

Master Thesis Report

Microdosing Psychedelics: Exploratory Data Analysis

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Microdosing psychedelics is the repeated use of small doses of, for example, lysergic acid diethylamide (LSD) and Psilocybin Mushrooms. Recent studies present promising results about its potential to become an alternative to traditional treatments for mental disorders (e.g. depression or anxiety). Furthermore, its consumption might provide another types of benefits reported regarding cognitive improvements and important reductions in drug dependences. A psychedelic full-dose therapy include perception-distorting properties, but microdosing may provide complementary clinical benefits using lower-risk, non-hallucinogenic doses. This exploratory data analysis assess the responses of a group of real-world microdosers recruited via questionnaire. The study has found relevant results regarding mood, focus, energy, and anxiety improvements. When asked specifically, a 92,88 % of participants reported improvements in mood, and a 59,18 % in anxiety reductions. The data also shows important reductions in caffeine use and alcohol use (44,19 % and 42,82 % of participants, respectively), in addition to other types of drugs. The drawbacks received were mainly related to its illegality, while there has been limited reporting on adverse events associated with microdosing. Despite the popular and scientific attention in recent years, there is still research to conduct and the need for more double-blind randomized controlled trials for further use at a large-scale application.

Available at: <https://github.com/dan1dr/microdosing>

Introduction

Psychedelics are one of those topics which deserves a profound explanation due to its ignorance, importance and misunderstanding. In this light, the author considers mandatory to briefly introduce the topic in order to understand the relevance of the scientific field, potentials, results, and other applied uses of psychedelics. Thus, before detailing the thesis process, it is presented an introduction to the psychedelics, while the project directly starts in the next section. This part encompass a piece of the scientific background underneath, history of psychedelics, and the potentials of recent evidence.

The term psychedelic derives from the Greek terms *psyche* (sould, mind) and *deloun* (to manifest). It was coined in 1956 and historically has received different and diffuse denominations such as hallucinogens or entheogens. The classical classification of psychedelics includes mescaline, lysergic acid diethylamide (LSD), psilocybin, and DMT¹. These substances have their primary mechanism of action via serotonin 2A receptor (5-HT_{2A/C}) agonism, causing robust alterations in perceptual, cognitive, affective, volitional, and somatesthetic functions, including visual and auditory sensory changes, thinking, mood fluctuations, and dissociative phenomena. It has been used for millennia by ancient cultures and tribes consumed as a sacrament during ceremonies and events in pre-columbian mesoamerican societies, ancient India, Siberia, etc. Wasson (1980); Carod-Artal (2015).

The most spread uses of psychedelics are in form of LSD, first synthesized by Albert Hoffman in 1938 from ergot Hofmann (1979), a fungus that grows on rye and other grains; and psilocibin, which is the principal psychoactive component of a genus of mushrooms (*psilocibe*). The distinction from other drugs is that psychedelics do not lead to addiction or dependence and are not considered to be reinforcing, while no overdose deaths have occurred after ingestion of typical doses of LSD, psilocybin, or mescaline Brunton et al. (2011). Their potential for medical application lead to its use for mental disorders and exploded by the early 1950s and 1960s Carhart-

¹Other compounds such as MDMA (known as ecstasy), cannabinoids, or ketamine, are rarely considered as a psychedelic, since they have a different mechanism of action.

Harris, Goodwin (2017), until 1966 when possession of LSD was banned in the United States and soon afterward almost all psychedelic research had ceased. Nonetheless, as popular and countercultural movements increasingly embraced the drugs, its societal impact bemushroomed, the highest-quality work in terms of history of drugs — and in this case, psychedelics — is covered in Escohotado (1999)

Although some more work were published after that, the true renaissance of psychedelics came in 2006, after the most rigorous study presented up to date, under the title "Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance". The double-blind randomized controlled study compared the acute and longer-term psychological effects of single high doses of psilocybin (30 mg) and methylphenidate (40 mg) in healthy volunteers. Significantly, greater improvements in psychological well-being were observed after psilocybin than methylphenidate at the 2-month end point, and more than half considered their psilocybin experience to be among the most personally meaningful experiences of their lives. Griffiths et al. (2006). In another study, after 14 months from the trial, volunteers attributed to the experience sustained positive changes in attitudes, mood, and behavior Griffiths et al. (2011). Another important study to treat cancer-related anxiety and depression produced immediate, substantial, and sustained improvements in anxiety and depression and led to decreases in cancer-related demoralization and hopelessness, improved spiritual wellbeing, and increased quality of life, as well as improved attitudes towards death. Ross et al. (2016). Significant improvements in obsessive compulsive disorder symptoms Moreno et al. (2006) and alcohol dependence with psilocybin Bogenschutz et al. (2015), anxiety with LSD Gasser et al. (2014), and depression with ayahuasca Osório et al. (2015) inspired questions regarding the potential generalized therapeutic action of psychedelics. An extensive detailing of the literature is presented in Nichols (2016), where poor evidence for adverse effects has been found, but patients suffering from psychosis might prevent its use.

New era for psychedelics had begun, where institution such as the Center for Psychedelic & Consciousness Research at John Hopkins University, the Imperial College of London, or the Multidisciplinary Association for Psychedelic Studies (MAPS) are leading the way for pioneer research. An increasing number of public figures are transmitting

promising results to the mainstream from autobiographies and story-telling, through experiences some more than others biased, but with unquestionable merit. Pollan (2018); Stamets (1996); Ferriss (2021); Carpenter (2020).

More recently, new studies have showed that psilocybin may be at least as good than the gold standard treatment for depression Carhart-Harris et al. (2021), and MDMA have completed the third phase study with highly efficacious in individuals with severe posttraumatic stress disorder, being safe and well-tolerated even in those with comorbidities Mitchell et al. (2021), pending to be applied in therapy in the following years, starting with MDMA and moving into other psychedelics.

Regarding to microdosing, it is the repeated use of small doses of, for example, lysergic acid diethylamide (LSD) and Psilocybin Mushrooms, typically for a few weeks into your weekly routine for enhanced levels of creativity, energy, focus, and improved relational skills. Recent studies on full-dose psychedelic psychotherapy reveal promising benefits for mental well-being, especially for depression and end-of-life anxiety Kuypers (2020). While full-dose therapies include perception-distorting properties, microdosing may provide complementary clinical benefits using lower-risk, non-hallucinogenic doses. Despite the popular and scientific attention in recent years, little scientific knowledge is available to back this. There has been limited reporting on adverse events associated with microdosing, and the experiences of microdosers in community samples have not been categorized Polito, Stevenson (2019); Anderson et al. (2017); Lea et al. (2020); Anderson et al. (2019b,a).

Yet further research is mandatory, new gates of dealing with several disorders and alternative therapies might be available to main population². According to 2017 data, 792 million people lived with a mental health disorder, accounting for more than 10,7 % of the total population: the most prevalent were anxiety disorders (around 3,8

²Other uncommon applications of psychedelics have not been assessed here, but there are some curious investigations showing changes in atheist conceptions: *"more than two-thirds of those who identified as atheist before the experience no longer identified as atheist afterwards"*, who rated the use as among the most meaningful and spiritually significant lifetime experiences. Griffiths et al. (2019). Other topics such as the "Stoned Ape Theory" and question of why the nature of psychedelics have these profound effects on the mind are always in the atmosphere Pollan (2018).

% of total population); and depression (with approximately 3,4 %) Ritchie, Roser (2018). Therefore, the need for exploring alternative methods seems obvious. The investigation field is deep and complex, but whose progress would enrich the human perspective and knowledge about the mind phenomenology and other virgin paths. This present analysis continues the work carried out by the Demography of Microdosing Community Survey, retrieved from osf.io/g5cwj.

Project structure

This a white paper style which full project is uploaded at the GitHub repository <https://github.com/dan1dr/microdosing>. Instruction and other requirements are also documented there, while the code is presented within the notebooks. These are numbered for correct following, the second one has been splitted for quick exploration.

Instructions for replicating the work is detailed in the repository. With that, the additional information per each piece of code is explained along the notebooks with its correspondent reasoning. Hence, in this report it has been decided to cover which aspects have been analysed, main conclusions reached, and other possible info which does not appear in notebooks — keeping this document shorter and avoiding unnecessary details about coding, format and error solutions.

Data Wrangling

The data has been downloaded through Anderson et al. (2017), and also available at the repository of the project.

Due to the authors criteria and the work they have carried out, the programming language R has been used during their study and other statistical analysis. However, the objective of this exploratory data analysis was to obtain a global picture of the problem while using other Python facilities. More information about statistical significance and results validation can be consulted on the cited study, with a wider sample.

Once the dataset has been downloaded, after a quick exploration checking NAN's,

duplicates, and main features, it is verified that the data is already "clean" but the long format has been applied in the data pre-processing. The decision to transform it into wide format has been made in order to facilitate the work and comparability, although it could have been possible to continue with the analysis with the long format.

The reason behind the long format is that each participants ranked 3 benefits and 3 drawback, so obtaining 6 attributes in total. Since this particularity only affects one question in the full questionnaire, it is decided to transform the answer into wide data —thus reducing the total length by 6 times.

Data is splitted into *wide_data* (including all the dataset until the long format is really useful), and *long_data* (the slice of the dataset to be transformed into wide). Different functions are written to do so, inputting the results obtained in a more friendly format. Finally, —once the latter has been cleaned and wrangled— both pieces of data are merged for further analysis and continuation of the project. Some graphics are here included, while majority of them are included in the notebooks and in the folder named *front* (which contains the Tableau environment).

Exploratory Data Analysis

The EDA is covered in *2.EDA_full.ipynb*. The main conclusions will be explained following the notebook structure, for which each subsection is a different notebook.

Demography

Firstly, the sample (n=287) of participants were asked to select their mood before continuing the questionnaire, who were mostly in a pleasant state. Then, they were asked if they were microdosing or their responses would be based on past experiences; for which more than half of the participants answer they were currently microdosing, and the rest the did it in the past (150 users were currently microdosing, and 128 had microsed in the past).

Majority of participants were from US (Reddit is predominantly used there), with

other usuaries from more anglophone countries, the rest were predominantly from Europe. The age distribution is mostly grouped into the range 18-35 yrs, with some veterans microdosers, being 237 males and 31 females, 215 heterosexual and 51 homosexual. Note the higher prevalence of homosexual orientation among females (17 versus 14). Etnia of the participants were mainly white, european or mixed, with some latinos and other minorities.

In terms of religiosity, more than half are considered themselves as non-religious (58,27 %), spiritual but non-religious (29,14 %), other answer or religion (12,59 %). However, average spirituality is ranked much higher than religiosity in a score from 0 to 100 (39,87 vs 8.14).

General occupation of participants was student, according to the age distribution; the same applied when they were asked for their highest completed formal education, with a majority of them coming from middle-class families, with no significant differences for education or background.

Dosing and patient history

Most microdosers use lysergic acid diethylamide-25, or LSD (228), with fewer taking psilocybin (83). Most of them started microdosing in the late adolescence or adulthood.

LSD users dose ranges from few micrograms up to 40 μg (most 5-20 μg), while users for psilocybing ranges from few μg up to 40 μg (most 100-300 μg). When asked for how many days did they space between doses, responses were typically 1 day on-1 day off, 1 day on-2 days off, 1 day on-3 days off; while few of them microdose every single day or space doses longer (showed in Figure 1). The average of total number of microdoses per user is around 26 doses. The scale to range the cost is quite diffuse, but users commonly pay from 1-2 to 15-20 \$ per month.

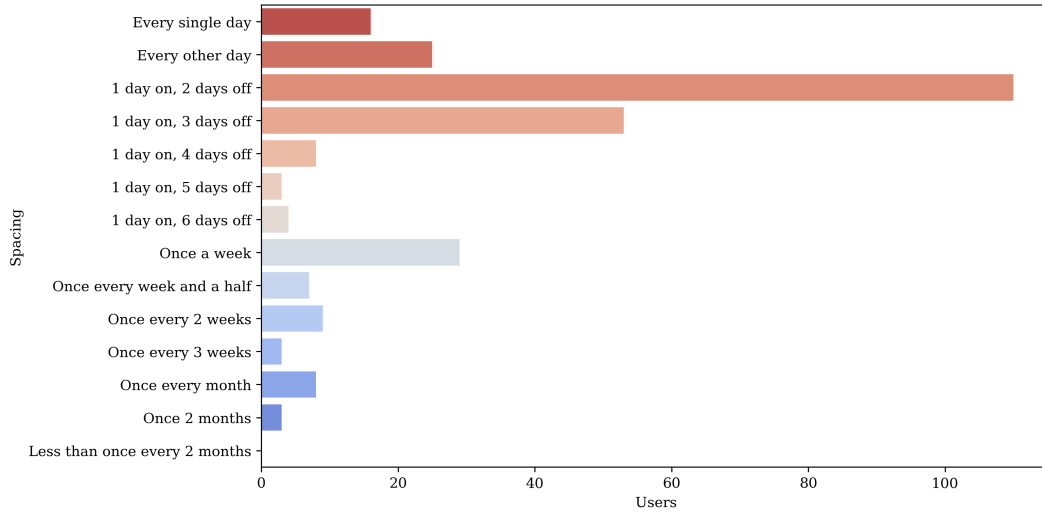


Figure 1. Spacing time between doses among participants.

Almost all of them know some other who was also microdosing. When participants were asked if they would recommend that others should try microdosing, 57.91 % replied "yes" (anyone or for most people), 39.21 % replied "maybe", and 2.88 % replied "no" (not for most people or not for anyone).

Later, respondents were asked to rank their global health from 0 to 100. The resultant mean was around 75 with no significant differences between substances (Figure 2).

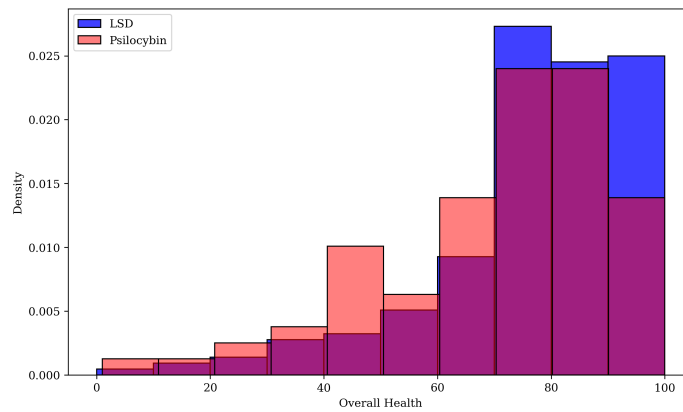


Figure 2. Overall health ranked from 0 to 100, by substance.

Regarding to recreational drug history, they were invited to indicate which of some substances they use for recreational purposes. As a consequence, participants showed a wide variety of drugs used before, where caffeine, alcohol and cannabis were the more frequent (Figure 3). A drug use index was also included in the code to summarise the different uses and drug profiles.

Recreational drug used

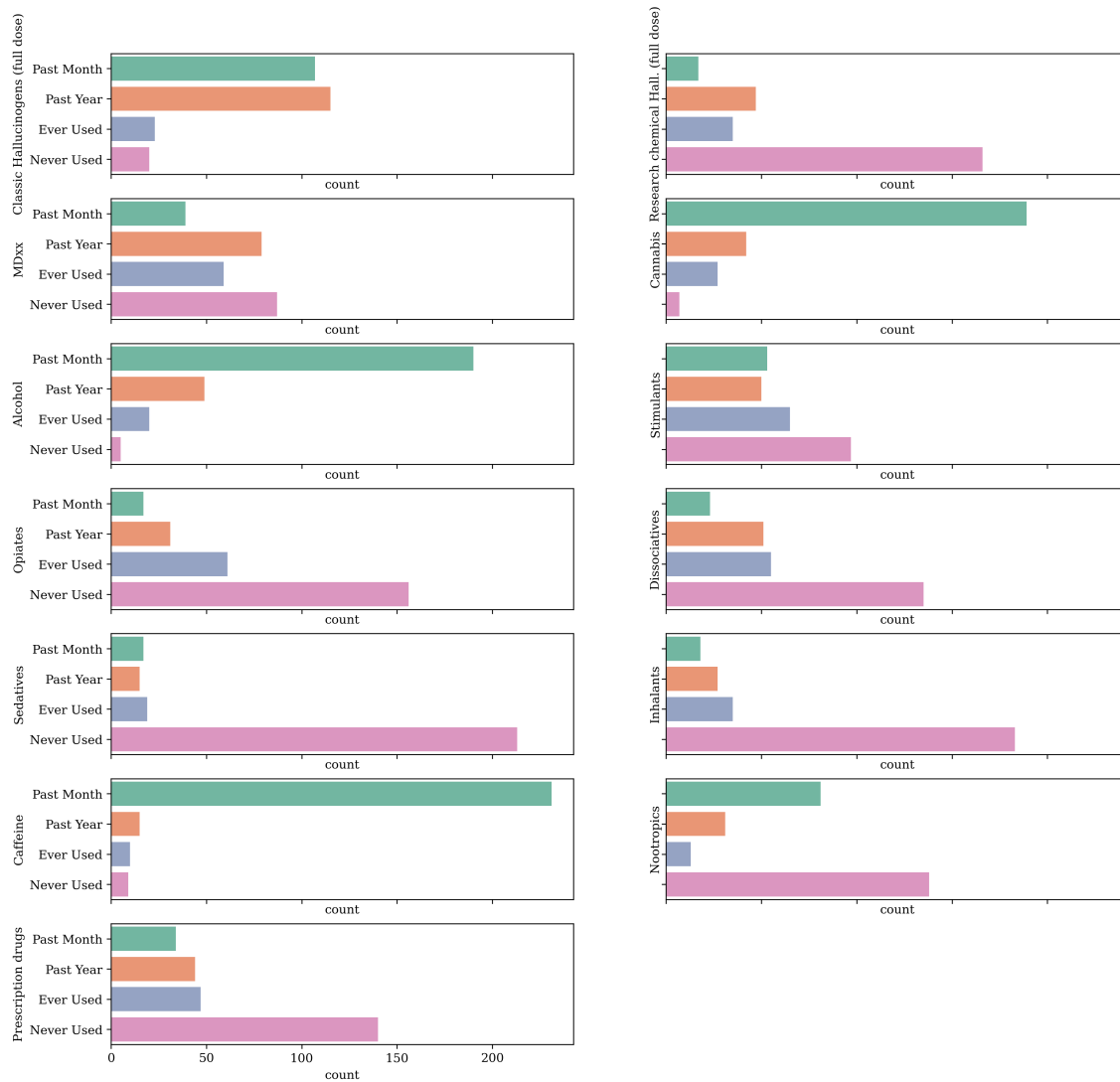


Figure 3. Drug use per each category.

Based on their previous diagnoses, 73 participants have ever been diagnosed with anxiety, 72 mood disorder, 54 Attention-Deficit/Hyperactivity Disorder (ADHD), 17 posttraumatic stress disorder, 9 Autism Spectrum Disorder, 7 Obsessive Compulsive Disorder, 4 schizophrenia spectrum disorder, 3 substance use disorder, 2 eating disorder, and 137 with none of the above. With that, 64 participants were currently taking some prescription drug (18 participants were taking non-psychotropics, 11 dopamine and norepinephrine reuptake inhibitor and releaser, 4 benzodiazepine receptor agonist, 3 SSRI, etc.). Among them, 11 kept using the medication while microdosing psychedelics.

Personality

In this section, different models were used in order to classify the psychological profile of the participants and specific emotions and attitudes. Concretely, negative emotionality (anxiety, depression and emotional volatility), open-mindedness (intellectual curiosity, aesthetic sensitivity and creative imagination), wisdom (brief wisdom screening scale), and dysfunctional attitude (DAS-A-17). Each model is detailed in the notebook with more profound information about its references, added to data distribution and matrix correlations.

Benefits and Drawbacks

Finally, it is detailed the evaluation of the main benefits and drawbacks of microdosing – the main objective of the analysis. Participants were asked to fill in 3 benefits or "pros", and 3 drawbacks or "cons" regarding microdosing. Each pro or con is also ranked from 0 (Not at all important) to 100 (Extremely important). Firstly, the list of *codes* will be showed with its correspondent wordcloud; later, *category* condense this list into a few and more visualizable topics.

On the one hand, the principal benefits that appeared at least in one of the three pros per each participant are presented in the next page (Table 1). As it shows, the most reported benefits were: improved mood (117), improved focus (94), improved energy (77), creativity (71), reduced depression (50), etc.

Benefit	Frequency
Improved mood	117 (42,39 %)
Improved focus	94 (34,06 %)
Improved energy	77 (27,89 %)
Creativity	71 (25,72 %)
Reduced depression	50 (18,11 %)
Improved motivation	30 (10,87 %)
Reduced Anxiety	30 (10,87 %)
Clarity of thought	29 (10,51 %)
Mindful presence	23 (8,33 %)
Sociability	22 (7,97 %)
Cognitive enhancement	22 (7,97 %)
Empathy	17 (6,16 %)
Perspective shifting	17 (6,16 %)
Calm	16 (5,80 %)
Improved productivity	16 (5,80 %)
Emotional intelligence	15 (5,43 %)
Confidence	14 (5,07 %)
Wakefulness	14 (5,07 %)
Introspection	13 (4,71 %)
Spirituality	13 (4,71 %)
Appreciation	13 (4,71 %)
Heightened awareness	12 (4,35 %)
Alertness	12 (4,35 %)
Others	< (4 %)

Table 1: Frequency for the most common benefits of microdosing.

It is also presented a wordcloud, which represents the frequency or the importance of each word (Figure 4). The importance of "improved mood" appeared almost in half of the microdosers (42,39 %), followed by improvements in focus and energy (34,06 % and 27,89 %, respectively). The most reported benefits are clearly represented by improvements in mood, energy, productivity and focus; while there are also reductions in depression and anxiety in some participants. It is important to remark that this types of psychedelics are also sometimes used with the aim of cognitive enhancement (i.e nootropics). In this part, the results could have also been dissagregated by its type of psychedelic (LSD or psilocibyn), and whether the participants had previous diagnosis or not. Since the dataset does not count with the trial group, it is not possible to estimate variations among microdosers and non-microdosers. As a consequence, it was decided that the sample was not sufficiently strong to establish some valid relationship between them.

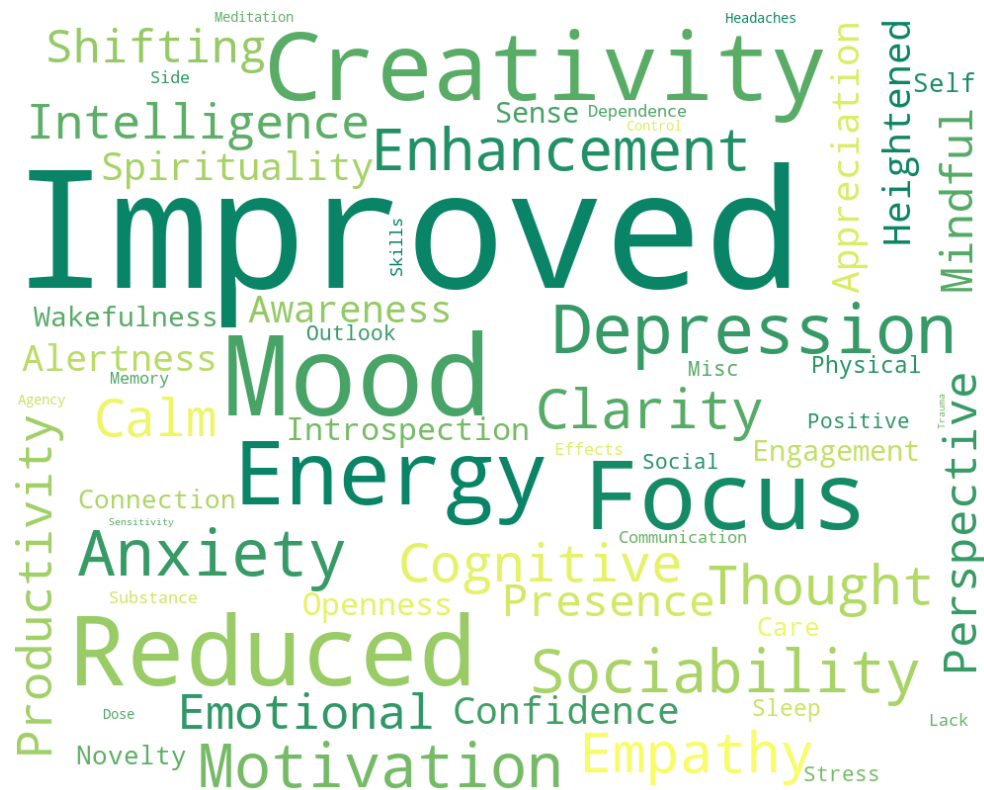


Figure 4. Wordcloud for the most common benefits of microdosing.

On the other hand, the principal drawbacks that appeared at least in one of the three *cons* are listed in Table 2. The most recorded drawbacks were: illegality (63), poor focus (57), dose accuracy (46), restlessness (33), stigma (32), etc.

Drawback	Frequency
Illegality	64 (23,19 %)
Poor focus	58 (21,01 %)
Dose accuracy	48 (17,39 %)
Restlessness	33 (11,96 %)
Anxiety	33 (11,96 %)
Stigma	32 (11,59 %)
Body discomfort	29 (10,51 %)
Sleep disturbances	27 (9,78 %)
Unknown risk-effect profile	24 (8,70 %)
Gastrointestinal issues	22 (7,97 %)
Miscellaneous	16 (5,80 %)
Psychological dependence	15 (5,43 %)
Substance availability	14 (5,07 %)
Decreased appetite	14 (5,07 %)
Emotional instability	12 (4,35 %)
Financial cost	11 (3,99 %)
Social overengagement	10 (3,62 %)
Unusualness	9 (3,26 %)
Preparation	9 (3,26 %)
Emotional depth	8 (2,90 %)
Social anxiety	8 (2,90 %)
Headache	8 (2,90 %)
Fatigue	8 (2,90 %)
Others	< (2,5 %)

Table 2: Frequency for the most common drawbacks of microdosing.

When exploring the categories, in order to get a more visual approach for the main benefits and drawbacks, these were grouped into a set of categories, reflected in Figure 6 and Figure 7.

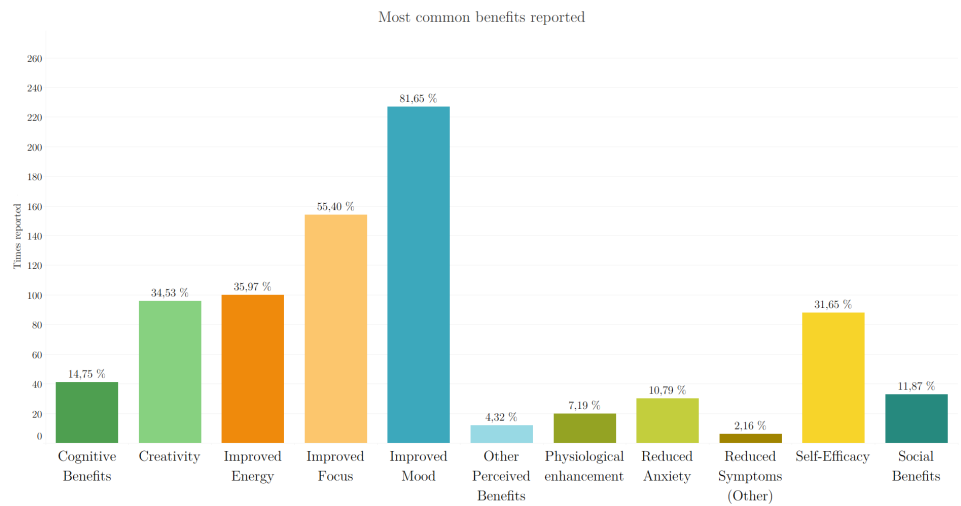


Figure 6. Categories for the most common benefits of microdosing.

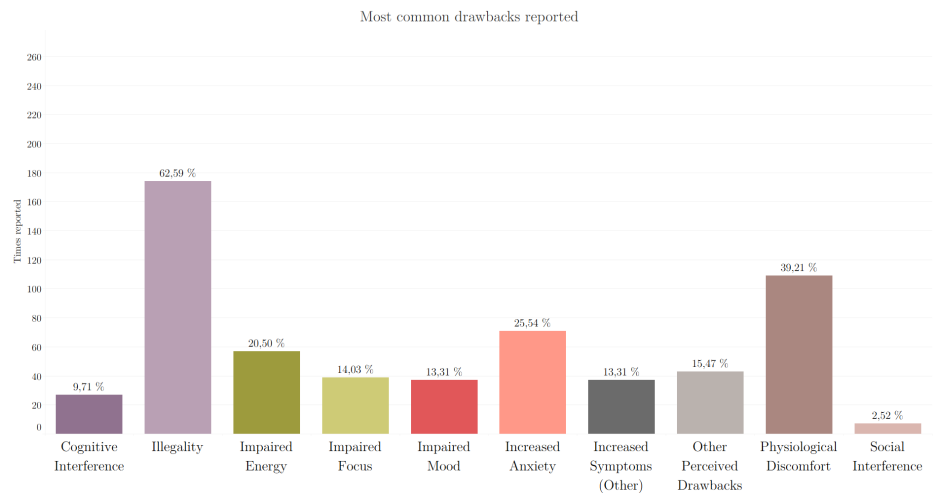


Figure 7. Categories for the most common drawbacks of microdosing.

Finally, at the end of the questionnaire, participants were asked whether they have noticed any improvements in mood, anxiety, meditative practice, eating habits, sleep, or exercise, as a result of microdosing. Their responses are summarized in Figure 8, with the share of participants reporting each improvement. According to the participants, the impact in mood was huge: more than 9 out of 10 participants reported improvement in mood (92,88 % of users). More than half in anxiety (59,18 %); almost half in meditative practice and exercise (49,06 % both of them); followed by better eating habits (35,96 %), and less frequent improvements in sleep (29,84 % of participants reported better sleeping quality).



Figure 8. Improvements as a result of microdosing.

In addition to it, they were asked if they had reduced their use of psychiatric prescription drugs, alcohol, caffeine, cannabis, tobacco, or other illicit drug, as a result of microdosing. The results are presented in Figure 9, per each type of drug. Important reductions in caffeine and alcohol consumption were reported by microdosers (44,19 % for caffeine, 42,32 % for alcohol), cannabis use was as well affected (30,34 %), while other use of drugs was also affected (tobacco for 20,97 % of them, prescription drugs 16,85 %, other illicit drugs 16,10 %). Recall the importance of these reductions based on the prevalence of some drugs listed in Figure 3, with strong prevalence of

caffeine, alcohol, and cannabis among participants in a daily basis consumption. As a consequence, microdosing might reduce the consumption of these types of drugs, next to other positive effects observed before.

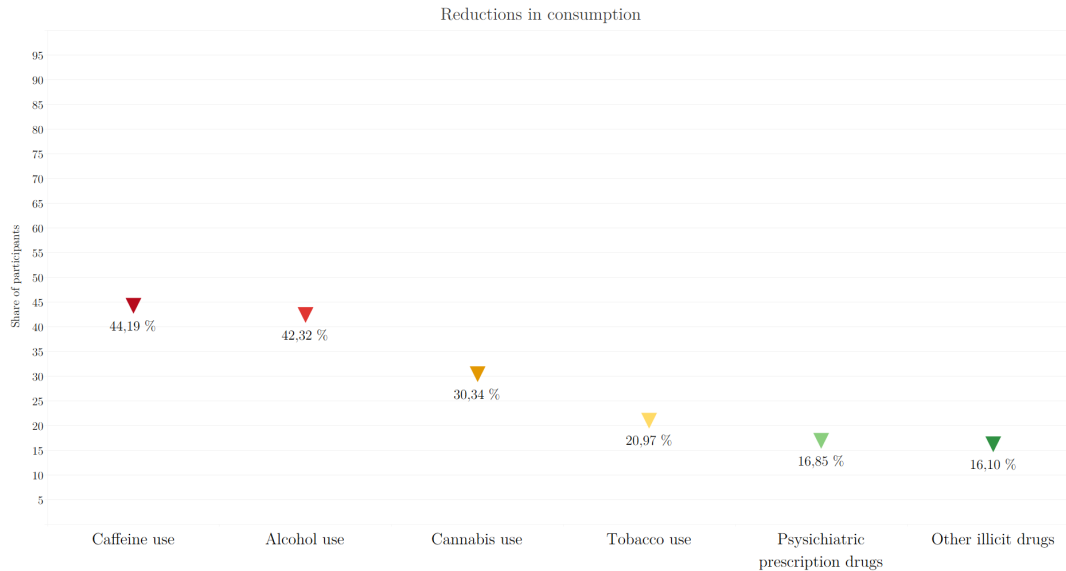


Figure 9. Consumption reductions as a result of microdosing.

Conclusions

The exploratory analysis has showed positive results regarding the microdosing of lysergic acid diethylamide (LSD) and psilocybin mushrooms. Most participants reported benefits about its use mainly in mood, focus and energy. When asked specifically about improvements, strong results were obtained for mood (92, 88 % of them) and anxiety (59,18 %) improvements in general. Furthermore, microdosing helped a substantial number of users to reduce caffeine use, alcohol use and cannabis use. In some cases was also observed a reduction in other prescription drugs. Otherwise, when asked about drawbacks, there were some important factors reported about its illegality, poor focus, and dose accuracy. A group of them also experienced some type of physiological discomfort (39,21 %), but the frequency observed for drawbacks was considerable lower than the benefits reported. In this sense, it is necessary to explore more about these substances in wider groups of people with double placebo-controlled trials, since participants were recruited via questionnaire and might be slightly biased

towards its consumption and use. Optimistic results have been analysed, for which further research is needed in order to become an alternative to traditional treatments and other potential applications.

Acknowledgements

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