**Naturalistic use of psychedelics is related to emotional reactivity and self-consciousness:
the mediating role of ego-dissolution and mystical experiences**

Paweł Orłowski^{1*}, Anastasia Ruban^{2*}, Jan Szczypiński^{1*},
Justyna Hobot^{3,4}, Maksymilian Bielecki², Michał Bola¹

* – equal contribution

¹ Laboratory of Brain Imaging, Nencki Institute of Experimental Biology of Polish Academy of Sciences, Warsaw, Poland

² Department of Psychology, SWPS University of Social Sciences and Humanities, Warsaw, Poland

³ Consciousness Lab, Psychology Institute, Jagiellonian University, Krakow, Poland

⁴ Center of Functionally Integrative Neuroscience, Aarhus University, Aarhus, Denmark

Corresponding author

Michał Bola

Laboratory of Brain Imaging

Nencki Institute of Experimental Biology

Polish Academy of Science

3 Pasteur Street

02-093 Warsaw, Poland

email: m.bola@nencki.edu.pl

ABSTRACT

Background: Psychedelics are able to acutely alter emotional reactivity and self-consciousness. However, whether the regular naturalistic use of psychedelics can be linked to more persistent trait-level changes in these domains remains an open question.

Aim: To test the hypotheses that i) using psychedelics is related to higher positive and lower negative emotional reactivity and ii) an adaptive pattern of self-consciousness, including diminished public self-consciousness and rumination, and increased reflection and self-awareness, and iii) these relations are mediated by the intensity of past ego-dissolution and mystical experiences.

Method: An online survey including questions about the history of psychoactive substance use; questionnaires measuring trait-levels of emotional reactivity and self-consciousness; questionnaires for retrospective assessment of ego-dissolution and mystical experiences. Data collected from 2,516 participants (1,661 psychedelics users) were analyzed using robust linear regression and mediation analysis.

Results: A higher number of lifetime uses of psychedelics predicted greater positive and lower negative emotional reactivity; also, in the domain of self-consciousness, it predicted greater reflection and internal state awareness, and reduced rumination tendency and public self-consciousness. Finally, the intensity of past mystical and ego-dissolution experiences mediated almost all the observed relationships between the lifetime number of psychedelics uses and psychological variables.

Conclusions: Lifetime psychedelics use predicts an adaptive pattern of trait-level emotional reactivity and self-consciousness. Ego-dissolution and mystical experiences are essential in understanding the long-lasting psychological effects of psychedelics use. Our findings might potentially explain previous observations of increased well-being in psychedelics users.

Keywords: psychedelics, long-term effects, emotional reactivity, self-consciousness, well-being

1. Introduction

Psychedelics (gr. *psyche* – soul, mind; *delos* – to reveal, manifest) are psychoactive substances able to profoundly change the state of consciousness (Hoffman, 1968; Preller and Vollenweider, 2018; Vollenweider and Preller, 2020). Classic psychedelics include substances such as psilocybin, lysergic acid diethylamide (LSD), and N,N-dimethyltryptamine (DMT). Their mechanism of action is based on 5-HT_{2A} receptor type activation and causes acute alterations of perception, emotions, and cognitive processes. Considering the robustness of the acute effects induced by psychedelic substances, an important question is whether using psychedelics might lead to more persistent psychological effects.

A growing body of evidence suggests that long-term changes in psychological functioning might indeed be observed even after a single psychedelic experience and that these changes are mostly beneficial (review: Aday et al., 2020). Healthy participants who received a single dose of psilocybin in the research context reported an increase in well-being and quality of life lasting from several days to months (eg. Griffiths et al., 2008; Uthaug et al., 2018, 2019). Similarly, one or two doses of psychedelics reduced symptoms of depression and anxiety in patients diagnosed with major depressive disorders (Carhart-Harris et al., 2016, 2021; Galvão-Coelho et al., 2021; Luoma et al., 2020; Palhano-Fontes et al., 2019) and increased their extraversion and openness (Erritzoe et al., 2018). Patients suffering from life-threatening cancer reported increased life satisfaction, well-being, and greater acceptance of death, even up to several years after a single psychedelic session (Agin-Liebes et al., 2020; Griffiths et al., 2016; Ross et al., 2016).

While long-term psychological benefits are observed after just a single experimental or therapeutic intervention, using psychedelics more frequently and in a naturalistic context might result in qualitatively different effects (e.g., due to a different set and setting; Carhart-Harris et al., 2018). Here, cross-sectional studies that compare psychedelics users and non-users might provide important insights. Two studies found that using psychedelics was not related to greater risk of experiencing a mental disorder (Johansen and Krebs, 2015; Krebs and Johansen, 2013). In fact, users of psychedelics reported lower distress and suicidal tendencies and exhibited higher scores on scales of spirituality and empathy in comparison to users of other psychoactive substances (Hendricks et al., 2015a; Hendricks et al., 2015b; Lerner and Lyvers, 2006). Similarly, regular users of *ayahuasca* (a DMT-containing brew) are characterized by higher well-being and lower levels of psychopathological traits when compared to non-users (Bouso et al., 2012; Galvão-Coelho et al., 2021; Lawn et al., 2017). While these studies reveal the positive side of using psychedelics, its naturalistic use might be also related to a higher occurrence of frightening and unpleasant experiences (colloquially referred to as *bad trips*) than in a research context. A great majority of psychedelics users who reported such experiences eventually considered them beneficial, but close to 10% of them reported experience-related negative psychological symptoms lasting over 12 months (Carbonaro et al., 2016). Therefore, more data is needed to thoroughly assess the benefits and risks of using psychedelics in naturalistic settings.

The present study aims to investigate the psychological effects associated with regular, naturalistic use of psychedelics, with a specific focus on the domains of emotional reactivity and self-consciousness. To this end, we designed an online survey comprising questions about demographics, history of psychoactive substance use, and several psychological questionnaires. The collected data were used to test the following three hypotheses.

First, because the processing of emotions is acutely impacted by psychedelics, participants under their influence become less reactive to emotionally negative stimuli and more receptive to positive ones (for reviews see: Rocha et al., 2019; Vollenweider and Preller, 2020); therefore, we hypothesized

that more frequent use of psychedelics will be related to increased trait-level positive emotional reactivity and decreased trait-level negative emotional reactivity.

Second, psychedelics are also able to acutely alter self-consciousness, with high doses resulting in the so-called phenomenon of ego-dissolution – an experience of a sense of unity with the world and other people, and disintegration of a coherent concept of ‘self’ (Letheby and Gerrans, 2017; Nour et al., 2016; reviews: Preller and Vollenweider, 2018; Smigielski et al., 2020). Thus, we investigated trait-level self-consciousness and hypothesized that more frequent use of psychedelics will be associated with a) decreased public self-consciousness, which can be understood as the social awareness of being an object of the observation of others (Ryan and Kuczkowski, 1994), which could be related to social anxiety and rumination; b) decreased rumination, which is defined as a mode of responding to distress that involves repetitively and passively focusing on symptoms of distress and on the possible causes and consequences of these symptoms (Nolen-Hoeksema, Wisco, B.E. & Lyubomirsky, 2008); c) increased reflective thinking, which is a type of self-focus that, unlike rumination, is flexible, adaptive, and based on curiosity and analysis of one's own behaviors, emotions, and thoughts (Trapnell & Campbell, 1999).

Finally, our third main hypothesis stated that the intensity of past mystical and ego-dissolution experiences caused by psychedelics will mediate the expected effects of psychedelics use on emotionality and self-consciousness. This is in line with reported evidence that the intensity of the subjective effects of psychedelics predicted long-term psychological outcomes in single-dose studies (Griffiths et al., 2016; Lyvers and Meester, 2012; Yaden and Griffiths, 2021).

2. Method

2.1. Data collection

An online survey was created in the LimeSurvey open-source software (version 3.22.7). The survey was distributed online via the social media profiles of Polish research institutions and associations committed to education concerning use of psychoactive substances and harm reduction (politykanarkotykowa.pl; sin.org.pl; psychodeliki.org). The survey and all questionnaires were in Polish, and only Polish-speaking participants were recruited. Each person read and electronically signed an informed consent form and a General Data Protection Regulation clause before proceeding to the survey. The survey was anonymous, but participants willing to participate in our future studies were asked to provide their email addresses. Completing the whole survey took circa 30 minutes. The survey was divided into the following subsections, which were always presented in the same order.

- a) *Demographics.* We collected basic demographic data, including gender, age, education, place of residence, history of mental disorders, and each participant's assessment of their own mental health, physical health, and financial situation.
- b) *Psychedelic use.* We collected data regarding the following psychedelics: LSD, psilocybin mushrooms, synthetic psilocybin, DMT, changa (a smoking mixture of DMT and β -carbolines), ayahuasca, mescaline, and derivatives of classic psychedelics. For each substance, participants reported i) the lifetime number of occasions on which they had administered a given psychedelic; ii) the number of occasions on which they had administered a given psychedelic in the past year; iii) whether they intended to use a given psychedelic in the future. Participants were asked not to include occasions on which they had microdosed psychedelics. Considering the lifetime use of psychedelics, the total reported number of uses was 34,186 (LSD, 42.4%; psilocybin mushrooms,

27.6%; derivatives of classic psychedelics, 10.9%; changa, 6.1%; DMT, 5.8%; ayahuasca, 5.1%; synthetic psilocybin, 1.4%; mescaline, 0.8%)

- c) *Use of other psychoactive substances*. Participants reported the total number of lifetime and last-year occasions on which they had administered psychoactive substances other than psychedelics. These substances were subdivided into following categories: cannabis, empathogens, dissociatives, stimulants, synthetic cannabinoids, benzodiazepines, opioids. The total number of reported lifetime uses of the listed substances was 1,133,866 (cannabis, 88.5%; stimulants, 5.6%; empathogens, 2.7%; benzodiazepines, 1.1%; opioids, 0.9%; dissociatives, 0.7%; synthetic cannabinoids, 0.4%).
- d) *Alcohol Use Disorder Identification Test (AUDIT)*. The AUDIT questionnaire is widely used as a screening tool for alcohol use disorder (World Health Organization, 2001). In our study we used three items of the Polish version of the AUDIT questionnaire (Klimkiewicz et al., 2021) to reduce the time needed to complete the questionnaire. Participants reported the frequency of alcoholic beverages intake (AUDIT 1); how often they drink more than 6 units of alcohol on one occasion in a month (AUDIT 2); and how often they state they cannot stop drinking after they have already started (AUDIT 4). Each question was answered on a 5-point ordinal scale.
- e) *Perth Emotional Reactivity Scale – Short Form (PERS-S)*. PERS-S was translated and used to measure trait levels of negative ($\alpha = 0.87$, $N = 2,561$) and positive ($\alpha = 0.87$, $N = 2,561$) emotional reactivity. The PERS-S measures the typical ease of activation, intensity, and duration of one's emotional responses for positive and negative emotions separately. PERS-S is an 18-item short form of the 30-item PERS (Becerra et al., 2017; Preece et al., 2019).
- f) *Self-Consciousness Scale (SCS)*. Initially, SCS was designed to measure three distinct psychological components of self-consciousness: public, private, and social anxiety (Fenigstein et al., 1975). Further research found that private self-consciousness was associated with a greater level of self-understanding or greater openness to experiences, but also with greater depression and anxiety. More in-depth exploration of the phenomenon of private self-consciousness revealed its two dimensions: internal state awareness and self-reflectiveness (Burnkrant and Page, 1984). While state awareness is related to lower neuroticism (Creed and Funder, 1998), rumination (Trapnell and Campbell, 1999), trait anxiety and depression (Anderson et al., 1996), and social anxiety (Watson et al., 1996), the opposite is true for self-reflectiveness. The Polish adaptation of SCS did not distinguish between internal state awareness and self-reflectiveness (Zakrzewski and Strzałkowska, 1989). Moreover, in the adaptation process these authors generated new items for the questionnaire, therefore scoring according to the original version was not possible. Since the distinction between internal state awareness and self-reflectiveness was of key theoretical importance, we decided to perform an exploratory factor analysis to recreate the four-factor structure. In line with Burnkrant and Page (1984), our analysis also identified four factors: public self, social anxiety, and two factors which were identified as internal state awareness and self-reflectiveness. Public self and social anxiety were loaded by the same items as in the Polish adaptation study. The details of the factor analysis are presented in the Supplementary Material.
- g) *Reflection Rumination Questionnaire (RRQ)*. RRQ is a 13-item questionnaire used to assess rumination ($\alpha = 0.83$, $N = 2,561$) and reflective thinking ($\alpha = 0.77$, $N = 2,561$; Carter, 2010; Trapnell and Campbell, 1999; Polish translation: Radoń, 2014a).
- h) *Ego Dissolution Questionnaire (EDI)*. EDI is an 8-item self-report scale designed to measure the experience of ego-dissolution, which is considered to be a key phenomenological feature of the psychedelic experience (Nour et al., 2016). Importantly, in our study, EDI was translated and used to measure the recalled intensity of previous ego-dissolution experiences induced by psychedelics ($\alpha = 0.87$, $N = 1,661$).

- i) *Hood's Mysticism Scale (HMS)*. HMS allows the assessment of mystical experience qualities, such as feelings of unity, bliss, and ego-dissolution. It was previously used to assess the quality of mystical experiences induced by psychedelic drugs (Griffiths et al., 2006; Lyvers and Meester, 2012). We used a Polish adaptation of the abridged (12-item) version of HMS (Anthony et al., 2010; Radoń, 2014b). We asked participants to complete HMS while considering one of their most prominent psychedelic experiences ($\alpha = 0.89$, $N = 1,661$).

2.2. Data analysis

Inclusion and exclusion criteria

The data of 2,561 participants were analyzed in the study. Data were collected from an additional 712 participants but were excluded for various reasons: incorrectly answering any of the attention-check questions included in the questionnaires ($N = 336$); careless responding, i.e., reporting more than 10,000 lifetime administrations of substances from any group ($N = 130$) or more than 366 last-year administrations of substances from any group ($N = 81$; we instructed in the survey to count one day when a substance has been administered as one administration); having a diagnosis of substance dependence ($N = 187$); not declaring gender as male or female ($N = 39$; for the purpose of controlling gender as a predictor); and little or no variation while responding to SCS, RRQ, or PERS-S (within-subject variability of responses not exceeding the cutoff set at 2.5 *SD* below the average; $N = 27$).

Table 1. Demographic and questionnaire measures compared between users and non-users. Groups were compared using t-test, Mann-Whitney U test or χ^2 test, depending on the variable type (* $p < 0.05$; ** $p < .001$).

	Psychedelics users ($N = 1,693$)	Psychedelics non-users ($N = 868$)
Male sex**		
	991 (58.54%)	325 (37.44%)
<i>M (SD)</i> Age in years*		
	26.86 (6.96)	25.95 (7.38)
Place of residence in %		
Village	10.40	12.21
City – population up to 50k	10.04	12.44
City – population from 50k to 150k	6.79	7.37
City – population from 150k to 500k	13.53	13.48
City – population over 500k	59.24	54.49
Education in %		
below secondary	5.38	7.03
secondary	46.25	43.09
bachelor's degree	20.44	20.16
master's degree or higher	27.94	29.72
Financial situation** in %		

very bad	0.59	0.46
bad	3.96	3.00
average	32.78	39.75
good	49.56	48.73
very good	13.11	8.06
Current well-being** in %		
very bad	0.47	1.04
bad	5.49	7.95
moderate	22.98	30.30
good	42.17	42.51
very good	28.88	18.20
Current physical health** in%		
very bad	0.30	0.46
bad	3.01	5.65
moderate	21.62	24.31
good	48.85	50.35
very good	26.23	19.24
MED (IQR) Lifetime meditation hours**	16 (114)	0 (30)
MED (IQR) Alcohol use (selected AUDIT items; max score = 12)*	3 (3)	3 (2)
MED (IQR) Negative reactivity (PERS-S; max score = 45)**	26 (11)	29 (12)
MED (IQR) Positive reactivity (PERS-S; max score = 45)**	34 (8)	32 (9)
MED (IQR) Public self (SCS; max score = 35)**	25 (8)	27 (7)
MED (IQR) Social anxiety (SCS; max score = 30)**	17 (10)	20 (10)
MED (IQR) Self-reflectiveness (SCS; max score = 25)	22 (5)	22 (5)
MED (IQR) Internal state awareness (SCS; max score = 25)**	21 (4)	21 (5)
MED (IQR) Rumination (RRQ; max score = 30)**	19 (8)	20 (8)
MED (IQR) Reflection (RRQ; max score = 35)**	26 (6)	25 (7)

MED - median, IQR - interquartile range;

Coding of variables

The main predictor of interest in the present study was factored lifetime psychedelics use. It was created by, first, summing the reported number of lifetime administrations of all classes of psychedelic substances; next, the obtained estimate was converted into a 4-level categorical factor. The baseline level included participants who have never used any psychedelic substance ($N = 868$); the other levels were created by dividing all psychedelics users into tertiles (T1, T2, T3, corresponding to occasional, moderate, and frequent users, respectively). The described transformation facilitates comparing the effects of different substances and solves the statistical problem of the

extreme skewness of the frequency distributions of substance use. Transformation into the described levels of use intensity and a group of non-users is also motivated by the fact that in the scientific literature there are no universally recognised objective norms of lifetime psychoactive substance use intensity to which we could refer. Applying the described transformation to a large population-based dataset allows us to provide an informative interpretation of the relationship between the lifetime number of experiences with psychoactive substances and the psychological indicators of interest.

To ensure comparability and facilitate comparisons, the data concerning the use of other psychoactive substances were converted in the same manner. Alcohol use data were transformed analogously, except that the AUDIT score was used as a basis to perform the tertile division. Also, the lifetime number of meditation hours data was transformed in the same way as the data on lifetime number of use of psychoactive substances. We therefore want to emphasize that the term “lifetime use” refers to a factored reported number of uses of a given substance (and not the binary fact of using or not using a given substance).

Finally, the age and education level of the participants were converted into 4-level categorical factors (age – 15–25, 25–35, 35–45, and 45+ years; education – below secondary, secondary, bachelor's degree, master's degree or higher).

Robust linear regression

We examined the relationships between factored lifetime psychedelic use and the psychological variables using robust linear regression with the KS2014 estimator (Koller and Stahel, 2017) and the robustbase package (Maechler et al., 2021) in R (R Core Team, 2018). We used factored lifetime psychedelics use as a predictor of the score of the PERS-S subscales (negative emotional reactivity, positive emotional reactivity), SCS factors (internal state awareness, self-reflectiveness, public self, and social anxiety), RRQ subscales (rumination and reflection), and HMS and EDI scores. Regression with HMS and EDI as dependent variables was performed for the group of psychedelics users only (as non-users did not fill out these questionnaires). In all models, we controlled for age, sex, education, lifetime meditation hours, measures of lifetime use of psychoactive substances (cannabis, empathogens, stimulants, benzodiazepines, opioids, synthetic cannabinoids), and frequency of alcohol use.

Mediation analysis

We performed the mediation analysis using the Python PyProcessMacro package (André, 2021; Hayes, 2012). Total effects were calculated using statsmodels (Seabold and Perktold, 2010). We included HMS and EDI scores as mediators of the relations between factored lifetime psychedelics use and the psychological variables. This analysis was performed only for psychedelics users, thus we used only 3 levels of factored lifetime psychedelics use. In order to include factored lifetime psychedelics uses a categorical predictor in the mediation analysis, we performed a separate mediation analysis for each level of lifetime psychedelics use, as suggested by Hayes and Preacher (2014), while controlling for the remaining levels. The same dependent variables and covariates were used in the mediation analysis as in the robust linear regression. Confidence intervals for indirect effects were calculated using bootstrapping (5,000 samples). We used an HC3 heteroscedasticity consistent covariance matrix to correct for heteroscedasticity.

The data and scripts used for analyses are publicly available at www.osf.io/g6ehv.

3. Results

3.1 Robust linear regression

The results section presents the effects of lifetime psychedelics use and only the significant effects of other predictors. Detailed results, including all non-significant predictors, are available in Supplementary Tables 2, 3, and 4.

Negative emotional reactivity

Lifetime psychedelics use was associated with less negative emotional reactivity ($F(3, 2523) = 3.64$, $p = 0.012$). Further, male sex ($F(1, 2523) = 113.18$, $p < 0.001$), lifetime meditation hours ($F(3, 2523) = 13.61$, $p < 0.001$) and empathogen use ($F(3, 2523) = 2.87$, $p = 0.035$) were also associated with less negative emotional reactivity, while lifetime benzodiazepine ($F(3) = 3.49$, $p = 0.015$), opioid ($F(3, 2523) = 3.82$, $p = 0.010$) and alcohol use ($F(3, 2523) = 7.08$, $p < 0.001$) were associated with more negative emotional reactivity (Figure 1).

Positive emotional reactivity

Lifetime psychedelics use was associated with greater positive emotional reactivity ($F(3, 2523) = 5.67$, $p < 0.001$). Further, lifetime meditation hours ($F(3, 2523) = 14.76$, $p < 0.001$), cannabis ($F(3, 2523) = 9.98$, $p < 0.001$) and empathogen use ($F(3, 2523) = 2.89$, $p = 0.035$) were also associated with higher positive emotional reactivity, while male sex ($F(1, 2523) = 25.84$, $p < 0.001$) and lifetime opioid use ($F(3, 2523) = 4.15$, $p = 0.006$) were associated with lower positive emotional reactivity (Figure 1).

Public self

Lifetime psychedelics use was associated with lower public self-consciousness ($F(3, 2523) = 4.15$, $p = 0.006$). Similarly, age ($F(3, 2523) = 7.05$, $p < 0.001$), lifetime meditation hours ($F(3, 2523) = 11.38$, $p < 0.001$) and cannabis use ($F(3, 2523) = 7.05$, $p < 0.001$) were associated with decreased public self-consciousness, while the opposite was true for education ($F(3, 2523) = 3.55$, $p = 0.014$) and alcohol use ($F(3, 2523) = 12.56$, $p < 0.001$; Figure 1).

Social anxiety

Lifetime psychedelics use was not a significant predictor of social anxiety ($F(3, 2523) = 1.62$, $p = 0.183$). Male sex ($F(1, 2523) = 21.72$, $p < 0.001$), lifetime meditation hours ($F(3, 2523) = 16.65$, $p < 0.001$) and lifetime empathogen use ($F(3, 2523) = 6.96$, $p < .001$) were associated with lower levels of social anxiety (Figure 1).

Internal state awareness

Lifetime psychedelics use was associated with higher internal state awareness ($F(3, 2523) = 6.72$, $p < 0.001$). Similarly, education ($F(3, 2523) = 5.22$, $p = 0.001$), lifetime meditation hours ($F(3, 2523) = 47.22$, $p < 0.001$) and benzodiazepine use ($F(3, 2523) = 3.17$, $p = 0.023$) were also associated with higher internal state awareness, while male sex ($F(1) = 15.36$, $p < 0.001$), age ($F(3, 2523) = 15.36$, $p < 0.001$) and alcohol use ($F(3, 2523) = 3.35$, $p = 0.018$) were associated with lower internal state awareness (Figure 2).

Self-reflectiveness

Lifetime psychedelics use was not a significant predictor of self-reflectiveness ($F(3, 2523) = 0.99$, $p = 0.399$). Male sex ($F(1, 2523) = 9.64$, $p = 0.002$), age ($F(3, 2523) = 33.65$, $p < 0.001$) and education ($F(3, 2523) = 2.87$, $p = 0.035$) were associated with higher self-reflectiveness, while lifetime

meditation hours ($F(3, 2523) = 2.89, p = 0.034$) was associated with lower self-reflectiveness (Figure 2).

Rumination

Lifetime psychedelics use was associated with lower rumination ($F(3, 2523) = 6.15, p < 0.001$). Further, male sex ($F(1, 2523) = 6.03, p = 0.014$), age ($F(3, 2523) = 10.87, p < 0.001$), education ($F(3, 2523) = 6.55, p < 0.001$), lifetime meditation hours ($F(3, 2523) = 16.00, p < 0.001$) and empathogen use ($F(3, 2523) = 2.60, p = 0.050$) were also associated with lower rumination, while lifetime benzodiazepine use ($F(3, 2523) = 2.61, p = 0.050$) and alcohol use ($F(3, 2523) = 6.25, p < 0.001$) were associated with higher rumination (Figure 2).

Reflection

Lifetime psychedelics use was associated with higher reflection ($F(3, 2523) = 6.69, p < 0.001$). Similarly, education ($F(3, 2523) = 3.24, p = 0.021$) and lifetime meditation hours ($F(3, 2523) = 150.56, p < 0.001$) were associated with higher reflection, while age ($F(3, 2523) = 13.52, p < 0.001$), lifetime stimulant use ($F(3, 2523) = 2.86, p = 0.035$) and alcohol use ($F(3, 2523) = 4.18, p = 0.006$) were associated with lower reflection (Figure 2).

Ego-dissolution

Lifetime psychedelics use ($F(3, 1624) = 56.23, p < 0.001$) and lifetime meditation hours ($F(3, 1624) = 23.73, p < 0.001$) were associated with reports of higher ego-dissolution, while lifetime opioid use ($F(3, 1624) = 3.06, p = 0.027$) and alcohol use ($F(3, 1624) = 3.97, p = 0.008$) were associated with reports of lower ego-dissolution. Age ($F(3, 1624) = 3.75, p = 0.01$) and lifetime cannabis use ($F(3, 1624) = 3.82, p = 0.009$) were also significant predictors of ego-dissolution, but neither of the revealed relationships were monotonic (Figure 3).

Mystical experience

Lifetime psychedelics use ($F(3, 1624) = 30.09, p < 0.001$) and lifetime meditation hours ($F(3, 1624) = 29.38, p < 0.001$) were associated with reports of more pronounced mystical experience, while the reverse was true for male sex ($F(1, 1624) = 25.85, p < 0.001$) and alcohol use ($F(3, 1624) = 3.20, p = .022$). The effects of lifetime cannabis use ($F(3, 1624) = 4.30, p = .005$) were also significant but non-monotonic (as in the ego-dissolution analysis; Figure 3).

Figure 1. Regression coefficients in the models predicting negative reactivity, positive reactivity, public self, and social anxiety. [T1] – first tertile, [T2] – second tertile, [T3] – third tertile; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Figure 2. Regression coefficients in the models predicting internal state awareness, self-reflectiveness, rumination, and reflection. [T1] – first tertile, [T2] – second tertile, [T3] – third tertile; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Figure 3. Regression coefficients in the models predicting the Ego Dissolution Inventory and Hood's Mysticism Scale scores. [T1] – first tertile, [T2] – second tertile, [T3] – third tertile; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2 Mediation analysis

The observed pattern of mediation results matched the theory-derived expectations concerning the role of the intensity of the mystical aspects of psychedelic experiences in shaping the relationship between the number of lifetime psychedelics uses and personality characteristics. We observed that the indirect effects of the number of lifetime psychedelics uses were mediated by ego-dissolution. This mediation effect statistically explained the increases in internal state awareness, reflection and positive reactivity, as well as the decreases in public self, rumination and negative reactivity. Moreover, for each tested variable the size of the indirect effect increased with the number of psychedelics uses, as revealed by the comparison of the effect sizes between the T2 and T3 effects (Table 2). More detailed results, including confidence intervals, standard errors, goodness-of-fit measures, and a full set of coefficients for the controlled variables are reported in the Supplementary Material (Supplementary Tables 5 and 6).

Considering that meditation practice predicted the investigated psychological variables in a similar manner to psychedelics use, in an additional analysis we estimated a mediation model after adding the

lifetime number of meditation hours as a controlled variable. The general pattern of the results remained unchanged after this modification. Most importantly, almost all the indirect effects of psychedelics retained significance (with the exception of the effect of ego-dissolution on *Negative reactivity*). Inclusion of the effects of meditation attenuated the size of the significant indirect effects, but the proportional reduction was 20.2–39.9% of the initial effects (the full description of this model along with all the statistics is included in Supplementary Table 7). These results suggest that some of the effects of psychedelics might be explained by meditation practices, but this does not undermine the postulated role of psychedelics use (Table 2).

Table 2. Results of the mediation analysis. Rows for each dependent variable represent effects for the second (T2) and third (T3) tertiles of the lifetime number of psychedelics uses when compared to the first tertile. * – significant indirect effects, with 95% confidence intervals not including 0, as indicated by bootstrapping.

	INDIRECT EFFECT		DIRECT EFFECT			TOTAL EFFECT		
	Effect (Myst)	Effect (EDI)	Effect	t	p	Effect	t	p
Negative reactivity								
Lifetime psychedelic use [T2]	-0.01	-0.20*	0.01	0.01	.990	-0.20	-0.44	.664
Lifetime psychedelic use [T3]	-0.01	-0.44*	-1.33	-2.62	.009	-1.78	-3.71	< 0.001
Positive reactivity								
Lifetime psychedelic use [T2]	0.45*	0.17*	0.32	0.80	.423	0.94	2.40	.017
Lifetime psychedelic use [T3]	0.77*	0.39*	0.16	0.35	.723	1.31	03.01	.003
Public self								
Lifetime psychedelic use [T2]	-0.01	-0.18*	0.12	0.34	.736	-0.07	-0.20	.845
Lifetime psychedelic use [T3]	-0.02	-0.41*	-0.74	-1.76	.079	-1.17	-2.91	.004
Self-reflectiveness								
Lifetime psychedelic use [T2]	0.13*	-0.01	-0.30	-1.45	.148	-0.18	-0.88	.381
Lifetime psychedelic use [T3]	0.22*	-0.02	-0.49	-2.23	.026	-0.29	-1.35	.177
Self-awareness								
Lifetime psychedelic use [T2]	0.17*	0.11*	0.18	0.86	.391	0.45	2.2	.028
Lifetime psychedelic use [T3]	0.29*	0.23*	0.11	0.51	.612	0.64	2.93	.003
Reflection								
Lifetime psychedelic use [T2]	0.36*	0.22*	0.16	0.57	.566	0.74	2.62	.009
Lifetime psychedelic use [T3]	0.61*	0.50*	0.61	1.98	.048	1.71	5.57	< 0.001
Rumination								
Lifetime psychedelic use [T2]	0.08	-0.25*	-0.78	-2.58	.010	-0.95	-3.20	0.001
Lifetime psychedelic use [T3]	0.13	-0.55*	-1.19	-3.53	< 0.001	-1.61	-4.99	< 0.001

4. Discussion

Classic psychedelics are able to cause robust changes in perception, cognition, and brain activity (review: Vollenweider & Preller, 2020), and a growing body of evidence indicates that even a single psychedelic experience might cause lasting psychological effects (review: Aday et al., 2020). It is thus conceivable that using psychedelics frequently in a naturalistic setting is also related to persistent changes in psychological functioning. Recent studies indeed found that naturalistic use of psychedelics is associated with a shift towards a more panpsychism-based worldview (Timmermann et al., 2021) and a better self-assessed state of one's own mental health (Uthaug, et al., 2021). In the present cross-sectional study, we focused on two psychological aspects (emotional reactivity and self-consciousness) and investigated how the total number of psychedelics uses in naturalistic settings and the subjective aspects of the induced experiences are related to functioning in these two areas.

4.1. Use of psychedelics predicts emotional reactivity and self-consciousness

Our first main finding is that a higher number of intakes of psychedelics is associated with greater positive and lower negative trait-level emotional reactivity. To the best of our knowledge, our study is the first to investigate emotional reactivity from the individual differences trait-oriented perspective in a population of psychedelics users. One related previous cross-sectional study reported that male psychedelics users have better emotion regulation when compared to males with no history of psychedelic use (Thiessen et al., 2018). Nevertheless, the majority of previous work focused mainly on emotion-related effects observed in clinical populations taking part in clinical trials employing psychedelics (Vollenweider & Preller, 2020). Further, our results can be interpreted in relation to experimental studies, which found healthy participants to be less reactive to stimuli with negative valence, but more reactive to positive ones during a psychedelic state (Dolder et al., 2016; Komater et al., 2012; Kraehenmann et al., 2015; Schmidt et al., 2013; Carhart-Harris et al., 2012). Here, a tentative interpretation of our data is that using psychedelics and consequently experiencing such an acute 'positivity bias' more frequently translates into more positive emotional reactivity at the trait level. However, this interpretation remains hypothetical as supporting it will require data from longitudinal studies.

Our second main finding concerns effects related to self-consciousness. While the concept of self is often discussed in psychedelics research, previous studies focused mainly on acute alterations in self-consciousness or disintegration of self caused by psychedelics (Nour et al., 2016; Smigielski et al., 2020). In contrast, our study aimed to investigate different aspects of self-consciousness at the individual-differences trait-like level. We found that using psychedelics is associated with diminished projected self-consciousness, defined as the social awareness of being the object of others' observation. This might mean that psychedelic users are less receptive to others' opinions about themselves, and this might be related to the previously reported increased self-directedness in psychedelics users (Bouso et al., 2018). Neuroimaging studies have found that activity and connectivity within the default mode network – a set of interconnected brain regions strongly related to the sense and narrative aspects of *self* – is diminished when taking psychedelics (Palhano-Fontes et al., 2015; Tagliazucchi et al., 2016; Carhart-Harris et al., 2017; Smigielski et al., 2019). Thus, we hypothesized that regular acute deactivation of this network might eventually lead to a more persistent downregulation of its activity that consequently affects self-consciousness in a way that one becomes less sensitive to external information about oneself. Next, we found that the use of psychedelics is associated with increased internal state awareness. Taking into account that, in general, mindfulness practice is focused on the cultivation of perceptual awareness of one's internal state, the observed effect can be linked to long-lasting increases in mindfulness-related capacities in psychedelic users (Uthaug et al., 2019; Sampedro et al., 2017). Further, we found that rumination was also reduced in

psychedelics users, whereas reflection was increased. These results can be linked to previous research on the effects of psychedelics on personality traits (e.g., increased openness and decreased anxiety; Lebedev et al., 2016; Erritzoe et al., 2018). Previously, the reflective aspects of self-consciousness were proposed to be related to openness, while ruminative aspects were proposed to be related to neuroticism (Trapnell and Campbell, 1999). Maclean and colleagues (2011) provided evidence that openness remained higher than baseline for more than one year in participants who had mystical experiences during a psilocybin session. Finally, a study that is very closely related to our work in terms of investigating self-consciousness was conducted by Franquesa and colleagues (2018), who characterized regular ayahuasca users in terms of *decentering*, defined as “the ability to observe one's own thoughts and feelings in a detached manner, as temporary events in the mind, neither necessarily true nor reflections of the self”; *positive self*, which was understood as a reflection of well-being, particularly spontaneity and creativity; and *public control of the self*, which indicated to what extent experience of self is controlled and influenced by others. They found that using ayahuasca is related to higher *decentering* scores, which resonates with the effect we observed on reflection and internal state awareness; however, they did not find differences in *public control of the self*, while we found that users of psychedelics scored lower on the public-self subscale of SCS. An important aspect here might be that Franquesa and colleagues (2018) compared users and non-users, while we investigated how the lifetime number of psychedelics uses predicts the measured psychological variables.

Overall, our data shows that not only clinical but also naturalistic use of psychedelics is related to psychological effects that might be considered positive and beneficial. The trait-level emotional “positivity-bias” we observed in psychedelics users might potentially contribute to greater well-being; this is in line with a hypothesis that emotion regulation is a key mechanism through which psychedelics influence mental health (Lafrance et al., 2021). Well-being and quality of life might also be positively influenced by greater reflection, which is the adaptive aspect of self-consciousness, and lower rumination, which can be considered the maladaptive aspect of the same or a similar process (DaSilveira et al., 2015). Therefore, the effects we observed might be related to the results of previous cross-sectional studies which found that using psychedelics in a naturalistic context is associated with higher self-assessed well-being and quality of life (Bouso et al., 2012; Galvão-Coelho et al., 2021; Hendricks et al., 2015a; Lawn et al., 2017, Uthaug et al., 2021) and does not constitute a risk factor for mental health problems (Johansen and Krebs, 2015; Sexton, Nichols and Hendricks, 2019). What is more, psychedelics users themselves consider using classic psychedelics as rather psychologically beneficial (Mason and Kuypers, 2018; Kettner et al., 2019) and causing fewer harmful effects than most other psychoactive substances (Carhart-Harris and Nutt, 2010). It is worth noting however that these conclusions are based on results of self-report studies, which might not provide a complete picture of the effects of naturalistic psychedelics use. Possible negative effects of psychedelic use might be underestimated and positive ones overstated due to the self-selection bias that is inherent to cross-sectional studies (further discussed in section 4.3).

4.2. Indirect effect of subjective aspects of psychedelic experiences

To what extent acute subjective effects are necessary to observe lasting psychological changes induced by psychedelics is one of the key research questions in the psychedelics research field (e.g. Yaden and Griffiths, 2021; Olson, 2021). Our third main finding, namely that the effects of psychedelic experiences on emotional reactivity and self-consciousness are mediated by the reported intensity of ego-dissolution and the mystical aspects of psychedelic experiences, supports the view that subjective effects are indeed important. Thus, our finding is in line with previous cross-sectional survey studies which found a relation between acute mystical experience induced by classic

psychedelics in a naturalistic setting and lasting increased sense of purpose, empathy, mindfulness, and concern for the environment and others (Lyvers and Meester, 2012; Yaden et al., 2017). A prospective survey study by Haijen and colleagues (2018) also supported the positive impact of mystical experiences on psychological well-being. Further, in single-dose studies and clinical trials, the intensity of acute psilocybin-induced mystical experiences predicted positive long-term clinical outcomes in patients with depression (Davis et al., 2021; Roseman, Nutt and Carhart-Harris, 2017); it also mediated antidepressant and anxiolytic effects in patients with life-threatening diagnosis (Griffiths et al., 2016; Ross et al., 2016) and the effects of psychedelics-assisted tobacco addiction treatment (Garcia-Romeu et al., 2014). Likewise, the intensity of ego-dissolution predicted increases in openness and well-being observed after a psychedelic session in healthy volunteers (Lebedev et al., 2016; Uthaug et al., 2018; Griffiths et al., 2018).

However, what limits conclusions regarding the role of subjective experiences (and which applies to both this and previous studies) is that the likelihood of having a mystical experience increases according to substance dose (Griffiths et al., 2011), and the effect of the substance dose and the effect of a mystical experience are hardly separable. Nevertheless, Griffiths and colleagues (2016) reported a correlation between mystical experience and treatment outcome when the substance dose was controlled for. Further, other subjective aspects of the psychedelic experience such as awe (van Mulukom et al., 2020, Hendricks, 2018) and emotional breakthrough (Roseman et al., 2019) are also hypothesized to mediate the positive effects of psychedelics. These aspects were not measured in our study, so their impact cannot be inferred. Thus, while our results add to the body of evidence that the intensity of acute psychedelics-induced experiences is associated with differences observed in psychological traits, the contribution of substance doses and of different components of the psychedelic experience remain to be further investigated.

4.3. Interpretation of cross-sectional findings

While we interpret our findings as being in line with results of previous research, including single-dose experiments, it is important to emphasize that our study is retrospective and cross-sectional, thus it has several limitations. Most importantly, the cause-effect relation cannot be inferred: we cannot establish whether people characterized by more positive emotional reactivity and more adaptive self-consciousness are more willing to try and regularly use psychedelics (e.g., because they experience fewer ‘bad trips’), or whether using psychedelics changes trait-level emotional-reactivity and self-consciousness. However, the latter interpretation is supported by three different pieces of evidence. The effects we observed were not primarily driven by the difference between users and non-users: instead, there was a monotonic relation between the number of psychedelics uses and the values of the psychological variables measured, so it seems unlikely that these effects might be explained by the mere predisposition to try psychedelics. Similarly, in the mediation analyses, the indirect effect indicated by the EDI and HMS scores increased in a frequency-related manner: the effect was greater for frequent users in comparison to moderate users, and for moderate users in comparison to occasional users. Second, we found a relation between psychedelics use and psychological variables while controlling for basic demographics (like gender, age, education), use of other illicit drugs, and meditation practice¹. Because these variables together account for important personality and lifestyle aspects, it is highly unlikely that such aspects drove the observed effects. Third, collecting detailed data about the use of other psychoactive substances allowed us to demonstrate that psychedelics exhibited a pattern of associations that was distinct from the other groups of investigated substances,

¹ Discussion of effects related to other psychoactive substances and meditation is included in the Supplementary Discussion.

which further supports our interpretation that it is not a mere predisposition to use illicit substances that drives the observed effects. All these effects were revealed thanks to a large sample of both non-users and users, the latter varying greatly in the reported frequency of psychedelics use.

Additional limitations related to the design of our study are self-selection biases and expectancy effects: users with more positive experiences and greater expectations might be more likely to take part in online surveys, which might have affected the results. Also, due to the retrospective design, we have no way to ensure that the participants were able to accurately assess their experiences due to potential memory inaccuracies or biases. Finally, it is also important to emphasize that the presence of the indirect effect in mediation analysis does not provide any information about the direction of the relationships among subjective ego-dissolution, mystical experiences, and the psychological variables we investigated. The direction we assumed was based on the current state of the knowledge, which indicates that the intensity of subjective experiences contributes to the beneficial effects of psychedelics, at least within a therapeutic context (Vollenweider and Preller, 2020). Further research is necessary to provide more evidence that a similar effect also occurs in naturalistic settings.

4.4. Conclusions

In summary, we found that using psychedelics frequently in a naturalistic context was related to more-positive emotional reactivity and an adaptive pattern of self-consciousness. Therefore, the observed psychological effects related to psychedelics use might be considered positive and might potentially contribute to better psychological well-being. Furthermore, the majority of the observed effects were mediated by the mystical- and ego-dissolution-related aspects of psychedelic experiences, thus highlighting the role of the subjective aspects of psychedelic experiences in psychological changes following psychedelics use. Future research using longitudinal measurements in groups of users and non-users is needed to establish to what extent these effects reflect a causal effect of regular psychedelics intake.

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Declaration of Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethical statement

All study procedures were in accordance with the Declaration of Helsinki. The study was approved by the ethics committee of the SWPS University (Warsaw, Poland; opinion number: 13/2020).

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Contributions

Conceived the study: AR, M. Bola; designed the online survey: PO, AR, JS, JH, M. Bola; programmed the online survey: PO, AR, JS; analyzed data: PO, AR, JS; supervised data analysis: M. Bielecki; interpreted data: all authors; drafted and revised the manuscript: all authors

ORCID IDs

Paweł Orłowski <https://orcid.org/0000-0003-1308-7478>

Anastasia Ruban <https://orcid.org/0000-0001-7039-148X>

Jan Szczypiński <https://orcid.org/0000-0002-5682-5840>

Justyna Hobot <https://orcid.org/0000-0002-4464-6415>

Maksymilian Bielecki <https://orcid.org/0000-0002-2881-4976>

Michał Bola <https://orcid.org/0000-0002-4609-8029>

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Supplementary Materials

Naturalistic use of psychedelics is related to emotional reactivity and self-consciousness: the mediating role of ego-dissolution and mystical experiences

Paweł Orłowski^{1*}, Anastasia Ruban^{2*}, Jan Szczypiński^{1*},
Justyna Hobot^{3,4}, Maksymilian Bielecki², Michał Bola¹

* – equal contribution

¹Laboratory of Brain Imaging, Nencki Institute of Experimental Biology of Polish Academy of Sciences, Warsaw, Poland

²Department of Psychology, SWPS University of Social Sciences and Humanities, Warsaw, Poland

³Consciousness Lab, Psychology Institute, Jagiellonian University, Krakow, Poland

⁴Center of Functionally Integrative Neuroscience, Aarhus University, Aarhus, Denmark

Corresponding author

Michał Bola

Laboratory of Brain Imaging

Nencki Institute of Experimental Biology

Polish Academy of Science

3 Pasteur Street

02-093 Warsaw, Poland

email: m.bola@nencki.edu.pl

Supplementary Text 1. Exploratory factor analysis of Self Consciousness Scale (SCS)

Four factors to extract were confirmed by Parallel analysis with 10000 Monte-Carlo simulations (Çokluk & Kocak, 2016; Horn, 1965). Principal axis factoring was together with PROMAX rotation were used in the analysis. The $KMO = 0.91$ and the Barlett's test of sphericity was significant ($\chi^2(253) = 29079.20, p < 0.001$). Public self and social anxiety were loaded by the same items as in the Polish validation study (Zakrzewski & Strzałkowska, 1989). Private self was divided into Internal self-awareness loaded by 5 items and Self-reflectiveness also loaded by 5 items (**Supplementary Table 1**).

Supplementary Table 1. Promax rotation pattern matrix of SCS.

SCS item	Public self	Internal self-awareness	Social anxiety	Self-reflectiveness
12	0.91	0.01	-0.02	-0.08
17	0.88	0.01	0.01	-0.11
3	0.85	-0.03	0.01	-0.03
2	0.79	-0.02	-0.10	0.00
15	0.71	0.01	0.03	0.03
10	0.68	-0.05	-0.04	0.03
8	0.49	0.14	0.08	0.06
21	-0.05	0.77	0.00	-0.05
23	-0.01	0.75	0.08	0.00
16	0.04	0.74	0.05	-0.03
11	0.04	0.61	-0.08	-0.02
19	0.00	0.53	-0.05	0.18
22	-0.04	0.01	0.88	-0.02
9	-0.05	0.03	0.85	0.01
4	0.01	-0.03	0.82	0.02
13	-0.02	0.11	0.82	-0.06
7	0.03	-0.01	0.65	-0.04
20	0.10	-0.14	0.55	0.14
5	-0.12	-0.07	-0.01	0.90
6	-0.10	0.13	0.01	0.73
14	0.10	-0.07	-0.05	0.58
1	-0.03	0.13	0.03	0.53
18	0.08	-0.04	-0.02	0.50

Supplementary Table 2. Anova tables of robust linear regression models of measures of emotional reactivity and public self-consciousness.

<i>Predictor</i>	<i>df</i>	Negative_reactivity (PERS-S)		Positive_reactivity (PERS-S)		Public_self (SCS)		Social_anxiety (SCS)	
		<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>
Intercept	1	5.82	0.016	1.33	0.249	0.00	0.953	8.80	0.003
Age (decades)	3	1.79	0.147	2.37	0.069	7.05	< 0.001	2.40	0.066
Sex	1	113.18	< 0.001	25.84	< 0.001	0.71	0.4	21.72	< 0.001
Education	3	0.81	0.488	0.46	0.713	3.55	0.014	2.54	0.055
Lifetime meditation hours	3	13.61	< 0.001	14.76	< 0.001	11.38	< 0.001	16.65	< 0.001
Lifetime psychedelics use	3	3.63	0.012	5.67	0.001	4.15	0.006	1.62	0.183
Lifetime cannabis use	3	0.49	0.69	9.98	< 0.001	7.05	< 0.001	2.13	0.094
Lifetime empathogens use	3	2.87	0.035	2.88	0.035	0.48	0.694	6.96	< 0.001
Lifetime dissociatives use	3	1.41	0.239	0.96	0.411	0.32	0.81	0.35	0.789
Lifetime stimulants use	3	0.36	0.78	0.87	0.458	0.28	0.838	0.01	0.999
Lifetime synthetic cannabinoids use	3	0.78	0.503	0.47	0.705	0.92	0.432	1.70	0.164
Lifetime benzodiazepines use	3	3.49	0.015	1.86	0.134	0.98	0.402	1.86	0.134
Lifetime opioids use	3	3.82	0.01	4.15	0.006	1.08	0.354	0.85	0.465
Alcohol use	3	7.08	< 0.001	1.44	0.228	12.56	< 0.001	0.29	0.829
Residuals	2523								

Supplementary Table 3. Anova tables of robust linear regression models of measures of private self-consciousness.

<i>Predictor</i>	<i>df</i>	Internal self-awareness (SCS)		Self-reflectiveness (SCS)		Rumination (RRQ)		Reflection (RRQ)	
		<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>
Intercept	1	2620.66	< 0.001	3300.05	< 0.001	5.14	0.023	20.00	< 0.001
Age (decades)	3	14.20	< 0.001	33.65	< 0.001	10.87	< 0.001	13.52	< 0.001
Sex	1	15.36	< 0.001	9.64	0.002	6.03	0.014	0.27	0.602
Education	3	5.22	0.001	2.87	0.035	6.55	< 0.001	3.24	0.021
Lifetime meditation hours	3	47.22	< 0.001	2.89	0.034	16.00	< 0.001	150.56	< 0.001
Lifetime psychedelics use	3	6.71	< 0.001	0.98	0.399	6.15	< 0.001	6.69	< 0.001
Lifetime cannabis use	3	0.51	0.674	0.44	0.722	2.32	0.074	0.74	0.528
Lifetime empathogens use	3	1.59	0.189	0.89	0.443	2.60	0.05	0.72	0.542
Lifetime dissociatives use	3	1.15	0.328	1.24	0.292	0.58	0.627	1.19	0.313
Lifetime stimulants use	3	1.17	0.318	0.65	0.583	0.77	0.511	2.86	0.036
Lifetime synthetic cannabinoids use	3	0.10	0.959	0.30	0.825	2.38	0.067	0.43	0.734
Lifetime benzodiazepines use	3	3.17	0.023	1.01	0.388	2.61	0.05	2.32	0.073
Lifetime opioids use	3	2.45	0.062	0.54	0.652	2.06	0.104	1.80	0.145
Alcohol use	3	3.35	0.018	0.54	0.655	6.25	< 0.001	4.18	0.006
Residuals	2523								

Supplementary Table 4. Anova tables of robust linear regression models of Ego Dissolution Inventory and Hood's Mysticism Scale.

<i>Predictor</i>	<i>df</i>	Ego Dissolution Inventory		Hood's Mysticism Scale	
		<i>F statistic</i>	<i>p.value</i>	<i>F statistic</i>	<i>p.value</i>
Intercept	1	116.50	< 0.001	0.20	0.654
Age (decades)	3	3.75	0.011	1.87	0.132
Sex	1	1.44	0.23	25.85	< 0.001
Education	3	0.97	0.405	1.29	0.276
Lifetime meditation hours	3	23.73	< 0.001	29.38	< 0.001
Lifetime psychedelics use	3	56.23	< 0.001	30.09	< 0.001
Lifetime cannabis use	3	3.82	0.01	4.30	0.005
Lifetime empathogens use	3	1.67	0.171	0.99	0.398
Lifetime dissociatives use	3	0.10	0.959	0.85	0.468
Lifetime stimulants use	3	0.58	0.627	1.72	0.162
Lifetime synthetic cannabinoids use	3	0.21	0.892	0.75	0.524
Lifetime benzodiazepines use	3	0.66	0.575	0.35	0.787
Lifetime opioids use	3	3.06	0.027	1.31	0.271
Alcohol use	3	3.97	0.008	3.20	0.022
Residuals	1624				

Supplementary Table 5. Extended results of the mediation analysis. Rows represent effects for the second (T2) and the third (T3) tertiles of lifetime psychedelics use (in comparison to the first tertile) for the Hood's Mystical Scale (HMS) and Ego Dissolution Inventory (EDI). Results for indirect effect where either CIs did not include 0, or $p < .05$, are marked with bold. *SE* - standard error, *LCI* - lower confidence interval, *UCI* - upper confidence interval.

		Indirect effect				Direct effect				Total effect				Goodness of fit					
		Effect	SE	LCI	UCI	Effect	SE	t	p	LCI	UCI	Effect	SE	t	p	LCI	UCI		
Negative reactivity																			
T2	HMS	-0.01	0.09	-0.18	0.16													R² / Adj R²	0.13 / 0.11
	EDI	-0.20	0.09	-0.41	-0.04	0.01	0.47	0.01	.990	-0.91	0.92	-0.20	0.46	-0.44	.664	-1.09	0.70	MSE	52.12
T3	HMS	-0.01	0.15	-0.30	0.27													F (35, 1625)	6.94
	EDI	-0.44	0.19	-0.82	-0.07	-1.33	0.51	-2.62	.009	-2.33	-0.34	-1.78	0.48	-3.71	< .001	-2.72	-0.84	p	< 0.001
Positive reactivity																			
T2	HMS	0.45	0.10	0.28	0.68													R² / Adj R²	0.11
	EDI	0.17	0.08	0.04	0.35	0.32	0.39	0.80	.423	-0.46	1.09	0.94	0.39	2.40	.017	0.17	1.71	MSE	36.40
T3	HMS	0.77	0.14	0.51	0.51													F (35, 1625)	5.94
	EDI	0.39	0.15	0.09	0.70	0.16	0.45	0.35	.723	-0.72	1.03	1.31	0.44	3.10	.003	0.46	2.17	p	< 0.001
Social anxiety																			
T2	HMS	-0.13	0.07	-0.29	0.00													R² / Adj R²	0.08
	EDI	-0.23	0.08	-0.42	-0.10	-0.23	0.39	-0.59	.555	-1.01	0.54	-0.60	0.39	-1.54	.123	-1.36	0.16	MSE	35.44
T3	HMS	-0.22	0.12	-0.47	0.01													F (35, 1625)	3.92
	EDI	-0.52	0.16	-0.84	-0.23	-0.70	0.41	-1.70	.089	-1.52	0.11	-1.44	0.39	-3.68	< .001	-2.21	-0.67	p	< 0.001

Public self																			
T2	HMS	-0.01	0.07	-0.15	0.12													R² / Adj R2	0.09/0.07
	EDI	-0.18	0.08	-0.36	-0.06	0.12	0.37	0.34	.736	-0.60	0.84	-0.07	0.36	-0.20	.845	-0.78	0.64	MSE	34.61
T3	HMS	-0.02	0.12	-0.26	0.21													F (35, 1625)	4.64
	EDI	-0.41	0.16	-0.74	-0.12	-0.74	0.42	-1.76	.079	-1.57	0.09	-1.17	0.40	-2.91	.004	-1.96	-0.38	p	< 0.001
Self reflectiveness																			
T2	HMS	0.13	0.04	0.06	0.22													R² / Adj R2	0.11/0.09
	EDI	-0.01	0.04	-0.08	0.06	-0.30	0.20	-1.45	.148	-0.70	0.10	-0.18	0.20	-0.88	.381	-0.57	0.22	MSE	9.76
T3	HMS	0.22	0.06	0.11	0.36													F (35, 1625)	5.18
	EDI	-0.02	0.08	-0.18	0.13	-0.49	0.22	-2.23	.026	-0.91	-0.06	-0.29	0.21	-1.35	.177	-0.71	0.13	p	< 0.001
Self awareness																			
T2	HMS	0.17	0.05	0.09	0.28													R² / Adj R2	0.1/0.08
	EDI	0.11	0.04	0.04	0.20	0.18	0.21	0.86	.391	-0.23	0.58	0.45	0.21	2.20	.028	0.05	0.86	MSE	9.86
T3	HMS	0.29	0.07	0.17	0.44													F (35, 1625)	5.93
	EDI	0.23	0.08	0.08	0.41	0.11	0.22	0.51	.612	-0.32	0.54	0.64	0.22	2.93	.003	0.21	1.60	p	< 0.001
Rumination																			
T2	HMS	0.08	0.06	-0.03	0.20													R² / Adj R2	0.11/0.09
	EDI	-0.25	0.07	-0.40	-0.13	-0.78	0.30	-2.58	.010	-1.37	-0.19	-0.95	0.30	-3.20	.001	-1.53	-0.37	MSE	22.37
T3	HMS	0.13	0.09	-0.05	0.32													F (35, 1625)	8.66
	EDI	-0.55	0.13	-0.81	-0.31	-1.19	0.34	-3.53	< .001	-1.85	-0.53	-1.61	0.32	-4.99	< .001	-2.25	-0.98	p	< 0.001
Reflection																			

T2	HMS	0.36	0.08	0.22	0.53	0.16	0.27	0.57	.566	-0.38	0.69	0.74	0.28	2.62	.009	0.19	1.29	R² / Adj R²	0.16/0.14
	EDI	0.22	0.06	0.12	0.36													MSE	18.53
T3	HMS	0.61	0.11	0.42	0.84	0.61	0.31	1.98	.048	0.01	1.21	1.71	0.31	5.57	< .001	1.11	2.32	F (35, 1625)	7.66
	EDI	0.50	0.12	0.28	0.73													p	< 0.001

Supplementary Table 6. Extended results of the mediation analysis. We present coefficients, standard errors (*SE*), *t* values, *p* values, and lower and upper confidence intervals values (*LCI*, *UCI*) for all confounder variables used in the mediation model.

	Negative reactivity					
	Coefficient	SE	t	p	LCI	UCI
Constant	26.60	1.45	18.38	< .001	23.77	29.44
Psychedelics lifetime T2	0.01	0.47	0.01	.99	-0.91	0.92
Psychedelics Lifetime T3	-1.33	0.51	-2.62	.009	-2.33	-0.34
Age 25-35	-0.65	0.47	-1.39	.165	-1.56	0.27
Age 35-45	-1.03	0.74	-1.39	.164	-2.48	0.42
Age 45+	-3.18	1.18	-2.70	.007	-5.49	-0.88
Sex male	-3.29	0.39	-8.51	< .001	-4.05	-2.53
Education secondary	0.97	0.83	1.16	.245	-0.66	2.59
Education bachelor	01.02	0.91	1.13	.261	-0.76	2.79
Education high	0.32	0.93	0.34	.732	-1.50	2.13
Cannabis Lifetime T1	-0.13	01.01	-0.13	.896	-2.11	1.85
Cannabis Lifetime T2	-0.95	01.07	-0.89	.374	-3.05	1.15
Cannabis Lifetime T3	-0.79	01.06	-0.75	.457	-2.85	1.28
Empathogens Lifetime T1	-0.90	0.55	-1.64	.101	-1.98	0.17
Empathogens Lifetime T2	-0.95	0.63	-1.52	.13	-2.19	0.28
Empathogens Lifetime T3	-1.22	0.66	-1.84	.067	-2.51	0.08
Dissociants Lifetime T1	-0.04	0.63	-0.07	.946	-1.27	1.18
Dissociants Lifetime T2	1.59	0.72	2.20	.028	0.18	03.01
Dissociants Lifetime T3	0.87	0.81	01.07	.285	-0.72	2.46
Stimulants Lifetime T1	-0.07	0.53	-0.13	.898	-1.11	0.97
Stimulants Lifetime T2	-0.12	0.57	-0.22	.827	-1.24	0.99
Stimulants Lifetime T3	0.65	0.65	1.00	.316	-0.62	1.91
Synthetic Cannabis Lifetime T1	1.38	0.88	1.57	.117	-0.35	3.11

Synthetic Cannabis Lifetime T2	0.43	0.75	0.58	.562	-1.03	1.89
Synthetic Cannabis Lifetime T3	0.19	1.15	0.16	.872	-2.07	2.45
Benzodiazepines Lifetime T1	0.31	0.69	0.46	.647	-1.03	1.66
Benzodiazepines Lifetime T2	-0.10	0.78	-0.13	.899	-1.62	1.42
Benzodiazepines Lifetime T3	2.17	0.83	2.61	.009	0.54	3.80
Opioids Lifetime T1	0.65	0.68	0.95	.343	-0.69	1.98
Opioids Lifetime T2	2.18	0.80	2.74	.006	0.62	3.74
Opioids Lifetime T3	1.80	0.74	2.42	.015	0.35	3.26
Alcohol T1	1.11	0.75	1.48	.139	-0.36	2.57
Alcohol T2	2.28	0.83	2.74	.006	0.65	3.91
Alcohol T3	3.10	0.80	3.89	< .001	1.54	4.66
HMS	0.00	0.03	-0.08	.934	-0.07	0.06
EDI	0.00	0.00	-2.30	.022	-0.01	0.00
Positive reactivity						
Constant	34.31	1.11	30.98	< .001	32.14	36.48
Psychedelics lifetime T2	0.32	0.39	0.80	.423	-0.46	01.09
Psychedelics Lifetime T3	0.16	0.45	0.35	.723	-0.72	01.03
Age 25-35	-0.30	0.39	-0.76	.45	-1.07	0.47
Age 35-45	-0.11	0.61	-0.18	.857	-1.30	01.09
Age 45+	0.34	1.11	0.31	.759	-1.84	2.52
Sex male	-1.29	0.33	-3.93	< .001	-1.94	-0.65
Education secondary	-0.62	0.68	-0.90	.368	-1.96	0.73
Education bachelor	-0.67	0.74	-0.90	.366	-2.11	0.78
Education high	-0.34	0.78	-0.44	.664	-1.86	1.18
Cannabis Lifetime T1	-0.39	0.79	-0.49	.622	-1.93	1.15
Cannabis Lifetime T2	0.47	0.84	0.56	.574	-1.17	2.11
Cannabis Lifetime T3	0.87	0.83	01.05	.294	-0.75	2.48

Empathogens Lifetime T1	01.03	0.46	2.25	.025	0.13	1.94
Empathogens Lifetime T2	0.78	0.52	1.50	.134	-0.24	1.79
Empathogens Lifetime T3	1.17	0.56	2.10	.036	0.08	2.26
Dissociants Lifetime T1	-0.34	0.53	-0.65	.514	-1.38	0.69
Dissociants Lifetime T2	0.02	0.67	0.03	.976	-1.29	1.33
Dissociants Lifetime T3	-0.54	0.69	-0.78	.435	-1.90	0.82
Stimulants Lifetime T1	-0.10	0.43	-0.24	.809	-0.94	0.73
Stimulants Lifetime T2	-0.55	0.48	-1.14	.253	-1.48	0.39
Stimulants Lifetime T3	-0.70	0.53	-1.32	.186	-1.73	0.34
Synthetic Cannabis Lifetime T1	-0.87	0.80	-1.09	.274	-2.44	0.69
Synthetic Cannabis Lifetime T2	0.82	0.71	1.16	.246	-0.57	2.20
Synthetic Cannabis Lifetime T3	0.25	0.82	0.31	.757	-1.34	1.85
Benzodiazepines Lifetime T1	-0.28	0.57	-0.49	.625	-1.40	0.84
Benzodiazepines Lifetime T2	-0.12	0.70	-0.18	.861	-1.49	1.25
Benzodiazepines Lifetime T3	-0.89	0.83	-1.07	.284	-2.51	0.74
Opioids Lifetime T1	-0.51	0.65	-0.79	.43	-1.77	0.76
Opioids Lifetime T2	-1.72	0.73	-2.34	.019	-3.15	-0.28
Opioids Lifetime T3	-1.42	0.74	-1.92	.055	-2.87	0.03
Alcohol T1	0.04	0.59	0.07	.944	-1.12	1.20
Alcohol T2	0.52	0.66	0.80	.427	-0.77	1.81
Alcohol T3	-0.80	0.64	-1.25	.21	-2.05	0.45
HMS	0.18	0.03	6.33	< .001	0.12	0.23
EDI	0.00	0.00	2.50	.013	0.00	0.00
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	Social anxiety					
Constant	18.19	1.12	16.24	< .001	15.99	20.38
Psychedelics lifetime T2	-0.23	0.39	-0.59	.555	-1.01	0.54

Psychedelics Lifetime T3	-0.70	0.41	-1.70	.089	-1.52	0.11
Age 25-35	-0.18	0.38	-0.46	.644	-0.92	0.57
Age 35-45	-1.27	0.59	-2.16	.031	-2.42	-0.11
Age 45+	-1.02	01.06	-0.96	.338	-3.10	01.06
Sex male	-1.20	0.32	-3.75	< .001	-1.83	-0.57
Education secondary	0.62	0.69	0.90	.371	-0.74	1.97
Education bachelor	0.09	0.74	0.12	.908	-1.37	1.54
Education high	-0.10	0.76	-0.14	.892	-1.60	1.39
Cannabis Lifetime T1	0.74	0.75	0.98	.329	-0.74	2.21
Cannabis Lifetime T2	0.12	0.81	0.14	.886	-1.48	1.71
Cannabis Lifetime T3	0.28	0.79	0.35	.727	-1.28	1.83
Empathogens Lifetime T1	-1.41	0.46	-3.05	.002	-2.32	-0.50
Empathogens Lifetime T2	-1.19	0.53	-2.26	.024	-2.22	-0.16
Empathogens Lifetime T3	-1.88	0.55	-3.39	.001	-2.96	-0.79
Dissociants Lifetime T1	-0.01	0.53	-0.03	.979	-1.06	01.03
Dissociants Lifetime T2	0.66	0.64	01.03	.305	-0.60	1.92
Dissociants Lifetime T3	0.99	0.67	1.48	.138	-0.32	2.30
Stimulants Lifetime T1	-0.14	0.43	-0.33	.742	-0.99	0.71
Stimulants Lifetime T2	-0.22	0.49	-0.45	.653	-1.18	0.74
Stimulants Lifetime T3	0.16	0.54	0.29	.771	-0.90	1.22
Synthetic Cannabis Lifetime T1	0.58	0.77	0.75	.454	-0.94	02.09
Synthetic Cannabis Lifetime T2	0.13	0.67	0.19	.852	-1.19	1.45
Synthetic Cannabis Lifetime T3	-1.67	0.87	-1.92	.055	-3.37	0.04
Benzodiazepines Lifetime T1	0.53	0.54	0.99	.323	-0.52	1.59
Benzodiazepines Lifetime T2	-0.33	0.65	-0.50	.619	-1.60	0.95
Benzodiazepines Lifetime T3	1.34	0.71	1.89	.058	-0.05	2.72

Opioids Lifetime T1	-0.22	0.58	-0.38	.703	-1.35	0.91
Opioids Lifetime T2	0.35	0.70	0.50	.618	-1.02	1.72
Opioids Lifetime T3	0.68	0.70	0.97	.331	-0.69	02.04
Alcohol T1	0.50	0.62	0.82	.415	-0.70	1.71
Alcohol T2	0.67	0.69	0.97	.333	-0.68	02.02
Alcohol T3	0.85	0.65	1.30	.193	-0.43	2.12
HMS	-0.05	0.03	-1.85	.065	-0.11	0.00
EDI	0.00	0.00	-3.48	.001	-0.01	0.00
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	Public self					
Constant	23.07	1.19	19.42	< .001	20.74	25.40
Psychedelics lifetime T2	0.12	0.37	0.34	.736	-0.60	0.84
Psychedelics Lifetime T3	-0.74	0.42	-1.76	.079	-1.57	0.09
Age 25-35	-1.14	0.37	-3.10	.002	-1.86	-0.42
Age 35-45	-2.78	0.60	-4.66	< .001	-3.94	-1.61
Age 45+	-2.81	01.03	-2.72	.007	-4.84	-0.79
Sex male	0.05	0.31	0.16	.875	-0.57	0.66
Education secondary	0.98	0.73	1.33	.183	-0.46	2.41
Education bachelor	0.84	0.79	01.07	.286	-0.70	2.39
Education high	1.51	0.81	1.87	.062	-0.08	3.10
Cannabis Lifetime T1	-1.40	0.77	-1.82	.069	-2.91	0.11
Cannabis Lifetime T2	-2.40	0.82	-2.91	.004	-4.01	-0.79
Cannabis Lifetime T3	-2.46	0.81	-3.03	.002	-4.06	-0.87
Empathogens Lifetime T1	0.48	0.45	01.07	.286	-0.40	1.36
Empathogens Lifetime T2	0.54	0.53	01.03	.302	-0.49	1.57
Empathogens Lifetime T3	-0.10	0.57	-0.18	.858	-1.22	01.01
Dissociants Lifetime T1	-0.12	0.54	-0.23	.82	-1.17	0.93
Dissociants Lifetime T2	0.18	0.62	0.29	.775	-1.04	1.40
Dissociants Lifetime T3	-0.50	0.63	-0.79	.428	-1.74	0.74

Stimulants Lifetime T1	0.05	0.42	0.11	.915	-0.78	0.87
Stimulants Lifetime T2	-0.13	0.46	-0.28	.781	-1.03	0.78
Stimulants Lifetime T3	0.08	0.54	0.16	.877	-0.97	1.14
Synthetic Cannabis Lifetime T1	0.66	0.77	0.86	.391	-0.85	2.17
Synthetic Cannabis Lifetime T2	-0.34	0.73	-0.46	.645	-1.77	1.10
Synthetic Cannabis Lifetime T3	0.31	0.90	0.35	.726	-1.44	02.07
Benzodiazepines Lifetime T1	0.02	0.59	0.03	.977	-1.13	1.16
Benzodiazepines Lifetime T2	0.03	0.68	0.04	.967	-1.31	1.36
Benzodiazepines Lifetime T3	0.83	0.66	1.26	.208	-0.46	2.12
Opioids Lifetime T1	-0.16	0.60	-0.27	.786	-1.34	01.01
Opioids Lifetime T2	-0.97	0.76	-1.27	.203	-2.47	0.52
Opioids Lifetime T3	0.13	0.67	0.19	.848	-1.18	1.44
Alcohol T1	2.27	0.69	3.28	.001	0.91	3.63
Alcohol T2	3.84	0.74	5.16	< .001	2.38	5.30
Alcohol T3	3.35	0.73	4.60	< .001	1.92	4.77
HMS	0.00	0.03	-0.14	.888	-0.06	0.05
EDI	0.00	0.00	-2.60	.009	-0.01	0.00
Self-awareness						
Constant	0.06	0.60	0.11	.915	-1.11	1.24
Psychedelics lifetime T2	0.18	0.21	0.86	.391	-0.23	0.58
Psychedelics Lifetime T3	0.11	0.22	0.51	.612	-0.32	0.54
Age 25-35	-0.02	0.20	-0.08	.937	-0.41	0.38
Age 35-45	-0.95	0.31	-3.07	.002	-1.55	-0.34
Age 45+	-1.83	0.54	-3.40	.001	-2.89	-0.78
Sex male	-0.53	0.17	-3.10	.002	-0.87	-0.20
Education secondary	01.01	0.41	2.45	.014	0.20	1.82

Education bachelor	0.95	0.44	2.16	.031	0.09	1.82
Education high	1.31	0.45	2.93	.003	0.43	2.19
Cannabis Lifetime T1	-0.13	0.35	-0.38	.704	-0.83	0.56
Cannabis Lifetime T2	0.15	0.39	0.38	.707	-0.62	0.91
Cannabis Lifetime T3	-0.17	0.38	-0.44	.658	-0.92	0.58
Empathogens Lifetime T1	0.04	0.24	0.16	.872	-0.42	0.50
Empathogens Lifetime T2	0.01	0.28	0.04	.968	-0.53	0.55
Empathogens Lifetime T3	-0.34	0.31	-1.13	.259	-0.94	0.25
Dissociants Lifetime T1	-0.43	0.30	-1.43	.154	-1.02	0.16
Dissociants Lifetime T2	0.11	0.35	0.31	.76	-0.58	0.79
Dissociants Lifetime T3	-0.55	0.36	-1.55	.122	-1.24	0.15
Stimulants Lifetime T1	-0.04	0.22	-0.16	.871	-0.46	0.39
Stimulants Lifetime T2	-0.33	0.26	-1.27	.205	-0.83	0.18
Stimulants Lifetime T3	-0.56	0.29	-1.91	.056	-1.13	0.01
Synthetic Cannabis Lifetime T1	-0.09	0.39	-0.24	.81	-0.86	0.67
Synthetic Cannabis Lifetime T2	0.00	0.37	0.00	1	-0.72	0.72
Synthetic Cannabis Lifetime T3	0.08	0.44	0.18	.86	-0.78	0.94
Benzodiazepines Lifetime T1	0.36	0.31	1.16	.247	-0.25	0.98
Benzodiazepines Lifetime T2	0.70	0.35	02.04	.042	0.03	1.38
Benzodiazepines Lifetime T3	0.33	0.40	0.81	.416	-0.46	1.11
Opioids Lifetime T1	-0.31	0.32	-0.96	.335	-0.95	0.32
Opioids Lifetime T2	-0.75	0.39	-1.93	.054	-1.50	0.01
Opioids Lifetime T3	-0.31	0.41	-0.75	.457	-1.12	0.50
Alcohol T1	-0.14	0.30	-0.46	.648	-0.72	0.45
Alcohol T2	-0.17	0.34	-0.51	.609	-0.84	0.49
Alcohol T3	-0.65	0.33	-1.98	.048	-1.30	-0.01

HMS	0.07	0.01	4.71	< .001	0.04	0.10
EDI	0.00	0.00	2.88	.004	0.00	0.00
Self-reflectiveness						
Constant	0.80	0.60	1.33	.183	-0.38	1.98
Psychedelics lifetime T2	-0.30	0.20	-1.45	.148	-0.70	0.10
Psychedelics Lifetime T3	-0.49	0.22	-2.23	.026	-0.91	-0.06
Age 25-35	-0.49	0.20	-2.46	.014	-0.88	-0.10
Age 35-45	-1.70	0.33	-5.22	< .001	-2.34	-1.06
Age 45+	-4.27	0.67	-6.42	< .001	-5.58	-2.97
Sex male	-0.42	0.17	-2.49	.013	-0.75	-0.09
Education secondary	0.27	0.33	0.81	.419	-0.39	0.92
Education bachelor	-0.26	0.38	-0.70	.486	-1.01	0.48
Education high	-0.37	0.40	-0.94	.348	-1.15	0.40
Cannabis Lifetime T1	-0.56	0.43	-1.31	.192	-1.41	0.28
Cannabis Lifetime T2	-0.49	0.46	-1.08	.281	-1.39	0.40
Cannabis Lifetime T3	-0.56	0.45	-1.24	.216	-1.43	0.32
Empathogens Lifetime T1	0.05	0.25	0.19	.851	-0.44	0.54
Empathogens Lifetime T2	-0.07	0.27	-0.24	.812	-0.60	0.47
Empathogens Lifetime T3	-0.16	0.30	-0.55	.58	-0.75	0.42
Dissociants Lifetime T1	-0.53	0.30	-1.77	.077	-1.12	0.06
Dissociants Lifetime T2	0.18	0.31	0.59	.557	-0.43	0.80
Dissociants Lifetime T3	-0.45	0.34	-1.34	.18	-1.11	0.21
Stimulants Lifetime T1	0.20	0.23	0.86	.39	-0.25	0.65
Stimulants Lifetime T2	0.22	0.25	0.87	.387	-0.28	0.71
Stimulants Lifetime T3	0.14	0.28	0.49	.627	-0.41	0.68
Synthetic Cannabis Lifetime T1	0.09	0.35	0.26	.794	-0.59	0.77
Synthetic Cannabis Lifetime T2	0.41	0.32	1.27	.205	-0.22	01.04

Synthetic Cannabis Lifetime T3	0.15	0.44	0.34	.734	-0.71	01.01
Benzodiazepines Lifetime T1	0.34	0.29	1.15	.252	-0.24	0.91
Benzodiazepines Lifetime T2	0.20	0.33	0.61	.541	-0.45	0.85
Benzodiazepines Lifetime T3	0.28	0.35	0.81	.419	-0.40	0.96
Opioids Lifetime T1	0.11	0.29	0.39	.699	-0.46	0.69
Opioids Lifetime T2	0.01	0.34	0.03	.975	-0.66	0.68
Opioids Lifetime T3	0.30	0.35	0.85	.393	-0.38	0.97
Alcohol T1	0.60	0.35	1.71	.087	-0.09	1.28
Alcohol T2	0.68	0.38	1.79	.074	-0.06	1.43
Alcohol T3	0.75	0.36	02.08	.038	0.04	1.46
HMS	0.05	0.01	3.58	< .001	0.02	0.08
EDI	0.00	0.00	-0.26	.798	0.00	0.00

Supplementary Table 7. Extended results of the mediation analysis including lifetime meditation practice as a covariate. Rows for each dependent variable represent effects for the second (T2) and the third (T3) tertiles of lifetime psychedelics use, in comparison to the first tertile. Results for indirect effect where either CIs did not include 0, or $p < .05$ are marked with bold. *SE* - standard error, *LCI* - lower confidence interval, *UCI* - upper confidence interval.

		Indirect effect				Direct effect						Total effect						Goodness of fit	
		Effect	SE	LCI	UCI	Effect	SE	t	p	LLCI	ULCI	Effect	SE	t	p	LCI	UCI		
Negative reactivity																			
T2	HMS	0.03	0.08	-0.11	0.19	0.07	0.46	0.15	.885	-0.84	0.98	-0.04	0.46	-0.10	.924	-0.94	0.85	R² / Adj R² MSE F (38, 1622) p	0.142/0.1 51.49 7.07 < .001
	EDI	-0.14*	0.08	-0.32	-0.01														
T3	HMS	0.05	0.12	-0.17	0.28	-0.98	0.52	-1.90	.057	-1.99	0.03	-1.24	0.50	-2.48	.013	-2.21	-0.26		
	EDI	-0.30	0.16	-0.63	0.01														
Positive reactivity																			
T2	HMS	0.37*	0.09	0.22	0.58	0.26	0.39	0.66	.512	-0.51	01.03	0.77	0.39	1.95	.051	-0.01	1.54	R² / Adj R² MSE F (38, 1622) p	0.123/0.1 36.08 5.98 < .001
	EDI	0.13*	0.07	0.02	0.29														
T3	HMS	0.57*	0.12	0.36	0.83	-0.07	0.45	-0.15	.88	-0.95	0.81	0.78	0.44	1.76	.078	-0.09	1.65		
	EDI	0.28*	0.13	0.03	0.55														
Social anxiety																			
T2	HMS	-0.08	0.06	-0.23	0.03	-0.18	0.39	-0.46	.647	-0.95	0.59	-0.45	0.39	-1.15	.25	-1.21	0.31	R² / Adj R² MSE F (38, 1622) p	0.088/0.0 35.13 4.1 < .001
	EDI	-0.18*	0.07	-0.34	-0.06														
T3	HMS	-0.13	0.10	-0.34	0.05	-0.43	0.42	-1.04	.3	-1.25	0.38	-0.94	0.40	-2.36	.018	-1.73	-0.16		
	EDI	-0.38*	0.13	-0.65	-0.14														
Public self																			
T2	HMS	0.02	0.06	-0.10	0.14	0.14	0.37	0.39	.699	-0.57	0.86	0.02	0.36	0.05	.963	-0.69	0.73	R² / Adj R² MSE F (38, 1622) p	0.104/0.0 34.18 4.95 < .001
	EDI	-0.14*	0.07	-0.30	-0.03														
T3	HMS	0.03	0.09	-0.16	0.2	-0.51	0.42	-1.20	.229	-1.34	0.32	-0.78	0.41	-1.92	.055	-1.58	0.02		
	EDI	-0.30*	0.13	-0.58	-0.06														
Self awareness																			
T2	HMS	0.13*	0.04	0.06	0.21	0.11	0.20	0.54	.589	-0.29	0.50	0.31	0.20	1.52	.129	-0.09	0.70	R² / Adj R² MSE F (38, 1622) p	0.118/0.0 9.73 5.72 < .001
	EDI	0.07*	0.04	0.01	0.16														
T3	HMS	0.19*	0.05	0.10	0.31	-0.11	0.22	-0.51	.609	-0.53	0.31	0.23	0.22	01.07	.283	-0.19	0.66		
	EDI	0.15*	0.07	0.03	0.3														

Self reflectiveness																			
T2	HMS	0.12*	0.04	0.05	0.21	-0.31	0.21	-1.51	.131	-0.71	0.09	-0.20	0.20	-0.97	.332	-0.59	0.20	R² / Adj R2 MSE F (38, 1622) p	0.128/0.1
	EDI	-0.01	0.03	-0.07	0.06												9.57		
T3	HMS	0.18*	0.05	0.09	0.3	-0.45	0.22	-2.07	.039	-0.88	-0.02	-0.28	0.22	-1.31	.19	-0.71	0.14		6.26
	EDI	-0.01	0.07	-0.15	0.12												< .001		
Rumination																			
T2	HMS	0.09*	0.05	0.00	0.21	-0.77	0.30	-2.57	.01	-1.35	-0.18	-0.87	0.30	-2.94	.003	-1.45	-0.29	R² / Adj R2 MSE F (38, 1622) p	0.244/0.1
	EDI	-0.20*	0.06	-0.33	-0.1												16.66		
T3	HMS	0.14*	0.08	0.00	0.3	-0.94	0.34	-2.77	.006	-1.61	-0.27	-1.22	0.33	-3.66	< .001	-1.87	-0.56		13.77
	EDI	-0.42*	0.11	-0.64	-0.21												< .001		
Reflection																			
T2	HMS	0.25*	0.06	0.14	0.39	0.01	0.26	0.04	0.972	-0.49	0.51	0.40	0.26	1.54	.125	-0.11	0.91	R² / Adj R2 MSE F (38, 1622) p	0.162/0.1
	EDI	0.14*	0.05	0.06	0.26												21.88		
T3	HMS	0.38*	0.08	0.24	0.56	0.02	0.29	0.06	0.955	-0.55	0.59	0.69	0.29	2.37	.018	0.12	1.27		8.26
	EDI	0.30*	0.09	0.13	0.49												< .001		

Supplementary Discussion

Empathogens

First, the number of lifetime use of empathogens was associated with enhanced positive reactivity, and diminished negative reactivity, social anxiety, and rumination. The most widely known and recreationally used member of this family of drugs is 3,4-methylenedioxymethamphetamine (MDMA). Acute effects of MDMA, as well as other empathogens, are an increase in well-being, positive mood, euphoria, increased empathy, moderate derealization, and slight perceptual changes (Vollenweider et al., 1998). However, considering more persistent effects, MDMA users report more depressive symptoms than drug-naïve subjects (but not more than drug users not using MDMA, thus the effect cannot be attributed solely to the neurotoxic effect of MDMA; Roiser and Sahakian, 2004). While we did not directly measure depressive symptoms and anxiety, our findings regarding empathogens use contradict the common notion of MDMA induced mood disorders. What is more, MDMA assisted psychotherapy was recently found to decrease anxiety and distress in patients with life-threatening diseases (Wolfson et al., 2020), and social anxiety in patients with autism (Danforth et al., 2018). While these findings are preliminary, together with our result they point out that psychological problems commonly associated with MDMA use should be carefully revisited.

Cannabis

Second, the number of lifetime use of cannabis was associated with increased positive emotional reactivity and a decrease in the domain of public self-consciousness. There is conflicting evidence in the literature regarding the effects of cannabis use on mood regulation and emotion processing. Acute emotional effects of cannabinoids can range from an increase in a good mood to amplification of negative emotions (Moreira & Lutz, 2008). Results from a recent fMRI study suggest that cannabis use is associated with deficits in response to negative emotions in expression recognition tasks (Bossong et al., 2013). Another study found that THC administration causes impairment in the accuracy of facial emotional expression recognition, whereas administration of cannabidiol (CBD) has a positive effect on the accuracy in such a task (Hindocha et al., 2015). Recognition of negative emotions seems to be particularly impaired in these studies, but our results suggest an enhanced positive emotionality in cannabis users. However, drawing clear conclusions might be difficult because the effects of cannabis on affective processes might vary depending on dose, strain, the form of administration, pre-existing tolerance, and 'set and setting'. Moreover, cannabis is the second most commonly used group of psychoactive substances in western societies, just behind alcohol (Global Drug Survey, 2020), with lifetime use in the hundreds or even thousands, which makes it difficult for frequent users to reliably estimate the number of times they have used cannabis. Nevertheless, our data suggests cannabis use might be related to more positive emotional reactivity and changes in the public aspect of self-consciousness, and these effects might be explored in future studies.

Alcohol

Third, alcohol consumption was strongly related with enhanced negative reactivity, rumination, public self-consciousness, and with diminished reflection. Alcohol is often used with the intention to reduce symptoms of anxiety and depression (Young et al., 1990), and individuals with a history of early-life stressful events report the early onset of alcohol use aimed at reducing mental distress (Rothman et al., 2008). Moreover, the comorbidity of alcohol use

disorder and mood disorders was found to be relatively high (18.8%; Subramaniam et al., 2017). Therefore, the effects of alcohol on various measures observed in our study may reflect the relationship of alcohol use anxiety and distress in the general population. Of note, the fact that alcohol consumption was related to the majority measured variables in a reverse manner than psychedelics is of interest in the context of using psychedelics as a treatment for alcohol addiction (e.g. Garcia-Romeu et al., 2019).

Meditation

Finally, the reported number of lifetime meditation hours was the strongest predictor of both emotional reactivity and self-consciousness. Importantly, the relationships between meditation and psychological traits were qualitatively very similar to those found for psychedelics. This is in line with previous studies showing that practising meditation is also related to a 'positivity bias', for instance, reduced reactivity to emotionally negative stimuli (Sobolewski et al., 2011); and to an altered concept of self (Trautwein et al., 2016). While it has been proposed theoretically that meditation and psychedelics-induced states share some phenomenological and neurophysiological characteristics (Millière et al., 2018), our study might be the first to show similarity of the trait-level features in psychedelics users and meditation practitioners. Interestingly, psilocybin intake combined with assisted mindfulness meditation led to positive changes in psycho-social functioning detectable even after 4 months (Smigielski et al., 2019), which suggests a possibility that both meditation and psychedelic experiences might strengthen each other's effects.

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