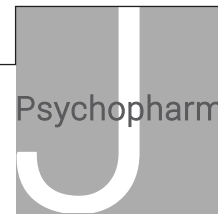


An online survey of tobacco smoking cessation associated with naturalistic psychedelic use

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Abstract

Data suggest psychedelics such as psilocybin and lysergic acid diethylamide (LSD) may hold therapeutic potential in the treatment of addictions, including tobacco dependence. This retrospective cross-sectional anonymous online survey characterized 358 individuals (52 females) who reported having quit or reduced smoking after ingesting a psychedelic in a non-laboratory setting ≥ 1 year ago. On average, participants smoked 14 cigarettes/day for 8 years, and had five previous quit attempts before their psychedelic experience. Of the 358 participants, 38% reported continuous smoking cessation after psychedelic use (quitters). Among quitters, 74% reported >2 years' abstinence. Of the 358 participants, 28% reported a persisting reduction in smoking (reducers), from a mode of 300 cigarettes/month before, to a mode of 1 cigarette/month after the experience. Among reducers, 62% reported >2 years of reduced smoking. Finally, 34% of the 358 participants (relapsers) reported a temporary smoking reduction before returning to baseline smoking levels, with a mode time range to relapse of 3–6 months. Relapsers rated their psychedelic experience significantly lower in personal meaning and spiritual significance than both other groups. Participants across all groups reported less severe affective withdrawal symptoms (e.g. depression, craving) after psychedelic use compared with previous quit attempts, suggesting a potential mechanism of action for psychedelic-associated smoking cessation/reduction. Changes in life priorities/values were endorsed as the most important psychological factor associated with smoking cessation/reduction. Results suggest psychedelics may hold promise in treating tobacco addiction as potentially mediated by spiritual experience, changed priorities/values, and improved emotional regulation.

Keywords

Hallucinogen, tobacco, smoking cessation, nicotine, addiction, psilocybin, psychedelic, mystical experience

Introduction

Converging evidence suggests that structured administration of serotonin 2A receptor (5-HT_{2A}R) agonist hallucinogens (i.e. psychedelics) may be an effective aid in the treatment of addiction (Bogenschutz et al., 2015; Garcia-Romeu et al., 2016; Johnson et al., 2014; Ross, 2012; Sessa and Johnson, 2015). Observational studies have reported addiction recovery associated with the ceremonial use of 5-HT_{2A}R agonists such as peyote and ayahuasca among indigenous cultures and syncretic religions (Albaugh and Anderson, 1974; Bergman, 1971; Blum et al., 1977; Calabrese, 1997; de Rios et al., 2002; Garrity, 2000; Halpern, 1996; Pascarosa and Futterman, 1976; Prue, 2013; Roy, 1973; Thomas et al., 2013). A meta-analysis of randomized clinical trials from the 1960s and 1970s also found that structured administration of lysergic acid diethylamide (LSD) in the treatment of alcoholism resulted in significantly less alcohol misuse than randomized control conditions at initial follow up, with a robust effect size (odds ratio: 1.96; Krebs and Johansen, 2012).

Research with psilocybin in healthy volunteers also shows effects that may be consistent with therapeutic potential for addiction treatment, including positive behavior change as assessed by blinded community observers (Griffiths et al., 2006, 2011), increased personality openness (MacLean et al., 2011), and high ratings of psychedelic session personal meaning and spiritual significance present 14 months (Griffiths et al., 2008), and 25 years (Doblin, 1991; Pahnke, 1963) after psilocybin

administration. Moreover, neuroscientific studies have discovered biological effects of psychedelics, including alterations in default mode network activation and changes in amygdala and anterior cingulate cortex reactivity to negative cues (Carhart-Harris et al., 2012, 2016; Kraehenmann et al., 2014; Palhano-Fontes et al., 2015; Petri et al., 2014; Preller et al., 2016), and it is plausible that these may mediate acute and persisting beneficial effects of psychedelics.

The authors recently conducted an open-label pilot study suggesting that the 5-HT_{2A}R agonist psilocybin may be a well-tolerated and promising adjunct to cognitive-behavioral smoking cessation treatment, with 80% of participants ($N = 15$) demonstrating biologically verified smoking abstinence at 6-month follow up (Johnson et al., 2014). The lack of control condition and

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open-label study design prohibit definitive conclusions about efficacy. However, these success rates substantially exceed those for the most efficacious accepted smoking cessation treatments, typically <35% abstinence rates at 6 months (Cahill et al., 2014; Mottillo et al., 2009).

No reports in the scientific literature have described tobacco smoking cessation resulting from non-clinical use of 5-HT_{2A}R agonists, although anecdotal evidence suggests that such accounts are not uncommon. Clinical psychologist Leo Zeff described how spontaneous reflections about tobacco smoking during an LSD experience in the 1960s prompted his own subsequent life-long smoking abstinence (Stolaroff, 2004). Similar reports attributing smoking cessation to psilocybin or other psychedelic use have appeared on websites related to psychoactive substances such as Erowid (<http://www.erowid.org>).

These anecdotal reports of smoking cessation or reduction attributed to the use of psychedelics in non-treatment contexts complement clinical studies that suggest psychedelics have anti-addiction effects. Therefore, to inform the clinical application of psychedelics in treating addiction, the present survey study characterized reports of smoking cessation or reduction attributed to psychedelic use among psychedelic users. The study examined factors associated with longer durations of abstinence, sustained abstinence versus relapse, and cessation versus reduction. We hypothesized that more personally meaningful and spiritually significant experiences would be associated with greater smoking cessation success. Online surveys have been used successfully in the past to identify trends in the natural ecology of drug use that would have otherwise been unknown from clinical laboratory research (McCambridge et al., 2005; Winstock et al., 2011, 2014). Although such a survey by itself cannot directly address the potential causal role of psychedelics in smoking cessation, it can complement laboratory research, for example, by identifying conditions for which psychedelic use is associated with persisting tobacco smoking cessation.

Method

This anonymous (i.e. no name or IP address recorded) survey was conducted online via SurveyMonkey (<http://www.surveymonkey.com>) from September 2013 to May 2014. Recruitment advertisements which included a link to the survey were distributed via social media (<http://www.facebook.com>; <http://www.reddit.com>), and on websites visited by individuals interested in psychedelics, including Erowid, Shroomery (<http://www.shroomery.org>), and the Multidisciplinary Association for Psychedelic Studies website (<http://www.maps.org>). Recruitment materials solicited individuals who had, “quit or reduced smoking after a psychedelic experience.” The stated goal of the survey was “to learn more information about whether psychedelic drugs are associated with reduction or cessation of cigarette smoking... [and] to characterize people’s experiences in non-laboratory settings in which taking a psychedelic may have led to reducing or quitting smoking.”

The survey took approximately 40 min to complete. Only individuals who reported quitting or reducing cigarette smoking, even temporarily, after the use of the following 5-HT_{2A}R agonist psychedelics were included: psilocybin (“magic”) mushrooms, LSD, morning glory seeds, mescaline, peyote cactus, San Pedro cactus, dimethyltryptamine (DMT), and ayahuasca. Other

inclusion criteria were that participants were at least 18 years of age, and were able to speak, read, and write English fluently. Participants received no compensation for their response. This study was approved by the Institutional Review Board of the Johns Hopkins University School of Medicine, USA, and all participants provided informed consent by choosing to complete the survey after the presentation of introductory information.

Measures

The full survey is available online (see Supporting Information). Demographic information, current non-psychedelic drug use, and lifetime psychedelic use were collected. The survey assessed participants’ previous smoking behavior, including number of cigarettes smoked per day (CPD) before the psychedelic experience to which they attributed their subsequent smoking cessation or reduction (hereafter referred to as “reference psychedelic experience”). Questions also assessed previous serious quit attempts (≥ 1 day) and associated withdrawal symptoms. Participants indicated categorically whether they were totally abstinent from smoking since their reference psychedelic experience, had a persisting reduction in their smoking since the reference psychedelic experience, or had a temporary reduction in their smoking after the reference psychedelic experience that later ended in relapse. Those who endorsed a persisting reduction in smoking since the reference psychedelic experience were asked to characterize their current smoking rate as falling into one of these four categories: ≤ 1 cigarette/month, ≤ 1 cigarette/week, ≤ 1 cigarette/day, or ≥ 1 cigarette/day.

Participants provided detailed information regarding their reference psychedelic experience. This included data on the drug used, the setting in which the experience took place, the intention for taking the drug, and the incidence of any adverse effects, or other behavioral changes attributed to this psychedelic experience. Participants were asked whether or not they found their reference psychedelic experience to be personally meaningful and spiritual or mystical in nature, and to retrospectively rate the personal meaning and spiritual significance of their reference psychedelic experience. Participants were also asked to endorse potential mechanisms of change attributed to their psychedelic-associated smoking cessation or reduction. Additional measures described below were used to probe relationships between constructs hypothesized to affect smoking cessation outcomes or the nature of the reference psychedelic experience. A series of hypothetical decision-making assessments were also conducted, which are not reported here.

Fagerström Test for Cigarette Dependence. The Fagerström Test for Cigarette Dependence (FTCD) is a 6-item questionnaire widely used to characterize the level of dependence of cigarette smokers (Fagerström, 2012; Heatherton et al., 1991). The FTCD was completed retrospectively, with items referring to smoking behavior in the 6-month period prior to the reference psychedelic experience (e.g. “In the 6 months prior to your psychedelic-occasioned smoking cessation or reduction, how soon after waking up did you want to smoke your first cigarette?”).

Questionnaire on Smoking Urges. The Questionnaire on Smoking Urges (QSU) is a 32-item multidimensional assessment of smoking craving with demonstrated sensitivity to smoking

cessation (Tiffany and Drobes, 1991). Participants were asked to complete the QSU twice, once retrospectively using a modified version of the assessment (e.g. “In the 6 months prior to my psychedelic-occasioned smoking cessation or reduction, my desire to smoke would have seemed overpowering at a time such as now.”), and once using the standard questionnaire with items in the present tense (e.g. “My desire to smoke seems overpowering.”). Although the QSU has not been psychometrically validated for retrospective use in this manner, our intention was to examine QSU data for evidence of within-subject changes in smoking craving following an individual’s reference psychedelic experience.

Toronto Alexithymia Scale. The Toronto Alexithymia Scale (TAS-20) is a 20-item assessment of alexithymia, a personality trait associated with difficulty identifying and describing one’s internal emotional state (Bagby et al., 1994). Individuals scoring higher on the TAS-20 have shown greater tobacco craving during a smoking cessation attempt (Sutherland et al., 2013). Therefore, we hypothesized that individuals high in alexithymia may exhibit less success in maintaining long-term abstinence.

Mystical Experience Questionnaire. The Mystical Experience Questionnaire (MEQ30) is a 30-item measure designed to assess the occurrence and intensity of mystical-type experiences occasioned by 5-HT_{2A}R agonists (Barrett et al., 2015; MacLean et al., 2012). Previous research has found associations between mystical-type effects of psilocybin and increased personality openness in healthy volunteers (MacLean et al., 2011), as well as sustained smoking abstinence in individuals undergoing psilocybin-facilitated smoking cessation treatment (Garcia-Romeu et al., 2015). Thus we hypothesized that individuals who scored higher on the MEQ30 would be more successful in maintaining long-term abstinence. The MEQ30 consists of four dimensions: unity, noetic quality, and sacredness (Factor 1), positive mood (Factor 2), transcendence of space/time (Factor 3), and ineffability (Factor 4). The MEQ30 was completed with respect to the reference psychedelic experience.

Tellegen Absorption Scale. The Tellegen Absorption Scale (TAS) is a 34-item measure of absorption, a personality trait linked to suggestibility and general predisposition to altered states of consciousness (Glisky et al., 1991; Tellegen and Atkinson, 1974). Given that higher scores on the TAS have been shown to predict pleasant and mystical-type experiences during psilocybin administration in the laboratory (Studerus et al., 2012), we predicted that participants scoring high on trait absorption would also score higher on the MEQ30 and subsequently report greater rates of long-term smoking abstinence.

Data analysis

Participants were categorized into three groups according to smoking cessation outcome: quit (smoking abstinence since the reference psychedelic experience), reduce (persisting reduction in smoking since the reference psychedelic experience), and relapse (temporary reduction in smoking after the reference psychedelic experience, but ultimately resumed smoking at baseline rate). Data from continuous and interval outcome measures (e.g. age, FTCD score) were assessed for normality of distribution using D’Agostino–Pearson omnibus tests (D’Agostino et al., 1990). For

normally distributed data, a one-way analysis of variance (ANOVA) was performed to assess between-group differences. For non-normally distributed data, Kruskal–Wallis tests by ranks were performed to assess between-group differences. Chi-square analyses were used to test for differences between groups in categorical variables (e.g. sex, intention to quit). Categories with few participants were combined with related categories for Chi-square analyses to ensure test validity (e.g. morning glory, mescaline, peyote, San Pedro were classified as “other”). Post hoc pairwise comparisons using the Tukey method for normally distributed data, or Dunn multiple comparison method for non-normally distributed data were used to examine ANOVAs and Kruskal–Wallis tests reaching statistical significance. Finally, a Spearman rank correlation analysis was conducted to assess the relationship between mystical experience as measured by the MEQ30, and trait absorption as assessed by the TAS. This relationship was examined because previous research indicated that individuals higher in trait absorption were more likely to have mystical-type experiences when administered psilocybin in a laboratory setting (Studerus et al., 2012). Due to the exploratory nature of these analyses, no corrections were made for multiple comparisons. Statistical analyses were conducted using GraphPad Prism 6.05 for Mac (GraphPad Software, Inc., La Jolla, CA).

Results

Participant information

A total of 1273 individuals completed the survey. Of these, individuals were removed from data analysis for a variety of reasons. A group of 163 individuals were removed because they reported smoking cessation or reduction following use of a non-serotonergic drug (e.g. ketamine). Another 329 individuals were removed because they provided inconsistent data (e.g. endorsed total smoking abstinence since the experience, but also indicated smoking in the 7 days prior to taking the survey). Another 423 individuals whose reference psychedelic experience occurred <12 months before taking the survey were removed in order for analyses to focus on long-term outcomes of psychedelic-associated smoking cessation and reduction. Thus, the final study sample consisted of 358 participants. Table 1 contains participant demographic and smoking-related information.

The majority of participants (65.1%, $n = 233$) learned about the survey through advertisements on www.erowid.org, with the remainder being referred via www.shroomery.org (8.4%, $n = 30$), www.facebook.com (4.2%, $n = 15$), other unspecified sources (19.0%, $n = 68$), and related websites (e.g. www.maps.org, $n < 10$). Participants resided in 27 different countries, with most coming from the United States (69.6%, $n = 249$), Canada (7.5%, $n = 27$), and the United Kingdom (7.0%, $n = 25$). Table 2 presents data on lifetime psychedelic drug use. Psilocybin mushrooms (95.3%) and LSD (88.8%) were the most commonly used psychedelics, with a mode of 2–5 lifetime uses (i.e. separate occasions) among individuals who had used these substances.

Smoking outcomes and group comparisons

Figure 1 shows duration of long-term abstinence or reduction in the quit and reduce groups. A total of 137 participants (38.3%; quit group) reported complete smoking cessation after their

Table 1. Participant demographic and smoking-related information.

	Whole sample (<i>N</i> = 358)	Quit group (<i>n</i> = 137)	Reduce group (<i>n</i> = 100)	Relapse group (<i>n</i> = 121)	Test statistic	<i>p</i>
Sex	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		
Male	306 (85.5)	115 (83.9)	89 (89.0)	102 (84.3)	$\chi^2 = 1.40$	0.50
Female	52 (14.5)	22 (16.1)	11 (11.0)	19 (15.7)		
Race	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		
White	307 (85.8)	116 (84.7)	82 (82.0)	109 (90.1)	$\chi^2 = 4.68$	0.32
American Indian/Alaska native	6 (1.7)	4 (2.9)	1 (1.0)	1 (0.8)		
Asian	6 (1.7)	3 (2.2)	2 (2.0)	1 (0.8)		
Mixed	26 (7.3)	9 (6.6)	11 (11.0)	6 (5.0)		
Other	13 (3.7)	5 (3.6)	4 (4.0)	4 (3.3)		
Education	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		
Some high school or less	14 (3.9)	4 (2.9)	4 (4.0)	6 (5.0)	$\chi^2 = 6.41$	0.78
High school or equivalent	40 (11.2)	14 (10.2)	10 (10.0)	16 (13.2)		
Some college	153 (42.7)	60 (43.8)	41 (41.0)	52 (43.0)		
College degree	73 (20.4)	27 (19.7)	22 (22.0)	24 (19.8)		
Some graduate/professional school	34 (9.5)	12 (8.8)	14 (14.0)	8 (6.6)		
Graduate/ professional degree	44 (12.3)	20 (14.6)	9 (9.0)	15 (12.4)		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Test statistic	<i>p</i>
Age, years	31.1 (11.2)	31.2 (10.9)	30.2 (10.5)	31.7 (12.0)	$H = 0.55$	0.76
Age started smoking	15.6 (3.2)	15.5 (3.4)	15.4 (2.9)	15.8 (3.3)	$H = 0.38$	0.83
Years smoking	7.7 (7.1)	8.2 (7.9)	7.2 (5.8)	7.7 (7.0)	$H = 0.15$	0.93
Cigarettes/day before psychedelic experience	14.0 (9.6)	13.9 (10.1) ^{a,b}	12.8 (9.1) ^a	15.2 (9.3) ^b	$H = 7.21$	0.03
Previous quit attempts	4.9 (5.3)	4.3 (4.6)	5.2 (5.5)	5.3 (5.7)	$H = 1.62$	0.45
FTCD (smoking dependence)	3.7 (2.4)	3.7 (2.4)	3.3 (2.5)	4.0 (2.4)	$H = 4.72$	0.09
QSU (craving) pre-quit/reduction	111.6 (26.1)	109.3 (27.6)	114.2 (24.6)	111.9 (25.4)	$F = 1.05$	0.35
QSU (craving) post-quit/reduction	87.5 (37.3)	61.7 (17.4) ^a	87.5 (31.5) ^b	116.8 (36.8) ^c	$H = 149$	<0.001

Note: Between-groups Chi-square analyses are shown for sex, race, and education. For all other categories, between-groups one-way ANOVA analyses or Kruskal–Wallis tests are shown. For all analyses, significant *p* values ($p < 0.05$) are shown in bold. For variables with significant main effects, group values not sharing a common letter are significantly different based on Tukey-corrected pairwise comparison or Dunn's multiple comparisons.

ANOVA: analysis of variance; FTCD: Fagerström Test for Cigarette Dependence; QSU: Questionnaire on Smoking Urges.

Table 2. Participants' self-reported total number of lifetime uses of serotonergic psychedelics (*N* = 358).

Lifetime use	Psilocybin mushrooms, <i>n</i> (%)	LSD, <i>n</i> (%)	Morning glory seeds, <i>n</i> (%)	Mescaline (pc), <i>n</i> (%)	Peyote cactus, <i>n</i> (%)	San Pedro cactus, <i>n</i> (%)	DMT (pc), <i>n</i> (%)	Ayahuasca, <i>n</i> (%)
Never	17 (4.7)	40 (11.2)	217 (60.6)	288 (80.4)	307 (85.8)	285 (79.6)	210 (58.7)	295 (82.4)
1 occasion	25 (7.0)	23 (6.4)	61 (17.0)	34 (9.5)	23 (6.4)	26 (7.3)	38 (10.6)	29 (8.1)
2–5 separate occasions	87 (24.3)	83 (23.2)	57 (15.9)	19 (5.3)	20 (5.6)	29 (8.1)	47 (13.1)	17 (4.7)
6–10 separate occasions	66 (18.4)	51 (14.2)	11 (3.1)	4 (1.1)	1 (0.3)	8 (2.2)	25 (7.0)	6 (1.7)
11–20 separate occasions	69 (19.3)	50 (14.0)	9 (2.5)	2 (0.6)	5 (1.4)	6 (1.7)	15 (4.2)	4 (1.1)
21–50 separate occasions	53 (14.8)	39 (10.9)	2 (0.6)	2 (0.6)	0 (0)	2 (0.6)	13 (3.6)	5 (1.4)
51–100 separate occasions	22 (6.1)	36 (10.1)	1 (0.3)	5 (1.4)	1 (0.3)	2 (0.6)	5 (1.4)	1 (0.3)
>100 separate occasions	19 (5.3)	36 (10.1)	0 (0)	4 (1.1)	1 (0.3)	0 (0)	5 (1.4)	1 (0.3)

Note: Modal responses in bold.

DMT: dimethyltryptamine; LSD: lysergic acid diethylamide; pc: pure compound.

reference psychedelic experience, with 102 of the 137 (74.5%) reporting >2 years' abstinence. Overall, 100 participants (27.9%; reduce group) reported a persisting reduction in smoking, from a mode of 300 cigarettes/month before ($n = 20$), to a mode of ≤ 1 cigarette/month after the experience ($n = 44$), with 62 of the 100 (62%) reporting >2 years reduction in smoking. Among the

reduce group, 44 participants reported current smoking ≤ 1 cigarette/month, 19 reported smoking ≤ 1 cigarette/week, 14 reported smoking ≤ 1 cigarette/day, and 23 reported smoking ≥ 1 cigarette/day. Finally, 121 individuals (33.8%; relapse group) reported a temporary reduction in their smoking before returning to baseline smoking levels, with a mode of 3–6 months to relapse

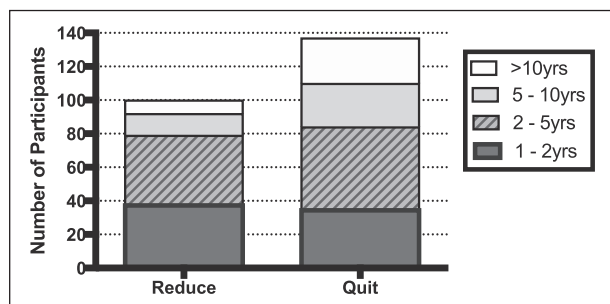


Figure 1. Distribution of participants reporting persisting smoking reduction (reduce group) by duration of reduction is shown on the left. Distribution of participants reporting ongoing smoking abstinence (quit group) by duration of abstinence is shown on the right.

($n = 21$). Only 30 of the 358 respondents (8.4%) reported going into their reference psychedelic experience with a premeditated intention to quit or reduce smoking (Table 3).

Demographic data are presented in Table 1. There were no significant between-group differences in demographic variables including age, sex distribution, racial composition, educational achievement, prevalence of self-reported psychiatric diagnoses, number of previous quit attempts, years smoking, or retrospective cigarette dependence scores. Kruskal–Wallis tests found significant between-groups differences in alexithymia scores ($p = 0.006$), cigarettes per day prior to the reference psychedelic experience ($p = 0.03$), confidence to abstain from smoking ($p < 0.001$), and current craving for tobacco ($p < 0.001$; Table 3). Dunn’s multiple comparisons found that individuals in the relapse group scored significantly higher on alexithymia than those in the quit group. Participants in the relapse group smoked significantly more cigarettes per day prior to the reference psychedelic experience than those in the reduce group (Table 1). Confidence to abstain from smoking was significantly higher in the quit than reduce and relapse groups. Additionally, current tobacco craving scores on the QSU showed significant between-groups differences, with the relapse group reporting greater craving at the time of the survey than the quit and reduce groups (Figure 2), and the reduce group scoring significantly higher than the quit group.

No significant differences were observed with regard to lifetime hallucinogen use (between-groups data not shown). Furthermore, there were no significant between-group differences in the substance associated with the reference psychedelic experience, intention for the experience, or setting in which the experience took place (Table 3). However, there was a significant between-groups difference in the age at which the reference psychedelic experience occurred ($p = 0.007$). Dunn’s multiple comparisons found participants in the relapse group were significantly younger when their reference psychedelic experience occurred than those in the quit and reduce groups, with a mean age of 22 at the time of the reference psychedelic experience for those in the relapse group compared with a mean age of 24.1 in the quit group, and 23.7 in the reduce group at the time of the reference psychedelic experience. Additionally, Chi-square analyses found significant between-groups differences in duration of longest prior quit ($\chi^2 = 34.9$, $p = 0.004$), with 53% of the longest previous quit attempts lasting 2 weeks or less in the quit group, compared

with 37% in the reduce, and 28% in the relapse group (data not shown).

Withdrawal symptoms

Table 4 shows participant ratings of withdrawal symptoms after their psychedelic-associated smoking cessation or reduction in comparison with previous quit attempts. The majority of withdrawal symptoms (e.g. weight gain, headaches, insomnia) were rated as similar in severity to previous quit attempts according to mode responses. Conversely, affective features of withdrawal (i.e. restlessness, depression, irritability, craving) were largely rated “much less severe” after the reference psychedelic experience in comparison with other quit attempts. Individuals reporting greater severity of withdrawal symptoms after their reference psychedelic experience compared with previous quit attempts were in the minority ($n \leq 16$). Chi-square analyses found no significant differences between groups in reported severity of withdrawal symptoms (data not shown).

Mechanisms of change, personal meaning, and spiritual significance

As shown in Table 5, participants endorsed “changing life priorities or values, such that smoking was no longer more important than quitting” (88.5%, $n = 317$), “changing your orientation toward the future, so that long-term benefits outweighed immediate desires” (85.2%, $n = 305$), and “strengthening your belief in your own ability to quit” (79.1%, $n = 283$) as the most important potential mechanisms leading to quitting or reducing smoking after their reference psychedelic experience.

In total, 336 (93.9%) participants characterized their reference psychedelic experience as personally meaningful with 218 (60.1% of entire study sample) considering it among the 10 most personally meaningful experiences of their lives. Additionally, 281 (78.5%) characterized their psychedelic experience as spiritual or mystical in nature (i.e. “a moment of sudden spiritual awakening or insight”), with 161 (45.0% of the entire sample) rating it among the five most spiritually significant experiences of their lives (data not shown).

Significant between-groups differences were found in ratings of personal meaning ($p = 0.03$) and spiritual significance ($p = 0.004$) of the reference psychedelic experience (Table 3). Participants in the relapse group rated the reference psychedelic experience as significantly less personally meaningful than those in the quit group. Individuals in the relapse group additionally rated their reference psychedelic experience as less spiritually significant than those in both the quit and reduce groups. Among the relapse group 33.9% ($n = 41$) rated their reference psychedelic experience among the five most spiritually significant of their lives compared with 50% ($n = 50$) in the reduce, and 51.1% ($n = 70$) in the quit group. No significant differences were observed between groups on MEQ30 scores, although a near-significant effect was found for the MEQ30 ($p = 0.06$), with the relapse group scoring the lowest. No significant differences were observed between groups on self-reported intentions for the reference psychedelic experience (Table 3). A significant positive correlation was found between MEQ30 and TAS scores ($r = 0.44$, $p < 0.001$; Figure 3).

Table 3. Participant questionnaire data and psychedelic-related information.

	Whole sample (<i>N</i> = 358)	Quit group (<i>n</i> = 137)	Reduce group (<i>n</i> = 100)	Relapse group (<i>n</i> = 121)	Test statistic	<i>p</i>
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
TAS	23.2 (6.4)	22.9 (6.8)	24.1 (5.8)	23.0 (6.3)	<i>H</i> = 1.52	0.47
TAS-20	48.4 (12.2)	46.1 (11.9) ^a	49.0 (11.7) ^{a,b}	50.4 (12.4) ^b	<i>H</i> = 10.32	0.006
MEQ30	72.8 (19.0)	74.4 (19.9)	74.5 (16.7)	69.5 (19.6)	<i>H</i> = 5.58	0.06
Personal meaning of psychedelic experience	5.7 (1.6)	5.9 (1.6) ^a	5.7 (1.6) ^{a,b}	5.4 (1.6) ^b	<i>H</i> = 6.29	0.04
Spiritual significance of psychedelic experience	3.1 (1.3)	3.2 (1.4) ^a	3.3 (1.1) ^a	2.8 (1.4) ^b	<i>H</i> = 10.89	0.004
Age of psychedelic experience	23.3 (7.2)	24.1 (7.9) ^a	23.7 (6.3) ^a	22.0 (6.8) ^b	<i>H</i> = 9.95	0.007
Confidence to abstain from smoking	76.3 (31.5)	97.5 (5.4) ^a	70.9 (28.9) ^b	56.1 (36.4) ^b	<i>H</i> = 147.1	<0.001
Premeditated intention to quit:	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	$\chi^2 = 4.13$	0.13
Yes	30 (8.4)	12 (8.8)	4 (4.0)	14 (11.6)		
No	328 (91.6)	125 (91.2)	96 (96.0)	107 (88.4)		
Drug associated with smoking cessation/reduction:	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	$\chi^2 = 8.09$	0.09
Psilocybin	157 (43.9)	64 (46.7)	47 (47.0)	46 (38.0)		
LSD	157 (43.9)	57 (41.6)	36 (36.0)	64 (52.9)		
DMT	14 (3.9)	7 (5.1)	6 (6.0)	1 (0.8)		
Ayahuasca	17 (4.7)	8 (5.8)	4 (4.0)	5 (4.1)		
Other (morning glory, mescaline, peyote, San Pedro)	13 (3.6)	1 (0.7)	7 (7.0)	5 (4.1)		
Where did this experience take place?	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		
At home	218 (60.9)	88 (64.2)	51 (51.0)	79 (65.3)	$\chi^2 = 5.73$	0.06
At a party	33 (9.2)	13 (9.5)	6 (6.0)	14 (11.6)	$\chi^2 = 2.05$	0.36
In a public place (e.g. shopping mall, movie theater)	38 (10.6)	15 (10.9)	10 (10.0)	13 (10.7)	$\chi^2 = 0.06$	0.97
At a concert or festival	26 (7.3)	9 (6.6)	11 (11.0)	6 (5.0)	$\chi^2 = 3.13$	0.21
Outdoors in nature	145 (40.5)	48 (35.0)	41 (41.0)	56 (46.3)	$\chi^2 = 3.39$	0.18
In a religious/spiritual setting (e.g. ritual ceremony)	18 (5.0)	7 (5.1)	4 (4.0)	7 (5.8)	$\chi^2 = 0.37$	0.83
Intention for taking the psychedelic?	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		
Because other people were, but no serious intention	17 (4.7)	8 (5.8)	3 (3.0)	6 (5.0)	$\chi^2 = 1.05$	0.59
Curiosity without any other serious intention	62 (17.3)	22 (16.1)	15 (15.0)	25 (20.7)	$\chi^2 = 1.47$	0.48
Recreational	205 (57.3)	77 (56.2)	60 (60.0)	68 (56.2)	$\chi^2 = 0.42$	0.81
A serious intention for psychological self-exploration	187 (52.2)	66 (48.2)	58 (58.0)	63 (52.1)	$\chi^2 = 2.24$	0.33
A serious intention to explore spirituality / the sacred	137 (38.3)	49 (35.8)	40 (40.0)	48 (39.7)	$\chi^2 = 0.59$	0.74
Other behavioral changes after this psychedelic session?	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		
Reduced or quit drinking alcohol	152 (42.5)	57 (41.6)	45 (45.0)	50 (41.3)	$\chi^2 = 0.37$	0.83
Reduced or quit other drugs	100 (27.9)	37 (27.0)	33 (33.0)	30 (24.8)	$\chi^2 = 1.93$	0.38
Negative effects from this psychedelic session?	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	$\chi^2 = 3.33$	0.50
Yes (typically acute anxiety or physical discomfort)	43 (12)	17 (12.4)	16 (16.0)	10 (8.3)		
No	281 (78.5)	107 (78.1)	74 (74.0)	100 (82.6)		
Not sure	34 (9.5)	13 (9.5)	10 (10.0)	11 (9.1)		

Note: Between-groups Kruskal–Wallis tests are shown for absorption, alexithymia, mystical experience, personal meaning, spiritual significance, age of psychedelic experience, and confidence to abstain. For all other categories, between-groups Chi-square analyses are shown. For items with mutually exclusive responses, modal responses are shown in bold. For all analyses, significant *p* values (*p* < 0.05) are shown in bold. Values not sharing a common letter are significantly different based on Dunn's multiple comparisons.

^{a,b}Values not sharing a common letter are significantly different based on Dunn's multiple comparisons.

DMT: dimethyltryptamine; LSD: lysergic acid diethylamide; MEQ30: Mystical Experience Questionnaire; TAS: Tellegen Absorption Scale; TAS-20: Toronto Alexithymia Scale.

Other outcomes attributed to reference psychedelic experience

In addition to tobacco smoking cessation or reduction, some participants also reported reductions in the use of alcohol (42.5%, *n* = 152), and other drugs (27.9%, *n* = 100) attributed to the reference psychedelic experience, with no significant between-group differences (Table 3). The majority of participants (78.5%, *n* = 281) reported no negative effects from their reference psychedelic experience, some responded that they were unsure whether the experience had any negative effects (9.5%, *n* = 34), and others did

report negative effects of their experience (12.0%, *n* = 43). Negative effects were typically described as acute anxiety or dysphoria, as well as feelings of physical discomfort such as gastrointestinal distress during drug effects. Prevalence of negative effects did not differ significantly between groups.

Discussion

This online survey study provides detailed information on a sample of 358 individuals who reported smoking cessation or reduction after using a serotonergic psychedelic in a non-laboratory

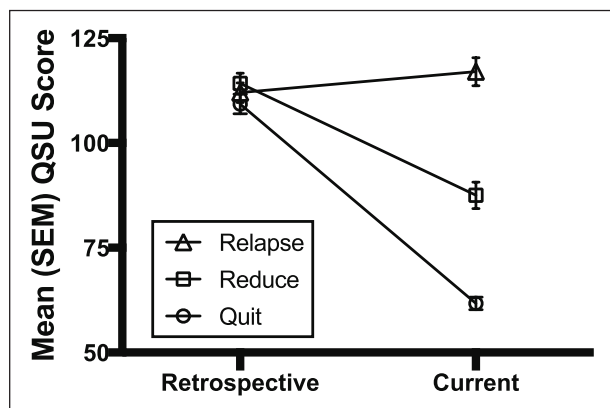


Figure 2. Group differences in smoking craving as assessed by the QSU from pre- to post-reference psychedelic experience. Retrospective ratings showed no significant differences among the groups. Current ratings showed significant difference among all three of the groups ($p < 0.001$). QSU: Questionnaire on Smoking Urges.

setting ≥ 1 year ago. Individual smoking outcomes varied, including total smoking abstinence after the reference psychedelic experience (quit group), persisting reductions in previous smoking rate (reduce group), and reductions in regular daily smoking ultimately culminating in relapse to baseline smoking levels (relapse group). Participants were predominantly young White males who reported using a psychedelic recreationally or for the purposes of psychological exploration, with no premeditated intention to decrease their smoking. However, participants claimed that they experienced a subsequent cessation or reduction in their smoking that they attributed in part to their reference psychedelic experience. These findings are consistent with laboratory data findings that controlled administration of 5-HT_{2A}R agonists may hold therapeutic potential in treating tobacco and other substance use disorders (Bogenschutz et al., 2015; Johnson et al., 2014; Krebs and Johansen, 2012), as well as anthropological reports suggesting that structured (i.e. religious) psychedelic use may confer benefits against addiction (Albaugh and Anderson, 1974; Bergman, 1971; Blum et al., 1977; Calabrese, 1997; de Rios et al., 2002; Garrity, 2000; Halpern, 1996; Pascarosia and Futterman, 1976; Prue, 2013;

Table 4. Withdrawal severity after psychedelic-associated smoking cessation or reduction in comparison with previous quit attempts. Modal responses shown in bold.

Withdrawal symptoms' severity (n) ^a	Much less severe, n (%)	Less severe, n (%)	Same, n (%)	More severe, n (%)	Much more severe, n (%)
Weight gain (258)	77 (29.8)	49 (19.0)	121 (46.9)	8 (3.1)	3 (1.2)
Increased eating (269)	71 (26.4)	61 (22.7)	121 (45.0)	14 (5.2)	2 (0.7)
Digestive problems (242)	69 (28.5)	40 (16.5)	127 (52.5)	6 (2.5)	0 (0)
Nausea (240)	74 (30.8)	41 (17.1)	118 (49.2)	7 (2.9)	0 (0)
Headaches (255)	84 (32.9)	54 (21.2)	106 (41.6)	9 (3.5)	2 (0.8)
Drowsiness (251)	80 (31.9)	42 (16.7)	123 (49.0)	6 (2.4)	0 (0)
Fatigue (257)	74 (28.8)	55 (21.4)	119 (46.3)	8 (3.1)	1 (0.4)
Insomnia (257)	76 (29.6)	51 (19.8)	122 (47.5)	5 (1.9)	3 (1.2)
Heart pounding/sweating (237)	78 (32.9)	29 (12.2)	125 (52.7)	4 (1.7)	1 (0.4)
Difficulty concentrating (268)	88 (32.8)	67 (25.0)	104 (38.8)	7 (2.6)	2 (0.7)
Anxiety (268)	93 (34.7)	72 (26.9)	93 (34.7)	6 (2.2)	4 (1.5)
Restlessness (272)	92 (33.8)	76 (27.9)	90 (33.1)	7 (2.6)	7 (2.6)
Depression/low mood (271)	114 (42.1)	69 (25.5)	80 (29.5)	7 (2.6)	1 (0.4)
Irritability (277)	118 (42.6)	73 (26.4)	73 (26.4)	10 (3.6)	3 (1.1)
Craving tobacco (284)	133 (46.8)	89 (31.3)	52 (18.3)	4 (1.4)	6 (2.1)

^aSample size varies by symptom (range = 237–284), as some participants reported no previous quit attempts as a basis for comparison, and others had never experienced particular withdrawal symptoms. Percentages were calculated based on the number of individuals who reported a particular withdrawal symptom.

Table 5. Smoking cessation or reduction mechanisms attributed to reference psychedelic experience.

Mechanism ^a	Endorsed item, n (%)	Ranked most important, n (%) ^b
Changing life priorities or values, such that smoking was no longer more important than quitting	317 (88.5)	95 (26.5)
Strengthening your belief in your own ability to quit	283 (79.1)	65 (18.2)
Changing your orientation toward the future, so that long-term benefits outweighed immediate desires	305 (85.2)	60 (16.8)
Reducing stress involved with quitting	287 (80.2)	44 (12.3)
Reframing quitting as a spiritual task	252 (70.4)	44 (12.3)
Increasing space between the desire to smoke and taking action	281 (78.5)	21 (5.9)

^aParticipants were asked to endorse any relevant mechanisms they believed played a role in their psychedelic-associated smoking cessation or reduction. These mechanisms are based on our laboratory research (Johnson et al., 2014).

^bFor each mechanism endorsed, participants were asked to rank order the items in terms of their importance to helping them quit or reduce smoking.

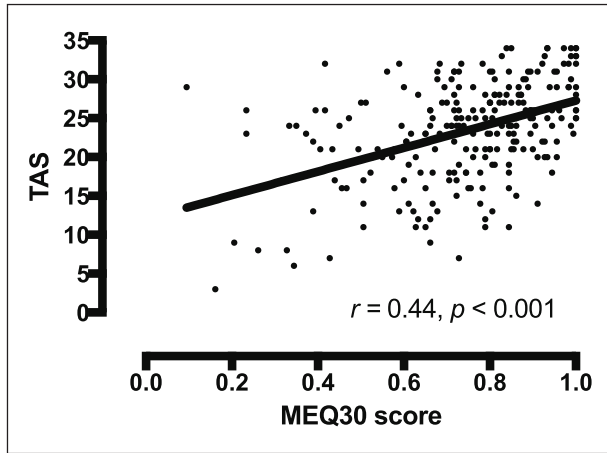


Figure 3. Relationship between MEQ30 and TAS scores. Data points show data from each of the 358 individual participants with best-fit linear regression.

MEQ30: Mystical Experience Questionnaire; TAS: Tellegen Absorption Scale.

Roy, 1973). It should be noted though that volunteers who underwent psilocybin-facilitated smoking cessation treatment in a prior laboratory study were purposefully attempting to quit smoking (Johnson et al., 2014), while participants in this survey were largely not intending to reduce their smoking. If psychedelics are capable of prompting smoking cessation or reduction in those not seeking to reduce smoking, potential efficacy may be even more likely in those who are treatment seeking and under therapeutic supervision.

Several group differences highlight potentially relevant clinical factors regarding smoking cessation and relapse. Ratings of personal meaning and spiritual significance of the reference psychedelic experience differed statistically between groups, with individuals who maintained long-term smoking abstinence rating their reference psychedelic experience as more personally meaningful and spiritually significant than those who relapsed to smoking, and those who reported persisting smoking reductions rating their reference psychedelic experience more spiritually significant than those who relapsed. Thus, these results support prior laboratory research demonstrating psychedelics' potential to occasion highly meaningful and spiritually significant experiences (Griffiths et al., 2006, 2008, 2011; MacLean et al., 2011), and suggest a mediating role for spiritual experience in promoting long-term smoking abstinence (Garcia-Romeu et al., 2015).

Moreover, participants in the relapse group reported smoking more cigarettes per day on average prior to the reference psychedelic experience than those in the quit group. Therefore, it is possible that the greater rate of smoking and the younger age at which the reference psychedelic experience occurred in the relapse group may account for their failure to maintain abstinence/reduction, rather than variance in alexithymia or personal meaning and spiritual significance of the psychedelic experience.

Groups did not differ significantly with respect to demographics (aside from differences in CPD discussed above), the psychedelic used, setting, or intention for use during the reference psychedelic experience. Although negative effects were reported at similar rates across groups, these were typically confined to

the period of acute drug effects, and were predominantly described as either psychological (i.e. dysphoria, anxiety), or physical discomfort (e.g. stomachache, headache). Adverse effects of psychedelics are relatively well documented, and represent risks to the user, especially in uncontrolled settings (Johnson et al., 2012; Ungerleider et al., 1968). Furthermore, illegal drugs acquired on the black-market are rarely verified with regard to substance, purity, and dose, representing an additional serious risk factor (Burrai et al., 2014). Thus, we do not encourage psychedelic use outside of medical or research settings that can provide the appropriate screening, structure, and supervision to ensure safety (Johnson et al., 2008). The majority of participants reported 10 or fewer lifetime uses of the psychedelics examined (Table 2), consistent with the low addictive potential of this drug class (Johnson et al., 2008).

Regarding potential mechanisms of action, decreased affective withdrawal symptoms after psychedelic-associated quit attempts compared with other, non-psychedelic-associated quit attempts suggest an important role for psychedelics in attenuating low mood and craving, which are known to precipitate relapse (Piper, 2015). Such effects may be related to psychedelics' serotonergic mechanism of action at the 5-HT_{2A} and possibly 5-HT_{1A} receptors (Bogenschutz and Pommy, 2012; Kraehenmann et al., 2014; Preller et al., 2016; Ross, 2012; Vollenweider and Kometer, 2010).

Participants also reported other behavioral changes as a result of their psychedelic session, with individuals across all three groups reporting reduction or cessation of alcohol ($\geq 41\%$) or other drug use ($\geq 25\%$) after their reference psychedelic experience (Table 3). These data support the hypothesis that psychedelic experiences may result in behaviorally plastic states in which habitual or addictive behaviors can be re-evaluated. These findings suggest that psychedelics may provide benefits against a range of substance use disorders, rather than being specific to tobacco per se.

The insights and processes that appear to be prompted by psychedelics, and which may lead to smoking cessation or reduction, may not be unique to psychedelics. For example, abstinence from tobacco and other drugs is sometimes prompted by naturalistic spiritual or insightful experiences (Miller, 2004; Miller and C'de Baca, 2001). Also, survey data indicate that smokers generally consider spirituality to be relevant to smoking cessation (Gonzales et al., 2007). It is our hypothesis that administration of psychedelics under structured conditions may strongly increase the likelihood of motivational insights leading to persisting behavior change such as smoking cessation. Further, we propose that while these motivational insights from psychedelics occur and sometimes prompt people to quit smoking in recreational or non-clinical contexts, such effects are likely to lead to substantially higher probability of persisting behavior change (abstinence) when smoking cessation is the a priori goal of the psychedelic experience, and when combined with effective behavioral therapy (Garcia-Romeu et al., 2015; Johnson et al., 2014).

The results presented here are limited due to participant self-selection, and the retrospective nature of the data, which are subject to recall bias. No definitive conclusions can be drawn about the role of psychedelics in smoking cessation or reduction as data were collected via online survey, and cannot be verified. Additionally, information on the identity and dosage of the

psychedelics used by participants cannot be confirmed due to limitations of the online study format.

Although efforts were made to allow only one response per computer per web browser, and to exclude inconsistent and nonsensical responses, it cannot be confirmed whether some individuals responded more than once, though we judge it unlikely due to the length of the survey. The current study design cannot address absolute prevalence or efficacy of psychedelic-associated smoking cessation or reduction, as negative cases were not taken into account (i.e. when psychedelic use did not affect, or exacerbated smoking). An additional design limitation was the omission of an item probing average cigarettes per day intake after the reference psychedelic experience, which made it impossible to quantify the magnitude of daily smoking reduction among the reduce group. The possibility of Type I errors should be noted, as alpha was not adjusted for multiple comparisons given the exploratory nature of the study aims. Moreover, most participants were White, college-educated males, consistent with epidemiological data on global psychedelic use (Winstock et al., 2014), raising the possibility that results may not generalize to other groups. Despite these limitations, our findings, in combination with pilot laboratory results (Garcia-Romeu et al., 2015; Johnson et al., 2014), suggest that psilocybin and other serotonergic psychedelics may hold considerable potential in the treatment of tobacco, and possibly other substance use disorders, and should therefore continue to be examined as a pharmacological aid in the treatment of addiction.

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