THESIS

# IDENTIFYING LATENT PROFILES OF PSILOCYBIN USE

Submitted by

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# ABSTRACT

## IDENTIFYING LATENT PROFILES OF PSILOCYBIN USE

Psilocybin, the hallucinogenic substance found in some mushrooms, may have medicinal and therapeutic uses. As such, it is garnering pronounced interest from the scientific community and general public. It is likely that psilocybin is on a trajectory to become more acceptable and sought out by researchers and individuals interested in its potential benefits.

Traditionally, psilocybin has been used in does large enough to produce hallucinogenic effects; however, there are some reports of beneficial outcomes of psilocybin use with particularly small (i.e., micro) doses. It is likely that there are different patterns of psilocybin use, including using psilocybin in different quantities, frequencies, and for differing purposes, which have yet to be described in the literature. Thus, I sought to determine whether or not there are identifiable psilocybin use patterns of psilocybin use, to describe their defining characteristics, and test for differences on other important constructs, e.g., benefits, consequences, and reasons for use.

This research uses mixture modeling to identify latent profiles of psilocybin use in a large population of adults endorsing lifetime psilocybin. Data for this project was sourced anonymously from subreddit community sites. I found three profiles indicated by frequency and quantity of psilocybin use. Auxiliary testing was used to evaluate differences among the profiles. The Chipper Profile (n =118) was associated with approximately 1-4 annual uses and between 0.75g and 1.0g quantities of dehydrated, psilocybin containing mushrooms. The Tripper Profile (n =428) was associated with a slightly higher psilocybin use frequency as the Chipper Profile (2

and 6 times annually), and self-reported quantities between 2 and 4g. The Microdose Profile (n =118), was related to substantively higher psilocybin use frequencies than the other two profiles (between 2 - 4 times a week) and a lower range of preferred quantities (between 0.25g - 0.75g).

The profiles differed in the total number reasons participants reported having for their psilocybin use and the total number of benefits they reported experiencing. This can potentially be understood in relation to psilocybin use expectancies and motives to use. Additionally, every profile was associated with a low number of psilocybin use consequences, but the profiles did not significantly differ on this measure. Psilocybin seems to be distinct from other substances in that use frequency and quantity do not appear to impact one's risk of experiencing undesirable consequences of use. Further research is required to identify risk and protective factors for negative outcomes, as well as those that optimize the one's likelihood of experiencing psilocybin use benefits.

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# BACKGROUND

## Neuro-Interaction of Psilocybin

Psilocybin (O-phosphoryl-4-hydroxy-N,N-dimethyltryptamine) is the primary psychoactive ingredient in "magic mushrooms," a category of mushroom housed within the *Psilocybe* genus (Mahmood, 2013). There are at least 115 known psilocybin-producing species within this genus categorization, some producing more than others (Tylš et al., 2014). The structure of psilocybin is similar to that of serotonin, an abundant neurochemical in the body that affects mood, digestion, emotions, sleep, appetite, and neural information processing (Lv & Liu, 2017; Mawe & Hoffman, 2013; Tylš et al., 2014).

Because psilocybin mimics serotonin, it is taken in through serotonin receptors throughout the body, especially the $5HT_{2A/C}$ and $5HT_{1A}$ receptors (Tylš et al., 2014). This process downregulates the serotonin receptors, temporarily making them less sensitive to serotonin in the future and allowing for serotonin to stay in the synapse longer before being reabsorbed, which is the primary use for Selective Serotonin Reuptake Inhibitors (SSRIs) (MacLean et al., 2011; Roseman et al., 2018). Downregulation at these sites is linked to improvements in OCD, mood disorders, drug addiction, and more (Kuypers et al., 2019; Leonard, 1996; Serretti et al., 2004). This is likely one of the main mechanisms that connects psilocybin use to symptom reduction in those same conditions(Bogenschutz et al., 2015; de Veen et al., 2017; Erritzoe et al., 2018; Foldi et al., 2020; Goldberg et al., 2020; Johnson et al., 2017; Spriggs et al., 2021).

Despite psilocybin's similarities to SSRIs, a major difference between the neuro-interaction of the two is that SSRIs tend to reduce activity in the limbic system and are connected to the experience of emotional "blunting," whereas psilocybin is related to increased activity in the amygdala (Roseman et al., 2018)and subsequent environmental reactivity and emotional

"release" (Carhart-Harris & Goodwin, 2017). This has been described in by Carhart-Harris and Goodwin (2017, p. 2107) as the difference between "decreasing depression" and "increasing wellness."

Psilocybin is categorized as a hallucinogenic substance, meaning that it has the capacity to distort a person's perception of reality. Sometimes, this can lead to hallucinations, which are distorted or imagined sensations and images that a person might believe to be real but are not (Preller & Vollenweider, 2016). These "trippy" effects can be traced to psilocybin's impact on neural information processing. When psilocybin is taken up by serotonin receptors, particularly the $5HT_{2A/C}$ receptors, a person's ability to interpret sensory information is impacted, and their ability to integrate perception, thoughts, and emotions is disrupted (MacLean et al., 2011; Nichols, 2004). People who take psilocybin may experience pronounced changes in their cognitive state, mood, affect, volition, and somaesthesia (MacLean et al., 2011). It is possible that psilocybin demonstrates such pronounced efficiency and rapid symptom reduction compared to traditional SSRIs because of the combination of diminished neural information processing and increased amygdala response to emotional stimuli. SSRIs work to alleviate negative emotions, whereas psilocybin may allow people to confront and work through uncomfortable emotions (Roseman et al., 2018).

The combination of psilocybin and 5HT receptors is also known to facilitate an increase dopamine in the ventral striatum in humans, which has been connected to the well-known experiences of depersonalization and euphoria seen in people who have ingested psilocybin (Tylš et al., 2014; Vollenweider et al., 1999). However, it is important to note that psilocybin, among other psychedelic drugs, does not directly influence the brain's dopaminergic systems, which is known to be an important process for developing dependency to drugs that have high addiction

potentials (Nichols, 2016). Thus, psilocybin is considered to have a low-risk addiction potential in humans. In fact, there is promising research indicated that psilocybin may be helpful in treating various addictions (de Veen et al., 2017; Geiger et al., 2018).

**Potential Benefits of Psilocybin**

Psilocybin has been shown to occasion “mystical" experiences, even in research settings (MacLean et al., 2011). Here, “mystical” means participants report feelings of “unity, sacredness, ineffability, peace, and joy, as well as a sense of transcending time and space and an intuitive belief that the experience is a source of objective truth about reality” (MacLean et al., 2012). This is likely why psilocybin has been integrated into spiritually charged rituals for over 3,000 years (Carod-Artal, 2015; Johnson & Griffiths, 2017a; Schultes, 1969).

Medical uses for psilocybin were touted by the Aztecs as far back as the early 1500s, who consumed “sacred mushrooms” to treat fevers and rheumatoid arthritis (Kuypers et al., 2019), Emerging research has also demonstrated that psilocybin may be useful for treating or stopping treatment-resistant cluster headaches (Johnson & Griffiths, 2017a; Sewell et al., 2006) and migraines (Schindler et al., 2021). However, this treatment potential has not been rigorously tested with large-scale clinical trials to date and existing research on the subject is largely based on self-reported data. Also, researchers who do implement controlled variables seem to base their conclusions off data from small participant sample sizes (Whelan & Johnson, 2018).

There is also evidence of psychiatric and psychological treatment potential with psilocybin. There are identifiable links between psilocybin and improvements in depression, anxiety, substance use disorders, and symptoms associated with eating disorders (Bogenschutz et al., 2015; Carhart-Harris & Goodwin, 2017; de Veen et al., 2017; Foldi et al., 2020; Goldberg et al., 2020; Johnson et al., 2017; Li et al., 2022; Spriggs et al., 2021). Researchers have not

reached a consensus about the mechanism of change with psilocybin, but symptom reductions in psychological dysfunction seems to be connected to a rapid downregulation of serotonin receptors and changes in functional connectivity across brain systems (Daws et al., 2022; Nichols et al., 2017; Preller et al., 2020).

Psilocybin may have other benefits for people who do not experience symptoms of disordered behavior. Even in the previously mentioned studies that evaluate mystical experiences, participants reported effects that extend past spirituality, and some continued to rate their experience as "having substantial personal meaning" and experiencing "sustained positive changes in attitudes and behavior" (Tylš et al., 2014, p. 348). One classic study known as "The Good Friday experiment" had participants receive either a dose of psilocybin or an active placebo before attending a Good Friday Mass (Pahnke, 1963). This study has since been replicated with some methodological adjustments. Not only did the participants who received psilocybin in these studies endorse having had a meaningful mystical experiences (Griffiths et al., 2006; Pahnke, 1963), but also asserted that their participation in the study led to sustained psychological benefits over 20 years later (Doblin, 1991; Elsey, 2017). This included a deeper sense of gratitude and appreciation for life and nature, as well as an enhanced sense of joy and appreciation concerning emotions and novel experiences (Doblin, 1991; Elsey, 2017). In small doses, psilocybin is also associated with increases in Openness and Extraversion personality traits and subsequent decreases in Neuroticism, even at three months after interventions (Erritzoe et al., 2018; MacLean et al., 2011). Many anecdotal claims exist that psilocybin boosts creativity, and one study by Prochazkova and their colleagues (2018) found that this may be related to increases in divergent thinking and convergent thinking associated with psilocybin use. The researchers said improvements in divergent thinking were demonstrated by problem-solving that

required enhanced cognitive flexibility, and that improvements in convergent thinking were measured with participants' ability to solve problems that required a greater ability to focus (Prochazkova et al., 2018).

**Potential Risks of Psilocybin**

There are many potential uses for psilocybin, but there are risks that must be considered as well. People who have not used psilocybin before or who take psilocybin in an unsupervised setting may react in a dangerous manner that puts themselves or other people at risk of physical harm (Johnson et al., 2018). Some individuals may find that they dislike the effects of the drug or find them frightening, which can lead to what is called a "bad trip." This describes a phenomenon in which a person might have psychologically difficult and/or emotionally challenging responses to the effects of psilocybin (Carbonaro et al., 2016; Johnson et al., 2008). Emotionally challenging experiences with psilocybin may have indirect benefits. There is evidence to support that while people who endure challenging experiences with psychedelic medicine find it emotionally painful and unpleasant, they often rank the experience as one of the most, if not the most, "personally meaningful and spiritually significant events" in their lives (Carbonaro et al., 2016, p. 1271). It seems that the majority of people (84%) who have had bad trips endorse having benefited from the especially difficult portions of their sessions, and a nearly half shared that they would wish to repeat their entire session if given the opportunity, including the challenging parts (Carbonaro et al., 2016). However, people who have had bad trips often share that the experience was one of the most emotionally difficult experiences of their lives (Carbonaro et al., 2016), and indirect benefits of bad trips do not negate the risks for upsetting or traumatic emotional experiences. Risks of dangerous behavior and bad trips can be

mitigated and/or deescalated with supportive information sessions prior to use, supervision during use, and debriefing (or integration) sessions after use (Johnson et al., 2008).

Along with psychological risks, there are medical risks that warrant further attention. Because there are serotonin receptors in the circulatory system that can get downregulated with psilocybin use, it is possible that frequent use may contribute to cardiovascular damage (Ghuran & Nolan, 2000; Kuypers et al., 2019) and hypertension (Aronson, 2014). While cardiovascular complications seem to happen infrequently and rarely life-threatening (Ghuran & Nolan, 2000), it is important to consider cardiovascular risk when one contemplates whether or not to use psilocybin or to recommend it to others, as this risk has not been robustly studied (Kuypers et al., 2019). Psilocybin also has the potential to exacerbate existing psychiatric problems (Aronson, 2014) or to trigger the onset of psychotic disorders in those who are genetically predisposed (van Amsterdam et al., 2011). These psychiatric complications are also rare (van Amsterdam et al., 2011), but they underscore the value of regulated psilocybin use with robust screening protocols that could mitigate risks in people who might otherwise use psilocybin independently.

In addition, there are also potential legal consequences that threaten those who own, consume, or distribute mushrooms that contain psilocybin. These risks are decreasing in some places that have decriminalized psilocybin use, such as Denver, CO or in places that have legalized medical use of psilocybin, such as Portland, OR. However, psilocybin remains federally illegal in most places around the world (Sheppard, 2021).

**The Changing Paradigm of Psilocybin**

The zeitgeist around substance use, including psilocybin, is changing. Modern society has become more open to and accepting of medicinal and recreational uses of some drugs (e.g., cannabis), and to the decriminalization and scientific investigation of other drugs, including

hallucinogenic substances. This trend is noticeably different than previous decades, in which the "war on drugs" raged and substance use carried social stigma ("War on Drugs," 2020). Cannabis illustrates this type of shift in public opinion particularly well, and demonstrates how changes in perception is connected with widespread changes in drug policy and actual use. For example, the perceived risks associated with using cannabis are decreasing steadily (Davis, Agin-Liebes, et al., 2021; Hallock et al., 2013) and the therapeutic effects of cannabis are being explored with newfound exuberance within the scientific community (Carliner et al., 2017; Earleywine, 2002; Levy et al., 2021; National Academies of Sciences and Medicine, 2017). This change in perception coincided with the widespread legalization of recreational cannabis use in many states (Levy et al., 2021). It is important to note that legalization has allowed for an increase in rigorous investigations of cannabis's therapeutic potential (Levinsohn & Hill, 2020), and may provide more opportunity to learn about the people who actually use cannabis. Research post-legalization likely provides a more robust knowledge base about cannabis consumers than pre-legalization, as participants seem to feel a higher level of safety and security in honestly answering questions about their use (Hammond et al., 2020).

While psilocybin may not follow the exact same trajectory as cannabis regarding the liberalization of laws, decriminalization and increased social acceptance may lead to changing patterns in psilocybin use. In 2018, an estimated 9.68% of US adults had tried psilocybin at least once in their life (Yockey & King, 2021). This rate seems to be increasing modestly, with only 8.5% of US adults reporting lifetime use in 2016 and 8.8% in 2017 (Center for Behavioral Health Statistics and Quality, 2018). Psilocybin is beginning to garner attention in a manner that is reminiscent of the public shift in opinion tied to cannabis use, and has resurfaced in the literature at a striking rate (Mayer et al., 2022; Pollan, 2018; Tylš et al., 2014). Possible therapeutic effects

of psilocybin became a topic of discussion in the scientific community in the 1960s, but the perception of psilocybin began to change in the 1970s and it was subsequently classified as a schedule-I drug. This effectively stunted therapeutic research going forward. In the late 1990s, perception began to change yet again and research on the possible therapeutic benefits of psilocybin was thus rejuvenated in response. Human research, in particular, became increasingly common in psychedelic-drug research as the long-term safety of psylocibin has continued to be documented in the literature (Nichols, 2016; Tylš et al., 2014), and concerns for addiction potential have been contested (Nichols, 2016; O'Brien, 2006).

Despite increasing prevalence, research interest, and changing legal status, the scientific community knows little about existing psilocybin use. Furthermore, there is a lack of comprehensive information about the people who use any kind of psychedelic drug, despite sharp upticks in scientific exploration of medicinal and psychotherapeutic uses for hallucinogenic substances (Johnstad, 2021). Thus, it is important to understand how people are using psilocybin and the sequelae associated with various types of use.

**New Patterns Emerging**

As mentioned before, the societal perception of psilocybin has changed over the last 50 years, which lends itself to further research focused on its potential uses and more underground exploration of the substance in the general population. One particular method of use garnering much interest is the practice of "microdosing," which is when an individual uses such small, or "micro," doses of a hallucinogenic drug that they do not elicit noticeable, psychoactive effects (Kuypers et al., 2019). With psilocybin, a microdose is considered somewhere between 5% and 10% of what would be a threshold dose, which is the minimum dose required for a person to start experiencing perceivable effects of psilocybin (Kuypers et al., 2019). Threshold doses are

estimated to start at about 0.25 grams, or .01oz (Erowid, 2015), indicating that a microdose would be around 25 milligrams. A person's exact threshold dose (and the corresponding microdose) differs depending on physiology, the strain of mushroom from which the psilocybin comes from, and a number of other factors (Passie et al., 2002; Tylš et al., 2014). As noted before, psilocybin use has been connected to improvements in various psychological disorders, dysfunctional behaviors, adaptive changes in Big 5 personality traits, and creative thinking, and many of these changes seem to be present in people who ingest microdoses of psilocybin (Albayrak, 2019; Cameron et al., 2020; Erritzoe et al., 2018; Johnstad, 2018; Lea et al., 2020; MacLean et al., 2011; Prochazkova et al., 2018).

Microdosing may not be a new phenomenon, but it is at least newly common in the modern zeitgeist and the benefits are still being studied. However, microdosing as a practice demonstrates that psilocybin use is not the same for all people who ingest the substance, and there may be differing schools of thought about how psilocybin could or should be used.

**Distinct Psilocybin Use Patterns**

As there are many theoretical applications for psilocybin, which range from spiritual experiences to alleviating symptoms of anxiety and depression, it is likely that there are multiple subgroups of people who use psilocybin in distinctive ways. It is important to note that while interest for psilocybin is increasing in media, scientific literature, and in the general public, there is yet to be a consensus on what "typical" or "standard" use is (Johnstad, 2021). As such, there is limited information about what effects people are experiencing with "standard" use. In addition, there have yet to be studies that establish whether or not there are distinct profiles of people who use psilocybin, and whether those hypothetical profiles are connected to distinct patterns of use. As research continues to evolve in this domain, it is important to have a better understanding of

the types of people already using psilocybin, the dose and frequency that utilize, and the perceived purpose it serves in their lives.

# METHODS

## Participants

All people above the age of 18 who could provide consent and reported having used psilocybin in their lifetime were invited to participate. These participants were recruited from 31 subreddit pages, including r/RationalPsychonaught, r/microdosing, r/PsychedSubstance, r/Mushrooms, r/Nootropics, r/Psychedelic. See Appendix H for a complete list of subreddit recruitment sites. The rationale of utilizing Reddit in data collection was due to it being one of the most frequently visited websites in the world, with over 50 billion monthly views and over 52 million daily users in January of 2021 (Reddit Inc., 2021). Recruitment from such a massive userbase seemed to allow for a large number of people with diverse backgrounds to participate in the study. Figure 1 (below) displays a participant flow. I recruited 1079 participants, of which 778 consented and met inclusion criteria. One participant was removed from the analytic sample due to having three or more incorrect responses to the attention check questions, which were pulled from the Infrequency Scale (e.g., I believe that most light bulbs are powered by electricity; Chapman and Jean, 1976). Of the remaining 777 participants, 113 participants were not included in the final model (n=664) due to missing data about their frequency and quantity of psilocybin use. In exchange for their participation, participants were given the option to enter a $100 gift card raffle.

Participants were mostly White (83.1%), male (67.2%), and from the United States (75.6%). Participants reported a median age of 28 years. Full sample demographics are reported in Table 1. 558 (84.0%) reported psilocybin use in the past year, with 405 (61.0%) using in the

past 3 months. 114 (17.2%) reported using psilocybin between 1 and 3 months prior, 334 (50.3%) reported psilocybin use in the past 30 days, and 8 (1.2%) reported daily use.

## Materials

At the time of this study, there are no established surveys for gathering information about psilocybin quantities, frequency of use, reasons for use, or positive and negative consequences of use. There is also a lack of visual tools available to assist participants gauge the quantities they use. Although visual aids certainly do not eliminate significant estimation errors in self-reported data (van der Pol et al., 2013), there is evidence that these charts and photographs sometimes help people estimate the quantities of different substances they use with better accuracy when objective measurements are not available (Kaskutas & Kerr, 2008; Ocke et al., 1997). Due to these limitations, this study utilized modified versions of existing survey tools that measure use of other substances.

### 1. *Psilocybin Use Questionnaire (PUQ)*

Participants self-reported the frequency with which they ingest psilocybin and the estimated quantities they ingest (in grams) in each session using a modified version of The Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU), which was originally designed to measure cannabis use in an undergraduate population (Cuttler & Spradlin, 2017). For this study, the DFAQ-CU was adapted to measure psilocybin use and will be referred to herein as the Psilocybin Use Questionnaire (PUQ). The PUQ is a 27-item, self-report questionnaire that gathers information about participants' lifetime use of psilocybin. The questions in the original DFAQ-CU have been shown to be reliable measures of frequency, age of onset, and quantity of marijuana and concentrates used by participants (Cuttler & Spradlin,

2017). Adaptations in the PUQ were designed to attempt to preserve reliability. Examples from the PUQ include "*Which of the following best captures the number of times you have used psilocybin in your entire life?*" and "*Which of the following best captures the average frequency you currently use psilocybin*?" The answer options provided are a combination of multiple choice, dichotomous "yes/no" responses, behavioral frequency reports, and open-ended options. Data from this survey was included as indicator variables during analysis. See Appendix B for the full survey.

Questions 15 -19 asked the participants to indicate an amount of psilocybin that they have consumed in certain contexts. Above these questions is a chart and 3 photographs that are designed to help participants who might be uncertain about the quantities they consume to provide an estimate of the amount of psilocybin they ingest. The provided chart and photographs replace the original photograph in the original DFAQ-CU that depict various amounts of cannabis with which participants could base their answers and estimations about quantities. The photographs in the PUQ depict psilocybin-containing mushrooms in various forms and doses. The information in the chart ranges from "Threshold" to "Heavy" doses of psilocybin, and is based on information gathered from the Erowid Center (Erowid, 2015). To my knowledge, the PUQ is the first measure to include photographs of different quantities (¼ gram, ½ gram, ¾ gram, 1 gram, 1¼ grams, 1½ grams, 1¾ grams, 2 grams) of actual psilocybin-containing mushrooms in loose, dried form and in pill form to assist participants with estimating the quantity of psilocybin they typically use. It is also the first to include isolated photos of three different iterations of a threshold dose (¼ gram) in an effort to demonstrate to participants at which dose perceivable effects may begin.

2. *Reasons for Psilocybin Use Questionnaire (R-PUQ)*

Participants were asked to self-report their reasons for ingesting psilocybin using a Reasons for Psilocybin Utilization Questionnaire (RPUQ), which is a list that was adapted from the work of Lake and their colleagues (2020). This is a list of reasons that participants can select multiple answers from that align best with their motivations to consume psilocybin. Participants were able to choose as many reasons as they wished to share, and they also had an "other" option to write in reasons that were not represented in this list. Data from the RPUQ was included as indicator variables during analysis. See Appendix C for the full inventory.

This 14-item inventory is based on the findings of a previous study investigating reasons for cannabis use. Using latent class analysis of self-reported data, they identified 9 discrete reasons for which participants in their study would ingest cannabis (Lake et al., 2020). In the present study, these reasons for use are mapped onto similar purposes people may choose to use psilocybin, including pain management, substance substitution, stress management, management of mental health concerns, spirituality, creativity, and social/ recreational consumption.

The original study on cannabis use motivations that developed the original list used a sample consisting of marginalized people who ingest cannabis in combination of a variety of other "illicit" drugs (Lake et al., 2020). However, this study aims to understand psilocybin use in any people who report ingesting psilocybin. Information related to participants' personal identities, socioeconomic status, and use of other substances is still of interest to this study, but these elements were examined as auxiliary variables and were not targeted during participant recruitment. Please see the Analysis section for more information.

In order to capture accurate data from the sample, additional reasons for use that are reported across the literature for psilocybin, but not cannabis, are incorporated in this list. This includes promotion of mindfulness and managing addiction (Lea et al., 2020; Webb et al., 2019).

Some cannabis use reasons that were not documented in the literature surrounding psilocybin and were not included in the inventory. This includes sleep management, assistance with HIV medications and AIDS symptoms, and management of nausea or loss of appetite.

3. *Consequences of Psilocybin of Use Questionnaire (C-PUQ)*

Participants were asked to indicate information about negative consequences they might have experienced as a result of psilocybin use with a modified version of the Brief Marijuana Consequences Questionnaire (B-MACQ), which will be referred to in this study as the Psilocybin Consequences of Use Questionnaire (C-PUQ). The C-PUQ is a 29-item, self-report questionnaire that gathers information about consequences related to consuming psilocybin. Most questions can be answered with a binary "Yes/ No" response. Examples from the C-PUQ include "*I have been unhappy because of my psilocybin use*" and "*I haven't been as sharp mentally because of my psilocybin use.*" The original Brief Marijuana Consequences Questionnaire (B-MACQ) was designed with cannabis in mind, which has different effects and legal status than psilocybin. Thus, the final question of the C-PUQ ("*I have experienced other consequences from my psilocybin use that are not listed here*") was added to capture information about consequences of psilocybin utilization that are not represented in the original B-MACQ. This question is also answered with a binary "Yes/ No" response, but if participants answered "Yes," they were prompted with a free-response question to indicate what consequences to which they are referring ("*What consequences?*"). Information gleaned from this survey was used as auxiliary variables in the statistical analysis. See Appendix D for the full survey.

4. *Benefits of Psilocybin of Use Questionnaire (B-PUQ)*

Participants responded to questions pertaining to potential benefits and other desirable outcomes they may have experienced as a result of psilocybin use with the 20-item, self-report Psilocybin Benefits and Outcomes of Use Questionnaire (B-PUQ). The first 12 items of the B-PUQ are modeled after the Positive Drinking Consequences Questionnaire (PDCQ), which was developed to assess specific, positive drinking consequences in college students (Corbin et al., 2008). These questions list several examples of a potential benefit that a participant may have experienced because of psilocybin use and participants were instructed to respond with "yes" or "no." Examples from the B-PUQ include "*I revealed a personal feeling or emotion that I had previously kept secret.*" and "*I found a creative solution to a problem I might otherwise have had difficulty solving.*" The original PDCQ was intended to capture data concerning the benefits of cannabis use, which has different effects and legal status than psilocybin. Because of this, the 13th question of the B-PUQ ("*I have experienced other benefits from my psilocybin use that are not listed here*") was added to capture further information that might not be represented elsewhere in the BPOQ. This question is also answered with a binary "Yes/ No" response, but if participants answer "Yes," they are prompted with a free-response question to indicate what consequences to which they are referring ("*What consequences?*").

Questions 14 through 20 are based off a 2006 study, in which the researchers aimed to evaluate both negative and the positive outcomes of real-world cannabis users (Hammersley & Leon, 2006). Participants in their study were asked to answer several questionnaires, one of which asked them to rate how strongly they agreed with statements about the impact that cannabis in multiple domains of their lives using a 5-point Likert scale. Examples from the B-PUQ that are modeled after Hammersley and Leon's (2006) work include "*Psilocybin has helped*

*me cope in difficult times*" and "*My health has benefited because of psilocybin*." Information gleaned from this survey was included as auxiliary variables in the statistical analysis. See Appendix F for the full survey.

**Procedures**

The research team posted recruitment posts on various community pages on Reddit.com. Interested participants clicked a link that routed them to a consent cover letter. After providing informed consent, they were prompted to answer screening questions. Eligible adults then completed the Psilocybin Use Questionnaire (PUQ), the Reasons for Psilocybin Use Questionnaire (R-PUQ), the Benefits of Psilocybin Use Questionnaire (B-PUQ), and the Consequences of Psilocybin Use Questionnaire (C-PUQ). After completing their responses, they were provided with the option to enter an email address where their prize could be sent to if they were randomly selected in for the gift-card raffle. Participation in this study was completely voluntary, as was the gift-card raffle. In an effort to maintain anonymity and strengthen participant's trust that their contact information could not be connected to their survey responses, email addresses were collected and stored separately from their survey responses.

After data collection, survey responses were evaluated using LPA to assess whether or not distinct profiles psilocybin use. See the analysis section of this document for more detail on this process. Raffle winners were also selected at this time. Using the compiled list of email addresses that participants opted to provide, one winner out of every 100 participants was randomly selected to win a $100 Visa gift-card. As I received 501 participant email addresses for the raffle, the number of winners was rounded down to 5 winners down because the sample was under 50 participants past the threshold. Microsoft Exel's random selection function was used to select the raffle winners (Microsoft, 2021).

# ANALYSIS PLAN

## Overview of Latent Profile Analysis

This study aims to identify latent (i.e., unobserved) patterns of psilocybin use. I also aimed to examine whether profiles differed on frequency and quantity of psilocybin use , as well as undesirable psilocybin-related consequences, beneficial psilocybin-related outcomes, and reasons for use. Latent Profile Analyses (LPA; cf. Berlin et al., 2014) were conducted in Mplus version 8.0 (L. K. Muthén & Muthen, 2017) with one psilocybin use frequency variable and one psilocybin use quantity variable as indicator variables.

Latent Profile Analysis (LPA), also known as "gaussian mixture modeling" (Oberski, 2016) is a statistical method used to identify and compare patterns of individuals' responses across variables instead of assessing the relationship between the variables themselves. In general, mixture models can be used to identify the various response patterns, referred to as "latent profiles", from a larger population (B. Muthén & Muthén, 2000; Tein et al., 2013). LPA is similar to cluster analysis, but the primary advantage of LPA is that it calculates a probabilistic membership for each participant in all profiles rather than grouping and assigning them to any one profile (Tein et al., 2013). Because no cases within the sample are ascribed to specific profiles, results from LPA are more generalizable to cases outside the dataset and there is less risk of overgeneralizing results from the present sample to the broader population. (Prince & Fidler, 2021). Thus, the results of LPA are better for theoretical speculation about the nature of the clustering, rather than describing the clustering.

## Statistical Power and Sample Size Justification

Regarding sample size considerations for LPA, Lubke and Neale (2006) conducted simulations that demonstrated that when the classes were particularly dissimilar (i.e., large separation between classes), a sample with as few as 25 participants could produce the appropriate class structure in 90% of their simulations with adequate signal strength. With small separation between classes (i.e., when the latent classes were not very different from one another), the simulations were able to distinguish meaningful latent profiles with a sample size of just 150 87% of the time with unadjusted fit indices and up to 98% of the time with adjusted fit indices. This simulation study provides a strong indication that as few as 150 responses would be sufficient to conduct the proposed analyses regardless of the degree of separation between latent classes (Lubke & Neale, 2006). The present sample of N = 664 of people reporting any lifetime psilocybin use is sufficient for the study aims.

**Fit Indices**

LPA has two primary steps. First, I used Mplus to run 1- through 4-profile models. Then I evaluated the overall model fit statistics of each model and selected the best fitting solution. For the latter step, I followed the best-practice recommendations of Spurk and colleagues (2020). They conclude that it is best to apply many variations of multiple fit values and considering each model's content decision criteria in making a finalized decision on the best profile solution. They offer a hypothetical order of events with which one can make decisions, which they base on the work of Ram & Grimm (2009).

First, they recommend an evaluation of estimation outputs for obvious errors, faulty parameters, and theoretical plausibility (Spurk et al., 2020) . Their instructions then advise comparing all remaining models using relative fit indices. For this study, I used the sample-adjusted Bayesian Information Criterion (saBIC; Schwarz, 1978), which is an information index

based on log-likelihood and the number of parameters used. Lower values of the saBIC indicate better model fit (B. Muthén & Muthén, 2000). It was particularly suited for this study as it produces the best models with increasing sample size. In traditional BIC, smaller sample sizes can lead to testing errors that result in fewer profiles being identified. Sample-adjusted BIC circumvents this issue, however by not penalizing the results for lower sample sizes (Morgan, 2015; Sclove, 1987; Spurk et al., 2020). This is an advantage as saBIC maximizes likelihood ratio statistics while rewarding parsimony, which is better for generalization. As this study was initially proposed to have anywhere between 150 to 1,000 participants, the saBIC was the most appropriate testing choice that would account for a wide-ranging sample size. Spurk and their colleagues (2020) then suggest to evaluate all models within the context of how much confidence one can classify participants as belonging to one group or another (e.g., entropy). Entropy values range from 0 to 1, with higher values indicating better classification quality (Celeux & Soromenho, 1996). It is generally agreed that values greater than 0.80 are considered to have appropriate classification quality (Jung & Wickrama, 2008). It is also recommend to compare different likelihood ratio tests using auxiliary variables, which quantifies specific comparisons between various models with differing numbers of profiles (Spurk et al., 2020). For this, I selected the Lo-Mendall-Rubin likelihood ratio test of model fit (LMR; (Lo et al., 2001) based on the recommendations from Muthén & Muthén (B. Muthén & Muthén, 2000). The LMR compares a designated model with k profiles with another model with k-1 profiles (e.g., comparing a model with k=2 profiles to a model with k=1 profiles). The LMR tests the statistical probability that the data would be best explained by the model with k-1 profiles (i.e., a significant p-value indicates that the k-profile model is a better fit than the k-1-profile model). The average latent profile probabilities are for the most likely profile membership by latent

profile discrimination. When these indicate a well-fitting model, the values should be close to 1 in the primary diagonal and values in off-diagonal should be close to 0. These values provide an index of how likely the individuals within a latent profile belong in that profile. (i.e., a values equal to 0.50 would mean that individuals fit equally well in more than one profile.)

Decisions about the final model were made after considering the goodness of model fit indices, as well as the equally important elements of parsimony and substantive interpretability of the model. I then compared the profiles using the BCH method (Asparouhov & Muthén, 2014; Bakk & Vermunt, 2016). This decision was founded on the BCH method accounting for the probabilistic natures of certain profile memberships and allows for both global and pairwise comparisons can be conducted using Wald tests. Wald tests employ Chi-square ($\chi^2$) for comparing latent profiles with posterior probability- based multiple imputation strategies (Clark & Muthén, 2009). An advantage of this method is that these analyses are conducted simultaneously with LPAs and allow consideration of the probabilistic profile membership of participants to control error.

**Auxiliary Testing**

During analysis of the data, variables measuring dose and frequency of psilocybin use acted as indicators of profile identification (i.e., the categories that participant data were separated into were determined by the amount of psilocybin participants consume and how often they consume it). Demographic information, such as race, socio-economic status, gender, sexual orientation, and education were included as auxiliary variables, which strengthen our ability to predict which profile a participant may fall into. Other auxiliary variables included whether or not participants use psilocybin in combination with other drugs, what reasons participants

endorse for using psilocybin, and whether or not they have experienced any perceived consequences of psilocybin use.

**Data Visualization**

Data visualization is a broad term to describe the illustration of data (Few, 2009). According to Hallgren and colleagues (2019), data visualization is a useful tool for enhancing the impact and transparency of statistical analyses and is underused across the literature. Tuft (E. R. Tufte, 1985) considers effective data visualization to convey complex ideas clearly, efficiently, and with precision. Thus, visual representations should not be confusing, overcomplicated, or misleading, and should function to help the reader understand the concepts and theoretical implications of one's result. Using Tuft's (Tufte, 1985, 2001, 2006) principles for graphic excellence and integrity, I created univariate and multivariate visualizations of my analyses using the ggplot2 (Morgan-Wall, 2020), rayshader (Morgan-Wall, 2020), and magick (Ooms, 2021) packages within RStudio (R Core Team, 2022). I also used the online application *SandkeyMATIC* (Bogart, 2022) to demonstrate the participant flow from initial response to the recruitment ad to the final analytic sample. As previously mentioned, participants were assigned ranked probabilities for their membership to each profile as a post-hoc procedure to the LPA. Each illustration of profile-specific distributions was created using participants' factor scores (i.e., the probability of class memberships), which was calculated in Mplus (L. K. Muthén & Muthen, 2017) and imported into R (R Core Team, 2022).

The average values of each profile indicator (i.e., psilocybin use frequency and quantity) are presented in a histogram plot (Figure 2) rendered with Microsoft Excel (2021). In an effort to emulate Tufte's (2001) principle of encouraging valuable comparisons, I also rendered two-

dimensional figures showing the distributions and count densities of each indicator variable in the total sample (Figures 3 and 4) and across the profiles (Figures 5 and 6).

As two-dimensional graphics only represent one profile indicator variable at a time, information concerning class separation was less apparent in Figures 5 and 6. As such, I also created a three-dimensional representation of the psilocybin use frequency and quantity count density across the profiles with facet wrapping, as well as a supplementary, two-dimensional model with heat mapping (Figure 7). A potentially misleading aspect of facet wrapping is that it can exaggerate the class separation. To illustrate the class separation/overlap, I created another three-dimensional representation of the count density of psilocybin use frequency and use quantity for the overall sample and a supplementary two-dimensional model with heat mapping (Figure 8).

Tuft (Tufte, 1985, p. 87) encourages the use of visual tools that deliver as much data as possible with "the least ink in the smallest space." As such, profile comparisons concerning the number of psilocybin use reasons, benefits, and consequences are compared to each profile indicator as boxplots (Figure 9, 10, and 11). These graphs are concise, visual summaries of auxiliary variable distributions across the profiles. They also carry the advantage of clearly displaying potential outlier values.

# RESULTS

## Fit Indices

Fit indices for 1- through 4-profile models are presented in Table 2. Using the guidelines stated above, I determined that the 3-profile model fit the data best. The LMR test results suggested that the 2-profile model was a better fit than the 1-profile model ($p = 0.00$), the 3-profile model was a better fit than the 2-profile model ($p = 0.00$), and that the 4-profile model was a poorer fit than the 3-profile model ($p = 0.09$). Entropy (a measure of classification quality) was within the acceptable range in all models, but did deteriorate in the 4-profile model, dropping below .90. In addition, the saBIC dropped by 207 points from the 2- to 3-profile model, only and additional 37 points to the 4-profile model. Finally, the 3-profile model was substantively interpretable and more parsimonious than the 4-profile model.

## Final Model

There were three distinct profiles of psilocybin use. The Chipper Profile (n =118) was associated with psilocybin use approximately 1-4 times a year and quantities of between 0.75 and 1.0 grams of dehydrated, psilocybin containing mushrooms. The Tripper Profile (n =428) was associated with using psilocybin between 2 and 6 times a year and self-reported quantities between 2g and 4g of dehydrated, psilocybin containing mushrooms. When compared to the first two profiles, the Microdose Profile (n =118), reported substantively higher psilocybin use frequency (2 - 4 times a week) and a lower range of quantieies than the other profiles (.25g - .75g).

The BCH and DCAT test results are presented in Tables 3 and 4, respectively. The Chipper Profile was connected to the fewest benefits of use, the fewest reasons for use, and the

youngest age of use onset (21.2 years). The Chipper Profile was also associated with the fewest lifetime uses. This was measured with the PUQ 8 *("Which of the following best captures the number of times you have used psilocybin in your entire life?"*), which provides binned ranges of numbers. The average score of the PUQ8 for the Chipper Profile was 2.1, meaning that participants who were most likely to be members of the Chipper Profile reported using psilocybin between 6-10 times (choice 2) and 11-50 times total (choice 3), but that this value was closer to the 6-10 value. The Chipper Profile also seemed to be more associated with the mid-range of the observed ages, with an average age of 30 years old. In addition, participants who were most likely to be included in the Chipper Profile reported having used psilocybin about 1-5 times total in their life. The Tripper Profile tended to include more men and was associated with the youngest participants, with an average age of 27.6 years old. Similar to chippers, those who were most likely to be trippers reported their lifetime use as between choice 2 (6-10 lifetime uses) and choice 3 (11-50 times) on the PUQ 8. Their score (2.4) was significantly higher than that of the chippers, indicating that the true value of their total lifetime use values were closer to 11-50 than the chippers. The Microdose Profile was connected to a slightly higher income (between $50,000 - $100,000), more participants reporting being employed, and using psilocybin earlier in the day. The participants who were most likely members of this profile tended to be older than the other two profiles, with an average of 35.6 years old. Microdosers were also associated with the latest age of psilocybin use onset, with its most likely members reporting having tried psilocybin for the first time an average of 26.9 years old. This profile was also characterized by the highest number of lifetime uses, with a PUQ8 score of 4.0 (between 51-100 lifetime uses). In addition, the most likely members of the Microdose Profile tended to report using psilocybin sooner after waking up (44% within 1-3 hours of waking.)

Notably, the profiles showed no differences in the number of negative consequences experienced (Figure 9). In addition, none of the profiles differed significantly in race, ethnicity, US citizenship, identifying with a gender binary, or religious status. There were also no differences concerning legal status of psilocybin where participants were living, though the differences between the Tripper and Microdose Profiles was trending towards significance ($p=0.07$).

**Data Illustration**

The fit indices indicated that the 3-model solution was most appropriate, but there was some degree of overlap between the profiles concerning the profile indicators (i.e., psilocybin use frequency and quantity). Data visualization is thus helpful in articulating the defining features of the observed profiles.

Estimated means for each profile indicator are presented as a histogram plot in Figure 2, which I created to highlight the primary differences and defining indicators of each profile. The Microdoser Profile is described by very frequent use of small quantities and the Tripper Profile by high psilocybin quantities. While the Chipper and Tripper Profiles have similar use frequencies, Figure 2 demonstrates that the Chipper Profile is defined by use quantities that would elicit a milder hallucinogenic experience than those seen in the Tripper Profile (Erowid, 2015).

The distributions and sample densities of psilocybin use frequency and quantities (up to 15 grams of dehydrated mushrooms) are presented for the total sample in Figures 3 and 4, respectively. In each of these images, the distributions are noticeably non-normal and/or multimodal, which is to be expected with the observance of multiple latent profiles. However, the three-class solution is not clearly apparent in the total sample, as the Tripper Profile was

nearly twice as prevalent as the other two profiles combined and appears to influence the distributions. Thus, the distributions and sample densities of each profile indicator in each profile are provided in Figures 5 and 6 to present class separation.

Two-dimensional density plots are useful as univariate visualizations; however they convey limited information concerning multivariate mixture models. As such, I created three-dimensional density plots depicting psilocybin use frequency and quantity distributions and two-dimensional heat maps. These images serve as useful comparisons of the profile distributions and that of the total sample (Figures 7 and 8, respectively). In Figure 7, the most common response patterns are represented with yellow and the least frequent responses with black. In Figure 8, the more frequent response patterns are represented with red and the least common response patterns with light blue. Figure 8, in particular, demonstrates that the Microdoser group is wholly distinct from the other two profiles, which share some overlap with respect to psilocybin use frequency.

Finally, the total numbers of psilocybin use reasons, benefits, and undesirable consequences associated with each profile are compared as boxplots Figures 9, 10, and 11. There is considerable overlap between all profiles concerning these auxiliary variables. However, it is apparent in Figures 9 and 10 that the most likely members of the Tripper and Microdoser profiles report more reasons to use psilocybin and experience more benefits from their use than those of the Chipper Profile. In addition, each profile appears to have approximately equal distributions of negative consequences with the exception of outliers in all profiles (Figure 11).

# DISCUSSION

There is increasing interest in psilocybin due to both the potential medicinal and therapeutic benefits and the potential risks associated with use of the substance. Potential medicinal and therapeutic benefits include improvements in treatment-resistant cluster headaches and migraines (Johnson & Griffiths, 2017b; Schindler et al., 2021; Sewell et al., 2006) and psychological disorders such as depression, anxiety, substance use disorders, and symptoms associated with eating disorders (Bogenschutz et al., 2015; Carhart-Harris & Goodwin, 2017; de Veen et al., 2017; Foldi et al., 2020; Goldberg et al., 2020; Johnson et al., 2017; Li et al., 2022; Spriggs et al., 2021). In contrast, high doses of psilocybin can have adverse effects including severe anxiety while under the influence of the substance (i.e., a bad trip) or exacerbation of psychotic disorders (Aronson, 2014; Johnson et al., 2008; van Amsterdam et al., 2011). Moreover, risks associated with regular use may include damage to the cardiovascular system via repeated activation of the $5HT_{2B}$ serotonin receptor (Kuypers et al., 2019). While research on psilocybin use has been steadily increasing and use prevalence has been increasing, much remains unclear about current psilocybin use outside of the context of clinical trials (Johnstad, 2021). One aim of this study was to determine whether there were distinct psilocybin use profiles based on frequency and quantity of use using latent profile analysis. The second aim was to explore what characteristics and outcomes of use distinguish each use pattern using auxiliary testing. I observed three latent profiles of psilocybin use based on self-reports of frequency and quantity of use, which differed on the total number of psilocybin use benefits and reasons for use participants reported. There were also observed differences between the profiles with respect to

the participants' mean age, age of psilocybin use onset, income, gender, total lifetime uses, and use timing (i.e., number of hours after waking before using psilocybin).

The Chipper Profile, named after the kind of causal nicotine use seen in people who regularly smoke cigarettes but do not show symptoms of addiction (i.e., "chippers"; Shiffman et al., 1994), was associated with self-reported quantities between 0.75g and 1.0g of psilocybin between 1 and 4 times a year. This dosage range is at least .5g grams above a threshold dose but is within the range associated with "light" effects (Erowid, 2015). People who were most likely to be psilocybin chippers reported the fewest reasons for their psilocybin use, the fewest benefits of use, and the least frequent use of all the profiles (see Figures 9, 10, and 11).

The Tripper Profile was identified as using psilocybin only slightly more often than the Chipper Profile, but with substantially higher quantities, typically between 2 and 4 grams. Though the effects of dried psilocybin containing mushrooms vary person to person and are dependent on individual factors about the mushrooms themselves (Aronson, 2014), these quantities are known to have considerably strong, hallucinogenic effects (Erowid, 2015). Participants who were most likely to be in the Trippers Profile reported having more reasons to use psilocybin, experiencing more benefits of their use, and having used psilocybin slightly more often in their life than the chippers.

The Microdose Profile was associated with using lower doses of psilocybin compared to the other profiles, but much more frequently, as much as once a week. Participants who were most likely to be members of the Microdosing Profile reported using quantities between 0.25g and 0.5g, which is also above a threshold dose, but is consistent with fewer, less acute effects than are likely being experienced with the larger quantities described in the other profiles (Erowid, 2015). This use profile was associated with experiencing more benefits than the

Chipper Profile and the highest reports of lifetime psilocybin use. Item-specific evaluations of each benefit, consequence, and reason for psilocybin use among the three profiles is beyond the scope of this paper, however previous research has indicated that those intending to take "micro" doses may be partially motivated by a desire to increase productivity and creative outputs (Ona & Bouso, 2020; Webb et al., 2019). This may inform this profile's association with more full-time employees, slightly higher wages, and using psilocybin within 3 hours of waking.

Previous research has demonstrated a relationship between use motivations, expected outcomes, and use frequency for other substances, including cannabis (Anthenien et al., 2021), alcohol (Kuntsche et al., 2010), and nicotine (Patel & Fromme, 2010). In this study, the three observed profiles of psilocybin use were determined by frequency and quantity of use, but each differed in the number of reasons and benefits that were associated with each profile. This may be indicative of a relationship between participants' use expectancies and motives for psilocybin use. Psilocybin chippers seem to engage in occasional, light psilocybin use without as many positive expected outcomes compared to the other two profiles. This might be understood as a "special occasions" use pattern, in which the chippers use psilocybin casually. The Tripper Profile seems to describe those who are seeking experiences in which they can have much higher quantities, perhaps with the expectation of experiencing more beneficial use outcomes and/or having more salient experiences. The Microdose Profile is suggestive of individuals who regularly use psilocybin and also report experiencing more benefits than psilocybin chippers. Like the trippers, microdosers might have positive use expectancies connected a higher number of reasons to use psilocybin. Microdosing might be understood as an attempt to experience the potential benefits more frequently while minimizing the intoxicating effects of psilocybin with smaller doses.

Psilocybin use questionnaires have been developed with relation to mystical experiences (Barrett et al., 2015; MacLean et al., 2012), personally challenging experiences (Barrett et al., 2016), psychological insights (Davis, Barrett, et al., 2021), and the subjective effects on attitudes, mood, spirituality, and behaviors (Griffiths et al., 2011), but there is a paucity of research on the implications of psilocybin use in differing quantities and frequencies. Researchers that have included measurements of psilocybin use frequency and/or quantity in their studies have mostly investigated the effects of predetermined, specific quantities (i.e., micro or large quantities; Marschall et al., 2022; Rootman et al., 2022; van Elk et al., 2022). When exploratory approaches have been applied to clinical trials and metanalyses using any measure of psilocybin use frequency and quantity, researchers have mostly focused on identifying appropriate dose ranges for various disorders (e.g., depression, end-of-life anxiety; (Griffiths et al., 2016; Li et al., 2022 ) or evaluating the safety and subjective effects of psilocybin at differing quantities (Hirschfeld & Schmidt, 2021; Hodge et al., 2022; Studerus et al., 2011, 2012). Furthermore, their findings and conclusions have largely been based on data collected in controlled, laboratory settings. The present study is the first exploratory evaluation of self-reported psilocybin use frequency and quantity in existing psilocybin users. It is also the first to develop a battery of assessments measuring multiple dimensions of psilocybin use, (e.g., use frequency, preferred quantities, reasons for use, methods of use, positive and negative consequences of use), all of which may benefit research on health outcomes related to psilocybin use.

There are important implications underscoring the lack of differences between the use profiles in the number of negative outcomes experienced as a consequence of psilocybin use. Previous research has demonstrated that frequency and quantity of use predict negative use outcomes for people who use other substances, such as cannabis (Callaghan et al., 2020; Walden

& Earleywine, 2008; Zeisser et al., 2012) and alcohol (Coskunpinar et al., 2013; Saha et al., 2020). One qualitative study used self-reported data to define the consequences that participants experienced as a result of their psilocybin use, and the researchers found that high doses of psilocybin were associated with "bad trips" and that multiple psilocybin doses within the same session were linked to long-term problems (Bienemann et al., 2020). However, Bienemann and colleagues (2020) only analyzed reports of negative experiences and used frequency and quantity indicators to predict the *kind* of negative consequences participants reported. The nature of their data did not allow them to explore whether use frequency and use quantity indicators predict participants' risk of experiencing negative consequences in general. The present study moved beyond previous research by evaluating the relationship between psilocybin use frequency/ quantity and the occurrence of negative consequences. The results indicate that there is *not* a discernable connection. While there were negative consequences observed in each psilocybin use profile, the total number of negative consequences experienced by participants was not impacted by how much or how often they reported using. This sets psilocybin apart from other psychoactive substances that are known to be associated with higher risks of consequences with increasing use.

**Strengths**

The primary strength of this study is its large sample size and use of latent profile analysis. The nature of this approach ensures that no participants get assigned to a specific profile. Instead, their probabilistic membership is calculated for all profiles (Tein et al., 2013). This allows the results to be generalizable beyond the scope of this sample.

The recruitment methods also contributed to generalizability. Reddit is uniquely suited to gather information about unconventional substance use trends because it allows individuals to

connect with each other over common interests and to share their experiences openly with the protection of anonymity. As such, using it as the platform for recruitment posts encouraged participants from across the world to provide honest responses to questions they might otherwise be hesitant to answer. In addition, sourcing participants is an inexpensive method by which to gather large, quality datasets in a short amount of time. Data collection was complete within 2 months and only *one* participant was removed from the analytic sample for failing the attention check questions.

The use of innovative data visualization techniques contributes to the interpretability of the model. Concise, simple figures enhance the impact of structural models, as they allow for clear communication to those who might not have the training to otherwise understand statistical jargon (Hallgren et al., 2019; Tay et al., 2016). This is important, as psilocybin laws are changing. Those who are writing the laws that will inevitably impact future clinicians, clients, taxpayers, and other researchers need to understand the state of existing psilocybin use. Clear visualizations support data transparency, and they encourage future researchers to test the credibility of the results with replication (Hallgren et al., 2019; McCabe et al., 2018; Tay et al., 2016). This is essential, as public interest on psilocybin use seems to have outpaced the scientific research that should be informing it.

**Limitations**

The primary limitation of this study is that there are no existing, validated questionnaires to measure the dimensions of psilocybin use evaluated in this study (i.e., frequency of use, quantity of use, reasons for use, outcomes of use, age of use onset). Though I used previous research as a foundation for building my questionnaires, I was required to use new, untested tools for data collection. It is important to evaluate the validity of these questionnaires in future

research with psychometric testing. The next step in my research will be to examine the validity of my questionnaires using Exploratory Graph Analysis.

It is possible that this data does not represent the full range of use outcomes that exist for people using psilocybin. Previous research has shown that online surveys are vulnerable to self-selection bias (Khazaal et al., 2014) and this study may have attracted individuals who felt motivated to share positive experiences. Though Reddit is a large online platform with many users, not everyone who uses psilocybin is a member of these subreddits, or Reddit at all, and this sample does is not representative of everyone who has ever used psilocybin. As such, further research is needed to identify risk factors that predispose people who use psilocybin to negative use consequences. In addition, it is necessary to understand whether there are any protective factors or behavioral strategies for psilocybin use that could inform harm-reduction interventions.

The accuracy of self-reported data is not fully reliable, and the psilocybin quantities reported by participants should be interpreted with this in mind. Participants were provided with photographs of psilocybin-containing mushrooms in various amounts. Tools like this cannot guarantee accurate results, but they may be helpful to participants who don't have another metric by which to measure the amounts they had consumed. The photos likely did not help participants give *precise* answers about their preferred quantities of psilocybin, but they may have been helpful to participants to give more better *estimates* of how much they have used in the past. Previous research demonstrates that individuals tend to underestimate the amounts of cannabis (Prince et al., 2018), alcohol (Kaplan & Koffarnus, 2019), and nicotine (Gorber et al., 2009) they use. However, it seems that participant responses do seem to fall within consistent ranges of misestimation in these studies. This suggests that while the participants of this study likely did

not give accurate answers, they answered in a manner that would allow us to rank order the results (i.e., those who reported using smaller doses likely did use smaller amounts than those reporting using more).

In addition, it is difficult to determine how much psilocybin someone consumes, even with exact measurements of the mushrooms' weight. In their chapter overview of bioactive compounds in fungi, Mahmood (2013) explains that psilocybin content varies across species and increases with the age and maturity of the mycelium colony. They also note that psilocybin content may also vary depending on which parts of the mushrooms are used to estimate the overall content, and that content estimates have been known to vary as much as 10x in uncontrolled growing conditions (Mahmood, 2013). A similar problem arises in cannabis research, as there are also intra-plant and inter-varietal variations in THC content (Knight et al., 2010). In studies measuring cannabis, the cannabis-containing flower has been processed to circumvent this issue (Thomas & Pollard, 2016), whereas it remains unknown whether people who use psilocybin employ any tactics to standardize their doses.

Due to the nature of free response questions in some of the questions, there were instances of necessary data wrangling. This may have led to some data loss or imperfect interpretations. Decisions about the best way to approach some of the analyses were made with logic that was not codified in any of my sources. An important example of this was the data selected as the fit indicator for psilocybin quantities. Participants were prompted to enter a numerical value to represent the typical dose (in grams) of psilocybin that they used. The raw data of participant responses resulted in a range of up to 42 grams. In an effort to limit the effect of outliers, I decided to bin the data into dose ranges.

## Conclusions

Psilocybin is likely to become more easily accessible in research, clinical, and recreational settings, as interest in psilocybin continues to gain traction in the media and scientific literature. It is important that laws and clinical protocols be grounded in the context of what defines extant psilocybin use and what benefits and risks need to be taken into account for public safety. This study provides a foundation for understanding what patterns of psilocybin use exist in non-clinical settings and prompts future research to explore the relationships between psilocybin use motivations, expectations, and experiences of benefits and consequences of use.

My results demonstrate that there are three distinct profiles of psilocybin use indicated by quantity and frequency of psilocybin use. There were some differences across the profiles in age, income, gender identity, age of psilocybin use onset, employment, total lifetime uses, reasons for use, and benefits of use. Though negative consequences were observed across all profiles of psilocybin use, I did not observe any profiles based on frequency and quantity of psilocybin use that were more associated with negative consequences. More research is needed to understand what factors exist that impact one's vulnerability to experiencing negative outcomes.

This study is the first to identify a use profile that is distinct from high dose users and microdosers (i.e., chippers). Previous research has explored optimized psilocybin quantities for positive health outcomes (Garcia-Romeu et al., 2021; Li et al., 2022), but this study demonstrates that people who already use psilocybin seem to use in identifiable patterns connected to both dose *and* frequency. Microdosing has been rising in popularity as the topic of investigations, but I that found microdosers and chippers were equally represented in the data, and that tripping seems to be the most common kind of psilocybin use (Figure 8). Also, trippers seem to experience more benefits than chippers, but more research is warranted to explore how long

these benefits last and whether the consequences trippers experience are distinct to their use behaviors.

This study offers compelling data that warrants future research to investigate other profiles of psilocybin use, risk and protective factors that impact one's likelihood of experiencing negative outcomes, and factors that increase one's likelihood of experiencing beneficial outcomes of psilocybin use. It also emphasizes the need to develop valid measurements of psilocybin with psychometric testing.

TABLES AND FIGURES

Table 1. *Sample Demographics (N = 664)*

| **Variable** | **M (SD) / N(%)** |
|---|---|
| Age | 29.4 (9.3) |
| Age of First Use | 21.12 (8.0) |
| Gender | |
| Male | 446 (67.2%) |
| Female | 174 (26.2%) |
| Non-binary/Other | 44 (0.7%) |
| Race/Ethnicity | |
| White | 552 (83.1%) |
| Asian (Eastern) | 8 (1.2%) |
| Asian (Indian) | 13 (0.2%) |
| Hispanic/Latino | 27 (4.1%) |
| African American/Black | 7 (1.1%) |
| Native American | 6 (1.0%) |
| Multiracial | 33 (5.0%) |
| Not listed or specified | 18 (2.7%) |
| Country | |
| United States | 502 (75.6%) |
| Other / Unspecified | 162 (24.4%) |
| Religious Status | |
| Religious | 110 (17.0%) |
| Non-religious/ Other | 395 (59.5%) |
| Employment Status | |
| Full-time | 360 (55.6%) |
| Part-time | 96 (14.5%) |
| Unemployed | 69 (10.4%) |
| Other/ specified | 129 (19.4%) |

Table 2. *Fit Indices*

| | 1 Class | 2 Class | **3 Class** | 4 Class |
|---|---|---|---|---|
| SaBIC | 6737 | 6361 | **6154** | 6117 |
| Entropy | - | .90 | **.91** | .89 |
| ALC | - | .94-.99 | **.92-.98** | .80-.95 |
| 1 | 664 | 439 | **118** | 110 |
| 2 | | 225 | **428** | 25 |
| 3 | | | **118** | 406 |
| 4 | | | | 123 |
| LMR | - | 0.00 | **0.00** | 0.09 |

Table 3. *BCH Auxiliary Variables*

| | Chipper Profile | Tripper Profile | Microdoser Profile |
|---|---|---|---|
| Number of Use Reasons [A,B] | 3.5 | 4.2 | 4.7 |
| Number of Negative Consequences | 1.5 | 1.7 | 1.4 |
| Number of Use Benefits [A,B] | 4.4 | 5.9 | 6.2 |
| Age [A,B,C] | 30.0 | 27.6 | 35.6 |
| Age of Onset [B,C] | 21.2 | 22.0 | 26.9 |
| Income [C] | 2.6 | 2.5 | 3.0 |
| Total Lifetime Uses [A,B,C] | 2.1 | 2.4 | 4.0 |

*Notes.* The *Income* and *Total Lifetime Uses* variables represent a range of binned continuous values, which can be found in the survey questionnaires. The superscripts indicate significant differences between the profiles. *A* indicates a significant difference between the Chipper and Tripper Profiles, *B* indicates a significant difference between the Chipper and Microdoser Profiles, and *C* indicates a significant difference between the Tripper and Microdoser Profiles.

Table 4. *DCAT Auxiliary Variables*

| | Chipper Profile | | Tripper Profile | | Microdoser Profile | |
|---|---|---|---|---|---|---|
| Race | White | 0.773 | White | 0.858 | White | 0.796 |
| Gender (Binned) [A,C] | Men | 0.605 | Men | 0.778 | Men | 0.626 |
| | Women | 0.395 | Women | 0.222 | Women | 0.374 |
| Gender Binary | Non-Binary | 0.082 | Non-Binary | 0.061 | Non-Binary | 0.070 |
| Employment [C] | Employed | 0.846 | Employed | 0.823 | Employed | 0.930 |
| | Not Employed | 0.154 | Not Employed | 0.177 | Not Employed | 0.070 |
| Religious Status | Religious | 0.163 | Religious | 0.232 | Religious | 0.224 |
| | Non-religious | 0.837 | Non-religious | 0.768 | Non-religious | 0.776 |
| How long after waking before using psilocybin (PUQ-10) [B,C] | 12-18 hours | 0.118 | 12-18 hours | 0.090 | 12-18 hours | 0.000 |
| | 9-12 hours | 0.192 | 9-12 hours | 0.223 | 9-12 hours | 0.029 |
| | 6-9 hours | 0.227 | 6-9 hours | 0.233 | 6-9 hours | 0.039 |
| | 3-6 hours | 0.232 | 3-6 hours | 0.261 | 3-6 hours | 0.176 |
| | 1-3 hours | 0.109 | 1-3 hours | 0.151 | 1-3 hours | 0.435 |
| | Within 1 hour | 0.032 | Within 1 hour | 0.013 | Within 1 hour | 0.276 |
| | Within ½ hour | 0.007 | Within ½ hour | 0.002 | Within ½ hour | 0.027 |
| | Immediately upon waking | 0.000 | Immediately upon waking | 0.005 | Immediately upon waking | 0.018 |

*Notes.* The superscripts indicate significant differences between the profiles. *A* indicates a significant difference between the Chipper and Tripper Profiles, *B* indicates a significant difference between the Chipper and Microdoser Profiles, and *C* indicates a significant difference between the Tripper and Microdoser Profiles.

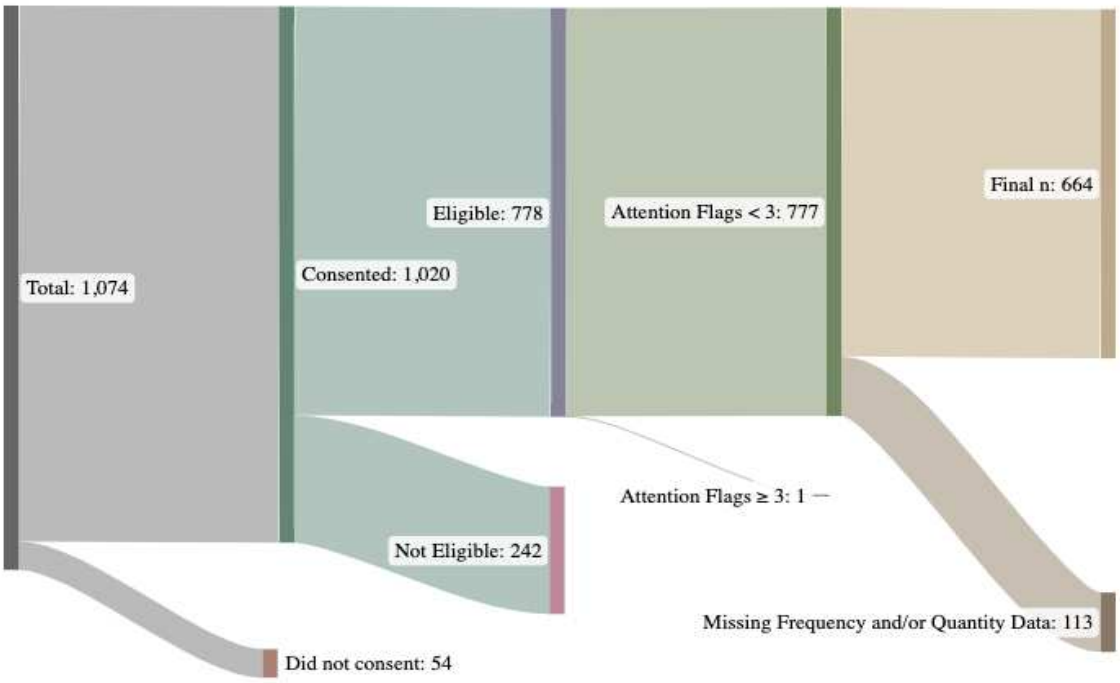


Figure 1. Sankey Diagram of Participant Flow

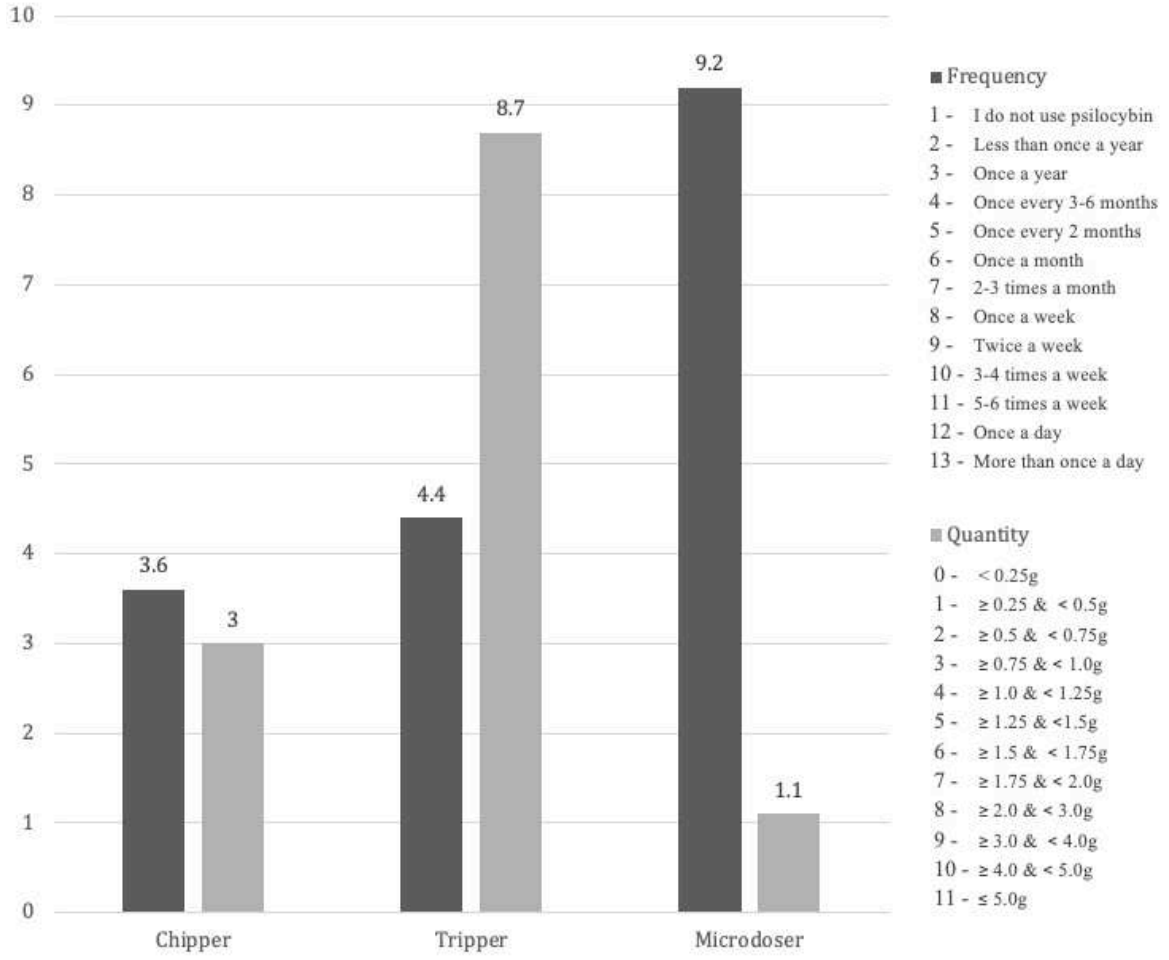


Figure 2. Indicator Variable Clustered Bar Charts for the Final 3-Class Latent Profile Analysis

*Note.* The mean of the *Frequency* (PUQ-3) variable represents a range of binned continuous values, which can be found in the survey questionnaires. The Quantity variable (PUQ-15) was binned post data collection.

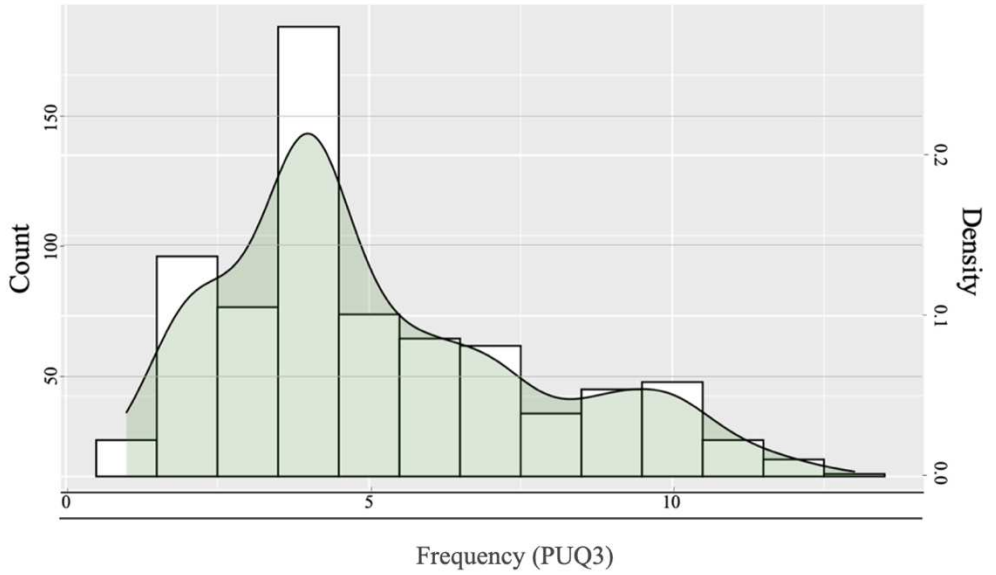


Figure 3. Frequency of Psilocybin Use: Count Histogram with Total Sample Density Overlay

*Note.* Frequency values are as follows: 1= Less than once a year, 2= Once a year, 3= Once every 3-6 months, 4 = Once every 2 months, 5= Once a month, 6= 2-3 times a month, 7= Once a week, 8= Twice a week, 9= 3-4 times a week, 10= 5-6 times a week, 11 = Once a day, 12= More than once a day

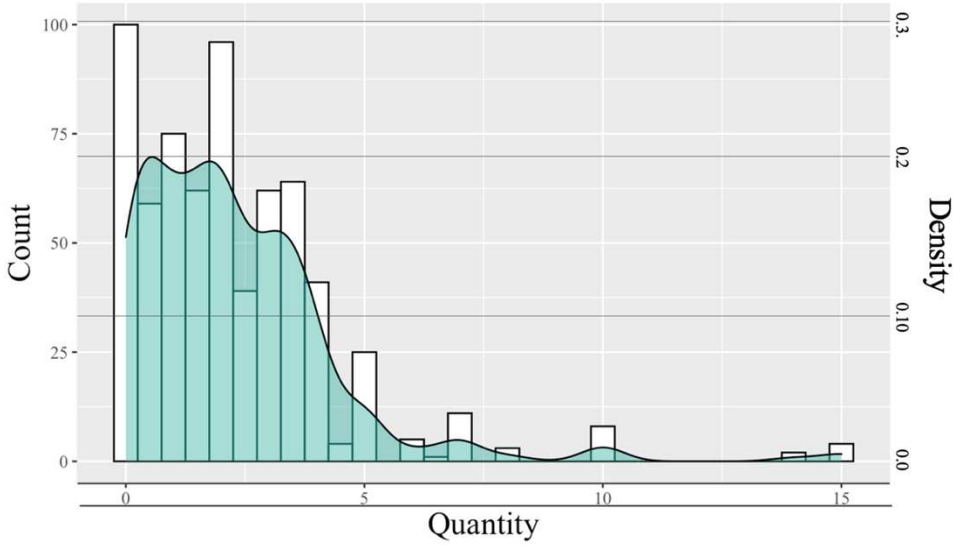


Figure 4. Quantity of Psilocybin Use: Count Histogram with Total Sample Density Overlay

*Note.* This figure only represents self-reported preferred quantities up to 15g of dehydrated, psilocybin containing mushrooms. Outlier quantities were reported (up to 42g), but are not included here.

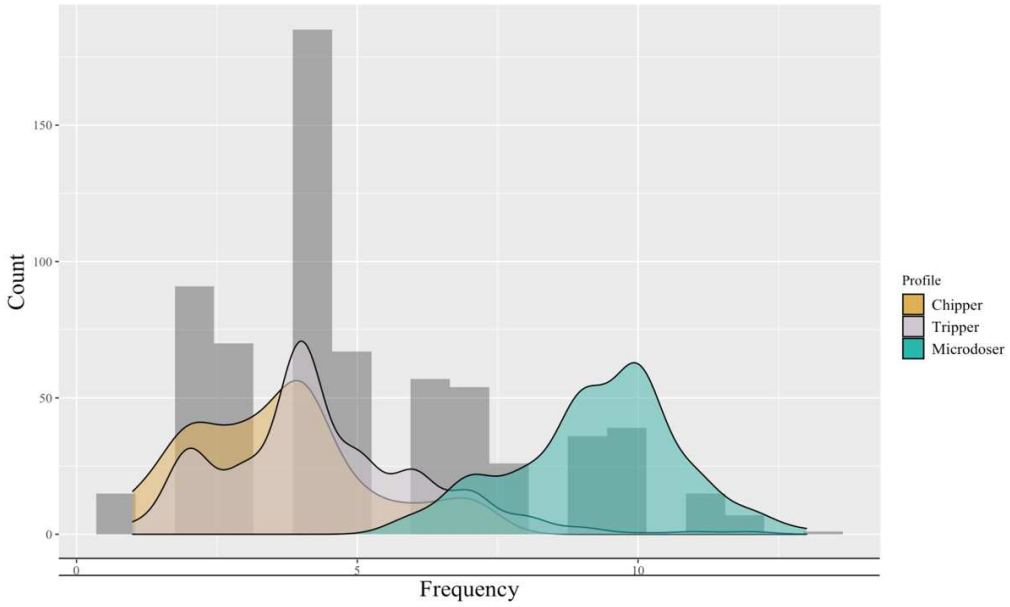


Figure 5. Frequency of Psilocybin Use: Count Histogram with Profile Density Overlay

*Note.* Frequency values are as follows: 1= Less than once a year, 2= Once a year, 3= Once every 3-6 months, 4 = Once every 2 months, 5= Once a month, 6= 2-3 times a month, 7= Once a week, 8= Twice a week, 9= 3-4 times a week, 10= 5-6 times a week, 11 = Once a day, 12= More than once a day

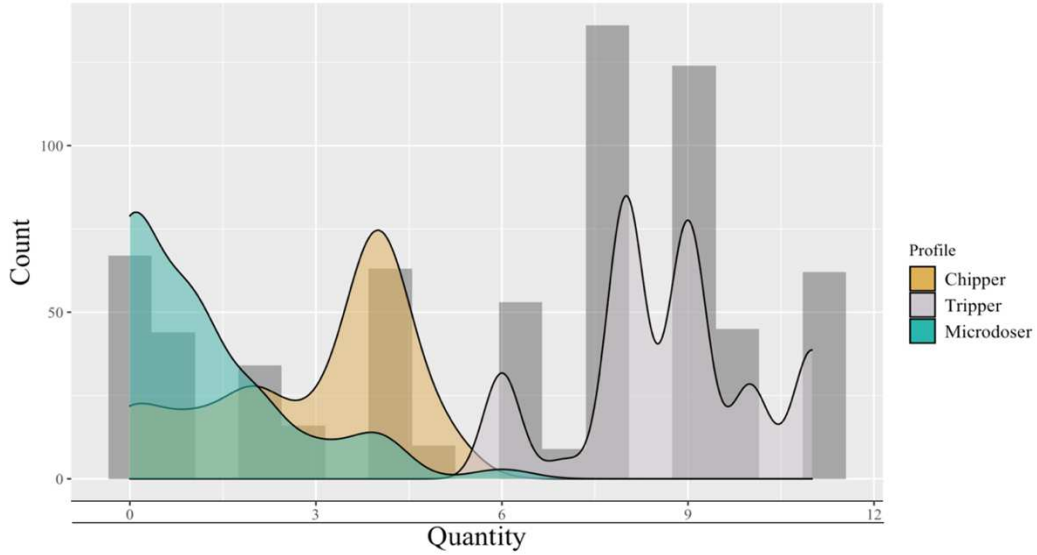


Figure 6. Quantity of Psilocybin Use: Count Histogram with Profile Density Overlay

*Note.* Quantity values are as follows: 0 = < 0.25g, 1 = ≥ 0.25 & < 0.5g, 3 = ≥ 0.5 & < 0.75g, 4 = ≥ 0.75 & < 1.0g, 5 = ≥ 1.0 & < 1.25g, 7 ≥ 1.25 & <1.5g, 8 = ≥ 1.5 & < 1.75g, 9 = ≥ 1.75 & < 2.0g, 10 = ≥ 2.0 & < 3.0g, 11 = ≥ 3.0 & < 4.0g, 12 = ≥ 4.0 & < 5.0g, 13 = ≤ 5.0g

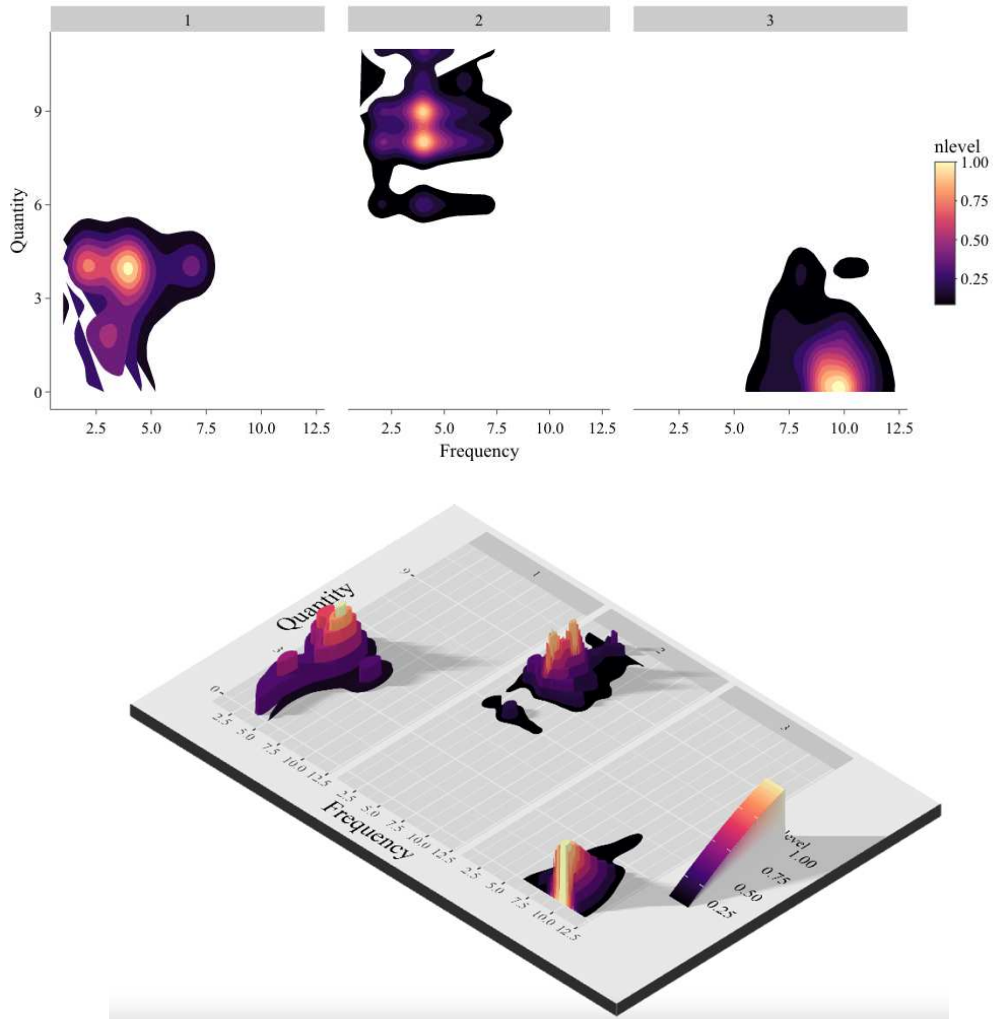


Figure 7. Frequency and Quantity of Psilocybin Use: Profile Densities

*Note.* Frequency values are as follows: 1= Less than once a year, 2= Once a year, 3= Once every 3-6 months, 4 = Once every 2 months, 5= Once a month, 6= 2-3 times a month, 7= Once a week, 8= Twice a week, 9= 3-4 times a week, 10= 5-6 times a week, 11 = Once a day, 12= More than once a day

Quantity values are as follows: 0 = < 0.25g, 1 = ≥ 0.25 & < 0.5g, 3 = ≥ 0.5 & < 0.75g, 4 = ≥ 0.75 & < 1.0g, 5 = ≥ 1.0 & < 1.25g, 7 ≥ 1.25 & <1.5g, 8 = ≥ 1.5 & < 1.75g, 9 = ≥ 1.75 & < 2.0g, 10 = ≥ 2.0 & < 3.0g, 11 = ≥ 3.0 & < 4.0g, 12 = ≥ 4.0 & < 5.0g, 13 = ≤ 5.0g

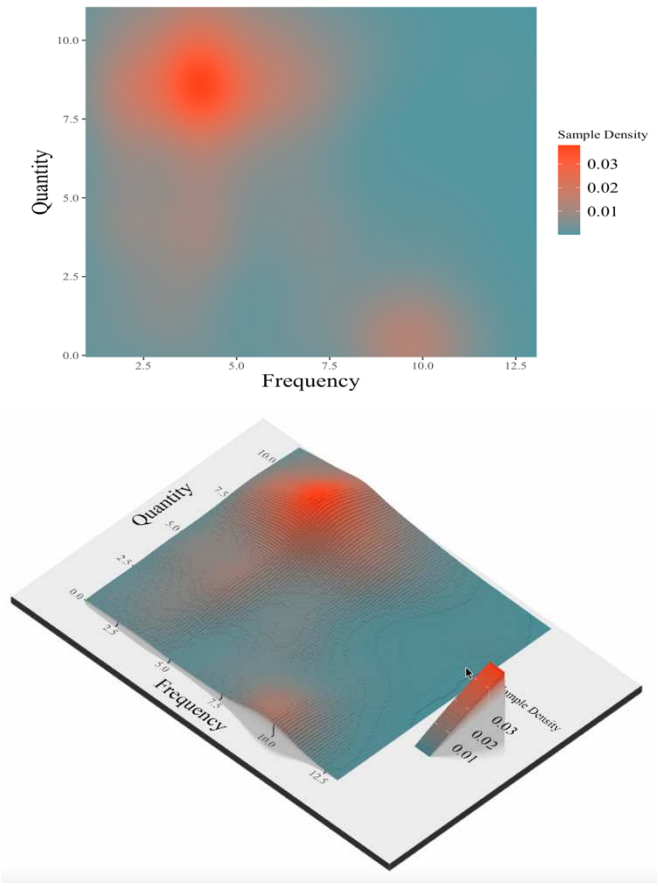


Figure 8. Frequency and Quantity of Psilocybin Use: Sample Densities

*Note.* Frequency values are as follows: 1= Less than once a year, 2= Once a year, 3= Once every 3-6 months, 4 = Once every 2 months, 5= Once a month, 6= 2-3 times a month, 7= Once a week, 8= Twice a week, 9= 3-4 times a week, 10= 5-6 times a week, 11 = Once a day, 12= More than once a day

Quantity values are as follows: 0 = < 0.25g, 1 = ≥ 0.25 & < 0.5g, 3 = ≥ 0.5 & < 0.75g, 4 = ≥ 0.75 & < 1.0g, 5 = ≥ 1.0 & < 1.25g, 7 ≥ 1.25 & <1.5g, 8 = ≥ 1.5 & < 1.75g, 9 = ≥ 1.75 & < 2.0g, 10 = ≥ 2.0 & < 3.0g, 11 = ≥ 3.0 & < 4.0g, 12 = ≥ 4.0 & < 5.0g, 13 = ≤ 5.0g

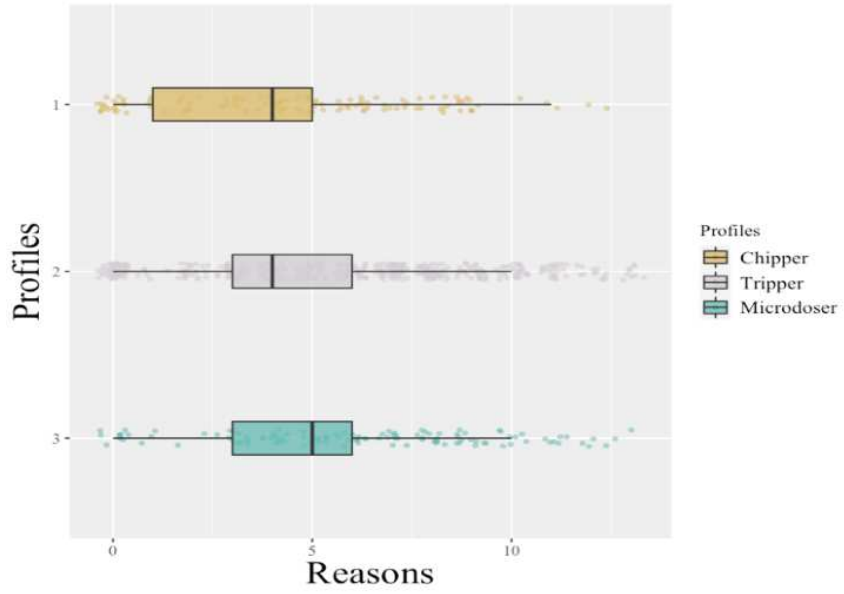


Figure 9. Profile Comparisons: Cumulative Reasons for Psilocybin Use

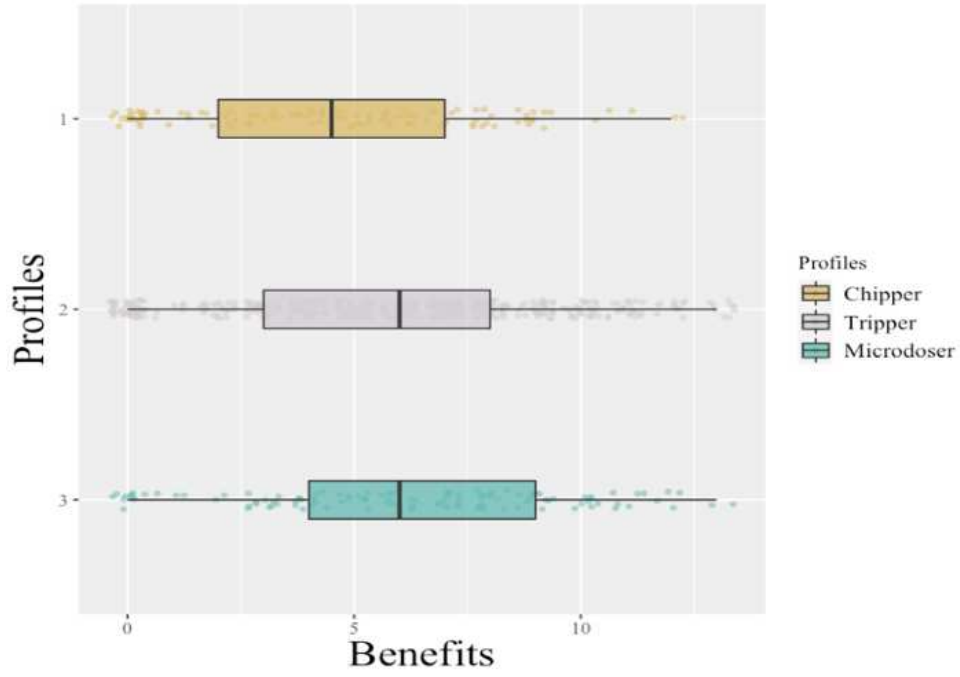


Figure 10. Profile Comparisons: Cumulative Benefits of Psilocybin Use

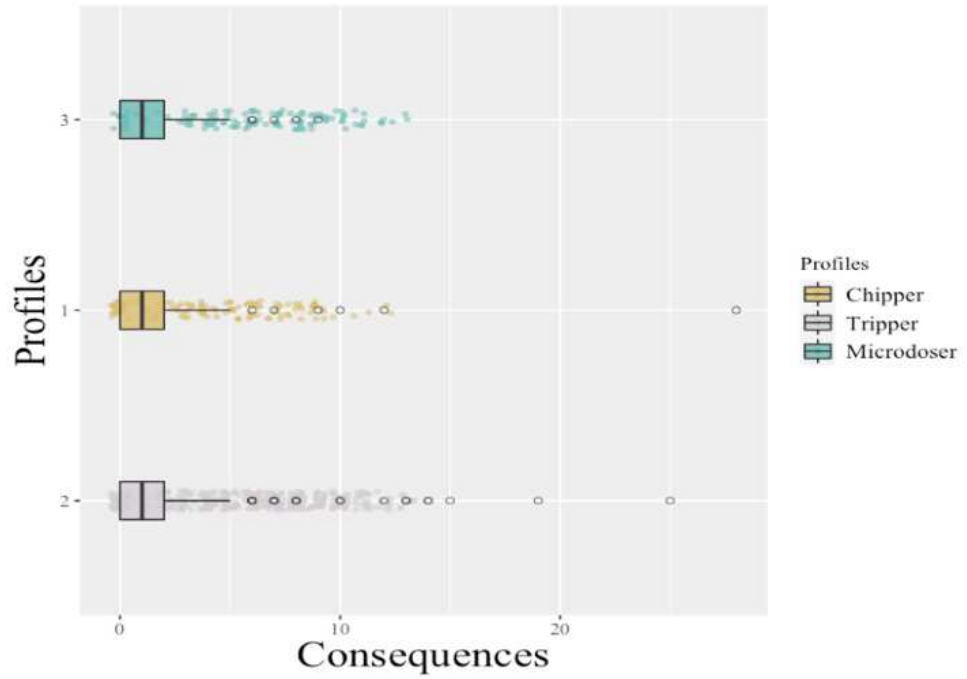


Figure 11. Profile Comparisons: Cumulative Consequences of Psilocybin Use

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APPENDICES

## *Appendix A: Screening Questions*

If any participants with anything other than "no" to questions 2 – 5, they were directed to a page displaying the message below. Most resources are suicide hotlines, but homicidality is assessed for on suicide hotlines, and the individuals taking these calls are trained to provide help from there.

| | Answer Choices | | |
|---|---|---|---|
| Question | | | |
| 1. Have you ever consumed psilocybin in any dosage or form? | Yes | No | |
| 2. Do you have suicidal thoughts? | Yes | No | |
| 3. Do you consider yourself suicidal? | Yes | No | |
| 4. Do you have thoughts about harming or killing other people? | Yes | No | |
| 5. Do you intend to hurt or kill other people? | Yes | No | |
| 6. Are you 18 years old or older? | Yes | No | |
| 7. Do you have any personal history of psychotic disorders, including any of the following: Schizophrenia, Schizoaffective Disorder, Schizophreniform Disorder, Brief Psychotic Disorder, Delusional Disorder, Substance-Induced Psychotic Disorder, Psychotic Disorder Due to a Medical Condition, or Paraphrenia | Yes | No | I don't know |

At this time, we will not be able to invite you to participate in our study. However, we encourage you to explore these resources, which has international resources listed for most locations.

- https://www.opencounseling.com/suicide-hotlines
- https://www.stompoutbullying.org/international-suicide-prevention-resource
- https://save.org/find-help/international-resources/
- https://www.befrienders.org/

***Appendix B: Demographic Information***

| Question | Answer Choices | |
|---|---|---|
| 1. What is your age? | Options 18-65 | |
| 2. What is your race? | White / Caucasian<br>Asian - Eastern<br>Asian - Indian<br>Hispanic<br>African-American<br>Native-American | Mixed racez<br>Other (with a blank entry field for the participant to self-identify)<br>I prefer not to say |
| 3. What is your ethnicity? | White / Caucasian<br>Asian - Eastern<br>Asian - Indian<br>Hispanic<br>African-American<br>Native-American | Mixed race<br>Other (with a blank entry field for the participant to self-identify)<br>I prefer not to say |
| 4. What country do you live in? | All existing countries listed in a dropdown box, alphabetically organized | |
| 5. If you live in the United States or Canada, what state or providence do you live? | All existing states and providences listed in a dropdown box, alphabetically organized | |
| 6. What is the legal status of psilocybin where you live? | Illegal<br>Decriminalized | Legal<br>I don't know |
| 7. What is your annual income? | Less than $25,000<br>$25,000 - $50,000<br>$50,000 - $100,000 | $100,000 - $200,000<br>More than $200,000<br>I prefer not to say |
| 8. What is the highest level of education you have completed? | No schooling completed<br>Nursery school to 8th grade<br>Some high school, no diploma<br>High school or GED<br>Trade/technical/vocational training<br>Some college | Associate degree<br>Bachelor's degree<br>Master's degree<br>Professional degree<br>Doctorate degree<br>I prefer not to say |

***Appendix B: Continued***

| Question | Answer Choices | | |
|---|---|---|---|
| 9. How do you identify your gender? | Man<br>Woman<br>Prefer not to answer | Other (with a blank entry field for the participant to self-identify)<br>Non-binary | |
| 10. What was your assigned sex at birth? | Male<br>Female | Other (with a blank entry field for the participant to self-identify) | |
| 11. What is your marital status? | Married<br>Divorced<br>In a domestic partnership | Separated<br>Single<br>I prefer not to say | |
| 12. What is your employment status? | Full-time<br>Part-time<br>Contract/ Temporary | Unemployed<br>Unable to work<br>I prefer not to say | Other (with a blank entry field for the participant to self-identify) |
| 13. How many dependents do you have? | 0<br>1 | 2-3 | 4 or more<br>I prefer not to say |
| 14. Are you registered to vote? | Yes<br>No | I don't know | I prefer not to say |
| 15. Are you a citizen of the country you live in? | Yes | No | I prefer not to say |
| 16. What is your religion? | Protestant<br>Roman Catholic<br>Mormon<br>Orthodox - Greek<br>Orthodox - Russian | Jewish<br>Muslim<br>Buddhist<br>Hindu<br>Atheist | Agnostic<br>Other (with a blank entry field for the participant to self-identify)<br>I prefer not to say |
| 17. Would you consider yourself to have a disability? | Yes | No | I prefer not to say |

***Appendix C: Psilocybin Use Questionnaire (PUQ)***

---

1. Have you ever used psilocybin?
    0 = No
    1 = Yes

**If response = 0 then skip to end of questionnaire*

2. Which of the following best captures when you last used psilocybin?

| | |
|---|---|
| 1 = over 5 years ago | 7 = less than 1 month ago |
| 2 = over a year ago | 8 = last week |
| 3 = 9 – 12 months ago | 9 = this week |
| 4 = 6 – 9 months ago | 10 = yesterday |
| 5 = 3 – 6 months ago | 11 = today* |
| 6 = 1 – 3 months ago | 12 = I am currently high |

**If response = 11 (today) or 12 (I am currently high) then answer 2b below*

2b. How high are you right now?

| | |
|---|---|
| 0 = I am not at all high | 3 = I am very high |
| 1 = I am a little bit high | 4 = I am extremely high |
| 2 = I am moderately high | |

3. Which of the following best captures the average frequency you currently use psilocybin?

| | |
|---|---|
| 0 = I do not use psilocybin | 7 = once a week |
| 1 = less than once a year | 8 = twice a week |
| 2 = once a year | 9 = 3 – 4 times a week |
| 3 = once every 3-6 months (2-4 times/yr)) | 10 = 5 – 6 times a week |
| 4 = once every 2 months (6 times/yr) | 11 = once a day |
| 5 = once a month (12 times/yr) | 12 = more than once a day |
| 6 = 2 – 3 times a month | |

4. Which of the following best captures how long you have been using psilocybin **at this frequency?**

| | |
|---|---|
| 1 = less than 1 month | 7 = 2 – 3 years |
| 2 = 1 – 3 months | 8 = 3 – 5 years |
| 3 = 3 – 6 months | 9 = 5 – 10 years |
| 4 = 6 – 9 months | 10 = 10 – 15 years |
| 5 = 9 – 12 months | 11 = 15 – 20 years |
| 6 = 1 – 2 years | 12 = more than 20 years |

*Appendix C: Continued*

5. Before the period of time you indicated above, how often did you use psilocybin?

0 = I did not use psilocybin
1 = less than once a year
2 = once a year
3 = once every 3-6 months (2-4 times/yr.)
4 = once every 2 months (6 times/yr.)
5 = once a month
6 = 2 – 3 times a month
7 = once a week
8 = twice a week
9 = 3 – 4 times a week
10 = 5 – 6 times a week
11 = once a day
12 = more than once a day

6. How many days of the past week did you use psilocybin?

0 = 0 days
1 = 1 day
2 = 2 days
3 = 3 days
4 = 4 days
5 = 5 days
6 = 6 days
7 = 7 days

7. Approximately how many days of the past month did you use psilocybin? _____

8. Which of the following best captures the number of times you have used psilocybin in your entire life?

1 = 1 – 5 times in my life
2 = 6 – 10 times in my life
3 = 11 – 50 times in my life
4 = 51 –100 times in my life
5 = 101 – 500 times in my life
6 = 501 – 1000 times in my life
7 = 1001 – 2000 times in my life
8 = 2001 – 5000 times in my life
9 = 5001 – 10,000 times in my life
10 = More than 10,000 times in my life

9. Which of the following best captures your pattern of use psilocybin when you use it?

0 = I do not use psilocybin at all
1 = I only use psilocybin on weekends
2 = I only use psilocybin on weekdays
3 = I use psilocybin on weekends and weekdays

10. How many hours after waking up do you typically first use psilocybin?

0 = I do not ingest psilocybin at all
1 = 12 – 18 hours after waking up
2 = 9 – 12 hours after waking up
3 = 6 – 9 hours after waking up
4 = 3 – 6 hours after waking up
5 = 1 – 3 hours after waking up
6 = within 1 hour of waking up
7 = within ½ hour of waking up
8 = immediately upon waking up

11. How many times a day, on a typical weekday, do you use psilocybin? _____

12. How many times a day, on a typical weekend, do you use psilocybin? _____

*Appendix C: Continued*

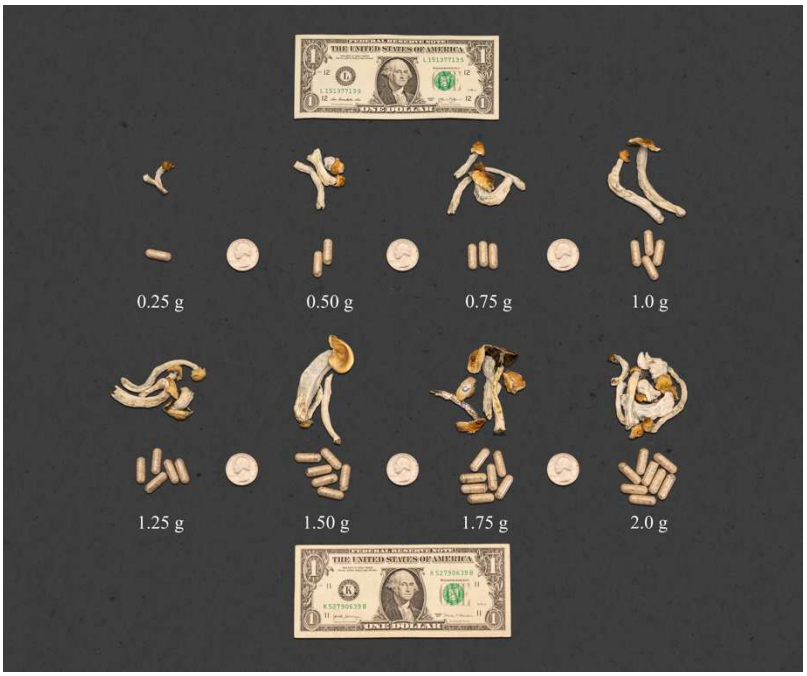
13. What is the **primary** method you use to ingest psilocybin?

0 = I do not use psilocybin
1 = Eating dehydrated mushroom(s) by themselves
2 = Eating other foods with added psilocybin (e.g., chocolates, candies, etc)
3 = Brewed tea
4 = Capsules /pills
5 = Lemon tek
6 = Other _____

14. Which of the following other methods to ingest psilocybin do you use **regularly** (at least 25% of the time use you psilocybin)? [Mark all that apply]

0 = I do not ingest psilocybin
1 = Eating dehydrated mushroom(s) by themselves
2 = Eating other foods with added psilocybin (e.g., chocolates, candies, etc)
3 = Brewed tea
4 = Capsules /pills
5 = Lemon tek
6 = Other _____

***Please use the images below to refer to various quantities of psilocybin***





*Appendix C: Continued*

| | | |
|---|---|---|
| Threshold | .25 g | 1/100 oz |
| light | .25 - 1 g | 1/100 - 1/28 oz |
| Common | 1 - 2.5 g | 1/28 - 1/10 oz |
| Strong | 2.5 - 5 g | 1/10 - 1/6 oz |
| Heavy | 5 + g | 1/6 oz + |

For questions 17 to 19 below, clearly indicate the number of grams of psilocybin you use with a number between 0 – 100. You may use up to 3 decimals to indicate amounts under 1 gram.

Note: 1/8 of a gram = 0.125 grams, ¼ of a gram = 0.25 grams, ½ of a gram = 0.5 grams, ¾ of a gram = 0.75 grams. 1/8 of an ounce = 3.5 grams, ¼ of an ounce = 7 grams, ½ ounce = 14 grams, 1 ounce = 28 grams

15. In a typical session, how much psilocybin do you personally use? _____

16. On a typical day you use psilocybin, how much do you personally use? (total for the day) ___

17. In a typical week you use psilocybin, how much psilocybin do you personally use? _____

18. On a typical day you use psilocybin, how many sessions do you have? _____

19. Do you ever use considerably less or considerably more psilocybin than the dose that is typical for you?

1 = Yes 2 = No

19a. In sessions that you have considerably less or considerably more psilocybin than is typical for you, how much do you personally use in that session? _____

19b. On days that you have considerably less or considerably more psilocybin than is typical for you, how much psilocybin do you personally use? (total for the day) _____

19c. On weeks that you have considerably less or considerably more psilocybin than is typical for you, how much psilocybin do you personally use that week? _____

19d. On days that you have considerably less or considerably more psilocybin than is typical for you, how many sessions do you have? _____

20. What is your current age? _____

21. How many years in total have you used psilocybin? _____

***Appendix C: Continued***

22. How old were you when you FIRST tried psilocybin? _____

23. Has there been any time in your life when you used psilocybin regularly (2 or more times per month for 6 months or longer)?

0 = No
1 = Yes*

**If response = 1 (Yes) then answer questions 31b and 31c below*

23a. How old were you when you FIRST STARTED using psilocybin regularly (2 or more times/month)? _____

23b. Has there been any time in your life when you used psilocybin on a daily or near daily basis for 6 months or longer?

0 = No
1 = Yes*

**If response = 1 (Yes) then answer question 22bi below*

23bi. How old were you when you FIRST STARTED using psilocybin on a daily or near daily basis? _____

23c. Has there been any time in your life when you used psilocybin on a weekly or near weekly basis for 6 months or longer?

0 = No
1 = Yes*

**If response = 1 (Yes) then answer question 22ci below*

23ci. How old were you when you FIRST STARTED using psilocybin on a weekly or near weekly basis? _____

23d. Has there been any time in your life when you used psilocybin on a monthly or near monthly basis for 6 months or longer?

0 = No
1 = Yes*

**If response = 1 (Yes) then answer question 22di below*

23di. How old were you when you FIRST STARTED using psilocybin on a weekly or near weekly basis? _____

*Appendix C: Continued*

24. Which of the following best captures the average frequency that you used psilocybin before the age of 16?

0 = more than once a day
1 = once a day
2 = 5 – 6 times a week
3 = 3 – 4 times a week
4 = twice a week
5 = once a week
6 = 2 – 3 times a month
7 = once a month
8 = once every 2 months (6 times/yr.)
9 = once every 3-6 months (2-4 times/yr.)
10 = once a year
11= less than once a year
12 = never

25. Are you using psilocybin under the supervision of a medical professional to treat any condition?

0 = No
1 = Yes*

25a. Which condition(s) do you use psilocybin for? _____

26. Do you use other substances other than psilocybin? (Not at the same time)

0 = No
1 = Yes*

**If response = 1 (Yes) then answer questions 26a*

26a. What other substances do you use? (Select all that apply)

0 = Tobacco
1 = Alcohol
2 = Cannabis
3 = LSD (acid)
4 = Cocaine
5 = MDMA (Ecstasy / Molly)
6 = Ketamine
7 = Benzodiazepines
8 = Amphetamines
9 = Heroine
10 = Other _____

27. Do you use psilocybin with other substances at the same time?

0 = No
1 = Yes*

**If response = 1 (Yes) then answer questions 27a*

27a. Which substances use psilocybin with? (Select all that apply)

0 = Tobacco
1 = Alcohol
2 = Cannabis
3 = LSD (acid)
4 = Cocaine
5 = MDMA (Ecstasy / Molly)
6 = Ketamine
7 = Benzodiazepines
8 = Amphetamines
9 = Heroine
10 = Other _____

***Appendix D: Reasons for Psilocybin Use Questionnaire (R-PUQ)***

Which of these are reasons that you use psilocybin?

*Select all that apply*

**(1)** To relieve physical pain, including headaches

**(2)** For creativity

**(3)** For productivity

**(4)** To process existential fears

**(5)** As a social activity

**(6)** For recreational consumption

**(7)** To substitute for any substances

→ Which substance(s)? _____

**(8)** To relieve stress

**(9)** To promote mindfulness

**(10)** To maintain current abstinence/ maintain soberness from any substance

→ Which substance(s)? _____

**(11)** To manage a mental health concern other than addiction

→ Which mental health concern(s)? _____

**(12)** For spiritual purposes

**(13)** To manage withdrawal symptoms from any substance

→ Which substance(s)? _____

**(14)** Other _____

*Appendix E: Consequences of Psilocybin Use Questionnaire (C-PUQ)*

Please note that in this survey, "psilocybin" refers to the hallucinogenic substance found in many species of mushrooms. The wording here is meant to capture psilocybin use in any form (i.e., tea, chocolate, dried mushrooms, etc.).

| | Answer Choices | |
|---|---|---|
| Question | | |
| 1. The quality of my work or schoolwork has suffered because of my psilocybin use. | Yes | No |
| 2. I have driven a car under the influence of psilocybin. | Yes | No |
| 3. I have felt in a fog, sluggish, tired, or dazed the morning after using psilocybin. | Yes | No |
| 4. I have been unhappy because of my psilocybin use. | Yes | No |
| 5. I have gotten into physical fights because of my psilocybin use. | Yes | No |
| 6. I have spent too much time using psilocybin. | Yes | No |
| 7. I have felt like I needed psilocybin after I'd gotten up. | Yes | No |
| 8. I have become very rude, obnoxious, or insulting after using psilocybin. | Yes | No |
| 9. I have been less physically active because of my psilocybin use. | Yes | No |
| 10. I have had trouble sleeping after stopping or cutting down on psilocybin use. | Yes | No |
| 11. I have neglected obligations to family, work, or school because of my psilocybin use. | Yes | No |
| 12. When using psilocybin, I have done impulsive things that I regretted later. | Yes | No |
| 13. I have awakened the day after using psilocybin and found I could not remember a part of the evening before. | Yes | No |
| 14. I have been overweight because of my psilocybin use. | Yes | No |
| 15. I haven't been as sharp mentally because of my psilocybin use. | Yes | No |
| 16. I have received a lower grade on an exam or paper than I ordinarily could have because of psilocybin use. | Yes | No |
| 17. I have tried to quit using psilocybin because I thought I was using too much. | Yes | No |
| 18. I have felt anxious, irritable, lost my appetite, or had stomach pains after stopping or cutting down on my psilocybin use. | Yes | No |
| 19. I often have thought about needing to cut down or to stop using psilocybin. | Yes | No |
| 20. I have had less energy or felt tired because of my psilocybin use. | Yes | No |
| 21. I have lost motivation to do things because of my psilocybin use. | Yes | No |

***Appendix E: Continued***

| Question | Answer Choices | |
|---|---|---|
| 22. I have had a "bad trip" as a result of using psilocybin | Yes | No |
| 23. I have experienced lasting negative mental health consequences that began with a "bad trip" | Yes | No |
| 24. I have experienced worsening symptoms of a pre-existing mental health problem because of my psilocybin use | Yes | No |
| 25. I have experienced negative effects to my cardiovascular health because of my psilocybin use | Yes | No |
| 26. I put myself at risk of physical harm because of my psilocybin use | Yes | No |
| 27. I put others at risk of physical harm because of my psilocybin use | Yes | No |
| 28. I have experienced legal consequences because of my psilocybin use | Yes | No |
| 29. I have experienced other consequences from my psilocybin use that are not listed here. | Yes | No |
| 29a. What consequences? | Free Response | |

### *Appendix F: Benefits of Psilocybin Use Questionnaire (B-PUQ)*

Please note that in this survey, "psilocybin" refers to the hallucinogenic substance found in many species of mushrooms. The wording here is meant to capture psilocybin use in any form (i.e., tea, chocolate, dried mushrooms, capsules, etc.).

| Question | Answer Choices | |
|---|---|---|
| 1. I approached a person that I probably wouldn't have spoken to otherwise. | Yes | No |
| 2. I told a funny story or joke and made others laugh. | Yes | No |
| 3. I revealed a personal feeling or emotion that I had previously kept secret. | Yes | No |
| 4. I felt like I had enough energy to stay out all night partying or dancing. | Yes | No |
| 5. In a situation in which I would usually have stayed quiet, I found it easy to make conversation. | Yes | No |
| 6. I stood up for a friend or confronted someone who was in the wrong. | Yes | No |
| 7. I have experienced an "afterglow" following my psilocybin use. | Yes | No |
| 8. I found myself in a frightening situation and I felt surprisingly fearless. | Yes | No |
| 9. I found a creative solution to a problem I might otherwise have had difficulty solving. | Yes | No |
| 10. I felt especially confident that other people found me attractive. | Yes | No |
| 11. The intensity of a sexual experience was enhanced. | Yes | No |
| 12. I acted out a sexual fantasy that I might ordinarily be embarrassed to reveal or attempt. | Yes | No |
| 13. I have experienced other benefits from my psilocybin use that are not listed here. | Yes | No |
| 13a. What benefits? | Free Response | |

*Appendix F: Continued*

**Please indicate how to what degree you agree with the following statements:**

| | Strongly disagree | Somewhat disagree | Neutral | Somewhat agree | Strongly agree |
|---|---|---|---|---|---|
| 14. Psilocybin has led me to use other drugs | 0 | 1 | 2 | 3 | 4 |
| 15. Psilocybin has led me to use less of other drugs | 0 | 1 | 2 | 3 | 4 |
| 16. Psilocybin has helped me cope in difficult times | 0 | 1 | 2 | 3 | 4 |
| 17. Psilocybin has been one of my main pleasures | 0 | 1 | 2 | 3 | 4 |
| 18. My health has suffered because of psilocybin | 0 | 1 | 2 | 3 | 4 |
| 19. My health has benefited because of psilocybin | 0 | 1 | 2 | 3 | 4 |
| 20. Overall, the effect of psilocybin on my life has been good | 0 | 1 | 2 | 3 | 4 |

*Appendix G: Recruitment Message*

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Are you at least 18 years old? Have you ever used psilocybin (the psychoactive drug found in "magic mushrooms")?

If so, consider participating in a research study on patterns of psilocybin use. We want to learn more about why psilocybin is being used in the real world right now, whether there are different types of psilocybin use, and what benefits/ positive outcomes/ consequences/ risks are associated with each type of use.

Participants in this study will:
(1) Complete four online surveys and a demographic questionnaire for 25 minutes total

If you participate, you will be asked questions about:

- The dosages of psilocybin you typically use
- The frequency with which you use psilocybin
- Your demographic information
- What benefits and/ or consequences you have experienced from your psilocybin use
- Why you choose to use psilocybin

Participants will be eligible to enter a raffle for a $100 gift card!

Note: participants who wish to join the raffle will be asked for an email address that the gift card can be sent to. Any information that you provide in the survey will **NOT** be linked to the email address you provide. Providing an email address to participate in the raffle is NOT required to participation in the research study.

To participate, click the link to the survey below:
https://qualtrics.com/sample/website/url/here

Email bethany.gray@colostate.edu with questions. Thank you!

Bethany Gray
Doctoral Student at Colorado State University

***Appendix H: List of Subreddit Recruitment Pages (Alphabetical)***

1. r/Assistance
2. r/boulder
3. r/CSUFoCo
4. r/cuboulder
5. r/DrugNerds
6. r/Drugs
7. r/FortCollins
8. r/MagicMushroomHunters
9. r/microdosing
10. r/Mushrooms\
11. r/Nootropics
12. r/PsilocybinTherapy
13. r/Psychedelic
14. r/psychedelicrock
15. r/PsychedelicSpiritualy
16. r/PsychedSubstance
17. r/psychologyresearch
18. r/Psychonaut
19. r/psytrance
20. r/RationalPsychonaught
21. r/replications
22. r/SampleSize
23. r/Shroom
24. r/shroomers
25. r/shroomery
26. r/shrooms
27. r/shroomstocks
28. r/shroomstories
29. r/SurveyCircle
30. r/SurveyExchange
31. r/unclebens