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ORIGINAL INVESTIGATION

Perceived outcomes of psychedelic microdosing as self-managed therapies for mental and substance use disorders

Toby Lea[1,2] · Nicole Amada[3] · Henrik Jungaberle[4] · Henrike Schecke[5] · Norbert Scherbaum[5,6] · Michael Klein[1]

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Abstract

Rationale The regular consumption of very small doses of psychedelic drugs (known as microdosing) has been a source of growing media and community attention in recent years. However, there is currently limited clinical and social research evidence on the potential role of microdosing as therapies for mental and substance use disorders.

Objectives This paper examined subjective experiences of microdosing psychedelics to improve mental health or to cease or reduce substance use, and examined sociodemographic and other covariates of perceived improvements in mental health that individuals attributed to microdosing.

Methods An international online survey was conducted in 2018 and examined people's experiences of using psychedelics for self-reported therapeutic or enhancement purposes. This paper focuses on 1102 respondents who reported current or past experience of psychedelic microdosing.

Results Twenty-one percent of respondents reported primarily microdosing as a therapy for depression, 7% for anxiety, 9% for other mental disorders and 2% for substance use cessation or reduction. Forty-four percent of respondents perceived that their mental health was "much better" as a consequence of microdosing. In a multivariate analysis, perceived improvements in mental health from microdosing were associated with a range of variables including gender, education, microdosing duration and motivations, and recent use of larger psychedelic doses.

Conclusions Given the promising findings of clinical trials of standard psychedelic doses as mental health therapies, clinical microdosing research is needed to determine its potential role in psychiatric treatment, and ongoing social research to better understand the use of microdosing as self-managed mental health and substance use therapies.

Keywords LSD · Psilocybin · Mental health · Alcohol · Drugs · Self-treatment · Microdose

✉ Toby Lea
toby.lea@unsw.edu.au

[1] German Institute for Addiction and Prevention Research, Catholic University of Applied Sciences, Cologne, Germany

[2] Centre for Social Research in Health, UNSW Sydney, Kensington, Australia

[3] City University of New York, New York, NY, USA

[4] MIND European Foundation for Psychedelic Science, Berlin, Germany

[5] LVR-Hospital Essen, Department of Addictive Behaviour and Addiction Medicine, Medical Faculty, University of Duisburg-Essen, Essen, Germany

[6] LVR-Hospital Essen, Department of Psychiatry and Psychotherapy, Medical Faculty, University of Duisburg-Essen, Essen, Germany

Introduction

Over the past decade, there has been a renewed interest in psychedelic drugs as potential therapies for mental and substance use disorders (Sessa 2018). Clinical trials have investigated 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 et al. 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). While not technically a psychedelic, 3,4-methylenedioxymethamphetamine (MDMA) has resulted in improved outcomes for people with post-traumatic stress disorder (PTSD) (Mithoefer et al. 2019) and is being investigated as a treatment for alcohol use disorder (Sessa et al. 2019). These studies have shown promising results, and have been

driven in part by the limited effectiveness of many conventional treatments for mental health and substance use disorders, low rates of treatment engagement and high rates of attrition (Hoskins et al. 2015; Moncrieff 2018; Pampallona et al. 2002). For example, one-third of depressed patients do not respond to currently available psychiatric medications (Conway et al. 2017), and treatment engagement and adherence for mental and substance use disorders is typically well below 50% (Cipriani et al. 2018; Milward et al. 2014; Whiteford et al. 2014).

Psychedelics are also being used by individuals to manage mental health and substance use issues outside of approved clinical and research settings. In a recent survey of psychedelic users, 62% of those who had been diagnosed with a mental disorder had used psychedelics as a self-administered adjunct or replacement therapy to prescribed medication or psychotherapy, although it was unclear whether participants had discussed this with a clinician (Mason and Kuypers 2018). In addition, there are increasing reports of people seeking out shamanic healers (e.g., ayahuasca ceremonies), and "underground" therapists (i.e., providing psychedelic-assisted therapy illegally via word of mouth) (Kavenská and Simonová 2015; Noorani 2019).

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 psychedelic drugs (typically between 5 and 10% of a standard dose) on a routine schedule (e.g., every third day) without the intention of experiencing effects typically experienced at higher psychedelic doses (e.g., visual distortions, mystical experiences) (Fadiman 2011; Kuypers et al. 2019; Liechti 2019). Although a recent randomised controlled trial reported 13 mcg of LSD as a threshold microdose above which psychedelic effects may be experienced (Bershad et al. 2019), there is currently no scientific consensus about what dose ranges constitute LSD and psilocybin microdoses (Kuypers et al. 2019; Passie 2019). Microdosing has been characterised in the news and popular media as a workplace trend that started among technology professionals in Silicon Valley to enhance productivity, focus and creativity (Dean 2017; Glatter 2015). There has also been some focus on people microdosing as a self-managed treatment for depression, anxiety and other mental disorders, both in traditional media outlets and online platforms such as YouTube and Reddit (Hupli et al. 2019; Lea et al. 2019; Waldman 2017; Williams 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 "vigour" (Bershad et al. 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). An observational online study followed respondents microdosing over a 6-week period, and reported reductions in symptoms of depression and stress, but no significant change in symptoms of anxiety (Politi and Stevenson 2019). A small number of online cross-sectional surveys have also assessed different aspects of microdosing. One of few studies to examine motivations to microdose found that performance enhancement was the most commonly reported motivation (37% of the sample), followed by mood enhancement (29%) and "symptom relief" (14%) (Hutten et al. 2019a). While their respondents rated microdosing as more effective than conventional therapies for depression, anxiety and substance use disorders, they rated microdosing as less effective than full psychedelic doses for depression and anxiety, with no significant differences between ratings of full doses and microdoses as therapies for substance use disorders (Hutten et al. 2019b). Another study reported that people who had microdosed scored higher on measures of open-mindedness and creativity, and lower on measures of dysfunctional attitudes and negative emotionality compared with people without microdosing experience (Anderson et al. 2019b). From the same study, respondents most commonly reported improved mood (27%), focus (15%) and creativity (13%) as benefits of microdosing, and physiological discomfort (18%), impaired focus (9%), impaired mood (7%) and increased anxiety (7%) as unwanted effects (Anderson et al. 2019a).

A small number of qualitative studies have also been conducted. An online interview study with 21 men reported perceived improvements from microdosing in symptoms of depression and anxiety, as well as enhanced energy and cognition, with few adverse effects aside from inadvertently taking too high a dose (Johnstad 2018). Another study comprised semi-structured interviews with 30 people who had microdosed and found 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 et al. 2019, p. 35). A content analysis of microdosing discussions on the online forum Reddit found that posters were primarily motivated to microdose to improve mental health and wellbeing, and to enhance cognitive performance (Lea et al. 2019). While many reported that microdosing had met or exceeded their expectations, particularly in providing relief from depression and anxiety and fostering improved health practices and habits, some posters reported no discernible improvements and some reported increased anxiety while microdosing (Lea et al. 2019).

To date, most quantitative microdosing studies have excluded people with a history of mental illness, have not reported microdosing motivations, and no study has examined the sociodemographic and other correlates of microdosing as

mental health and substance use therapies, nor the sociodemographic and other correlates of perceived improvements in mental health that people attribute to microdosing. This paper aimed to address these research gaps using findings from an international online survey.

Methods

Sample and recruitment

An international online survey was conducted that aimed to examine people's experiences of using psychedelics at microdoses and standard doses as self-managed therapies to improve mental health, cease or reduce alcohol and other drug use, or manage other health conditions, as well as for personal development and to enhance cognitive performance. This paper is focused on respondents who reported experience of microdosing, including individuals who were microdosing at the time of the survey, were taking a break, or had stopped. We recruited 2088 respondents who reported having ever microdosed psychedelics, and excluded 257 respondents who primarily microdosed with non-psychedelics (e.g., MDMA, cannabis). From the remaining 1831 respondents who primarily microdosed psychedelics, 1102 completed the survey (60.2% completion rate).

Baseline recruitment was conducted in late 2018 via email lists of psychedelic community and non-profit organisations (e.g., The Third Wave, MIND Foundation, 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. A follow-up survey is planned in late 2019. People were eligible to participate if they were aged 16 years or older, had used psychedelic drugs for any purpose and could comprehend written English. Respondents received no remuneration. The study received ethical approval from the University of Duisburg-Essen, Germany (Reference: 18-8215-BO).

Measures

Mental health, substance use and treatment Respondents were asked questions about mental health diagnoses (ever, past 12 months), which disorders they had been diagnosed with, and use of conventional treatments including psychotherapy (ever, past 12 months), psychiatric medications (ever, past 12 months, current) and which medications had been prescribed. Respondents were asked whether they had experienced treatment for alcohol and other drug use (ever, past 12 months) and which treatments they had accessed (e.g., counselling, group programs, inpatient detoxification or rehabilitation, pharmacotherapies for withdrawal or maintenance). Respondents were asked to report how helpful they found these treatments on a 5-point Likert scale (very helpful, somewhat helpful, neither helpful nor unhelpful, somewhat unhelpful, very unhelpful).

The Patient Health Questionnaire (PHQ-9) (Kroenke et al. 2001) measured depressive symptoms in the previous 2 weeks. Scores in the range of 0–4 indicate minimal depression, 5–9 mild depression, 10–14 moderate depression, 15–19 moderately severe depression and 20–27 severe depression. The Generalised Anxiety Disorder 7-item scale (GAD-7) (Spitzer et al. 2006) measured anxiety symptoms in the previous 2 weeks, with scores of 0–4 indicating minimal anxiety, 5–9 mild, 10–14 moderate and 15–21 severe anxiety. The Sense of Coherence 13-item scale (SOC-13) (Antonovsky 1993) assessed successful coping with internal and external stressors to support health and wellbeing. The instrument was scored using a single summary score ranging from 13 to 91, with higher scores indicating greater sense of coherence.

Microdosing and other psychedelic use Questions about microdosing examined microdosing status (current, taking a break, stopped), microdosed substance (e.g., LSD, psilocybin), dose, dosing schedule, and total duration of microdosing. Respondents microdosing at the time of the survey were asked if they had disclosed that they were microdosing to different groups (e.g., doctor, psychiatrist, other health professional). Respondents' motivations for microdosing were elicited with the following questions "What were your main reasons for starting microdosing?" and "What was the most important reason for you starting microdosing?". Respondents could select items from a list of 32 items or write in their own responses. For each motivation reported, respondents were asked how helpful they found microdosing for that objective using a 5-point Likert scale (very helpful, somewhat helpful, neither helpful nor unhelpful, somewhat unhelpful, very unhelpful). A composite measure was generated from these items for overall perceived helpfulness of microdosing among respondents who were motivated to microdose to improve their mental health.

Respondents were also asked if they had "taken a full dose of psychedelic drugs for therapeutic purposes (e.g., for healing or dealing with mental health, physical health, alcohol and other drug issues, or other issues)?" ever or in the past 12 months. In addition, they were asked if they had used a full dose of psychedelics for recreational purposes ever and in the past 12 months.

Perceived outcomes of microdosing Respondents were asked to report whether their use of alcohol, tobacco, cannabis, other recreational drugs, pain medication (e.g., opioids), antidepressants and other prescription mental health medications had "changed since starting microdosing". The response scale for each substance was: stopped use, use less often, no change, use more often and not applicable.

Perceived improvements in mental health since commencing microdosing was measured with the following question: "Do you think microdosing has changed any of the following aspects of your life?" with "mental health" as one of the domains (NB. other domains will be reported in a future publication). Responses were rated on a 5-item Likert scale (much worse, somewhat worse, no change, somewhat better, much better).

Statistical analyses

Analyses were conducted with Stata Version 16.0 and statistical significance was set at $p < 0.05$. Sociodemographic characteristics and microdosing practices were compared according to microdosing status (current, taking a break, stopped) using chi-squared tests for categorical variables and linear regression for continuous variables. Standardised betas are reported for linear regression outputs.

Logistic regression models were used to examine covariates of (i) being primarily motivated to microdose as a therapy for mental health or substance use cessation or reduction, and (ii) self-perceived "much better" mental health as a consequence of microdosing. For each of these two analyses, variables reaching statistical significance in bivariate comparisons were block entered into a multivariate model.

A sensitivity analysis was conducted to compare the sociodemographic characteristics of respondents included in this analysis ($n = 1102$) with those who had microdosed psychedelics and did not complete the survey ($n = 729$). Respondents who did not complete the survey were younger (M = 30.6, SD = 0.4; $p < 0.001$), were less likely to have completed a university degree (41.4%, $p < 0.001$), and were more likely to have stopped microdosing (36.6%; $p < 0.001$) and to have primarily microdosed psychedelics other than LSD and psilocybin (28.7%, $p < 0.001$). The sociodemographic characteristics of respondents who completed the survey are described below.

Results

Sample characteristics

The mean age of the 1102 respondents was 33 years (SD = 12.1). Most respondents were male (73.1%), identified as heterosexual (78.6%), were in a relationship (53.3%) and had completed a university degree (51.6%) (Table 1). Almost half (47.6%) were in full-time employment and the largest group of respondents resided in the USA (43.6%), followed by Western Europe (20.9%), Eastern Europe (10.5%), United Kingdom (7.9%), Canada (6.9%), and Australia and New Zealand (6.2%).

Thirty-six percent of respondents were microdosing at the time of the survey, 37.1% were taking a break, and 27.0% had stopped microdosing. The mean age at commencement of microdosing was 29 years (SD = 12.1), most respondents (78.5%) had microdosed for up to 6 months in total, and primarily microdosed psilocybin (46.4%) or LSD/1P-LSD (45.0%) (Table 1). Fourteen percent of respondents microdosed every day, 11.3% every second day, 26.6% every third day, 14.8% every fourth day, 18.2% once a week or less often and the remaining 15.5% had a different dosing schedule or no fixed schedule. The median LSD microdose reported by respondents was 11 micrograms (interquartile range 10–20). Among respondents who reported psilocybin microdosing ($n = 541$), 23.3% reported typically ingesting a microdose of up to 0.1 g, 25.5% between 0.1 g and 0.2 g, 29.4% between 0.2 g and 0.5 g, and 17.9% over 0.5 g. Four percent did not have a fixed psilocybin microdose or did not know their dose.

Eighty-two percent of respondents reported having taken a full dose of psychedelics for self-reported "therapeutic purposes" outside of approved clinical settings; 63.7% in the past 12 months. Eighty-nine percent of respondents had used psychedelics recreationally; 65.5% in the past 12 months. Eighty-nine percent had used other illicit drugs and drugs for non-medical purposes in the past 12 months. Fourteen percent of respondents had ever sought conventional treatments for alcohol or other drug use (Table 1), including individual counselling (9.6%), group programs (7.8%), inpatient treatment (5.1%) and medications to assist with withdrawal and maintenance (3.7%).

Over half of respondents (56.7%) had ever been diagnosed with a mental disorder (excluding substance use disorders), including depression (41.2%), anxiety disorders (32.0%; generalised anxiety disorder, 25.4%; social anxiety disorder, 14.5%; panic disorder/panic attacks, 12.5%), ADHD (19.5%), PTSD (15.6%), bipolar disorder (7.4%), personality disorder (5.1%), eating disorder (4.8%), obsessive compulsive disorder (4.7%) and schizophrenia (1.0%). The median number of diagnosed mental disorders was 1 (interquartile range 0–3). Forty-four percent of all respondents had been prescribed psychiatric medications and 8.1% were prescribed these at the time of the survey. Sixty-five percent of respondents had ever seen a counsellor or psychotherapist for their mental health. At the time of the survey, 17.5% of respondents showed at least moderate levels of depression on the PHQ-9, and 12.6% showed at least moderate levels of anxiety on the GAD-7 (Table 1).

Microdosing motivations

Thirty-nine percent of respondents reported that they primarily microdosed as mental health or substance use therapies, including for depression (21.3%), anxiety (6.9%), other mental health conditions including PTSD and ADHD (8.9%), and

Table 1 Sociodemographic and other characteristics of respondents whose primary motivation for microdosing was a therapy for mental health or for substance use cessation or reduction

		Primary microdosing motivation: mental health or substance use therapy		Bivariate	Multivariate
	All respondents ($n = 1102$) n (%)	No (Ref.) ($n = 674$, 61.2%) (n, %)	Yes ($n = 428$, 38.8%) (n, %)	OR (95% CI)	AOR (95% CI)
Age (M, SD)	32.7 (12.1)	32.1 (12.5)	33.7 (11.3)	1.01 (1.00, 1.02)*	1.01 (0.99, 1.02)
Gender					
Male	806 (73.1)	520 (64.5)	286 (35.5)	1.00	1.00
Female	273 (24.8)	138 (50.5)	135 (49.5)	1.78 (1.35, 2.34)***	1.20 (0.87, 1.65)
Non-binary/other identity	23 (2.1)	16 (69.6)	7 (30.4)	0.80 (0.32, 1.96)	0.60 (0.22, 1.62)
Completed education					
University degree	569 (51.6)	341 (59.9)	228 (40.1)	1.00	
Trade certificate/diploma	171 (15.5)	93 (54.4)	78 (45.6)	1.25 (0.89, 1.77)	
Up to high school	362 (32.8)	240 (66.3)	122 (33.7)	0.76 (0.58, 1.00)	
Employment					
Full-time	525 (47.6)	326 (62.1)	199 (37.9)	1.00	1.00
Part-time/casual	179 (16.2)	96 (53.6)	83 (46.4)	1.42 (1.01, 2.00)*	1.23 (0.83, 1.82)
Student	199 (18.1)	138 (69.3)	61 (30.7)	0.72 (0.51, 1.03)	0.84 (0.56, 1.26)
Unemployed/other	199 (18.1)	114 (57.3)	85 (42.7)	1.22 (0.88, 1.70)	0.89 (0.61, 1.31)
Place of residence					
North America	557 (50.5)	321 (57.6)	236 (42.4)	1.00	1.00
Europe	433 (29.3)	287 (66.3)	146 (33.7)	0.69 (0.53, 0.90)**	1.15 (0.85, 1.57)
Other location	112 (10.2)	66 (58.9)	46 (41.1)	0.95 (0.63, 1.43)	1.22 (0.76, 1.95)
Microdosing status					
Currently microdosing	396 (35.9)	235 (59.3)	161 (40.7)	1.00	
Taking a break	409 (37.1)	250 (61.1)	159 (38.9)	0.93 (0.70, 1.23)	
Stopped microdosing	297 (27.0)	189 (63.6)	108 (36.4)	0.83 (0.61, 1.14)	
Microdosed substance					
Psilocybin	511 (46.4)	280 (54.8)	231 (45.2)	1.00	1.00
LSD/1P-LSD	496 (45.0)	343 (69.2)	153 (30.8)	0.54 (0.42, 0.70)***	0.53 (0.39, 0.72)***
Other psychedelic or > 1 substance	95 (8.6)	51 (53.7)	44 (46.3)	1.05 (0.67,1.62)	1.03 (0.63, 1.70)
Microdosing total duration					
Up to 1 month	360 (32.7)	242 (67.2)	118 (32.8)	1.00	1.00
1–6 months	505 (45.8)	293 (58.0)	212 (42.0)	1.48 (1.12, 1.97)**	1.69 (1.22, 2.33)**
More than 6 months	237 (21.5)	139 (58.6)	98 (41.4)	1.45 (1.03, 2.03)*	1.59 (1.08, 2.35)*
Regular psychedelic dose for therapeutic purposes in past 12 months					
No	400 (36.3)	263 (65.8)	137 (34.2)	1.00	1.00
Yes	702 (63.7)	411 (58.5)	291 (41.5)	1.36 (1.05, 1.75)*	1.43 (1.06, 1.91)*
Mental health diagnosis					
Never	477 (43.3)	366 (76.7)	111 (23.3)	1.00	1.00
Over 12 months ago	458 (41.6)	234 (51.1)	224 (48.9)	3.16 (2.38, 4.18)***	1.71 (1.17, 2.49)**
In past 12 months	167 (15.2)	74 (44.3)	93 (55.7)	4.14 (2.86, 6.01)***	1.57 (0.95, 2.58)
Prescribed psychiatric medications					
Never	622 (56.4)	459 (73.8)	163 (26.2)	1.00	1.00
Over 12 months ago	296 (26.9)	150 (50.7)	146 (49.3)	2.74 (2.05, 3.66)***	1.32 (0.90, 1.95)
In past 12 months	184 (16.7)	65 (35.3)	119 (64.7)	5.16 (3.63, 7.32)***	2.35 (1.48, 3.73)***
Counselling/psychotherapy					
Never	391 (35.5)	305 (78.0)	86 (22.0)	1.00	1.00
Over 12 months ago	419 (38.0)	239 (57.0)	180 (43.0)	2.67 (1.96, 3.63)***	1.55 (1.07, 2.24)*
In past 12 months	292 (26.5)	130 (44.5)	162 (55.5)	4.42 (3.17, 6.16)***	2.04 (1.35, 3.11)**
Substance use treatment					
Never	944 (85.7)	587 (62.2)	357 (37.8)	1.00	1.00
Over 12 months ago	117 (10.6)	60 (51.3)	57 (48.7)	1.56 (1.06, 2.30)*	1.05 (0.68, 1.64)
In past 12 months	41 (3.7)	27 (65.9)	14 (34.1)	0.85 (0.44, 1.65)	0.44 (0.21, 0.93)*
PHQ-9 depression score					
Minimal	617 (56.0)	422 (68.4)	195 (31.6)	1.00	1.00
Mild	292 (26.5)	170 (58.2)	122 (41.8)	1.55 (1.16, 2.07)**	1.24 (0.87, 1.78)
Moderate	101 (9.2)	48 (47.5)	53 (52.5)	2.39 (1.56, 3.66)***	1.35 (0.78, 2.34)
Moderately severe/severe	92 (8.3)	34 (37.0)	58 (63.0)	3.69 (2.34, 5.83)***	1.41 (0.72, 2.74)
GAD-7 anxiety score					
Minimal	687 (62.3)	473 (68.9)	214 (31.1)	1.00	1.00
Mild	276 (25.0)	146 (52.9)	130 (47.1)	1.97 (1.48, 2.62)***	1.65 (1.15, 2.36)**
Moderate	88 (8.0)	43 (48.9)	45 (51.1)	2.31 (1.48, 3.62)***	1.48 (0.81, 2.70)
Severe	51 (4.6)	12 (23.5)	39 (76.5)	7.18 (3.69, 14.00)***	4.28 (1.80, 10.17)**
SOC-13 score (M, SD)	54.2 (7.2)	54.9 (7.0)	53.1 (7.3)	0.97 (0.95, 0.98)***	0.98 (0.96, 1.00)

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

GAD-7, Generalized Anxiety Disorder 7-item scale; *PHQ-9*, Patient Health Questionnaire; *SOC-13*, Sense of Coherence 13-item scale

cessation or reduction of alcohol and other drug use (1.7%; Fig. 1). Thirty percent of respondents were primarily motivated to microdose for personal development and general wellbeing (69.0% when including those who reported this as a secondary motivation), 15.4% for cognitive enhancement (62.2% when including secondary motivations), 1.7% for physical health issues (7.3% when including secondary motivations) and 12.6% out of curiosity.

Among respondents primarily microdosing as a mental health therapy ($n = 409$), 75.3% had ever been diagnosed with a mental disorder (excluding substance use disorders), 62.6% had ever been prescribed psychiatric medications, 15.2% were prescribed psychiatric medications in the past 12 months but were not currently taking them, and 13.4% had a current prescription. Thirty-nine percent had seen a counsellor or psychotherapist in the past 12 months. In total, 85.3% of these respondents had ever received conventional mental health therapies (i.e., medication and/or counselling). Among these respondents, 24.8% of those microdosing at the time of the survey had told a doctor, psychiatrist or psychotherapist that they were microdosing. Among respondents primarily microdosing to cease or reduce substance use ($n = 19$), seven (36.8%) had experienced conventional alcohol or other drug treatment.

In a multivariate analysis, being motivated to microdose primarily for mental health or substance use cessation or reduction was significantly associated with a longer duration of microdosing, microdosing with psilocybin rather than LSD, taking a full dose of psychedelics for self-described "therapeutic" purposes in the past 12 months, diagnosis with a mental disorder over 12 months ago, psychiatric medication prescription in the past 12 months, having seen a counsellor or psychotherapist, and current mild or severe anxiety symptoms (Table 1). In addition, alcohol and other drug treatment attendance in the previous 12 months was associated with lower odds of being motivated to microdose for mental health or substance use.

Changes in medication and substance use

A variety of changes in medication use and non-medical substance use were reported by respondents since commencing microdosing (Table 2). Among respondents who had ever been prescribed psychiatric medications, half (50.6%) reported having ceased antidepressants and 39.7% reported having ceased other psychiatric medications. Among those who had used pain medications, over one-quarter (27.5%) reported having ceased taking them since commencing microdosing. A smaller proportion of respondents reported cessation of non-medical substance use since commencing microdosing (e.g., tobacco: 19.5%; alcohol: 15.9%), although more respondents reported having reduced consumption (Table 2).

Compared with respondents who had stopped microdosing, respondents who were currently microdosing or taking a break were more likely to report reduced alcohol use (44.6% vs. 35.2%; $\chi^2 = 9.54$, $p = 0.008$), reduced cannabis use (28.1% vs. 18.3; $\chi^2 = 9.60$, $p = 0.008$) and cessation of antidepressants (55.2% vs. 38.5%; $\chi^2 = 11.99$, $p = 0.002$) since commencing microdosing.

Perceived improvements in mental health

Forty-four percent of all respondents perceived that their mental health was much better and 35.8% perceived that it was somewhat better because of microdosing. Nineteen percent of respondents perceived no changes to their mental health, 1.3%

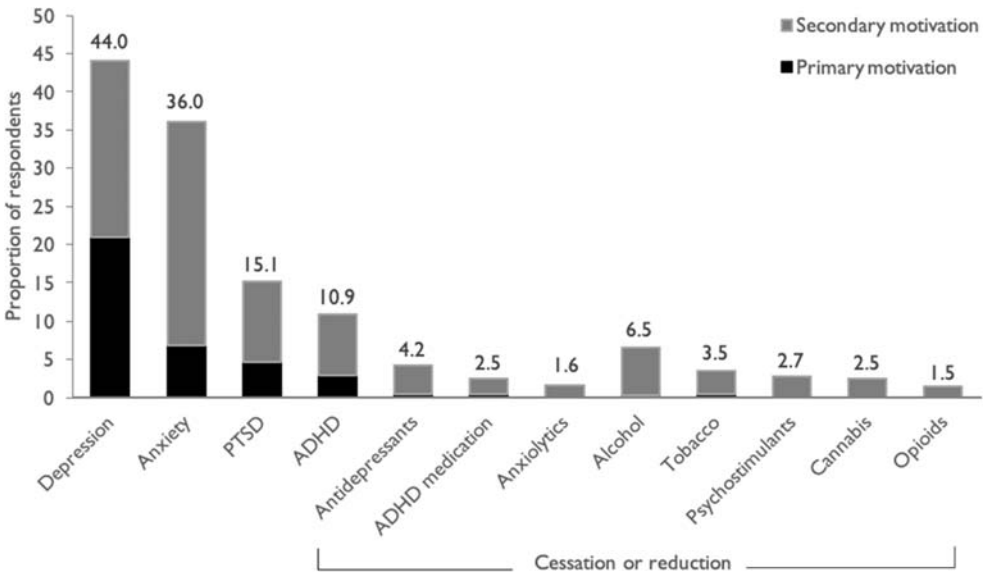

Fig. 1 Primary and secondary motivations for microdosing related to self-managed or alternative therapies for mental health and cessation or reduction of psychiatric medications and alcohol and other drug use. ADHD, attention deficit hyperactivity disorder; PTSD, post-traumatic stress disorder

Table 2 Respondents' reported changes in medication use and non-medical substance use since commencing microdosing

	Stopped *n* (%)	Reduced *n* (%)	No change *n* (%)	Increased *n* (%)
Antidepressants (*n* = 239)	121 (50.6)	31 (13.0)	82 (34.3)	5 (2.1)
Other psychiatric medications (*n* = 229)	91 (39.7)	39 (17.0)	95 (41.5)	4 (1.7)
Pain medication (*n* = 444)	122 (27.5)	81 (18.2)	236 (53.2)	5 (1.1)
Tobacco (*n* = 687)	134 (19.5)	187 (27.2)	331 (48.2)	35 (5.1)
Alcohol (*n* = 926)	147 (15.9)	390 (42.1)	369 (39.8)	20 (2.2)
Cannabis (*n* = 880)	60 (6.8)	223 (25.3)	513 (58.3)	84 (9.5)
Caffeine (*n* = 940)	60 (6.4)	260 (27.7)	590 (62.8)	30 (3.2)
Other non-medical drug use (*n* = 647)	93 (14.4)	191 (29.5)	338 (52.2)	25 (3.9)

For each substance above, denominators are respondents who did not respond "not applicable" for that substance and who reported having ever used it

reported that it was somewhat worse, and two respondents (0.2%) reported that their mental health was much worse due to microdosing.

In a multivariate analysis, compared with all other respondents, respondents who perceived that their mental health was much better due to microdosing were more likely to be female, had lower levels of education (compared to a university degree), had microdosed for a longer duration, were motivated to microdose for depression, substance use cessation or reduction, or other mental health issues (excluding anxiety), had used a full dose of psychedelics for "therapeutic" purposes in the past 12 months, and had a higher sense of coherence score (SOC-13 scale) (Table 3). Respondents who perceived that their mental health was much better due to microdosing were also less likely to have stopped microdosing, and less likely to have moderately severe or severe symptoms of depression (PHQ-9), and moderate symptoms of anxiety (GAD-7).

Perceived helpfulness of microdosing and conventional mental health therapies

Figure 2 shows respondents' ratings of how helpful they found microdosing for mental health and conventional mental health therapies, among those who reported experience of each therapy. Among those who had microdosed primarily as a self-managed therapy for mental health, 89.2% rated it as helpful and 1.7% as unhelpful. Among those who had ever attended counselling or psychotherapy, 64.8% rated it as helpful and 18.4% as unhelpful. For prescribed psychiatric medications, 35.5% of respondents rated antidepressants as helpful and 53.9% as unhelpful, while 53.1% rated prescribed anxiolytic medications as helpful and 34.5% as unhelpful (Fig. 2).

Discussion

In this online survey examining subjective experiences of microdosing psychedelics, almost 40% of respondents reported that improving their mental health was their main reason for microdosing. Microdosing was perceived by most respondents (79%) as having a beneficial effect on mental health, and many respondents reported having ceased psychiatric medications since commencing microdosing. Only a minority of respondents were microdosing to stop or reduce alcohol and other drug use, despite rates of prior engagement with alcohol and other drug treatment approximately twice as high as typically reported in the general population in English speaking countries (Grant et al. 2016; Roxburgh et al. 2016). Despite this, many respondents reported reduction or cessation of alcohol and other drug use since commencing microdosing.

Contrary to much of the media coverage on microdosing espousing its popularity as a tool to enhance focus, productivity and creativity, cognitive enhancement was the primary motivation for microdosing among less than one in six of our respondents. However, cognitive deficits are commonly reported among people with mental disorders (Castaneda et al. 2008; McDermott and Ebmeier 2009; Mowinckel et al. 2015), which may have partly contributed to why almost half of respondents reported cognitive enhancement as a secondary motivation for microdosing.

Most of those microdosing for mental health had been diagnosed with a mental disorder, had received counselling and been prescribed psychiatric medications, many over 12 months ago which suggests longer-term engagement with mental health services. The high levels of dissatisfaction with antidepressants and other medications reported by respondents, and moderate levels of satisfaction with psychotherapy suggest that these treatments have not been optimally effective for these respondents. In addition, among respondents prescribed psychiatric medication, half reported stopping antidepressants and over a third stopped other psychiatric medications since commencing microdosing, which suggests that microdosing was being used by many as a replacement therapy. As most people currently microdosing reported that they had not discussed microdosing with their doctor, it appears

Table 3 Sociodemographic and other characteristics associated with perceived improvements in mental health from microdosing

	Perceive mental health "much better"		Bivariate	Multivariate
	No (Ref.) ($n = 621$, 56.4%) n (%)	Yes ($n = 481$, 43.4%) n (%)	OR (95% CI)	AOR (95% CI)
Age (M, SD)	33.0 (13.2)	32.3 (10.5)	0.99 (0.98, 1.00)	
Gender				
Male	475 (58.9)	331 (41.1)	1.00	1.00
Female	136 (49.8)	137 (50.2)	1.34 (1.10, 1.90)**	1.42 (1.02, 1.96)*
Non-binary/other identity	10 (43.5)	13 (56.5)	1.87 (0.81, 4.31)	1.93 (0.77, 4.87)
Completed education				
University degree	338 (59.4)	231 (40.6)	1.00	1.00
Trade certificate/diploma	76 (44.4)	95 (55.6)	1.83 (1.30, 2.58)**	1.93 (1.32, 2.84)**
Up to high school	207 (57.2)	155 (42.8)	1.10 (0.84, 1.43)	1.57 (1.16, 2.14)**
Employment				
Full-time	281 (53.5)	244 (46.5)	1.00	1.00
Part-time/casual	99 (55.3)	80 (44.7)	0.93 (0.66, 1.31)	0.73 (0.49, 1.07)
Student	131 (65.8)	68 (34.2)	0.60 (0.43, 0.84)**	0.72 (0.49, 1.05)
Unemployed/other	55.3	44.7	0.93 (0.67, 1.29)	0.75 (0.51, 1.09)
Place of residence				
North America	296 (53.1)	261 (46.9)	1.00	1.00
Europe	270 (62.4)	163 (37.6)	0.68 (0.53, 0.88)**	0.94 (0.70, 1.27)
Other location	55 (49.1)	57 (50.9)	1.18 (0.78, 1.76)	1.46 (0.93, 2.31)
Microdosing status				
Currently microdosing	184 (46.5)	212 (53.5)	1.00	1.00
Taking a break	229 (56.0)	180 (44.0)	0.68 (0.52, 0.90)**	0.84 (0.62, 1.15)
Stopped microdosing	208 (70.0)	89 (30.0)	0.37 (0.27, 0.51)***	0.50 (0.35, 0.73)***
Microdosed substance				
Psilocybin	287 (56.2)	224 (43.8)	1.00	
LSD/1P-LSD	288 (58.1)	208 (41.9)	0.93 (0.72, 1.19)	
Other psychedelic or more than one substance	46 (48.4)	49 (51.6)	1.36 (0.88, 2.12)	
Microdosing total duration				
Up to 1 month	250 (69.4)	110 (30.6)	1.00	1.00
1–6 months	280 (55.4)	223 (44.6)	1.83 (1.37, 2.43)***	1.47 (1.07, 2.02)*
More than 6 months	91 (38.4)	146 (61.6)	3.65 (2.58, 5.15)***	2.88 (1.94, 4.27)***
Primary microdosing motivation				
Depression	110 (46.8)	125 (53.2)	1.63 (1.22, 2.18)**	1.75 (1.23, 2.49)**
Anxiety	39 (51.3)	37 (48.7)	1.24 (0.78, 1.98)	
Other mental health	39 (39.8)	59 (60.2)	2.09 (1.37, 3.19)**	2.08 (1.26, 3.42)**
Substance use cessation/reduction	4 (21.1)	15 (78.9)	4.97 (1.64, 15.06)***	5.93 (1.79, 19.62)**
Physical health concern	11 (57.9)	8 (42.1)	0.94 (0.37, 2.35)	
Personal development/wellbeing	183 (56.0)	144 (44.0)	1.02 (0.79, 1.33)	
Cognitive enhancement	110 (64.7)	60 (35.3)	0.66 (0.47, 0.93)*	0.83 (0.56, 1.23)
Regular psychedelic dose for therapeutic purposes in past 12 months				
No	259 (64.8)	141 (35.2)	1.00	1.00
Yes	362 (51.6)	340 (48.4)	1.73 (1.34, 2.22)***	1.58 (1.19, 2.09)**
Mental health diagnosis				
Never	302 (63.3)	175 (36.7)	1.00	1.00
Over 12 months ago	229 (50.0)	229 (50.0)	1.73 (1.33, 2.24)***	1.23 (0.85, 1.80)
In past 12 months	90 (53.9)	77 (46.1)	1.48 (1.03, 2.11)*	1.51 (0.91, 2.49)
Prescribed psychiatric medications				
Never	391 (62.9)	231 (37.1)	1.00	1.00
Over 12 months ago	132 (44.6)	164 (55.4)	2.10 (1.59, 2.79)***	1.48 (0.99, 2.21)
In past 12 months	98 (53.3)	86 (46.7)	1.49 (1.07, 2.07)*	1.22 (0.76, 1.99)
Counselling/psychotherapy				
Never	245 (62.7)	146 (37.3)	1.00	1.00
Over 12 months ago	209 (49.9)	210 (51.1)	1.69 (1.27, 2.23)***	1.21 (0.85, 1.72)
In past 12 months	167 (57.2)	125 (42.8)	1.26 (0.92, 1.71)	0.88 (0.57, 1.33)
Substance use treatment				
Never	540 (57.2)	404 (42.8)	1.00	1.00
Over 12 months ago	54 (46.2)	63 (53.8)	1.56 (1.06, 2.29)*	0.99 (0.63, 1.57)
In past 12 months	27 (65.9)	14 (34.1)	0.69 (0.36, 1.34)	0.76 (0.36, 1.59)
PHQ-9 depression score				
Minimal	328 (53.2)	289 (46.8)	1.00	1.00
Mild	166 (56.8)	126 (43.2)	0.86 (0.65, 1.14)	0.94 (0.67, 1.33)
Moderate	63 (62.4)	38 (37.6)	0.68 (0.44, 1.06)	0.67 (0.38, 1.18)
Moderately severe/severe	64 (69.6)	28 (30.4)	0.50 (0.31, 0.80)**	0.42 (0.20, 0.86)*
GAD-7 anxiety score				
Minimal	371 (54.0)	316 (46.0)	1.00	1.00
Mild	158 (57.2)	118 (42.8)	0.88 (0.66, 1.16)	0.95 (0.67, 1.36)
Moderate	67 (76.1)	21 (23.9)	0.37 (0.22, 0.61)***	0.49 (0.26, 0.95)*
Severe	25 (49.0)	26 (51.0)	1.22 (0.69, 2.16)	1.94 (0.86, 4.37)
SOC-13 score (M, SD)	53.5 (7.0)	55.1 (7.3)	1.03 (1.01, 1.05)***	1.03 (1.01, 1.05)*

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

GAD-7, generalized anxiety disorder 7-item scale; *PHQ-9*, patient health questionnaire; *SOC-13*, sense of coherence 13-item scale

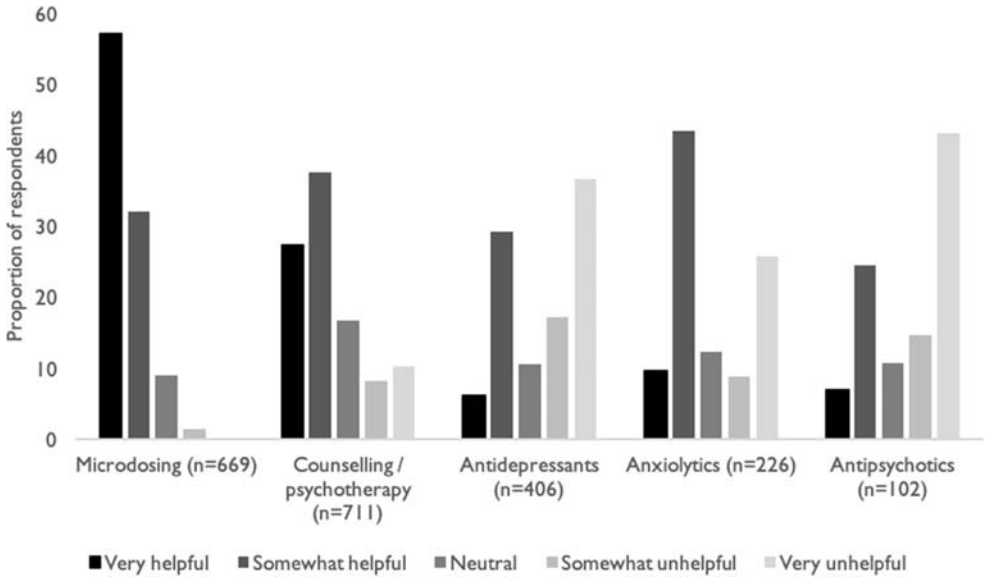

Fig. 2 Perceived helpfulness of microdosing and conventional treatments for mental health, among respondents who had used these therapies

that most of these respondents ceased psychiatric medications without clinical support. This is not unusual, and a recent UK mental health survey found that 45% of participants had ceased antidepressants without consulting their prescribing doctor (Read et al. 2019).

Respondents microdosing with psilocybin rather than LSD were more likely to be motivated to microdose to improve their mental health, which may be due to exposure to media coverage about the findings of recent clinical trials of psilocybin at standard doses for depression and anxiety (Carhart-Harris et al. 2018; Griffiths et al. 2016; Ross et al. 2016), as well as possible perceived differences in the subjective effects of psilocybin and LSD, which would be worth investigating in controlled studies (Nichols 2016). Respondents who had been microdosing for a longer duration were also more likely to be motivated to microdose for mental health. This may suggest that microdosing is working for these people, and that they are continuing to microdose as an ongoing therapy to replace or supplement psychiatric medications, some with the knowledge of their doctor and/or psychotherapist.

As trials of psychedelic-assisted therapy with medium to large doses have shown promising results for various mental disorders, clinical trials are needed to determine whether microdosing is an effective therapy, and some are currently underway (e.g., MindMed, http://www.mindmed.co). One of the purported benefits of standard psychedelic doses for mental health treatments, and likewise for MDMA, is that these are not ongoing therapies akin to antidepressants and other psychiatric medications (Sessa 2018). Rather, psychedelics are provided within a psychotherapy program on typically 1–4 occasions including pre-psychedelic preparation sessions and post-psychedelic integration sessions (Reiche et al. 2018). Microdosing, on the other hand, if found to be effective, may be more beneficial as an ongoing, intermittently administered therapy, but clinical research is needed to determine both whether microdosing has a place in psychiatric treatment and if so, how it can be optimally delivered. Future comparative studies using different microdoses of psychedelics versus stimulants could also determine if reported mood enhancement from microdosing is due to the stimulant effects of psychedelics, enhanced neuroplasticity (Korpi et al. 2015) or psychoplasticity—described as a selective modulation of neural circuits (Olson 2018).

Most respondents had used psychedelics at higher doses for self-treatment in the 12 months preceding the survey. This could confound the mental health benefits that respondents attributed to microdosing, as recent clinical research has shown promising results using standard doses of psychedelics in the treatment of mental disorders (Carhart-Harris et al. 2018; Gasser et al. 2014; Griffiths et al. 2016; Palhano-Fontes et al. 2019; Reiche et al. 2018). This has implications for clinical research on microdosing in the recruitment of a sample willing to microdose without prior experience of using psychedelics at higher doses. It is possible that for many people without psychedelic experience, microdosing psychedelics may be unappealing or associated with trepidation about possible unwanted psychological effects such as anxiety or impaired judgement (Nichols 2016). However, as psychedelic-assisted therapy continues to attract media attention, increasing numbers of people who are dissatisfied with conventional mental health treatments may consider psychedelics as self-managed interventions.

The prevalence of microdosing in the general population cannot currently be estimated, and national population surveys about substance use and mental health could consider including questions about psychedelic use for therapy or enhancement to monitor and report trends in these practices. It would be beneficial to do this promptly given the rapid growth

in psychedelic clinical research and associated media coverage.

Due to the small number of respondents who reported substance use cessation or reduction as a microdosing motivation, we cannot make confident inferences about the potential role of microdosing as novel treatments for alcohol and other substance use disorders, and we did not use standardised measures to assess the presence and severity of substance use disorders. Instead, microdosing for substance use cessation or reduction was taken as an indicator that respondents considered their substance use to be in need of intervention. The results support the findings of other research that has reported reductions in alcohol, tobacco and other drugs that study participants attributed to microdosing (Anderson et al. 2019a), as well as research that showed higher self-reported effectiveness of microdosing for the management of substance use disorders compared with conventional treatments, but no difference between microdosing and higher psychedelic doses (Hutten et al. 2019b). Given that higher psychedelic doses have shown positive results for alcohol and tobacco cessation (Bogenschutz et al. 2015; Johnson et al. 2014; Krebs and Johansen 2012), and ibogaine is being investigated as a treatment for opioid dependence (Argento et al. 2019), it would be worth investigating microdosing as potential novel therapies for some substance use disorders.

The primary limitation of this study is that we cannot determine whether the mental health improvements that most respondents reported having experienced from microdosing were actually due to microdosing, and not due to a placebo effect/meaning response (Hutchinson and Moerman 2018), reductions in alcohol and other drug use, other lifestyle changes (e.g., diet, exercise), the use of full psychedelic doses, or a combination of these factors. In addition, we recruited a sample that was relatively well-engaged with online psychedelic communities and most had used psychedelics before, so it is possible that they were a motivated group who were enthusiastic about microdosing and as such our findings may be biased towards beneficial effects. Planned follow-up will determine whether reported benefits are sustained, and which baseline characteristics are associated with longer-term improvements in mental health, using standardised measures of depression and anxiety. These findings, building on previous microdosing research, do suggest that microdosing may play a role in improving mental health (Anderson et al. 2019a; Fadiman and Korb 2019; Hutten et al. 2019a; Kuypers et al. 2019; Lea et al. 2019; Politi and Stevenson 2019), but the results of double-blind, randomised controlled trials are needed to determine this more conclusively.

Mental and substance use disorders are the leading cause of years lost to disability globally (Whiteford et al. 2013), and according to the World Health Organization (2017) depression is the leading cause of ill health internationally. Psychedelics could represent important new therapies in the management of mental and substance use disorders, particularly for conditions that do not respond well to current treatments, including severe depression and anxiety, PTSD and substance dependence (Nichols 2016). Whether the same can be said for microdosing is yet to be determined, although it is clear that many people microdosing perceive that it has been beneficial to their mental health and wellbeing. While we await the findings of clinical trials, which could take some years, people will continue to self-manage their health with microdosing. It is therefore important to monitor people's microdosing practices and experiences in the long term in order to provide appropriate harm reduction resources and other support.

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References

Anderson T, Petranker R, Christopher A, Rosenbaum D, Weissman C, Dinh-Williams L-A, Hui K, Hapke E (2019a) Psychedelic microdosing benefits and challenges: an empirical codebook. Harm Reduct J 16:43

Anderson T, Petranker R, Rosenbaum D, Weissman CR, Dinh-Williams L-A, Hui K, Hapke E, Farb NA (2019b) Microdosing psychedelics: personality, mental health, and creativity differences in microdosers. Psychopharmacology 236:731–740

Antonovsky A (1993) The structure and properties of the sense of coherence scale. Soc Sci Med 36:725–733

Argento E, Tupper KW, Socias ME (2019) The tripping point: the potential role of psychedelic-assisted therapy in the response to the opioid crisis. Int J Drug Policy 66:80–81

Bershad AK, Schepers ST, Bremmer MP, Lee R, de Wit H (2019) Acute subjective and behavioral effects of microdoses of LSD in healthy human volunteers. Biol Psychiatry 86:792–800

Bogenschutz MP, Forcehimes AA, Pommy JA, Wilcox CE, Barbosa P, Strassman RJ (2015) Psilocybin-assisted treatment for alcohol dependence: a proof-of-concept study. J Psychopharmacol 29:289–299

Carhart-Harris R, Bolstridge M, Day C, Rucker J, Watts R, Erritzoe D, Kaelen M, Giribaldi B, Bloomfield M, Pilling S (2018) Psilocybin with psychological support for treatment-resistant depression: six-month follow-up. Psychopharmacology 235:399–408

Castaneda AE, Tuulio-Henriksson A, Marttunen M, Suvisaari J, Lönnqvist J (2008) A review on cognitive impairments in depressive and anxiety disorders with a focus on young adults. J Affect Disord 106:1–27

Cipriani A, Furukawa TA, Salanti G, Chaimani A, Atkinson LZ, Ogawa Y, Leucht S, Ruhe HG, Turner EH, Higgins JP (2018) Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network meta-analysis. Lancet 391:1357–1366

Conway CR, George MS, Sackeim HA (2017) Toward an evidence-based, operational definition of treatment-resistant depression: when enough is enough. JAMA Psychiat 74:9–10

Dean J (2017) Micro-dosing: the drug habit your boss is gonna love. GQ January 4. Available via https://www.gq.com/story/micro-dosing-lsd

Fadiman J (2011) The psychedelic explorer's guide: safe, therapeutic, and sacred journeys. Park Street Press, Rochester

Fadiman J, Korb S (2019) Might microdosing psychedelics be safe and beneficial? An initial exploration. J Psychoactive Drugs 51:118–122

Gasser P, Holstein D, Michel Y, Doblin R, Yazar-Klosinski B, Passie T, Brenneisen R (2014) Safety and efficacy of lysergic acid diethylamide-assisted psychotherapy for anxiety associated with life-threatening diseases. J Nerv Ment Dis 202:513–520

Glatter R (2015) LSD microdosing: the new job enhancer in Silicon Valley and beyond? Forbes November 27. Available via https://www.forbes.com/sites/robertglatter/2015/11/27/lsd-microdosing-the-new-job-enhancer-in-silicon-valley-and-beyond/#1261fba7188a

Grant BF, Saha TD, Ruan WJ, Goldstein RB, Chou SP, Jung J, Zhang H, Smith SM, Pickering RP, Huang B (2016) Epidemiology of DSM-5 drug use disorder: results from the National Epidemiologic Survey on Alcohol and Related Conditions–III. JAMA Psychiat 73:39–47

Griffiths RR, Johnson MW, Carducci MA, Umbricht A, Richards WA, Richards BD, Cosimano MP, Klinedinst MA (2016) Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. J Psychopharmacol 30:1181–1197

Hoskins M, Pearce J, Bethell A, Dankova L, Barbui C, Tol WA, Van Ommeren M, De Jong J, Seedat S, Chen H (2015) Pharmacotherapy for post-traumatic stress disorder: systematic review and meta-analysis. Br J Psychiatry 206:93–100

Hupli A, Berning M, Zhuparris A, Fadiman J (2019) Descriptive assemblage of psychedelic microdosing: netnographic study of Youtube™ videos and on-going research projects. Perform Enhanc Health 6:129–138

Hutchinson P, Moerman DE (2018) The meaning response, "placebo," and methods. Perspect Biol Med 61:361–378

Hutten NR, Mason NL, Dolder PC, Kuypers KP (2019a) Motives and side-effects of microdosing with psychedelics among users. Int J Neuropsychopharmacol 22:426–434

Hutten NR, Mason NL, Dolder PC, Kuypers KP (2019b) Self-rated effectiveness of microdosing with psychedelics for mental and physical health problems amongst microdosers. Front Psych 10:672

Johnson MW, Garcia-Romeu A, Cosimano MP, Griffiths RR (2014) Pilot study of the 5-HT2AR agonist psilocybin in the treatment of tobacco addiction. J Psychopharmacol 28:983–992

Johnson MW, Garcia-Romeu A, Griffiths RR (2017) Long-term follow-up of psilocybin-facilitated smoking cessation. Am J Drug Alcohol Abuse 43:55–60

Johnstad PG (2018) Powerful substances in tiny amounts: an interview study of psychedelic microdosing. Nordic Stud Alcohol Drugs 35:39–51

Kavenská V, Simonová H (2015) Ayahuasca tourism: participants in shamanic rituals and their personality styles, motivation, benefits and risks. J Psychoactive Drugs 47:351–359

Korpi ER, den Hollander B, Farooq U, Vashchinkina E, Rajkumar R, Nutt DJ, Hyytiae P, Dawe GS (2015) Mechanisms of action and persistent neuroplasticity by drugs of abuse. Pharmacol Rev 67:872–1004

Krebs TS, Johansen P-Ø (2012) Lysergic acid diethylamide (LSD) for alcoholism: meta-analysis of randomized controlled trials. J Psychopharmacol 26:994–1002

Kroenke K, Spitzer RL, Williams JB (2001) The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med 16:606–613

Kuypers KP, Ng L, Erritzoe D, Knudsen GM, Nichols CD, Nichols DE, Soula A, Nutt D (2019) Microdosing psychedelics: more questions than answers? An overview and suggestions for future research. J Psychopharmacol 33:1039–1057

Lea T, Amada N, Jungaberle H (2019) Psychedelic microdosing: a subreddit analysis. J Psychoactive Drugs:Published online 25 November 2019. 2010.1016/j.drugpo.2019.2011.2008

Liechti ME (2019) Psychedelics: what are low doses and 'microdoses'? Commentary on Kuypers et al. (2019). J Psychopharmacol 33:1052–1053

Mason NL, Kuypers KPC (2018) Mental health of a self-selected sample of psychedelic users and self-medication practices with psychedelics. J Psychedelic Stud 2:45–52

McDermott LM, Ebmeier KP (2009) A meta-analysis of depression severity and cognitive function. J Affect Disord 119:1–8

Milward J, Lynskey M, Strang J (2014) Solving the problem of non-attendance in substance abuse services. Drug Alcohol Rev 33:625–636

Mithoefer MC, Feduccia AA, Jerome L, Mithoefer A, Wagner M, Walsh Z, Hamilton S, Yazar-Klosinski B, Emerson A, Doblin R (2019) MDMA-assisted psychotherapy for treatment of PTSD: study design and rationale for phase 3 trials based on pooled analysis of six phase 2 randomized controlled trials. Psychopharmacology 236:2735–2745

Moncrieff J (2018) Against the stream: antidepressants are not antidepressants–an alternative approach to drug action and implications for the use of antidepressants. BJPsych Bull 42:42–44

Mowinckel AM, Pedersen ML, Eilertsen E, Biele G (2015) A meta-analysis of decision-making and attention in adults with ADHD. J Atten Disord 19:355–367

Nichols DE (2016) Psychedelics. Pharmacol Rev 68:264–355

Noorani T (2019) Making psychedelics into medicines: the politics and paradoxes of medicalization. J Psychedelic Stud. https://doi.org/10.1556/2054.2019.1018

Olson DE (2018) Psychoplastogens: a promising class of plasticity-promoting neurotherapeutics. J Exp Neurosci 12:1–4

Palhano-Fontes F, Barreto D, Onias H, Andrade KC, Novaes MM, Pessoa JA, Mota-Rolim SA, Osório FL, Sanches R, dos Santos RG (2019) Rapid antidepressant effects of the psychedelic ayahuasca in treatment-resistant depression: a randomized placebo-controlled trial. Psychol Med 49:655–663

Pampallona S, Bollini P, Tibaldi G, Kupelnick B, Munizza C (2002) Patient adherence in the treatment of depression. Br J Psychiatry 180:104–109

Passie T (2019) The science of microdosing psychedelics. Psychedelic Press, London

Politi V, Stevenson RJ (2019) A systematic study of microdosing psychedelics. PLoS One 14:e0211023

Prochazkova L, Lippelt DP, Colzato LS, Kuchar M, Sjoerds Z, Hommel B (2018) Exploring the effect of microdosing psychedelics on creativity in an open-label natural setting. Psychopharmacology 235:3401–3413

Read J, Gee A, Diggle J, Butler H (2019) Staying on, and coming off, antidepressants: the experiences of 752 UK adults. Addict Behav 88:82–85

Reiche S, Hermle L, Gutwinski S, Jungaberle H, Gasser P, Majić T (2018) Serotonergic hallucinogens in the treatment of anxiety and depression in patients suffering from a life-threatening disease: a systematic review. Prog Neuro-Psychopharmacol Biol Psychiatry 81:1–10

Ross S, Bossis A, Guss J, Agin-Liebes G, Malone T, Cohen B, Mennenga SE, Belser A, Kalliontzi K, Babb J (2016) Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. J Psychopharmacol 30:1165–1180

Roxburgh A, Lea T, de Wit J, Degenhardt L (2016) Sexual identity and prevalence of alcohol and other drug use among Australians in the general population. Int J Drug Policy 28:76–82

Sessa B (2018) The 21st century psychedelic renaissance: heroic steps forward on the back of an elephant. Psychopharmacology 235:551–560

Sessa B, Sakal C, O'Brien S, Nutt D (2019) First study of safety and tolerability of 3, 4-methylenedioxymethamphetamine (MDMA)-assisted psychotherapy in patients with alcohol use disorder: preliminary data on the first four participants. BMJ Case Rep 12: e230109

Spitzer RL, Kroenke K, Williams JB, Löwe B (2006) A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med 166:1092–1097

Waldman A (2017) A really good day: how microdosing made a mega difference in my mood, my marriage, and my life. Alfred A, Knopf

Webb M, Copes H, Hendricks PS (2019) Narrative identity, rationality, and microdosing classic psychedelics. Int J Drug Policy 70:33–39

Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, Charlson FJ, Norman RE, Flaxman AD, Johns N (2013) Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 382:1575–1586

Whiteford HA, Buckingham WJ, Harris MG, Burgess PM, Pirkis JE, Barendregt JJ, Hall WD (2014) Estimating treatment rates for mental disorders in Australia. Aust Health Rev 38:80–85

Williams A (2017) How LSD saved one woman's marriage. New York Times January 7. Available via https://www.nytimes.com/2017/01/07/style/microdosing-lsd-ayelet-waldman-michael-chabon-marriage.html

World Health Organization (2017) Depression and other common mental disorders: global health estimates. WHO, Geneva

Yanakieva S, Polychroni N, Family N, Williams LT, Luke DP, Terhune DB (2019) The effects of microdose LSD on time perception: a randomised, double-blind, placebo-controlled trial. Psychopharmacology 236:1159–1170