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Cannabis-induced oceanic boundlessness

Mitch Earleywine, Luna F Ueno, Maha N Mian and Brianna R Altman

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Abstract

Background: Despite tetrahydrocannabinol (THC)'s reputation for creating dramatic effects at high doses, empirical work rarely addresses cannabis's impact on subjective responses common to the tryptamine psychedelics. We focused on these effects because they have preceded and covaried with the therapeutic impact of psilocybin in previous work.

Aims: The current study examined if self-reported responses to cannabis products might parallel those found in clinical trials of psilocybin administration. We also investigated if measures of demographics and cannabis use might correlate with these responses.

Methods: Participants reported the subjective effect of their highest THC experience using 27 items that assess oceanic boundlessness, a correlate of mystical experiences. They also answered infrequency items and questions on demographics and cannabis consumption.

Results: In an effort to address concerns about replication, we divided respondents who passed infrequency items into two random samples. Self-reported "breakthrough" experiences were significantly greater than zero but significantly lower than those reported in randomized clinical trials of psilocybin (17–19% vs. 59%). Total scores covaried with perceived dosages of THC, but only in one sample. Heavier users of cannabis reported lower scores.

Conclusions: Self-report data suggest that high doses of cannabis can create subjective effects comparable to those identified in trials of psilocybin that precede relief from cancer-related distress, treatment-resistant depression, alcohol problems, and cigarette dependence. Given the disparate mechanisms of action, comparing THC-induced to psilocybin-induced effects might improve our understanding of the mechanisms underlying subjective experiences. This work might also support the development of a cannabis-assisted psychotherapy comparable to psilocybin-assisted psychotherapy.

Keywords
Tetrahydrocannabinol, oceanic boundlessness, mystical experiences, psychedelic-assisted psychotherapy, cancer, depression, cigarettes

Introduction

Cannabis consumption creates numerous subjective effects that appear to contribute to use (Brackenbury et al., 2016; Luba et al., 2018; Schafer and Brown, 1991), associated problems (Buckner and Schmidt, 2008), and purported therapeutic impact (e.g., Altman et al., 2019; Slavin et al., 2017). Self-reported effects of high doses include reactions that are not only aversive but also meaningful (Farmer et al., 2019). An investigation of the various disparate subjective effects that cannabis can create might prove interesting in its own right. Such data also have the potential to reveal intriguing information about the role of the cannabinoid system in affect and consciousness, both acutely (Mathew et al., 1997) and chronically (Gruber et al., 2009). Nevertheless, the question of which subjective effects to examine can seem overwhelming, given the range of possibilities. Participants have reported impairing, stimulating, relaxing, erotic, cognitive (Schafer and Brown, 1991), sedating (Luba et al., 2018), time-altering, paranoid, and psychotic effects, to name just a few (Green et al., 2003; Mokrysz et al., 2020).

Recent work on the therapeutic use of psilocybin has also generated considerable interest in its subjective effects. Those who use classic serotonergic psychedelics (drugs that produce an altered state of consciousness) have reported improvement in various mental health conditions such as anxiety, depression, and addictions (Bogenschutz et al., 2015, Carhart-Harris et al., 2016; Garcia-Romeu et al., 2014; Griffiths et al., 2016; Johnson et al., 2017; Klavetter and Mogar, 1967; Maclean et al., 2011; O'Reilly and Funk, 1964; Pahnke et al., 1970; Kurland et al., 1972; Richards et al., 1977; Ross et al., 2016). An alleviation of mental health symptoms or negative affect also appears soon after altered states are induced in other ways. These states are ineffable (almost by definition), but often include a sense of oneness as well as a mystical, revelatory sense of awe. Nevertheless, aversive, frightening moments frequently accompany even the most meaningful of these experiences (Carbonaro et al., 2016; Farmer et al., 2019; Smith, 1964).

Despite the potential for fear, generating these altered states of consciousness via dance, prayer, meditation, hypnosis, or other actions often precedes a better attitude or relief from angst. Nevertheless, the relevant activities for inducing altered states frequently require extensive effort, practice, or expertise (Csikszentmihalyi and Csikszentmihalyi, 1992; James, 1902; Ludwig, 1966; Maslow, 1959; Noyes, 1980; Snell and Simmonds, 2015), leading many researchers and clinicians to focus on psychoactive substances, if only because they can induce these states fairly consistently. The exact mechanism behind the link between these experiences and decreased psychopathology or troubles is

Department of Psychology, University at Albany, SUNY, Albany, USA

Corresponding author:
Mitch Earleywine, Department of Psychology, University at Albany, SUNY, 1400 Washington Avenue, SS399, Albany, NY 12222, USA.
Email: mearleywine@albany.edu

unclear and might even be spurious (Majić et al., 2015). Psychedelic experiences vary dramatically; some create more benefits than others. But several studies reveal that "mystical" or "boundless" moments covary with later improvement (e.g., Carhart-Harris et al., 2018, Garcia-Romeu et al., 2014, Griffiths et al., 2016; Richards et al., 1977). Formal work linking the subjective effects of these substances with relief or improvement employs psychedelic-assisted psychotherapy. This treatment usually includes preparatory sessions designed to build rapport with facilitators while participants set some intention or goal for the therapy. Drug administration occurs in comfortable environs in a soothing physical space, in the presence of tranquil facilitators, eyeshades for blocking distractors, and selected music. Follow-up discussions for making sense of the drug administration sessions are also an inherent part of the therapy. Unlike many prescription antidepressants that patients take daily for months or years, this approach frequently employs only one or two administrations (see Johnson et al., 2019, for a detailed review).

Generally, ratings of mystical-type experiences (measured by unity, spirituality, and "insightfulness" on the 11-Dimension Altered States of Consciousness Questionnaire or comparable self-report scales) tend to increase in sessions prior to improvements in cancer-related psychological distress (Griffiths et al., 2016; Richards et al., 1977), depression (Carhart-Harris et al., 2018), alcohol problems (Bogenschutz et al., 2015), or smoking cessation (Garcia-Romeu et al., 2014). Although the relevant analyses are essentially correlational, the idea that a specific subjective state precedes improvement underscores reports from non-pharmacological interventions that focus on transformative experiences (e.g., Miller and C'De Baca, 2001). That is, a more mystical experience occurs prior to dramatic change. Hundreds of people have reported mystical experiences after the administration of tryptamine psychedelics in laboratory or survey research (see Barrett and Griffiths, 2017). Cannabis's potential to create these experiences remains under-investigated. Spiritual traditions suggest that many humans believed cannabis could generate these kinds of mystical moments through the millennia. Religions in Asia, the Middle East, and Africa allude to cannabis's role in ineffable peak experiences that emphasize a sense of blessedness. Subsets of Sufi mystics, Tibetan Buddhists, Zion Coptics, Rastafarians, and Hindus detail the plant's role as part of religious offerings, rituals, or traditions. Most of these allude to transcending materialism or enhancing philosophical insight (Ferrara, 2016). The subjective effects map on to formal definitions of peak experiences that include "unitive consciousness at the heart of mystical insight" (Ferrara, 2020).

Although high doses of tetrahydrocannabinol (THC) appear to create aversive as well as meaningful subjective effects common to serotonergic psychedelics (Farmer et al., 2019), as well as psychotic symptoms that might overlap (e.g., Mokrysz et al., 2020), the potential for cannabis to create these mystical experiences specifically is unclear. Some responses to cannabinoids, both the stereotypically positive and negative, overlap with those reported after the consumption of psilocybin or dimethyltryptamine (DMT; Barrett et al., 2018; Carbonaro et al., 2016; Farmer et al., 2019). For example, >30% of a sample who reported on an uncomfortable experience with psilocybin also suggested that the period was among the most meaningful of their lives (Carbonaro et al., 2016). A different sample reporting on uncomfortable experiences with edible cannabis products found that >7% claimed that the time was "one of their most meaningful" despite the aversive qualities (Farmer et al., 2019). "Meaningful" and "mystical" are hardly synonyms, but their covariation in response to psychedelics appears frequently (e.g., Griffiths et al., 2006). In addition, a recent case study suggests that a high dose of THC can create subjective changes comparable to, but distinct from, those generated by DMT or psilocybin. These parallels can appear intriguing, given different cites of action. The tryptamine psychedelics generally serve as agonists of the 2A (5-HT2A) serotonin receptors, in contrast to THC's function as a partial agonist of the cannabinoid CB1 receptor (Carbonaro et al., 2016).

Should THC-induced changes parallel those created by psilocybin, continued work could reveal if the subjective changes, rather than the neurotransmitter activities, are meaningful correlates of therapeutic effects (Barrett et al., 2018). Tryptamine psychedelics might prove more likely to create a meaningful, relevant experience, but cannabis might have the potential to create comparable effects that could inspire clinical trials for alleviating human suffering such as cancer-related anxiety and distress, treatment-resistant depression, and maladaptive consumption of drugs. Clearly, the presence of these mystical experiences alone might not be necessary or sufficient to create improvement (Majić et al., 2015), but evidence of THC's potential to create them could help researchers and clinicians make informed decisions about pursuing this path further. Should available cannabinoids lead to mystical experiences that compare favorably with those created by psilocybin, further work on cannabis-assisted psychotherapy might seem justifiable. In contrast, if cannabinoids cannot create these effects, the results would certainly underscore the novelty and potential uniqueness of psilocybin and comparable substances.

With these findings in mind, we hypothesized that self-reports of cannabis experiences involving high doses might reveal some of the oceanic boundlessness that appears commonly when psilocybin has therapeutic effects. Thus, we hypothesized that cannabis could increase relevant mystical experiences, a first step toward justifying supervised formal trials of cannabis-assisted psychotherapy, as well as investigations into the role of the cannabinoid system in the alteration of consciousness.

Method

Participants

Participants (N = 1069) were recruited through two methods: social media postings on Facebook (N = 309) and Amazon Mechanical Turk (MTurk) listings (N = 760). MTurk is a crowdsourcing platform commonly used for study recruitment. Interested individuals are able to view a brief description of the study and prerequisites for participation prior to choosing to participate. MTurk recruitment is a useful method for sampling from a diverse nationally representative population, and has been previously used to assess experiences relating to the use of psychedelics (Russ et al., 2019). All participants were directed to an anonymous survey hosted on Qualtrics, an online survey platform. Of the 1069 who hit the initial link, 927 completed at least some of the target items before quitting. A total of 852 passed the two infrequency items.

All study protocols, materials, and procedures were approved by a University Institutional Review Board.

Table 1. Demographics.

Total	*N*=421 (%)	*N*=421 (%)
Sex		
Female	239 (56.8)	243 (57.7)
Male	174 (41.3)	168 (39.9)
Non-binary	4 (1)	10 (2.4)
Blank	4 (1)	0 (0)
Age (years)		
18–24	108 (25.7)	133 (31.6)
25–34	160 (38)	169 (40.1)
35–44	84 (20)	66 (15.7)
45–54	35 (8.3)	25 (5.9)
55–64	22 (5.2)	21 (5)
65+	11 (2.6)	7 (1.7)
Blank	1 (0.2)	0 (0)
Ethnicity		
Caucasian	303 (72)	302 (71.7)
Hispanic or Latinx	43 (10.2)	36 (8.6)
Asian	35 (8.3)	27 (6.4)
African or Caribbean descent	24 (2.9)	41 (9.7)
Native American or Alaska Native	0 (0)	2 (0.5)
Other or mixed	12 (2.9)	13 (3.1)
Education		
Some high school	7 (1.7)	6 (1.4)
High school diploma or equivalent	50 (11.9)	46 (11)
Some college	166 (39.4)	123 (29.4)
Associate degree	42 (10)	55 (13.2)
Bachelor's degree	101 (24)	124 (29.7)
Master's degree	40 (9.5)	51 (12.2)
Doctorate degree	15 (3.6)	13 (3.1)
Blank	0 (0)	3 (0.7)

Measures

Measures include demographics, cannabis use, and subjective experiences of oceanic boundlessness during the highest high the participant had experienced from cannabis products.

Demographics

Participants reported age, sex, ethnicity, and education. Relevant statistics appear in Table 1.

Cannabis use

Participants reported the average number of days per month they used cannabis in the past year (0–31), and their average subjective high from 0 ("not at all high") to 4 ("very high"). Details appear in Table 1.

Cannabis use for highest high

We asked participants to consider the most dramatic THC experience of their lives and to rate their consumed dosage and the perceived accuracy of their estimate: "By highest high, we mean the peak effects you experienced from the plant at one specific time. Please choose a specific incident that was the highest you ever felt." They gave a best guess of how many milligrams of THC they consumed for their highest high and rated the accuracy of their guess using these options: "It's an exact estimate," "It's very close to exact," "It's in the ballpark," and "I honestly have no clue." Details appear in Table 1.

Mystical experiences during highest high

We chose items from the oceanic boundlessness subscale that showed the highest correlations with subsequent improvement from depression as our measure of mystical experiences (Roseman et al., 2018). This subscale from the Altered States of Consciousness Scale (Dittrich, 1998) covaried with antidepressant effects of psilocybin at five-week follow-up in a psylocibin-assisted treatment trial. The current sample described their most dramatic experience after using cannabis in the absence of other drugs and rated responses using the scoring options described for the Mystical Experiences Questionnaire (Griffiths et al., 2006), which covaries with oceanic boundlessness above $R=0.9$ in one study (Liechti et al., 2017). The MEQ asks participants to respond with the following scale: 0=none/not at all, 1=so slight cannot decide, 2=slight, 3=moderate, 4=strong (equivalent in degree to any other strong experience), or 5=extreme (more than any other time in my life and stronger than 4). This rating scale seemed appropriate, given its use in psilocybin research (e.g., Garcia-Romeu et al., 2014; MacLean et al., 2012; Roseman et al., 2018; Ross et al., 2016). The Likert scale approach also sidesteps potential problems that might arise when computerized "sliders" substitute for 0–100 mm items administered in the laboratory (Kemper et al., 2019). Participants used the full range of the scale for each item. Cronbach's alpha was >0.94 and could not improve with dropping items. Distributions had acceptable skew. Details appear in Table 1.

Results

We gathered these data to estimate percentage rates of oceanic boundlessness exceeding a threshold score as well as to identify potential predictors of the responses based on demographics and measures of cannabis consumption via regression. Given recent concerns related to replication (e.g., Amrhein et al., 2019), we decided to divide the sample in half using the randomization procedure IBM SPSS for MAC 26 (IBM Corp., Armonk, NY). Large samples reach statistical significance even with small effect sizes, potentially creating an illusion of clinical significance in the absence of meaningful effects. This approach can help minimize the reification of type I errors should they arise, potentially keeping the effect sizes of statistically significant findings reasonable (Anderson and Magruder, 2017.)

Rate of completers or breakthrough experiences

The current work focused on identifying if cannabis or cannabis products could create changes in mystical experiences (oceanic boundlessness) consistent with the idea of "breaking through" or having an experience as a "completer," which covaries with antidepressant effects in psilocybin research. Previous work suggests that those who reach total scores that are ⩾60% of the maximum would qualify (Roseman et al., 2018). A comparable

threshold for mystical experiences (scores >0.6 times the maximum) helped investigators identify a "peak" or "complete mystical-type" experience in a range of work (Garcia-Romeu et al., 2014; Johnson et al., 2017; Maclean et al., 2011; Pahnke et al., 1970; Richards et al., 1977). The 27 items, each ranging from 0 to 5, required a total score of 81 to qualify as a "completer" or "breakthrough" experience. A comparable approach to the definition of "completer" also helped identify those who were more likely to quit smoking cigarettes after psilocybin sessions (Garcia-Romeu et al., 2014). For sample 1, 75/421 (17.8%) qualified. For sample 2, 86/421 (20.45%) qualified. Both percentages are significantly greater than zero based on estimates using the adjusted Wald method (Agresti and Coull, 1998). Sample 1's 99% confidence interval (13.5–23.1%) and that of sample 2's (15.82–25.95%) surpass the values needed for $p < 0.01$. Nevertheless, these rates are significantly smaller than estimates from formal psilocybin trials. For example, recent work validating the use of the oceanic boundlessness subscale as a predictor of psilocybin's antidepressant effects found 11/19 (57.89%) participants qualified (Roseman et al., 2018). Chi-square tests (1 df) suggest that the psilocybin rate is significantly higher than the cannabis rate in sample 1 (18.549, $p < 0.001$) as well as sample 2 (14.784, $p < 0.001$).

Predictors of mystical experiences (oceanic boundlessness)

We hypothesized that exploratory predictors of these subjective effects during the highest high would relate primarily to dosage, accuracy of dosage estimates, and tolerance (as measured by experience with cannabis). That is, we thought that higher doses should lead to more dramatic effects, particularly if participants thought that their estimates were accurate, but tolerant users might find effects smaller. We regressed the mystical experience score on sex, age, cannabis used per month, average high, best guess of THC consumed, accuracy of guess, and the interaction of guess and accuracy. For sample 1, tests of assumptions for regression led to the loss of five more participants who were multivariate outliers based on Mahalanobis distances. This sample showed that subjective responses increased with best guess of THC consumed and decreased with age and "average high." In sample 2, oceanic boundlessness decreased with "average high," the only predictor significant at $p < 0.05$ (see Table 2). Effects were generally small.

Table 2. Predicting oceanic boundlessness.

	Sample 1			Sample 2		
	B	*SE B*	*B*	*B*	*SE B*	*B*
Sex	2.36	3.03	0.04	3.33	2.54	0.07
Age	–3.67	1.23	–0.15*	–1.67	1.19	–0.07
Cannabis frequency per month	0.07	0.133	0.03	0.06	0.14	0.02
Intensity of average high	5.97	2.112	0.15*	7.036	1.93	0.18*
THC best guess	3.70	1.691	0.13*	0.507	1.68	0.01
Accuracy	3.02	3.046	0.05	4.802	2.86	0.09
Guess × accuracy	–4.18	3.09	–0.07	3.371	2.912	0.06

*$p < 0.05$.

Cannabis frequency per month: days used cannabis in an average month (0–31); intensity of average high: how high participant gets in an average session (0–4); THC best guess: participants' estimation of THC ingested for highest experience; Accuracy: participant assessment of accuracy of THC guess ("no clue" vs. other); guess × accuracy: standardized interaction of best huess and accuracy group.

Discussion

Groundbreaking new work suggests that psilocybin sessions with psychological support have novel therapeutic effects for clients suffering from numerous problems, including cancer-related anxiety and distress, treatment-resistant depression, and cigarette dependence. The positive impact appears to covary with specific subjective experiences created during the sessions. Those who report more of a subset of mystical experiences known as oceanic boundlessness also report more post-administration improvement. The mystical experiences are hard to articulate but generally include feeling connected, "at one" with surroundings, a sense of awe, and freedom from humdrum irritations (e.g., Roseman et al., 2018).

Alternative generators of these subjective experiences might also precede therapeutic effects via different physiological mechanisms. In addition, psilocybin's illegal status currently decreases opportunities for use. An alternative approach for creating comparable experiences seemed worthy of investigation. Reports of ingesting high doses of THC parallel some experiences with psilocybin (Barrett et al., 2018; Farmer et al., 2019), inspiring the current study. Recent changes in the prohibition of cannabis products might make formal clinical trials that borrow heavily from the psilocybin literature a feasible path to examine potential improvements of treatments for cancer-related angst, treatment-resistant depression, and nicotine and alcohol dependence. Available treatments are less than perfect; cannabis-assisted psychotherapy might provide a helpful addition or alternative (Cuijpers, 2017; Earleywine and De Leo, 2020, Heckman et al., 2010; Niedzwiedz et al., 2019).

Participants recalled their highest experience induced by THC and completed 27 items identified as measures of oceanic boundlessness, an aspect of mystical experiences that also covaried with ameliorative effects of psilocybin in previous work. Those who scored ⩾60% of the maximum (a criterion for a "breakthrough" experience in previous work) were more likely to improve from depression at five-week follow-up (Roseman et al., 2018) or stop smoking cigarettes (Garcia-Romeu et al., 2014). We found that roughly one in six to one in five participants reported an above-threshold "breakthrough" score on the measure, suggesting that THC can lead to a comparable "breakthrough." This rate of breakthrough scores, however, was significantly lower than the rate found in samples of psilocybin users, which can exceed one in two (e.g., Roseman et al., 2018). Formal protocols that borrow from psilocybin research, including the use of stated intentions, psychological support, music, and an eye mask, might enhance the rates of THC-induced breakthrough, potentially leading to therapeutic effects. In addition, since THC's initial pharmacological impact varies from psilocybin's, comparing the two in randomized clinical trials might answer important questions related to the role of subjective experiences in psychoactive-assisted psychotherapy. This work could provide crucial information with important implications for

understanding subjective aspects of consciousness, mood, and psychopathology (see Carhart-Harris et al., 2016; Romeo et al., 2020; Roseman et al., 2018). Regressions suggested that contributors to tolerance as well as dosage likely account for variance in this type of mystical experience, but accounting for meaningful variance in the subjective state would likely require markedly more control of dosage and setting. These results support the serious consideration of tolerance and dosage if investigators choose to continue the pursuit of the use of cannabis to generate these experiences. They also underscore that trials would need considerably more control over the administration environment, preparatory sessions that set a tone for participant expectations, the dosage itself, and forms of administration (inhalation, oral ingestion, etc.) before predictors of subjective effects can account for meaningful variance.

The potential promise of THC-assisted psychotherapy needs markedly more than a simple chance to induce mystical experiences. The treatment can undoubtedly benefit from the lessons provided by the administration of ketamine (Dore et al., 2019; Singh et al., 2017), psilocybin (Roseman et al., 2018), ayahuasca (Mian et al., 2020; Palhano-Fontes et al., 2019) and MDMA (Marseille et al., 2020). The most successful outcomes arise with careful attention to set and setting. Experienced sitters accompany clients and frequently provide reassurance, encourage looking inward, and emphasize safety. Correlational work suggests that those who report decreases in experiential avoidance (Zeifman et al., 2019) or increases in mindfulness and values-consistent action (Mian et al., 2020) benefit most. Perhaps introductory sessions and debriefing periods could focus on these topics. Introductory sessions that enhance the therapeutic alliance, help clients target relevant cognitions and behaviors, and encourage comfort with the mystical experiences have considerable potential. Reasonable integration sessions after THC administration seem likely to improve outcomes as well. In a sense, good therapeutic practice should apply as much, if not more, when psychoactive experiences become part of treatment. Clinicians with more interpersonal skills who can enhance the treatment relationship, provide reasonable expectations about the process, and help clients build on strengths will likely see the most successes, much as they do in psychotherapy that lacks a psychoactive component (Schöttke et al., 2017). An important concern related to cannabis-assisted psychotherapy includes the potential for the development of cannabis use disorder. The diagnosis can apply to 30% of past-year users of cannabis (see Hasin et al., 2015). More than 18% of samples with cannabis use disorder can also have major depressive disorder (Wu et al., 2017). THC administration increases dopamine release, a hallmark of addictive substances (Ferland and Hurd, 2020) that is extremely unlikely to appear in response to the serotonergic hallucinogens (Johnson et al., 2019). Most psychedelics used in assisted treatments rarely create problems with severity or prevalence that parallels cannabis use disorder. For example, epidemiological data suggest that $<1\%$ of the population in the USA use psilocybin, MDMA, or LSD in a year, with even fewer qualifying for a related disorder (Shalit et al., 2019). Thus, monitoring reactions to cannabis-assisted psychotherapy is essential. Those who experience only temporary improvements in mood, few mystical experiences, and little behavior change might fall into a stereotypical self-medication predicament that fails to address depressive symptoms optimally. These results also underscore psilocybin's novelty. THC's rates of breakthrough in unstructured settings is significantly lower than psilocybin's rate in an available protocol. This result might serve as a call to alter psilocybin policy in addition to continuing multiple lines of research. The fact that psilocybin interventions already create breakthrough experiences roughly three times as often as THC might give many clinicians and researchers pause. Psilocybin has potential as a therapeutic agent, and current administration strategies have an efficacy comparable to many other accepted treatments for mood disorders (Carhart-Harris et al., 2016; Romeo et al., 2020), cancer-related distress (Griffiths et al., 2016), alcohol problems (Bogenschutz et al., 2015), and cigarette smoking (Garcia-Romeu et al., 2014). International laws against possession of psilocybin can include severe penalties, and rates of enforcement can vary dramatically, suggesting that limited resources might be better devoted to changing policy in addition to continuing research with THC and other psychoactives. In addition, psilocybin-related problems are markedly rarer than cannabis-related ones (e.g., Altman et al., 2020; Johnson et al., 2017). Cannabis-assisted psychotherapy must accompany detailed recommendations for discouraging frequent high-dose use, particularly early in the day (Earleywine et al., 2016). Saving THC and other psychoactives for important infrequent therapeutic sessions, especially if the treatment targets drug problems, seems essential. Note that these recommendations parallel those that accompany religious use of psychoactives as well (Ferrara, 2016).

This study, like other correlational work, has notable limitations related to sampling and procedures. We did not ask directly about expectations of cannabis-induced effects on depression, angst, or drug use, and evidence for oceanic-boundlessness as a mechanism underlying these effects is often correlational and indirect. Generalization requires caution. The current sample had Internet access and was primarily Caucasian, educated, and involved with cannabis. Rates of THC-induced mystical experiences in other people might vary dramatically from these estimates. Although we did form two samples in an effort to minimize incorrect interpretation of type I errors or statistical flukes, alternative recruitment strategies that focus on a more diverse sample could prove informative. The current study also relied upon recall of an experience that might have been years ago, whereas the psilocybin-induced mystical experiences were often assessed soon after administration (e.g., Roseman et al., 2018). Memories of the intensity of a high dose of THC could fade or grow over time in ways that are difficult to predict. We also asked about the "highest high," but oceanic feelings might peak when other sensations are not necessarily at their peak. An enormous sample that includes participants with a vast variety of cannabis exposure, symptoms, and a wider range of ages, ethnicities, and educational backgrounds who report mystical experiences soon after a standardized dose of THC would be particularly helpful for generalization. In addition, assessing other facets of the psychedelic experience could prove particularly informative. Assessing oceanic boundlessness, levels of anxiety or distress, and other theoretically relevant experiences such as a new "emotional breakthrough" construct could provide more information on the role of subjective responses in psychedelic-assisted treatment (Roseman, et al., 2018, 2019). We reiterate that this approach would not require daily use of cannabis by unscreened individuals who might be at risk for problems, as the habit has the potential to lead to respiratory irritation (see Loflin and Earleywine, 2015) and could potentially contribute to

mood disorder (Morley et al., 2017) or precede psychotic symptoms among heavy users at genetic risk (Marconi et al., 2016). We are also eager to emphasize that links between the use of cannabis, both acutely and chronically, and mood are complex and frequently unpredictable unless confounds, dosage, and comorbid conditions receive careful attention (see Curran et al., 2002; Denson and Earleywine, 2006; El-Alfy et al., 2010; Gruber et al., 1996). Despite these drawbacks, the current data suggest that continued work refining paradigms for increasing THC-induced mystical experiences and examining potential treatment might have considerable potential.

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ORCID iDs

Mitch Earleywine https://orcid.org/0000-0002-6870-0623
Luna F Ueno https://orcid.org/0000-0001-7062-5231
Maha N Mian https://orcid.org/0000-0001-7051-7820

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