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Microdosing Psychedelics: Results from the Global Drug Survey 2019

Petranker, R.[1,2], Anderson, T.[2,3], Maier, L. J.[4,5], Barratt, M. J.[6,7], Ferris, J. A.[8], & Winstock, A. R.[9,10]

[1] *Clinical Psychology, York University, Toronto, ON, Canada*

[2] *Psychedelic Studies Research Program, University of Toronto Mississauga, Mississauga, ON, Canada*

[3] *Department of Psychology, University of Toronto, Toronto, ON, Canada.*

[4] *Department of Psychiatry and Weill Institute for Neurosciences, University of California, San Francisco, CA, United States*

[5] *Early Postdoc Mobility Grantee, Swiss National Science Foundation, Bern, Switzerland*

[6] *Social and Global Studies Centre, RMIT University, Australia*

7 National Drug and Alcohol Research Centre, UNSW Sydney, Australia

[8] *Centre for Health Services Research, Faculty of Medicine, The University of Queensland, Brisbane, Australia*

[9] *University College London, Gower St, Bloomsbury, London, UK*

[10] *Global Drug Survey Ltd, London, UK*

***Corresponding Author**

Rotem Petranker

Toronto, ON, Canada

Email: rotem@boredomlab.org

Abstract

Microdosing psychedelics – the practice of taking small, sub-hallucinogenic amounts of substances like psilocybin-containing mushrooms or LSD – is becoming increasingly popular. Despite its surging popularity, little is known about the effects of this practice. This research had two aims. First, we attempted to replicate previous findings in the literature regarding the subjective benefits and challenges involved in microdosing. Second, we wanted to examine whether people who microdose test their substances for purity before consumption, and whether approach-intention to microdosing was predictive of more reported benefits.

7,313 people who reported microdosing, from a variety of countries, ages, and other demographics participated in our survey. Our results suggest a close replication of previous benefits and challenges to those reported in Anderson et al. (2019). Furthermore, most participants in our survey reported not testing their substances. Lastly, intention to microdose was not a good predictor of benefits, with mixed results for different substances. Our results suggest that while microdosing may be beneficial, a framework explaining how it may work best is still lacking.

Introduction

Recent years have seen a groundswell of interest in psychedelics (Waldman, 2017; Pollan, 2018). Evidence is mounting that large doses of substances such as lysergic acid diethylamide (LSD) and psilocybin-containing "magic" mushrooms can help treat depression (Ross et al., 2016), anxiety (Grob et al., 2011), and substance use (Johnson, Garcia-Romeu, Cosimano, & Griffiths, 2014). The popularity of microdosing – consuming small, sub-hallucinogenic amounts of psychedelics such as LSD and psilocybin – has also been rising in recent years, with online forums such as reddit *r/microdosing* growing exponentially (Anderson, Petranker, Rosenbaum, et al., 2019). Microdosing has been anecdotally proposed as an alternative to antidepressants (Weiss, 2019) as well as a performance-enhancing supplement (Plante, 2017). Despite the growing public interest in this phenomenon, however, research has been slow to follow this cultural trend with only a few studies published, all in the last two years.

Evidence suggests that microdosing may enhance performance in certain domains, with no serious side-effects reported to date. One study, conducted at a popular microdosing conference, found that administering small amounts (1g) of psilocybin-containing truffles acutely improved divergent, but not convergent creativity (Prochazkova et al., 2018). An experimental study using small amounts (1-26μg) of LSD found that a single microdose enhanced feelings of "vigor" and social relatedness (Bershad, Schepers, Bremmer, Lee, & de Wit, 2019). Neither of these intervention studies reported any adverse effects, consistent with the relatively benign safety profile of these substances (Johnson, Griffiths, Hendricks, & Henningfield, 2018; Nutt, King, & Phillips, 2010).

Survey work with large sample sizes has been informative regarding the experiences of people who reported microdosing with LSD or psilocybin, and the research potential associated

with this practice. One survey reported that people who reported microdosing with LSD or psilocybin score low in negative emotionality and dysfunctional attitudes, and higher on wisdom, open-mindedness, and creativity (Anderson et al., 2019). Another survey reported somewhat conflicting results, with people who reported microdosing with LSD or psilocybin experiencing an increase in negative emotionality, but also reduced depression and stress (Polito & Stevenson, 2019). Finally, Anderson et al. (2019) created a taxonomy of the most commonly reported benefits and challenges associated with microdosing. They found that the three most commonly reported benefits were improved mood, improved focus, and increased creativity; the three most commonly reported challenges were concerns about illegality, physiological discomfort, and impaired focus (Anderson et al., 2019). We predicted that these same categories of benefit and challenge would be popular among the large sample collected in the present study.

Due to the concerns around illegality and the many unknowns surrounding microdosing, we were also interested in whether those who report microdosing test their substances. While people who use drugs recreationally are concerned about the content and purity of the substances they use, most of them do not test their substances. For example, Day et al. (2018) found that 52.8% 95% CI [48.3, 57.4] of people who use illicit drugs at an Australian music festival were concerned about the content and purity of their substances, but only 14.3% 95% CI [11.1, 17.5] always test their substances and 37.2% 95% CI [32.8, 41.6] never test their substances. Similarly, a recent study found that only 22.7% 95% CI [19.9, 25.5] of Australian users of hallucinogens and psychostimulants who go to nightclubs/festivals and responded to a substance-testing questionnaire reported using testing kits on their substances (Barratt, Bruno, Ezard, & Ritter, 2018). Accordingly, we hypothesized that most people in our sample would not have tested their substances.

Given the lack of research, we were also interested in intention when microdosing. The relevance of intention when taking psychedelics was recognized by Timothy Leary, who popularized the concept of "Set and Setting" (Pollan, 2018). The use of intention was introduced as one of the main tenets of psychedelic psychotherapy in the first wave of research in the 1960s (Dimascio & Klerman, 1960; Lasagna 1963, as cited in Hartogsohn, 2016) and remains central in current research (Carhart-Harris et al., 2018). No empirical work has investigated whether there is a relationship between intention and the reported benefits of microdosing. Some theories suggest that for full-dose psychedelic experiences, approaching the experience with the intention of engaging rather than circumventing or avoiding the experience improves the outcome of psychedelic experiences (Fadiman, 2011; Zendo, 2017). These theories echo Reinforcement Sensitivity Theory (RST), which includes the Behavioral Approach System (BAS) and the Behavioral Inhibition System (BIS; Gray, 1982). According to RST, some individuals are characterized by sensitivity to rewarding stimuli (high BAS) while others are sensitive to aversive stimuli (high BIS). While we were unable to directly measure approach/avoidance motivation in the present study, we measured initial intention to microdose, indexing these intentions with an a priori approach vs avoid motivation dichotomy. We hypothesized that an approach-motivation would predict more positive experiences, a pattern suggested by Fadiman (2011).

Hypotheses

The present study had three main aims. First, we aimed to validate our previous findings on perceived benefits and challenges of microdosing with LSD and psilocybin in a larger, international sample (H1 & H2). Second, we wanted to assess whether people who microdose test their substances prior to use when purchasing the substances from the black market (H3).

Third, this study tested the theory that specific intentions towards microdosing could be predictive of deriving more benefit from this practice; specifically, that an approach-motivation would be related to more subjective microdosing-related benefits than an avoidance-motivation (H4). In line with these three aims, four hypotheses were pre-registered on the Open Science Framework (OSF; https://osf.io/vp4nw/).

H1: The three most common benefits of microdosing will be improved mood, improved focus, and increased creativity.

H2: The three most common challenges of microdosing will be concerns about illegality, physiological discomfort, and impaired focus.

H3: The majority of participants who microdose will not have tested the substance they used to microdose.

H4: Participants who report an approach-motivation will report significantly more benefits than participants who report an avoidance-motivation.

Methods

Pre-Registration.

Prior to data collection, the methods and hypotheses reported here were pre-registered on the Open Science Framework (OSF; https://osf.io/vp4nw/). We define microdosers as participants with experience microdosing, whether current or in the past 12 months. The data reported here concerns respondents from the 2019 Global Drug Survey who reported microdosing in the last 12 months.

Study design and recruitment

The Global Drug Survey (GDS) is the world's largest anonymous online drug survey, which has been conducted annually since 2012 (Barratt et al., 2017). GDS2019 was available in 19 languages (English, Albanian, Azerbaijani, Brazil, Czech, Danish, Dutch, Finnish, French,

German, Hungarian, Italian, Lithuanian, Portuguese, Romanian, Serbian, Slovak, Spanish, and Turkish) and was promoted through partnerships with media partners, harm reduction organizations, and via social media. As a self-nominating sample, our population represents a non-probability sample and should not be used to infer the prevalence of drug use and related activities to the general public. Ethical approval for GDS2019 was obtained from the University College London (11671/001), University of Queensland (No: 2017001452) and from the University of New South Wales (HREC HC17769) Research Ethics Committees. GDS surveys are labelled by the year that the data was analysed and released. GDS2019 launched online on October 24, 2018 and ran for nine weeks until December 30, 2018.

Measures

The GDS starts with demographics questions, followed by an extensive drug screen (100+ drugs) where participants indicate when they last used specific drugs (never, more than 12 months ago, within the last 12 months but not last month, or within the last 30 days). Participants who indicated the use of either LSD or psilocybin-containing mushrooms during the last 12 months were then offered the opportunity to complete an in-depth section including questions specifically about their experience of microdosing with either substance using a previously compiled list of possible benefits and challenges (Anderson et al. 2019).

Microdosing Benefits.

The benefits and challenges questions used in this survey were based on our empirically derived taxonomy (Anderson et al., 2019, see Table 1). We asked participants to indicate which benefits from the following list applied to their experience of microdosing (missing values were excluded from the analysis): (1) Enhanced mood, reduced depression symptoms; (2) Enhanced focus; (3) Enhanced creativity and/or curiosity; (4) Enhanced productivity, motivation, or

confidence; (5) Enhanced energy and/or alertness; (6) Enhanced empathy, sociability or communication skills; (7) Enhanced mental clarity and/or memory; (8) Enhanced sight, smell, hearing, athletic performance or sleep; (9) Reduced stress; (10) Reduced anxiety, including social anxiety; (11) Reduced substance dependence symptoms; (12) None; I experienced no effect at all or negative effect.

Table 1
GDS 2019 Benefits and Challenges questions based on empirical taxonomy from Anderson et al. (2019).

Category	**Anderson et al (2019)**	**GDS Question**
Creativity	Creativity	Enhanced creativity and/or curiosity
Illegality	Illegality	Legal consequences
Mood	Improved Mood	Enhanced mood, reduced depression symptoms
Mood	Impaired Mood	Negative mood, irritability or instability
Self	Self-Efficacy	Enhanced productivity, motivation, or confidence
Self	Self-Interference	Dissociation and/or rumination
Focus	Improved Focus	Enhanced focus
Focus	Impaired Focus	Reduced Focus
Social	Social Benefits	Enhanced empathy, sociability or communication skills
Social	Social Interference	Social Problems
Energy	Improved Energy	Enhanced energy and/or alertness
Energy	Impaired Energy	Restlessness and/or fatigue
Cognitive	Cognitive Benefits	Enhanced mental clarity and/or memory
Cognitive	Cognitive Interference	Mental confusion, memory problems, or racing thoughts
Anxiety	Reduced Anxiety	Reduced anxiety, including social anxiety
Anxiety	Increased Anxiety	Increased anxiety, including social anxiety

Symptoms	Reduced Symptoms	Reduced substance dependence symptoms
Symptoms	Increased Symptoms	Substance dependence symptoms and hard comedown
Other	Other Benefits	Reduced stress
Other	Other Challenges	Unpredictable effects and/or negative drug interactions
Physiological	Physiological Enhancement	Enhanced sight, smell, hearing, athletic performance or sleep
Physiological	Physiological Discomfort	Stomach pain, headache, sleep problems, loss of appetite
None	None (Benefit)	None; I experienced no effect at all or negative effect
None	None (Challenge)	None, I experienced no side effects

Microdosing Challenges.

We asked participants to indicate which challenges from the following list (see Table 1) applied to their experience of microdosing (missing values were excluded from the analysis): (1) Negative mood, irritability or instability; (2) Reduced focus; (3) Legal consequences; (4) Restlessness and/or fatigue; (5) Social problems; (6) Mental confusion, memory problems, or racing thoughts; (7) Stomach pain, headache, sleep problems, loss of appetite; (8) Dissociation and/or rumination; (9) Increased anxiety, including social anxiety; (10) Substance dependence symptoms and hard comedown; (11) Unpredictable effects and/or negative drug interactions (12) None; I experienced no side effects.

Drug Checking.

Participants were asked “Did you usually analyse the substance used to microdose with?” and could use the following 5 responses: 1) “Yes, and it was the substance I expected to use”, 2)

"Yes, but it was a different substance than I expected, but I still microdosed", 3) "No, but I tried a full-dose of the same batch beforehand and it seemed to be the substance I expected", 4) "No, but I bought from a source I consider reliable", 5) "No, and I cannot be sure". Responses 1–2 were treated as testing substances and responses 3–5 were treated as not testing substances.

The relevance of intention to reported benefits.

To measure initial intention, participants were asked to pick one of the following reasons for initiation of microdosing: (1) to enhance creativity and/or ingenuity; (2) to improve mood and/or overall life satisfaction; (3) to avoid boredom; (4) to escape negative feelings, e.g. depression, anxiety; (5) to improve my relationships with myself and/or others in my life; (6) to get away from bad habits and unhealthy behaviours; (7) to be more productive and effective; (8) to treat ADHD symptoms; (9) just curious; (10) to stop problematic substance use; (11) I don't know / I didn't have a particular reason.

We indexed intentions as either approach- or avoidance-motivated. Responses 1, 2, 5, 7, and 9 were considered approach-motivated intentions and responses 3, 4, 6, 8, and 10 were considered avoidance-motivated intentions; option 11 was not coded in either direction. Benefits were calculated as a sum of benefits reported in the "benefits and challenges" section.

Microdosing and Anxiety Disorder - Exploratory analyses.

Our previous work showed that microdosers were less likely to have been diagnosed with an anxiety disorder (Rosenbaum, et al. under review). Having only analyzed these results after pre-registering the analysis plan for this paper this hypothesis was not pre-registered and should be treated as exploratory. We asked participants "Which illnesses have you ever been diagnosed with?" Possible responses were "Depression", "Anxiety", "Bipolar", "Psychosis", "ADHD", "Post-traumatic stress disorder (PTSD)", and "Other, please specify".

E1: Microdoser status will predict lower probability of anxiety disorder diagnoses.

Results

Sample characteristics

Unique responses from 123,814 participants in 215 countries and territories were recorded in the Global Drug Survey (GDS) 2019, Most participants were from Germany (N = 35,038), the USA (N = 11,247), Australia (N = 7,864), Denmark (N = 7,738), or England (N = 6,586). Out of this larger sample, 4,783 report having microdosed LSD in the last 12 months (74% male; median age = 23, SD = 8.43), 2,832 participants report having microdosed psilocybin-containing "magic" mushrooms (MM) in the last 12 months (71% male; median age = 26, SD = 9.66), and 862 participants reported microdosing both in the last 12 months (73% male; median age = 26). Microdosing was defined as less than 20 micrograms of LSD and less than 0.2 grams of MM. Most people who reported microdosing were from the USA (LSD: N = 997, MM: N = 732) or Germany (LSD: N = 843, MM: N = 397).

Most Commonly Reported Benefits and Challenges

Microdosing Benefits.

In partial support of H1, the two most commonly reported benefits of microdosing with LSD and MM were improved mood (LSD: 51.23%, 95% CI: [49.81%, 52.64%]; MM: 56.84%, 95% CI: [55%, 58.66%]) and creativity (LSD: 46.61%, 95% CI: [45.2%, 48.03%]; MM: 49.29%, 95% CI: [47.45%, 51.14%]). Counter to H1, the third most commonly reported benefit for LSD was increased energy (44.54%, 95% CI [43.13%, 45.95%], and the third most commonly reported benefit for MM was social benefits (41.03%, 95% CI: [39.23%, 42.86%]). Counter to H1, improved focus was not in the top three; it was the 6th most commonly reported benefit

among participants who microdosed with LSD (39.33%, 95% CI: [37.55%, 41.15%]), and the 9th most commonly reported benefit for the MM group (30.01%, 95% CI: [28.35%, 31.73%]).

See Table 1 for reported benefits of microdosing with LSD and MM:

Table 2
Microdosing benefits by substance: Count and Percent (%)

Benefit	LSD (%)	MM (%)
Enhanced mood, reduced depression symptoms	2443 (79.81)	1604 (56.84)
Enhanced creativity & curiosity	2223 (72.62)	1391 (49.29)
Enhanced energy & alertness	2124 (69.39)	1110 (39.33)
Enhanced empathy, sociability or communication skills	1797 (58.71)	1158 (41.03)
Enhanced productivity, motivation, or confidence	1706 (55.73)	955 (33.84)
Enhanced focus	1561 (51.00)	847 (30.00)
Reduced stress	1475 (48.19)	1079 (39.23)
Reduced (social) anxiety	1443 (47.14)	937 (33.20)
Enhanced mental clarity & memory	1374 (44.89)	825 (29.23)
Enhanced sight, smell, hearing, athletic performance, or sleep	1260 (41.16)	879 (31.15)
Reduced substance dependence symptoms	566 (18.49)	414 (14.67)
None, I experienced no effect at all or negative effect	194 (6.34)	153 (5.42)
Total N = 5883	N = 3061	N = 2822

Note. Participants were able to select more than one option, such that total number of reports amounts to more than the number of participants.

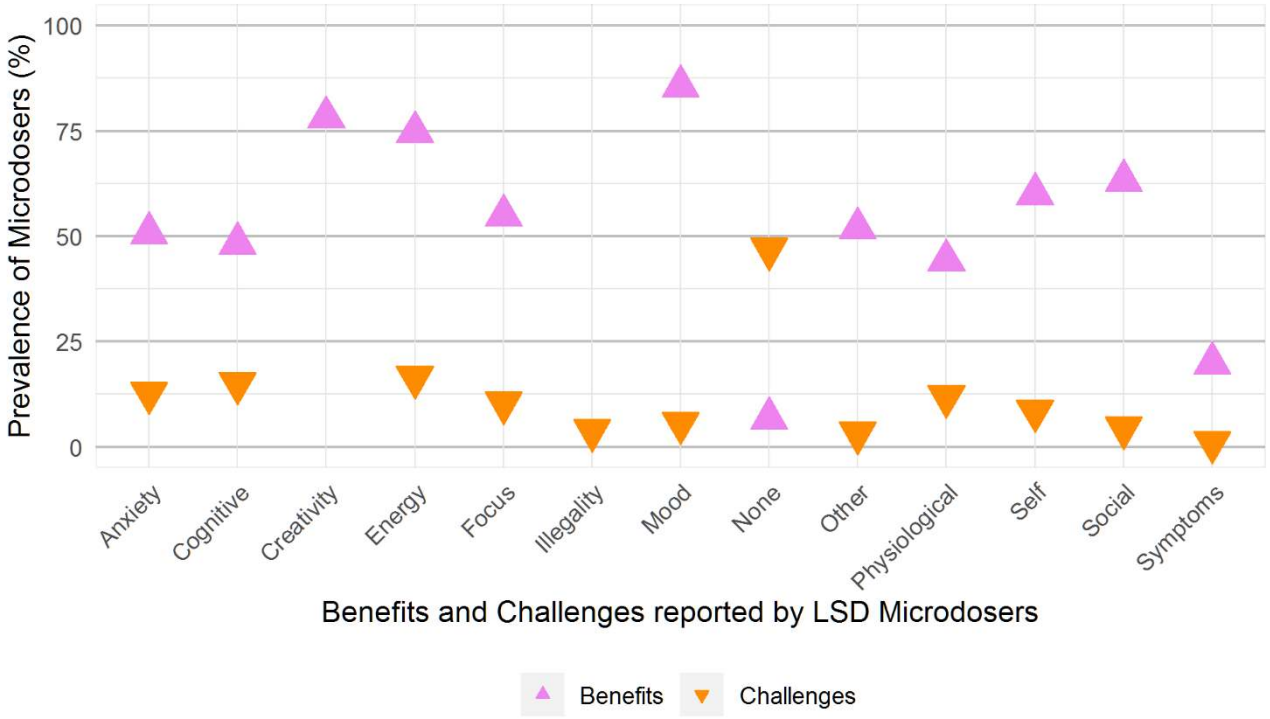

Figure 2. Percent of LSD microdosers reporting benefits and challenges of microdosing by category. Note that microdosers could select more than one benefit or challenge thus percentages add to over 100%.

Figure 1. Percent of psilocybin "magic mushroom" microdosers reporting benefits and challenges of microdosing by category. Note that microdosers could select more than one benefit or challenge thus percentages add to over 100%.

Microdosing Challenges.

Counter to H2, the most commonly reported challenge for both substances was not illegality: it was "none, I experienced no side effects" (for LSD, 29.92%, 95% CI: [28.64, 31.24]; for MM: 37.53%, 95% CI: [35.76%, 39.33%]). We subsequently detail the next most commonly reported challenges after "none" below. For LSD, the next three most commonly reported challenges were restlessness or fatigue (impaired energy: 10.59%, 95% CI: [9.75, 11.49]), mental confusion, memory problems, or racing thoughts (cognitive interference: 9.69%, 95% CI: [8.88, 10.56]), and impaired focus (8.87%, 95% CI: [8.10, 9.71]), which does not support H2. For MM, the next three most commonly reported challenges were physiological discomfort (10.21%, 95% CI: [9.14%, 11.38%]), impaired focus (7.97%, 95% CI: [7.03%, 9.03%]), and impaired energy (7.97%, 99% CI: [7.03%, 9.03%]), the first two of which partially support H2.

Counter to H2, illegality was not in the top three; it was the 10th most commonly reported challenge in the LSD group (2.43%, 95% CI [2.03%, 2.91%]), and the 9th most commonly reported challenge for the MM group (1.64%, 95% CI [1.31%, 2.04%]. In the LSD group, physiological discomfort was the 6th most commonly reported challenge. See Table 2 for reported challenges for LSD and MM.

Table 3
Perceived challenges from microdosing by substance

Challenge	LSD (%)	MM (%)
None, I experienced no side effects	1396 (46.91)	1034 (53.44)
Restlessness and/or fatigue	491 (16.50)	216 (11.16)
Mental confusion, memory problems, or racing thoughts	449 (15.09)	211 (10.90)
Increased anxiety, including social anxiety	379 (12.74)	188 (9.72)

Stomach pain, headache, sleep problems, loss of appetite	356 (11.96)	284 (14.68)
Reduced Focus	311 (10.45)	216 (11.16)
Dissociation or rumination	254 (8.53)	128 (6.61)
Negative mood, irritability or instability	167 (5.61)	82 (4.24)
Social Problems	133 (4.47)	57 (2.95)
Legal Consequences	116 (3.90)	78 (4.03)
Unpredictable effects and/or negative drug interactions	97 (3.26)	75 (3.88)
Substance dependence symptoms and hard comedown	32 (1.08)	15 (0.78)
N = 4911	N = 2976	N = 1935

Note. Participants were able to select more than one option, such that total number of reports amounts to more than the number of participants.

Substance Purity Testing

Supporting H3, less than half of respondents reported testing their substances (LSD: 37.88%, 95% CI: [35.66%, 40.14%], MM: 46.31%, 95% CI [44.13%, 48.51%]; see Figure 3). Specifically, participants reported Yes, it was the substance I expected to use (LSD: 36.87%, 95% CI [35.19%, 38.59%], MM: 45.30%, 95% CI [43.12, 47.5]), Yes, but it was a different substance than I expected, but I still microdosed (LSD: 1.00%, 95% CI [0.71%, 1.42%], MM: 1.01%, 95% CI [0.65%, 1.56%]), No, but I tried a full-dose of the same batch beforehand and it seemed to be the substance I expected (LSD: 14.14%, 95% CI[12.96%, 15.41%], MM: 11.26%, 95% CI: [9.94%, 12.73%]), No, but I bought from a source I consider reliable (LSD: 35.55%, 95% CI [33.88%, 37.25%], MM: 31.52%, 95% CI [29.51%, 33.6%]), and No, and I cannot be sure (LSD: 12.43%, 95% CI[11.32%, 13.64%], MM: 10.91%, 95% CI [9.61%, 12.36%]).

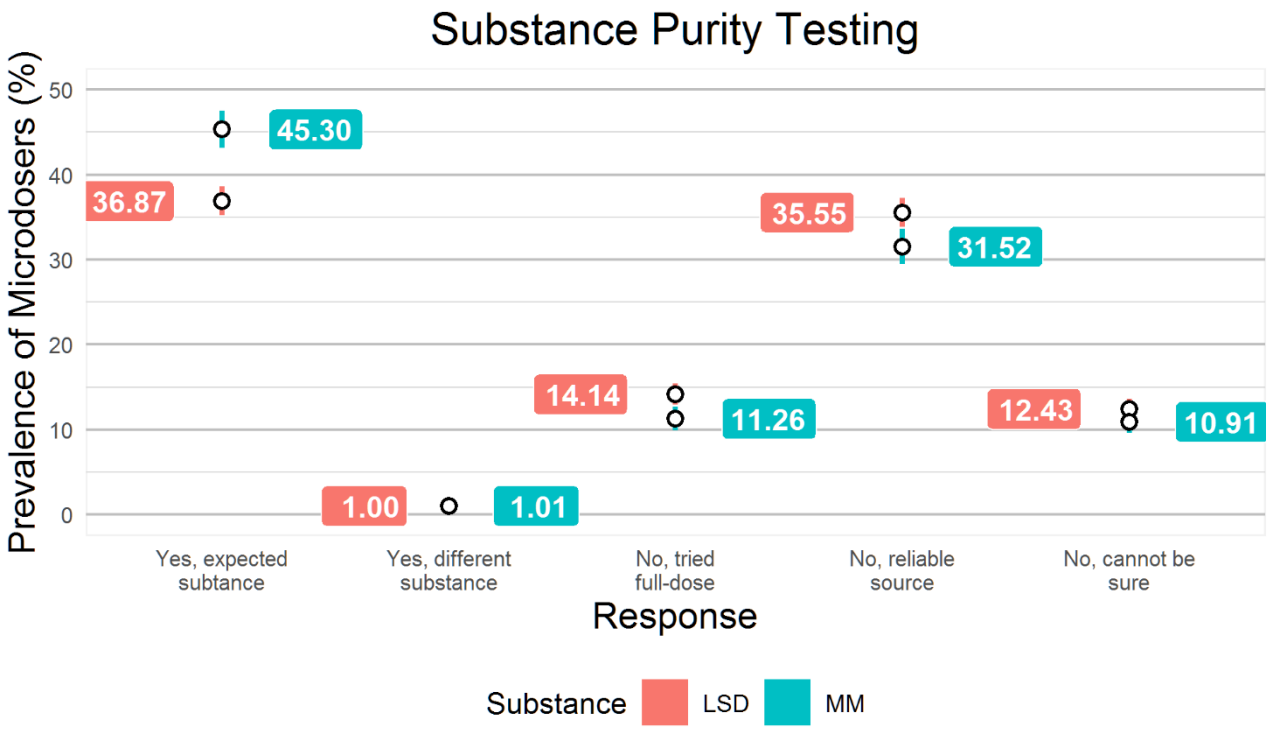

Figure 3. Percent of microdosers reporting testing their substances. Error bars indicate 95% CI around mean. For full question text, see body.

The Relevance of Intention to Reported Benefits

Participants had mostly approach-motivation for both LSD (80.31%, 95% CI: [78.90, 81.64]) and MM (78.82%, 95% CI: [77.02, 80.52]); see Table 3 for a breakdown of individual reasons to begin microdosing. In contrast and against H4, however, approach-motivation was predictive of fewer benefits for both LSD and MM. Using a Wilcoxon Signed-Rank test, approach motivation was predictive of less reported benefits for those who reported microdosing LSD compared to avoidance motivation (mean approach motivation benefits: 5.81; mean avoid motivation benefits: 6.41; $W = 468411$, $p < 0.001$). For those who reported microdosing MM, approach motivation was also predictive of less benefits than avoidance motivation (mean

approach motivation benefits: 5.29; mean avoid motivation benefits: 6.23, W = 210605, $p < 0.001$).

Table 4
Reasons to begin microdosing by substance

Motivation	**Reason**	**LSD (%)**	**MM (%)**
Approach	To improve mood and/or overall life satisfaction	821 (25.42)	606 (28.97)
Approach	Just curious	798 (24.71)	541 (25.86)
Approach	To enhance creativity and/or ingenuity	575 (18.70)	288 (13.77)
Avoid	To treat ADHD symptoms	268 (8.30)	81 (3.87)
Approach	To improve my relationships with myself and/or others in my life	196 (6.07)	179 (8.56)
N/A	I don't know / I didn't have a particular reason	179 (5.54)	133 (6.36)
Avoid	To get away from bad habits and unhealthy behaviours	132 (4.09)	133 (6.36)
Avoid	To avoid boredom	92 (2.85)	31 (1.48)
Avoid	To escape negative feelings, e.g. depression, anxiety	77 (2.38)	40 (1.91)
Approach	To be more productive and effective	72 (2.23)	40 (1.91)
Avoid	To stop problematic substance use	20 (0.62)	20 (0.96)
	N =5322	N = 3230	N = 2092

Note. Participants were able to select one option only.

Microdosing and anxiety disorder.

We used a bivariate logistic regression model to determine whether microdoser status was predictive of an anxiety disorder diagnosis. Contrary to E1, neither microdosing LSD nor MM were significant predictors of a diagnosis of anxiety disorder diagnosis ($p = .12$; $p = .70$).

Discussion

This study had three primary aims: validating previous research on the most common benefits and challenges associated with microdosing with LSD and psilocybin, informing harm reduction initiatives of substance analysis practices for people who microdose, and assessing the utility of approach-avoid motivations when considering the relationship between initial intentions and reported microdosing benefits.

Most Commonly Reported Benefits and Challenges

Microdosing Benefits.

We expected the three most commonly reported benefits would match the findings of our previous empirical taxonomy, i.e. improved mood, improved focus, and creativity (Anderson et al., 2019). Improved mood and creativity were correctly predicted, but improved focus was considerably less commonly reported than expected. Additional benefits that were commonly reported in the present sample (improved energy, social benefits) were also highly reported in our previous sample (5^{th} and 6^{th} most common respectively). Similar but non-identical findings are not surprising given that the methodologies used in the two studies were quite different; Anderson et al. (2019) used a qualitative grounded theory approach to develop categories from free text responses whereas the present study used closed-ended focal questions based off the categories that were developed. Improved mood and creativity being so commonly reported

across both study methodologies speaks to their importance as high-potential research avenues for future microdosing trials.

The benefits reported here converge with the wider literature. Prochazkova et al. (2018) found that participants performed significantly better on a divergent creativity task following a small dose of psilocybin. Polito and Stevenson (2019) found that on the day participants reported microdosing, their self-reported creativity, focus, and well-being were significantly elevated compared to baseline. Bershad et al. (2019) found that acute effects of a microdose of LSD included an increased feeling of vigor and friendliness, similar to our findings of increased energy and social benefits. The literature is not of one voice, however, as a recent survey that found some people who report microdosing with psychedelic substances experienced negative psychological effects (Hutten, Mason, Dolder, & Kuypers, 2019).

Microdosing Challenges.

We expected the three most commonly reported challenges would be concerns about illegality, physiological discomfort, and impaired focus, as we found previously (Anderson et al., 2019). Counter to our predictions and quite remarkably, the most commonly reported challenge was "none", suggesting approximately one third of participants experienced no noticeable adverse side-effects from microdosing. Physiological discomfort and impaired focus were correctly predicted for top three challenges in MM microdosing, but impaired focus was fourth with LSD microdosing and physiological discomfort was sixth. These findings align well with a recent survey that found microdosers reported negative physiological effects including nausea and dizziness (Hutten et al., 2019).

Illegality was considerably less commonly reported than expected. This was surprising given the wide margin by which it was the most reported challenge in our previous work

(Anderson et al., 2019). These discrepant findings may be due to limitations in naming conventions for this study or due to an over-general category in the previous work. The original illegality category from Anderson et al (2019) conceptually included illegality per se, but also included the consequences thereof, i.e. substance ambiguity due to lack of regulation and the social stigma surrounding substance use. The current operationalization of illegality reduced this category to "Legal consequences", which may have overly limited the scope of the category. It is also possible that the original category was too broad and these sub-categories would be better operationalized separately as "Legal consequences", "Substance-related issues (e.g. dosing, purity)", and "Social stigma" in future research. Another explanation for this discrepancy is that the current sample was drawn from the GDS which targets more drug-involved populations, and such populations may already have dismissed/factored in 'illegality' risks due to their current use of other illegal drugs in addition to microdosing.

The most commonly reported challenges in this sample, alongside physiological discomfort and impaired focus, were impaired energy (restlessness and/or fatigue) and cognitive interference (i.e. mental confusion, memory problems, or racing thoughts). Some of these challenges could plausibly relate to dosing too high when attempting to microdose. The lack of precision dosing available when consuming LSD purchased from the black market or the natural variance in MM potency could contribute to higher doses than intended while remaining sub-hallucinogenic. Psychedelics are central nervous system stimulants that may result in unintentional overstimulation in the form of restless energy or racing thoughts. These differences may also arise from variation in how individuals metabolize psychedelic substances, or even the "set and setting" of the microdose. Future research should endeavour to characterize the ideal

dose-range and optimal conditions for microdosing such that people who microdose can maximize benefits and minimize challenges.

Benefits and Challenges - Future Directions.

Our results concur with other studies that suggest the benefits related to microdosing may be considerable, especially compared to the challenges, which appear relatively benign. Convergent findings demonstrate that people who microdose consistently report improved mood and creativity. If it is indeed the case that small, sub-hallucinogenic doses of LSD or psilocybin can enhance these domains, current theories proposing that psychedelics must be consumed in large doses to provide beneficial effect (Carhart-Harris & Friston, 2019) need to be revised.

Drug Checking

Our extension of the literature examined whether those who use psychedelics test their substances. Our findings indicate that, as predicted, most individuals did not test their substances. In our sample, fewer than half of participants tested their substances. Participants were reporting taking doses approximately 10% of a recreational dose, which may have dramatically reduced the perceived harm potential of consuming unknown substances. Furthermore, our survey did not ask participants how exactly they tested their substances (e.g. by at-home reagent testing, by on-site festival testing, by sending a sample away to a lab), so their exact testing procedures remain unknown. Additionally, it is quite possible that many participants were unaware of substance-testing kits or services, leading them to rely on a next-best option: buying their substance from a source they trusted. Indeed, this was the second most popular reported testing behaviour, in agreement with the finding that this approach is widespread (Davis & Rosenberg, 2017; Johnston et al., 2006). Educating the public about using test kits as well as progressive legislation and regulation both have the potential to reduce harm in those who use psychedelics both recreationally and therapeutically.

This finding is unsurprising considering previous work on similar substances. Johnston et al. (2006) found that one in five people who used MDMA analysed their substances. Similarly, a large survey that asked participants about pill-testing habits revealed that fewer than half of respondents used anything other than hearsay to validate the purity of the substance they were using (Davis & Rosenberg, 2017). Using samples of people with a high frequency of MDMA use, they showed that 74% of Americans tested their substances using a reagent kit, while only 34% of UK residents tested theirs. The findings from the field are somewhat inconsistent, suggesting that substance-testing behavior is not necessarily widespread and may differ dramatically between geographical locations.

It is worth noting that in the case of LSD on blotter paper, it is only possible to adulterate LSD with other psychedelics that are active at similarly small doses, such as DoX and NBOMe. series It can also be difficult to adulterate mushrooms in whole form, while powder form mushrooms may include other psychedelics. It may be that the most important issue faced by people who microdose is the consistency of the dose and especially ensuring that a large dose is not unintentionally consumed due to the unregulated and untested nature of these substances.

The Relevance of Intention to Reported Benefits

The results obtained from this sample directly contradict our predicted relationship. Participants who started microdosing to avoid a negatively-appraised state or behavior rather than approach a positively-appraised state or behavior reported significantly more benefits from microdosing. We provide three possible explanations: perhaps our operationalization of summing benefits was inadequate, perhaps the approach-avoid dichotomy is not theoretically applicable to microdosing and different conceptualizations would add clarity, or perhaps these

findings really reveal something surprising about microdosing with an avoidance mindset: the importance of being prepared to change.

It is possible that counting the number of benefits is not an effective operationalization of outcomes as benefits may vary on a spectrum of how valuable or important they are to the participants. For example, if a respondent credits microdosing with a transformative alleviation of depression or ADHD symptoms, whether this participant also reports enhanced physical senses may be clinically and subjectively negligible. This explanation seems plausible as in our previous work, we found that participants who microdosed with MM reported significantly more subjective importance of benefits compared to participants who microdosed with LSD. In the present data, a higher percentage of LSD microdosers endorsed more benefits (see Figures 1 & 2), but we did not measure subjective importance of benefits. Unfortunately, our previous work did not assess intention to microdose so cannot offer more insight here (Anderson et al., 2019). More precise measurements and validated scales planned for upcoming clinical trials on microdosing can be expected to be more informative than the present operationalization.

Another possible reason for this pattern of results is that the approach-avoid framework may not be theoretically applicable in this context. Gray's approach-avoid framework has been used as a trait-level construct to measure individual differences related to certain psychopathologies, e.g. high BAS is related to risk-taking behavior, such as substance use (Bijttebier, Beck, Claes, & Vandereycken, 2009), whereas individuals with high BIS tend toward anxiety disorders (Carver & White 1994). This theory also dovetails with mainstream psychedelic theories that suggest individual differences and expectancy drive some psychedelic effects (Carhart-Harris et al., 2018). Indeed, Carhart-Harris and colleagues specifically mention that the context in which individuals microdose is yet unstudied and may be an important

addition to the literature. We hypothesized that those intending to approach pleasant states — improved mood and life satisfaction, curiosity, creativity, better relationships, or enhanced productivity— would reap more benefits from their microdosing practice than those trying to avoid aversive experiences —ADHD symptoms, bad habits, unhealthy behaviours, boredom, depression, anxiety, or problematic substance use— but our results contradict this prediction. Instead, the data suggest that avoidance-intentions were predictive of more benefits. It is possible that conceptualizing intention along approach-avoid dimensions is less applicable than initially thought. Indeed, other dimensions of intention, such as those of self-improvement and self-medication, may provide more fruitful interpretations. It may be that participants with self-improvement intentions could face ceiling effects or diminishing returns if they are already doing well in life. Conversely, participants faring particularly poorly when starting to microdose would benefit from regression to the mean or from alleviating downstream issues by addressing primary causes. For example, ADHD and boredom are related to other mental health concerns (Eastwood, Frischen, Fenske, & Smilek, 2012). A participant using microdosing to self-medicate their ADHD symptoms could report an improvement not only in these symptoms, but also various comorbid issues or downstream issues cause by their ADHD, whether or not it was their intention to treat these issues. It is possible that other avoidance-intentions, such as self-medicating depression, anxiety, or problematic substance use, all of which are often comorbid with each other and with other disordered behaviours, could have resulted in the same spread of more general benefits and prevention of downstream problems.

A third possibility is that participants trying to avoid aversive states may have been more aware of concrete problems in their lives and so were psychologically prepared to address their issues and change for the better. Miller & Tonigan (1996) propose that readiness for change is

based on three main factors: awareness of the problem, certainty that it is a problem, and reported changes to behaviour. They use the Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES), a validated instrument used primarily for problem drinkers (Miller & Tonigan, 1996). Using the SOCRATES to assess how prepared an individual is to change their problem drinking behaviour has been shown to be a good predictor of psychotherapy outcomes (Norcross, Krebs, & Prochaska, 2011). It is possible that participants who had avoidance-intentions for microdosing were ready to change their lives for the better. Participants reporting avoidance-intentions recognized their issues, overcame their ambivalence about their issues, and took steps (i.e. microdosing) to try to overcome their issues. The SOCRATES may be a valuable instrument to add to future microdosing research.

Ultimately, the present results should still be considered inconclusive. Understanding the relations between intentions and outcomes in microdosing remains an open area for ongoing research. While the link between intentions and the benefits derived from the use of psychedelics is broadly accepted, curiously little systematic research has investigated the relationship between the two. Hartogsohn (2016) recounts the history and theory of the relationship between "set and setting" and the potential positive impact psychedelic substances can have. Specifically, Hartogsohn suggests that psychedelics may be "suggestibility-enhancing" and thus those who consume them expecting a positive outcome will experience better outcomes due to an enhanced placebo effect. Some empirical research suggests that in cases where higher-dose LSD was administered without care for set and setting, participants experienced worse mental health outcomes (Larsen, 2016). Similarly, a study predicting responses to psilocybin recently concluded that set and setting impact the subjective experience of higher doses of psilocybin: participants who were undergoing Positron Emission Tomography (PET) had significantly worse

unpleasant reactions to psilocybin, ostensibly due to the uncomfortable setting (Studerus, Gamma, Kometer, & Vollenweider, 2012).

Microdosing and anxiety disorder.

We did not find a relationship between microdosing psychedelics and lifetime anxiety disorder diagnosis. In our previous work we found that some participants reported microdosing reduced anxiety while others reported that microdosing increased anxiety (Anderson et al., 2019). The reasons for these discrepant findings were unknown and remain unknown. We proposed that the placebo effect could be driving inconclusive results, but also that there may be individual differences in response to psychedelic microdosing including genetic or metabolic factors, personality or clinical factors, and interoceptive interpretation differences (Anderson et al., 2019). It may also be possible that different time-frames are at fault: lifetime diagnosis may not be related whereas more proximate or ongoing diagnoses may have more predictive power. More broadly, different responses could also be related to set and setting, as described above. For example, it may be that a safe context wherein the microdoser feels competent and supported could precipitate reduced anxiety, but in a context of normally tolerable stress or social tension, a microdoser may feel increased anxiety and uncertainty. More research on the effects of microdosing in different settings is required in order to disambiguate the relationship between microdosing and anxiety.

Limitations and Conclusions

This study has several important limitations. First, while the sample size is relatively large, it is a cross-sectional online survey that is based on participants volunteering their time. The data collected is thus subject to various biases and does not necessarily represent the true population of all people who microdose globally. Second, we had no control over which

substances participants used, how much was in each dose, or the duration of their microdosing. There could be important differences depending on dose, schedule, chronic use, or concurrent use of other substances, all of which cannot be accounted for using this design. Finally, the large number of participants is a double-edged sword, in that it allows us to observe the habits of many individuals, but this overpowered design is vulnerable to Type II errors. For example, it may be that significant differences found between intentions to microdose predicting benefits among those who use MM are only significant due to the large sample size.

While this study joins a growing list of findings that suggest microdosing could be beneficial, the methodology employed here means that no causal claims can be made about microdosing as a practice. Future research should investigate microdosing using large sample-size randomized controlled trials over extended periods of time in order to examine the beneficial and challenging outcomes of microdosing while controlling for set and setting.

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Declaration of Conflicting Interests

Adam R Winstock is the founder of Global Drug Survey. The other authors declare that there is no conflict of interest.

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