.7 vs. M = =31.5, p < .001), more likely to be female (30.2% vs. 17.5%, p = .004) and live in the US (59.9% vs. 35.8%, p < .001), and less likely to be a student (12.4% vs. 24.5, p = .01). Twenty-two percent of participants were recruited via The Third Wave, 19.8% via Facebook/Instagram, 19.4% via Reddit, 8.8% via Shroomery.org and 4.2% via other psychedelic organisations and forums. Twenty-six percent did not report where they heard about the study.

Sixty-five percent of participants had ever taken a standard ("full") dose of psychedelics for self-reported "therapeutic" purposes; 53.3% in the past 12 months. Sixty-seven percent of participants had used standard psychedelic doses for recreational purposes; 47.8% in the past 12 months. Fifty-four percent of participants used psychedelics recreationally at a younger age than when they first microdosed, 10.3% were the same age when they first microdosed and used psychedelics recreationally, and 2.9% were younger when they microdosed.

Forty-three percent of participants had ever been diagnosed with a mental disorder, 49.3% had seen a psychotherapist for their mental health, 34.3% had been prescribed psychiatric medication, and 10.5% had accessed alcohol and other drug treatment.

Microdosing practices

The mean age of commencing microdosing was 31 years, and participants microdosing with psilocybin were older on commencement than those microdosing with LSD/1P-LSD (34 vs. 29 years, p < .001; Table 1). Most participants had been microdosing for 6 months or less (65.0%). The most common primary motivation for microdosing was to address issues with mental health or substance use (40.4%), which was more commonly reported among participants microdosing with psilocybin than with LSD/1P-LSD (47.1% vs. 32.1%, p = .001). Other participants reported microdosing for personal and spiritual development (31.2%) and to enhance cognitive performance at work or study (18.1%).

Fifty-five percent of participants were currently microdosing with psilocybin mushrooms or truffles, 48.2% with LSD/1P-LSD, 3.0% with DMT, and 3.0% with other psychedelics (Table 1). The most common dosing schedule was one day microdosing and two days off on a repeated cycle (31.8%), and most participants microdosed in the morning (72.0%).

Among participants microdosing with psilocybin (n = =287), 19.9% were microdosing up to 0.1 g of mushrooms or truffles, 26.8% from 0.11 to 0.2 g, 22.6% from 0.21 to 0.35 g, 13.9% from 0.36 to 0.5 g, 12.2% more than 0.5 g, and 4.5% did not know their dose in grams. Participants most commonly prepared microdoses by cutting dried mushrooms/truffles into small pieces (29.6%), putting ground mushrooms/truffles into capsules (22.0%), or grinding mushrooms/truffles to a powder (20.9%). A minority reported taking pre-ground (5.2%) or pre-encapsulated mushrooms/truffles (3.8%) or cutting up fresh mushrooms/truffles (3.5%). The majority of participants measured their microdoses with electronic scales (59.6%), and the remainder measured microdoses by sight (16.0%), with kitchen scales (1.7%), a measuring cup or spoon (1.4%) or an undisclosed method (21.3%).

Among participants who were microdosing with LSD/1P-LSD (n = =253), the mean microdose was 13 micrograms (SD = 7.5; median = 10; range 0–50). Half of participants used volumetric dosing to prepare microdoses (49.8%; i.e., diluting a blotter tab in liquid to extract the LSD), 36.4% cut each tab into pieces, 8.3% used liquid LSD (which they diluted themselves or purchased diluted), and 5.5% did something else (e.g., used lower strength tabs). Among participants who volumetrically dosed (n = =126), 45.2% diluted their LSD in alcohol (most often vodka, 35.7%), 33.3% in distilled or demineralised water, 11.9% in tap or spring water and 9.5% in another liquid. Thirty-three percent of participants diluted each standard dose tab in 5–10 ml of liquid, 28.0% in 15–50 ml and 39.2% in over 50 ml. Thirty-eight percent of participants waited up to 24 h for the LSD to extract before taking a dose, 36.8% waited 25–48 h, and 25.6% waited over 48 h. Most participants measured each microdose with an oral syringe (46.8%) or an eye dropper (30.2%), and the remainder used a small measuring cup or spoon (9.5%), by sight (5.6%) or some other method (7.9%).

Among the 16 participants microdosing DMT, the median dose was 8–9 milligrams. Nine participants measured their dose with electronic scales and 6 participants by sight. Ten participants administered DMT with a vape pen or pipe and 3 smoked Changa (DMT-infused smoking blend).

Among all participants, more than two-thirds (70.3%) reported initially adjusting their microdose through trial and error, and over a third (35.6%) reported having to readjust their dose at least some of the time with each new batch of psychedelics obtained (Table 1). Sixty-nine percent of participants reported sometimes taking a higher than normal microdose, either accidentally or intentionally. Few participants (2.5%, n = =13) reported SDS scores suggestive of an elevated risk of experiencing adverse consequences from psychedelic use.

Most participants (70.9%) learned about microdosing via psychedelic information and harm reduction websites and online forums, and via podcasts, YouTube videos, and other online forums for people who use drugs. Most participants had told friends or their partner they were microdosing (90.3%), and a minority had discussed microdosing with their doctor, psychiatrist/therapist (if applicable), or another health professional (17.9%; Table 1).

Perceived short-term microdosing benefits

Principal components analysis resulted in three reliable scales of perceived benefits participants usually experienced on days they microdosed (i.e., more than 50% of the time; Table 2). This included

Table 1
Microdosing practices among participants currently microdosing, and comparing participants currently microdosing only with LSD/1P-LSD or only with psilocybin.

	All participants (%) (n = 525)		Currently microdosing (%) LSD / 1P-LSD only (n = 212)		Psilocybin only (n = 242)	
Age at first microdose (M, SD)	31.4 (12.6)		29.4 (11.8)		33.6 (12.7)***	
Total microdosing duration						
Less than 1 month	18.5		19.8		19.4	
1–2 months	21.0		20.3		24.0	
3–6 months	25.5		29.2		24.0	
7–12 months	10.7		9.9		12.0	
1–2 years	10.7		10.4		9.5	
More than 2 years	13.7		10.4		11.2	
Primary motivation for microdosing					*	
Depression	24.4		18.9		31.0	
Anxiety	7.4		5.2		9.1	
Other mental health	6.5		7.1		5.8	
Substance use cessation / reduction	2.1		0.9		1.2	
Physical health	1.9		1.4		2.5	
Wellbeing and personal development	31.2		33.5		27.7	
Cognitive enhancement	18.1		22.2		16.5	
Curiosity	8.4		10.8		6.2	
Substances microdosed	Ever	Current	Ever	Current	Ever	Current
Psilocybin mushrooms	65.9	51.2	29.7	–	94.2	93.8
Psilocybin truffles	9.0	4.2	7.1	–	9.1	6.6
LSD	54.9	40.4	84.0	82.1	24.0	–
1P-LSD	12.4	8.4	21.7	17.9	2.5	–
DMT	11.2	3.0	8.5	–	6.6	–
Mescaline	5.3	1.0	2.4	–	2.9	–
Ayahuasca	4.0	0.8	1.9	–	1.7[a]	–
4-AcO-DMT	3.6	0.8	2.8	–	1.2[a]	–
Ibogaine	2.3	0.6	0.9	–	0.8[a]	–
Other psychedelics (e.g., 2C-B, ALD-52, 4-HO-MET)	4.6	0.0	3.3	–	2.9	–
Currently microdosing more than one psychedelic	9.7		0.0		0.4	
Microdosing schedule					***	
Every day	6.3		2.4		7.9	
Every second day	7.8		4.7		11.6	
Every 3 days (1 day on/2 days off)	31.8		36.8		30.6	
Every 4 days (1–2 times a week)	21.1		26.4		18.6	
Once a week	14.5		16.0		12.4	
Once a fortnight	3.4		3.3		1.7	
Five days on/2 days off	3.4		0.5		6.2	
Flexible schedule/as needed	4.0		4.2		2.9	
Something else	7.6		5.7		8.3	
Microdose usually taken…					***	
Morning	72.0		83.0		65.7	
Midday	13.9		10.4		17.4	
Afternoon	5.1		3.3		7.0	
Evening or before bed	9.0		3.3		9.9	
Needed to adjust dose to get it right after commencing microdosing						
Yes	70.3		73.6		68.6	
No	29.7		26.4		31.4	
Need to readjust dose with each new batch of psychedelics obtained						
Always	3.2		3.8		3.3	
Often	5.3		6.1		6.2	
Sometimes	27.0		20.3		30.6	
Rarely	21.0		25.9		16.1	
Never	43.4		43.9		43.8	
Severity of Dependence Scale (M, SD)	0.5 (1.0)		0.6 (1.1)		0.4 (0.8)	
Difficulty obtaining psychedelics						
Very difficult	4.8		3.3		5.8	
Somewhat difficult	24.8		25.0		25.2	
Neither difficult nor easy	19.4		22.6		16.9	
Somewhat easy	21.1		25.0		19.4	
Very easy	39.9		24.1		32.6	
Believe quality of psychedelics obtained consistent over time						
Yes	65.7		60.4		68.6	
No	8.6		8.5		8.3	
Unsure	25.7		31.1		23.1	
Where learnt how to microdose						
Psychedelic websites and online communities/podcasts/Youtube	70.9		75.5		71.1	
Online news/internet search	37.1		38.7		38.8	
Books and media by psychedelic experts	36.8		34.0		40.1	
Friends and other known people	31.4		34.9		27.3	
Self-experimentation	4.8		1.9		5.8*	
Health professional	3.8		1.9		4.1	
Told people you are microdosing						

(*continued on next page*)

Table 1 (*continued*)

	All participants (%) (n = 525)	Currently microdosing (%) LSD / 1P-LSD only (n = 212)	Psilocybin only (n = 242)
Friends or partner	90.3	89.2	91.8
Family members	40.4	33.5	43.0*
Work colleagues	22.5	17.9	23.6
Employer	7.2	4.7	7.5
Therapist/counsellor	11.2	10.4	12.4
General practitioner/doctor	8.2	8.0	7.0
Psychiatrist	4.4	3.3	5.0
Any health professional	17.9	16.0	18.6
Number of other microdosers known			
None	25.3	28.8	26.0
1–2	32.8	34.9	32.2
3–5	25.5	22.2	30.2
6–10	7.6	5.7	6.2
More than 10	8.8	8.5	5.4

* $p < .05$. ** $p < .01$.

*** $p < .001$. [a]Statistical comparisons not made due to small cell counts (< 5).

2C-*B* = 2,5-dimethoxy-4-bromophenethylamine; 4-AcO-DMT = 4-Acetoxy-N,N-dimethyltryptamine; 4-HO-MET = 4-Hydroxy-N-methyl-N-ethyltryptamine; ALD-52 = 1-Acetyl-N,N-diethyllysergamide; DMT = dimethyltryptamine.

improved mood and anxiety, comprising 8 items ($\alpha = 0.85$; $M = 0.56$, SD = 0.35), enhanced connection to people and environment, comprising 5 items, ($\alpha = 0.80$; $M = 0.52$, SD = 0.37), and enhanced cognitive and other performance, comprising 5 items ($\alpha = 0.78$; $M = 0.42$; SD = 0.36). In multivariate analyses, higher means on the improved mood and anxiety scale were reported among participants microdosing as a treatment for depression ($M = 0.62$; $\beta = 0.26$, $p = .001$), anxiety ($M = 0.64$; $\beta = 0.19$, $p = .002$) and other mental health conditions ($M = 0.68$; $\beta = 0.18$, $p = .002$). While high mean scores on this scale were also reported among participants microdosing to cease or reduce substance use ($M = 0.78$), this was not statistically significant in the multivariate analysis ($\beta = 0.06$, $p = .19$)

Participants microdosing LSD/1P-LSD reported a higher mean than participants microdosing psilocybin on the enhanced cognitive and other performance scale ($M = 0.47$ vs. $M = 0.37$; $\beta = 0.13$, $p = .008$), as did participants motivated to microdose for cognitive enhancement ($M = 0.48$; $\beta = 0.18$, $p = .015$). Secondary analyses showed no statistically significant associations between dose level and mean scale scores.

Table 2
Perceived benefits usually experienced on microdosing days (i.e., on more than 50% of days that participants microdosed).

	All participants (%) (n = 525)	LSD/1P-LSD only (n = 212)	Psilocybin only (n = 242)	Factor loading
1. Improved mood and anxiety Eigenvalue = 5.92; variance = 30.5%; $\alpha = 0.85$).				
Less depressed than usual	60.8	59.9	62.4	.55
Feel more self-confident/comfortable within myself	60.4	62.7	56.2	.62
Clearer mind than usual	60.0	62.3	55.4	.58
Less stressed than usual	55.6	50.9	57.9	.77
More patient than usual	53.3	50.0	54.5	.73
Calmer than usual	53.1	50.0	52.5	.67
Less anxious than usual	52.6	49.5	53.3	.74
Less irritable than usual	51.0	47.2	52.1	.80
2. Enhanced connection to people and environment (Eigenvalue = 5.40; variance = 27.8%; $\alpha = 0.80$).				
Feel more connected to nature and other living things	59.4	59.4	55.8	.88
Enhanced senses (e.g., sight, hearing, taste)	55.2	58.0	52.9	.58
More empathetic than usual	54.5	57.5	50.8	.69
Feel more connected to other people	54.5	52.4	52.1	.64
Heightened spiritual experiences	38.1	33.0	36.8	.83
3. Enhanced cognitive and other performance (Eigenvalue = 4.80; variance = 24.7%; $\alpha = 0.78$).				
Easier to get "in the zone"	47.8	50.0	45.9	.69
Work becomes more fun	46.7	52.4	40.9*	.65
More stamina/energy than usual	46.5	54.7	38.4**	.66
Better at solving problems	43.2	47.2	38.4	.67
Better athletic performance/physical capability	27.8	30.7	22.3*	.63
Loaded on more than one factor				
Happier than usual	65.0	66.5	62.4	–
Feel more connected to myself	59.2	60.4	55.8	–
Higher level of focus/concentration than usual	57.7	60.8	53.7	–
More creative than usual	54.1	57.1	50.0	–
Enjoy/appreciate music more	50.3	56.1	42.6**	–
Enjoy sex more/have better sex	26.5	30.7	19.0**	–
Enjoy/appreciate food more	22.7	19.8	21.9	–

* $p < .05$;; ** $p < .01$; *** $p < .001$.

Table 3
Negative and other potentially unwanted effects experienced on days when microdosing in the past 12 months.

	All participants (n = =467)		LSD/1P-LSD only (n = =187)	Psilocybin only (n = =216)	
	Ever (%)	Often or Always (%)	Ever (%)	Ever (%)	Factor loading
1. Psychedelic effects (Eigenvalue = 3.52; variance = 36.2%; α = 0.72)					
Euphoria	79.2	22.3	80.7	76.9	.56
Feel like you are mildly "tripping"	70.7	7.1	72.7	68.5	.69
Altered sense of time and space	52.9	8.4	54.5	47.7	.66
Dilated/enlarged pupils	40.9	7.3	43.9	36.1	.61
Hallucinations or visual distortions	37.7	2.4	36.9	33.8	.74
2. Anxiety effects (Eigenvalue = 3.50; variance = 35.9%; α = 0.72)					
Difficulty concentrating	49.9	1.9	56.7	46.8*	.52
Anxiety	44.8	2.1	43.9	45.8	.76
Feeling overwhelmed	37.3	1.9	44.9	30.6**	.59
Unwanted thoughts, emotions or memories	36.6	2.6	34.2	38.4	.65
Irritability	35.1	1.5	36.4	34.7	.56
Paranoia	21.4	0.2	19.8	21.3	.55
3. Physical effects (Eigenvalue = 1.82; variance = 18.7%; α = 0.56)					
Trouble sleeping	45.0	3.2	52.4	36.6**	.43
Overstimulated at end of day	43.3	3.2	54.5	33.3***	.43
Headache	26.8	1.9	34.8	20.4**	.61
Muscle or joint pain/stiffness	21.4	2.1	26.2	18.1*	.65
Loaded on no factor or more than one factor					
Vivid dreams	69.4	19.7	62.0	71.8*	–
Feeling sick in the stomach	32.5	2.8	28.3	35.6	–
Fast or irregular heartbeat	32.3	2.1	36.9	28.7	–
Feeling disoriented	31.1	0.6	35.5	28.7	–
Confusion	24.2	0.6	27.3	22.2	–
Loss of sense of self	20.3	2.1	20.9	19.0	–

* $p < .05$; ** $p < .01$.; *** $p < .001$.

Unwanted microdosing effects

Principal components analysis retained three factors about negative and other potentially unwanted effects ever experienced on days when participants had microdosed in the past 12 months (Table 3). The scales included potentially unwanted psychedelic effects (5 items, $\alpha = 0.72$; M = =0.99, SD = 0.68), anxiety effects (6 items, $\alpha = 0.72$; M = =0.51, SD = 0.48), and unpleasant physical effects (4 items, $\alpha = 0.56$; M = =0.52, SD = 0.52). There were differences between participants microdosing psilocybin and LSD/1P-LSD on the physical effects scale, with a higher mean reported among participants using LSD/1P-LSD (M = =0.68 vs. M = =0.38, $\beta = 0.30$, $p < .001$). While there were no differences for psilocybin and LSD/1P-LSD on the anxiety scale, participants microdosing LSD/1P-LSD were more likely to endorse two items on the scale, feeling overstimulated at the end of the day ($p < .001$) and difficulty concentrating ($p = .047$). Secondary analyses showed no statistically significant associations between dose level and mean scale scores.

Harm reduction and other practices

The most commonly reported harm reduction practices participants usually used on microdosing days (i.e., more than 50% of the time) were not microdosing when feeling unwell (31.0%), avoiding alcohol (30.8%) and caffeine (23.8%), not microdosing in new or unfamiliar settings (22.9%), and avoiding driving (20.3%; Table 4). One in four participants reported regularly microdosing before important work or study events (25.7%), almost one in ten reported being more likely to use cannabis on microdose days (8.6%), and very few respondents reported using more alcohol on microdose days (0.9%). Participants microdosing with LSD/1P-LSD were more likely than participants microdosing with psilocybin to avoid caffeine on microdosing days ($p = .005$) and to use a reagent test kit on newly obtained psychedelics ($p < .001$). Participants microdosing with psilocybin were more likely to only microdose at home ($p = .001$) or in quiet, familiar settings ($p = .03$).

Discussion

This study examined motivations, practices and subjective experiences of microdosing psychedelics in an international online sample. Almost all participants were microdosing psilocybin (55%) or LSD (48%), most had been microdosing for up to six months (65%), and a diverse range of motivations and dosing practices were reported. The most common motivation for microdosing was an alternative treatment for mental health (40%), either as a replacement or adjunct to conventional treatments, followed by personal development and general wellbeing (31%), and enhancement of cognitive function (18%). Most participants reported experiencing benefits on microdosing days, including improved mood and reduced anxiety, greater connection to other people and their environment, and enhanced cognitive performance. Some participants reported having experienced negative effects while microdosing, including psychedelic effects typically associated with regular doses, anxiety and physical symptoms, although few participants reported that these occurred regularly.

Two in five participants reported that their primary reason for microdosing was as an alternative mental health therapy, most of whom perceived that microdosing reduced depression and anxiety symptoms, and improved their self-confidence and social connectedness. This supports the findings of other non-clinical studies that have described improved psychological wellbeing among people microdosing (Anderson et al., 2019; Fadiman & Korb, 2019; Johnstad, 2018; Politi & Stevenson, 2019). However, most microdosing studies have excluded people with previous or current mental health diagnoses and have not reported microdosing motivations, a limitation that the present study addresses.

These findings suggest that standard mental health treatments like antidepressants have not met the needs of many of our study participants, who were resorting to self-managed treatment with psychedelics. As most participants had previous experience of using psychedelics, it is possible that they were less apprehensive about psychedelic use and had better knowledge of where to access them compared to those

Table 4
Harm reduction and other practices usually performed on microdosing days (i.e., more than 50% of the time).

	All participants (n = =467) (%)	LSD/1P-LSD only (n = =187) (%)	Psilocybin only (n = =216) (%)
Avoid microdosing when feeling physically unwell	31.0	28.3	29.6
Avoid or reduce alcohol on microdosing days	30.8	28.9	31.0
Avoid or reduce caffeine on microdosing days	23.8	29.4	17.6**
Avoid microdosing in situations new or outside regular routine	22.9	19.8	25.9
Avoid driving a car	20.3	20.3	19.0
Avoid stimulant drugs on microdosing days	19.3	18.7	16.7
Take lower dose on days doing something outside regular routine	18.8	17.6	20.4
Only take psilocybin mushrooms on an empty stomach	16.3	–	24.1
Avoid or reduce cannabis on microdosing days	15.4	15.0	14.8
Avoid microdosing if you have a hangover from alcohol	15.2	17.1	13.4
Only microdose at home	12.8	5.9	17.1**
Only microdose in quiet, familiar settings	12.8	9.1	16.2*
Avoid microdosing when feeling anxious	11.3	10.2	10.6
Test new batches you buy using a test kit (e.g., Ehrlich reagent test)	10.7	16.6	3.2***
Only microdose on non-work days	9.9	9.1	10.2
Avoid microdosing at work or college/university	9.2	8.0	9.3
Avoid taking SSRI antidepressants	9.0	7.0	9.3
Avoid microdosing when feeling depressed	6.9	5.9	5.1
Avoid taking lithium or tricyclic antidepressants	6.0	3.7	6.9
Check to see if mushrooms are not a poisonous variety by comparing to photos / descriptions online or in a manual	5.1	–	7.4
None of the above	21.8	23.0	21.3
Number of practices reported (M, SD)	3.1 (3.0)	2.8 (2.6)	3.1 (3.0)

* $p < .05$; ** $p < .01$; *** $p < .001$.

without prior experience. A recent study of psychedelic users found that among those diagnosed with a mental health disorder, 62% had used psychedelics as an adjunct or replacement therapy to prescribed medication or psychotherapy (Mason & Kuypers, 2018). It is unsurprising that some people are turning to alternative mental health treatments like microdosing. Psychiatric medications have variable levels of effectiveness and adherence (Moncrieff, 2018; Pampallona, Bollini, Tibaldi, Kupelnick & Munizza, 2002), and treatment engagement for mental disorders is often below 50% (Whiteford et al., 2014). Recent meta-analyses have found that differences in the effectiveness of antidepressants and placebo are small and unlikely to be clinical meaningful (Cipriani et al., 2018; Jakobsen et al., 2017). Antidepressant side effects are common (Read & Williams, 2018), and more than half report withdrawal on cessation (56%), which can last from weeks to months (Davies & Read, 2019).

Participants microdosing with psilocybin were more likely than participants microdosing with LSD to report that their primary motivation was as a treatment for depression and anxiety. It is unclear why this was found, but could be related to participants' knowledge of recent clinical trials, which are predominantly investigating psilocybin (Johnson & Griffiths, 2017) and have been reported in major newspapers. Additional research is required to better understand why people choose one psychedelic over another for different microdosing motivations, as well as more focused research with people who have microdosed more than one substance. Few participants reported microdosing to manage substance use cessation or reduction, which could reflect greater media attention on microdosing for cognitive enhancement and as alternative therapies for depression and anxiety, as well as the higher prevalence of mood and anxiety disorders than substance use disorders in the general population (and acknowledging the high comorbidity of substance use and mental disorders) (Lai, Cleary, Sitharthan & Hunt, 2015; Whiteford et al., 2013).

Less than one in five participants had discussed microdosing with a health professional. While this may be less of a concern for people microdosing for cognitive enhancement, people microdosing as a treatment for mental health, and particularly those ceasing psychiatric medications to commence microdosing, should consider discussing microdosing with their prescribing physician and psychotherapist. These may be difficult conversations given the legal status of these substances, and individuals may be concerned about unsupportive or stigmatizing responses, degradation of the therapeutic relationship or fear of legal repercussions. Opting not to discuss changes in psychiatric medications is common; a recent UK survey found that only half of those who stopped antidepressants did so in consultation with their doctor (Read, Gee, Diggle & Butler, 2019).

While popular media has often portrayed microdosing as a tool to improve focus, productivity and creativity (Glatter, 2015; Leonard, 2015), less than one in five participants reported cognitive enhancement as their primary motivation. We reported participants' primary motivation for microdosing, and it is possible that cognitive enhancement was a secondary motivation for some participants. Cognitive benefits while microdosing were not as commonly reported as improved mood, reduced anxiety and enhanced connectedness, but were still reported by more than 40% of the sample. Enhanced cognitive performance was more likely to be reported by participants microdosing with LSD than psilocybin, which may reflect psychopharmacological differences, and LSD may be more suited to focus and attention to a specific task than psilocybin (Nichols, 2016). Microdosing psychedelics for cognitive enhancement may carry fewer risks than using other nootropics like psychostimulants (Bisagno, Gonzalez & Urbano, 2016).

Most participants reported having experienced unwanted effects while microdosing, although few reported that this was a common occurrence. It is concerning that one in five participants reported having experienced paranoia while microdosing, and a more in-depth investigation is warranted. Very few participants reported regularly experiencing increased anxiety while microdosing, which does not support suggestions that people with anxiety consider avoiding microdosing (Fadiman & Korb, 2019). Although we found no relationship between dose and experiencing anxiety (which may be due to difficulty in reliably assessing dose size), people microdosing to reduce anxiety may do better at lower doses. Adverse physical effects were not commonly reported, consistent with evidence that there are few physical harms from psychedelics (Nutt et al., 2010). Physical effects were more commonly reported by participants microdosing LSD than psilocybin, which could reflect psychopharmacological differences (Nichols, 2016).

Effects more commonly associated with regular psychedelic doses such as euphoria and perceptual distortions were reported by most participants at least once while microdosing. However, most of these effects were uncommon. For the 22% of participants who reported regularly experiencing euphoria while microdosing, this may indicate dosing too high, but may in fact be a desired effect. The accompanying lift in mood and enthusiasm could feel like the microdose is "working", particularly for people microdosing as a mental health therapy. Participants motivated to microdose for mental health and cognitive enhancement were more likely to report improved psychological well-being and enhanced performance, respectively. Some degree of "meaning response" – a term proposed as an alternative conceptualisation of the "placebo effect" as an individual's response to the meaning of their treatment – may be present, and clinical research on microdosing is needed (Moerman & Jonas, 2002).

Accurately microdosing with prohibited substances that have not been tested for purity is challenging, due to the very small doses required and preparation and administration procedures that may result in inconsistency between doses. Studies have found that LSD tabs often contain varying amounts of LSD, no LSD at all, and on rare occasions dangerous contaminants like NBOMe, a class of substances associated with overdose and fatalities (Caldicott, Bright & Barratt, 2013; Caudevilla et al., 2016; Gerace et al., 2019; van der Gouwe, Brunt, van Laar & van der Pol, 2017). The use of home testing kits to identify the presence of LSD should be encouraged as a harm reduction practice when obtaining new batches, particularly as the use of test kits was uncommon in our sample. For people who had unsuccessfully undergone standard mental health and substance use therapies and are experiencing positive outcomes from microdosing, microdosing with low purity LSD or inert substances purchased as LSD could lead to the reappearance of symptoms and relapse. Difficulties in accessing a ready supply of psychedelics could lead some to reluctantly recommence psychiatric medications. Should clinical trials show microdosing to be safe and effective, the establishment of a legal market would resolve these issues.

This study has some limitations. Most participants were from high-income countries, in paid employment and well educated. While barriers to mental health treatment are often related to perceived need and stigma, people on low incomes often experience financial barriers to treatment and competing life demands that may limit opportunities to access standard or alternative therapies (Andrade et al., 2014). The small number of participants from low- and middle-income countries may be related in part to the survey being offered only in English, lower availability of psychedelics and awareness of microdosing, as well as lower engagement with standard mental health services in these countries, which may preclude consideration of alternative therapies (Wang et al., 2007).

This was not a controlled study and presents baseline data, so causal inferences and longitudinal mental health outcomes cannot be determined. Most participants had also taken a standard psychedelic dose in the previous year, which may confound attribution of benefits from microdosing. We recruited a sample that were relatively well-engaged with online psychedelic communities and most had used psychedelics before. An area for future research is the acceptability, knowledge and likelihood of the therapeutic use of psychedelics among people without prior psychedelic experience. While we found no dose differences in perceived benefits and unwanted effects of microdosing, this is better examined in a clinical trial where accurate doses can be administered. A clearer conceptual distinction should be made between microdosing and "minidosing" (recently suggested as 25–50 μg of LSD) (Kuypers et al., 2019; Passie, 2019). Clinical studies examining a range of doses would determine those that do not show perceivable psychoactive effects for the majority of people (Bershad, Schepers, Bremmer, Lee, & de Wit, 2019; Yanakieva et al., 2019). Our physical effects scale had a relatively low Cronbach's alpha, which may reflect the few common physical complications of psychedelic use (Nichols, 2016; Nutt et al., 2010). However, it is important to measure physical effects when examining substance effects and this measure will be refined in future survey rounds. Planned follow-up surveys will permit examination of longer-term perceived effects and outcomes, enduring unwanted effects and maintenance and cessation of microdosing.

The findings of this study contribute to the growing body of research that suggests a possible role for psychedelic microdosing as novel therapies for people experiencing problems with mental health and substance use. Compared to psychedelic-assisted therapy with standard doses (typically 1–4 sessions with psychedelics, preceded and followed by preparation and integration sessions) (Sessa, 2018), microdosing, either as a short-term or ongoing therapy, represents a different set of challenges for the design and implementation of clinical research and services. Attending a clinic for dosing several times a week, similar to how opioid substitution treatment is often delivered, would be unrealistic and a significant barrier to treatment for many people (Deering et al., 2011; Madden, Lea, Bath & Winstock, 2008). Should clinical trials show microdosing to be effective therapies for mental and substance use disorders, the logistics of microdosing provision should be done with consumer input in a way that is acceptable and responds to their needs. While we await the findings of clinical research on microdosing, which could take several years, people who are dissatisfied with available treatment services will continue to microdose as an alternative therapy. This may become more prevalent as media attention and community awareness of microdosing and psychedelic-assisted therapy grows. Longitudinal social science research is thus a necessary complement to clinical research, to gain insights into people's experiences of microdosing, develop better harm reduction resources, and consider how existing mental health and drug treatment services can better support people who are microdosing at a time when these substances are prohibited in most jurisdictions.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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