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Broadening Your Mind to Include Others: The relationship between serotonergic psychedelic experiences and maladaptive narcissism

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Abstract

Rationale

Recent research has showed that classical serotonergic psychedelic (CSP) drugs may be used to ameliorate certain health issues and disorders. Here we hypothesised that CSP experiences, through their ability to induce awe and ego-dissolution, may result in a reduction of maladaptive narcissistic personality traits, such as a strong sense of entitlement and lack of empathy.

Objectives

Our objective was to investigate whether high levels of awe and ego dissolution during recent CSP experiences are associated with currently lower levels of maladaptive narcissism.

Methods

In this pre-registered high-powered (N = 414) study, we used an online retrospective survey asking participants to describe their 'most awe-inspiring, impressive, significant, or emotionally intense experience', as well as several validated scales to test our hypothesis.

Results

A statistically significant mediation model indicated that recent CSP-induced experiences were associated with currently increased feelings of connectedness and affective empathetic drive, which in turn were associated with decreased exploitative-entitled narcissism. This relationship held even when taking into account sensation-seeking personality features. We found no evidence for feelings of ego dissolution to have the same effect.

Conclusions

Feelings of awe, but not ego dissolution, during recent CSP experiences were associated with increased feelings of connectedness and empathy, which in turn were associated with decreased levels of maladaptive narcissism personality features. This suggests that CSPs hold therapeutic potential for disorders involving connectedness and empathy, such as the treatment of pathological narcissism, and that the induction of connectedness through awe appears to be the driving force behind this potential.

Keywords: psychedelics, narcissism, awe, empathy, ego, connectedness, serotonergic, personality

1. Introduction

In recent years, there has been a steady increase in research suggesting that certain drugs typically classified as recreational drugs may be used effectively in mental health research and care, in particular for depression (Carhart-Harris et al. 2018a; Singh et al. 2016), post-traumatic stress disorder (Mithoefer et al. 2018), and substance addiction (Morgan et al. 2017). Psychedelic drugs in particular hold great potential not only for treating a wide range of clinical disorders (Carhart-Harris and Goodwin 2017), but also for fostering prosocial behaviour and helping to address non-clinical but problematic interpersonal styles and behaviours. Several research findings have indicated for instance that psychedelics may be useful for treating empathy-related disorders (Pokorny et al. 2017) and that psychedelics induce self-transcendent states and emotions such as feelings of connectedness (Lyons and Carhart-Harris 2018; Watts et al. 2017) and awe (Hendricks 2018). These experiences in turn may increase prosocial behaviour (Piff et al. 2015).

As of yet, it is however unclear whether psychedelics could also have beneficial effects for *maladaptive narcissism*. Maladaptive narcissism is associated with poor well-being and interpersonal problems (Cai and Luo 2018). In light of the beneficial potential of psychedelic drugs for mental health outcomes, here we investigated the relationship between narcissism and psychedelic drug use. More specifically, we studied the relationship between psychedelic drugs experiences and levels of narcissism through experiences of awe and ego dissolution. These experiences may in turn have positively affected feelings of connectedness and empathy, which are associated with lower levels of maladaptive narcissism.

1.1 Psychedelic experiences: Mysticism, awe, and ego dissolution

Classic serotonergic psychedelics (CSPs) are a group of psychoactive drugs the acute effects of which include substantial changes to sensory perception, mood, sense of self, relationship to external reality, and sense of passage of time (Preller and Vollenweider 2016). Clinical research suggests that CSP-assisted therapy – in which patients take a relatively mild or a large dose of psychedelics under the supervision of a therapist - can help to alleviate psychological distress and different mental health problems (see Carhart-Harris and Goodwin 2017 for an overview), including distress associated with life-threatening illness (Griffiths et al. 2016; Ross et al. 2016); various forms of addiction including alcoholism and tobacco addiction (Bogenschutz et al. 2015; Johnson et al. 2017; Morgan et al. 2017), and recurrent and treatment-resistant anxiety and depression disorders (Carhart-Harris et al. 2018a; Palhano-Fontes et al. 2019).

In the literature different suggestions have been made as to how CSP could exert their therapeutic effects: key psychological mechanisms appear to be mystical-like experiences, feelings of ego-dissolution, a sense of connectedness and feelings of awe (Carhart-Harris et al. 2018b; Hendricks

2018).Psychedelics can reliably induce mystical-type and self-transcendent states in users (Beauregard 2011; Nichols 2016) and such induced altered state of consciousness could be the driving psychological mechanism underlying the effect of CSPs on mental health. Mystical experiences are characterized by feelings of unity, sacredness, ultimate reality, transcendence of time and space, deeply felt positive mood, and ineffability (Pahnke 1963). The experience of ego-dissolution reflects the often-reported experience - typically induced at higher doses of psychedelics - of the sense of the disappearance of both the bodily and the narrative self (Milliere 2017). At the same time, many people also report strong feelings of connectedness with nature and humanity as a whole during their psychedelic experience, which in turn may drive long- and short-term changes in behaviour. Finally, for many people CSPs also induce strong feelings of awe, which are characterized by perceived vastness and a need for accommodating one's cognitive models (Hendricks 2018). Of course, the psychedelic experience is multifaceted and typically involves a combination of these different aspects, but for theoretical and practical purposes it makes sense to distinguish between these different psychological mechanisms through which psychedelics could exert their effects.

The notion that awe provides a mechanism underlying the therapeutic efficacy of psychedelics (Hendricks, 2018) is further supported by the observation that both psychedelic and awe experiences are characterized by a reduced sense of the self (Yaden et al. 2017). At a neural level, the psychedelic experience has been associated with a reduced activity of the so-called Default Mode Network (DMN) – a network of brain regions that has typically been implicated in self-referential processing and mind wandering (Carhart-Harris et al. 2012; Lebedev et al. 2015). Interestingly, the experience of awe is also accompanied by a reduced activation of the DMN (van Elk et al. 2019)– in line with the subjective reports that participants literally experience a smaller self during awe (Piff et al. 2015; van Elk et al. 2016). The degree of ego-dissolution - an experience induced by CSPs during which the boundaries of the ego are temporarily disrupted - experienced during a psychedelic 'trip' has previously been correlated with positive and lasting impacts on well-being (Nour et al. 2016; Schmid and Liechti 2018), in line with previous findings that scores on mysticism scales predict persisting changes in well-being after psilocybin use (Barrett et al. 2015) and with observations that the experience of 'deselfing' in awe underlies its prosocial and pro-environmental effects (Bai et al. 2017a; Piff et al. 2015).

Such findings may be of particular importance for mental health conditions and maladaptive trait profiles that involve a distorted view on or sense of the self. We suggest that narcissism may be one such condition, given that the experience of ego-dissolution and the reduced focus on the self, as induced by psychedelic drugs appear antagonistic to the self-focus and self-importance that is characteristic of high trait narcissism. Moreover, awe has been shown to foster humility (Stellar et al. 2018), to reduce self-focus and to increase collective engagement (Bai et al. 2017b) - all of which also appear antagonistic to narcissism. Awe also induces prosocial feelings and values and tends to diminish entitlement (Piff et al. 2015) – a repeatedly identified facet of trait narcissism (Gentile et al.

2013; Raskin and Terry 1988). One way in which this may happen is by occasioning feelings of a 'small self' or 'self-diminishment' (Piff et al. 2015), in which an individual and their concerns appear small and unimportant (often involving a comparison to something experienced that appears vast or important).

1.2 Narcissism, interpersonal problems, and well-being

Trait narcissism is negatively correlated with empathy, and in particular affective rather than cognitive empathy (Urbonaviciute et al. 2017). Affective or emotional empathy is the vicarious experience of a target's emotions as one's own, while cognitive empathy involves taking the perspective of others (see Cuff et al. 2016 for a review of the distinction). The relationship between trait narcissism and empathy is driven in particular by facets of narcissism identified as 'maladaptive' (Hepper et al. 2014b), in particular entitlement and exploitativeness, which both encompass a harmful perceived superiority of self over others. Recent findings also suggest that narcissists have an issue with their motivation with, rather than an inability to being empathic, in line with growing emphasis in the literature on the distinction between these two facets of empathy (Zaki 2014): while narcissists tend to lack empathy, they can nonetheless engage in empathy when instructed take the perspective of the other person (Hepper et al. 2014a).

Overall, trait narcissism is predictive of interpersonal problems, including pathological antagonism, narcissistic personality disorder, psychopathy, and externalising behaviours (Gentile et al. 2013). However, narcissism as a personality trait (as measured by the Narcissistic Personality Inventory, NPI; Raskin and Terry 1988) has also been positively correlated with some indicators of subjective well-being, including increased self-esteem and reduced neuroticism (Sedikides et al. 2004). By contrast, the exploitativeness and entitlement narcissism (EE narcissism) facet of NPD is *negatively* correlated with subjective well-being, including a positive correlation with neuroticism (see for an overview, Cai and Luo 2018). It is also the facet of narcissism most strongly associated with interpersonal issues such as antagonism, disagreeableness, and psychopathy (Ackerman et al. 2018), and predicts other problematic behaviours such as aggression (Cai and Luo 2018), conduct problems such as delinquency in youth (other NPI facets fail to predict such outcomes; Barry et al. 2007), and offender status (of seven NPI subscales examined in a study of youth offending and narcissism, only entitlement significantly predicted being in prison; Hepper et al. 2014b). As Brown and colleagues note, "the EE subscale of the NPI often carries the bulk of the variance in antisocial feelings and behaviors associated with the full NPI." (Brown et al. 2009).

1.3 Psychological mechanisms: Connectedness and empathy

Recently, the potential for utilising psychedelics as a course of therapy for psychiatric disorders involving low levels of trait empathy, such as psychopathy, has been suggested as a promising line of inquiry (Pokorny et al. 2017). Here, we suggest that psychedelic experiences might also to reduce narcissism, and in particular maladaptive/EE narcissism. Some previous findings suggest that this may be indeed be a promising avenue of research, by demonstrating that compared with placebo, experimental administration of psilocybin led to significantly higher increases in self-rated altruistic/positive social effects and positive behaviour changes (Griffiths et al. 2006). Community observer ratings confirmed positive changes in participants' behaviour and attitudes, both at two months (Griffiths et al. 2006) and fourteen months after administration (Griffiths et al. 2011). Such changes suggest reduced narcissism, and especially maladaptive narcissism given its strong correlation with antagonism (Ackerman et al. 2018) and being disliked socially (Paulhus 2001).

Empathy – and in particular emotional or affective empathy (as opposed to cognitive empathy) – can be affected by classic serotonergic psychedelics (CSPs). The experimental administration of both CSPs lysergic acid diethylamide (LSD) and psilocybin has been shown to acutely increase levels of emotional empathy, but not cognitive empathy (which is either unaffected or reduced; Dolder et al. 2016; Pokorny et al. 2017; Preller and Vollenweider 2016). An observational study of psilocybin users found that enhancements in valence-specific emotional empathy persisted for seven days after use (Mason et al. 2019), but if and how much longer such effects persist has yet to be studied experimentally. In a cross-sectional study, Lerner and Lyvers (2006) found that psychedelics users had higher emotional empathy levels than individuals without a history of drug use.

CSPs' ability to instil a persisting sense of connectedness – to the self, to other people and to the universe - has also been hypothesised as another therapeutic mechanism of action (Carhart-Harris et al. 2018b). Watts et al. (2017) found that, in 6-month follow-up interviews following a psilocybin clinical trial for treatment-resistant depression (Carhart-Harris et al. 2016) all patients made reference to a renewed sense of connectedness. Indeed, a sense of connectedness is pivotal to psychological well-being and recovery (Leamy et al. 2011; Lee et al. 2008), while a lack of deep connections to others has been described as a core element of narcissism (Twenge and Campbell 2009).

The current study

In light of this evidence, we hypothesised in the current study that a previous significant experience with CSPs would be inversely related to current maladaptive narcissism. We hypothesise that such an effect is mediated by previous experiences of awe and ego-dissolution, which in turn are associated with affective empathy and a sense of connectedness. Our theoretical model is pictured in Figure 1. By testing this model, we aim to answer the question: Is any relationship between CSP use and maladaptive narcissism sequentially mediated by, first, awe and ego-dissolution experiences and, second, affective empathic drive and connectedness?

Our study used a correlational approach, and as such, we are aware that we therefore cannot make causal inferences about the effects of psychedelics on narcissism. Instead, the critical prediction that we set out to test in our model is to what extent any relation between psychedelic drug use and narcissism is mediated by experiences of awe and ego-dissolution. We pre-registered all our hypotheses and analysis plan on the Open Science Framework prior to conducting the study (https://osf.io/nmh74/registrations).

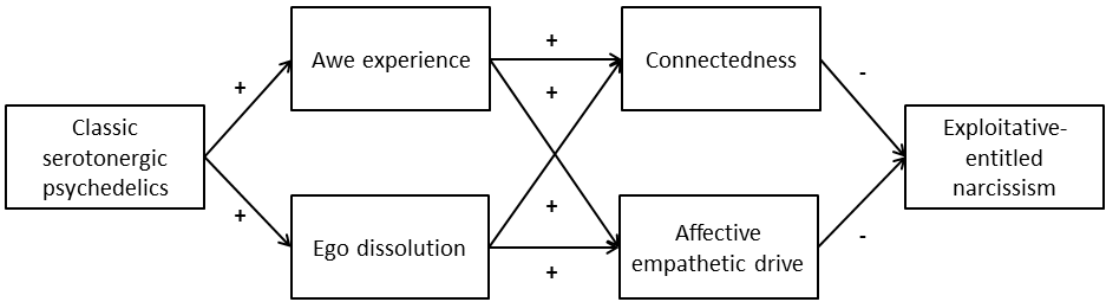

Figure 1: Hypothesised model of the pathway from CSPs use to reduced maladaptive narcissism

2. Methods and materials

2.1 Measures

Peak experience. All participants started by writing up, in a few sentences, their most awe-inspiring, impressive, significant, or emotionally intense experience of the past 5 years. If participants indicated they had used psychedelics drugs (psilocybin (magic mushrooms or truffles), LSD (acid), (N-N dimethyl tryptamine (DMT), Ayahuasca, mescaline, peyote, and 5-methoxy-dimethyl tryptamine (5-MeO-DMT), but not ketamine, salvia) in the past five years, then they (CSP users) were asked to pick their most awe-inspiring and significant experience under the influence of psychedelics (italics phrase in square brackets included for these participants only), and if they had not, to pick such an experience without being under the influence of psychedelics: "Please think of your most awe-inspiring, impressive, significant, or emotionally intense experience [*while under the influence of psychedelics*] of the past 5 years". All participants then indicated how long ago the experience took place (years & months ago), how spiritual and how religious the experience was (from 0-4: 0 "Not at all", 1 "A little bit", 2 "Somewhat", 3 "Considerable", 4 "Very"), and in the case of the CSP users, which psychedelic drug the experience the result was of.

Awe Experience Scale (AWE-S). The AWE-S (Yaden et al. 2018) is a 30-item measure of awe. It has a six-factor structure comprising altered time perception, self-diminishment,

connectedness, perceived vastness, physical sensations and need for accommodation. In the survey for the current study, the self-diminishment, connectedness, and perceived vastness subscales were used, resulting in a 15-item version of the measure. Examples of items in these subscales are, respectively, "I experienced a reduced sense of self"; "I had the sense of being connected to everything"; "I experienced something greater than myself". Participants were asked to indicate their agreement with these statements on a five-point Likert-type scale (-2 "Strongly Disagree", 1 "Disagree", 0 "Neither Agree nor Disagree", 1 "Agree", 2 "Strongly Agree") when thinking back to the experience they had just described. Together, the three subscales had good reliability, Cronbach's α =.89, as did the connectedness and vastness subscales together (i.e., without the self-diminishment subscale), Cronbach's α =.88. Separately, the subscales also had adequate reliability: self-diminishment, Cronbach's α =.86, connectedness, Cronbach's α =.89, perceived vastness, Cronbach's α =.82. It was decided by the researchers after data collection but before data analysis for this article that the items of the self-diminishment subscale and the *Ego-Dissolution Inventory* (see below) were conceptually too close, and to avoid any potential overlapping of effects, awe experiences were calculated in this study as the average of the connectedness and perceived vastness AWE-S subscales.

Ego-Dissolution Inventory (EDI). The EDI (Nour et al. 2016) is an eight-item scale measuring the experience of a compromised sense of self, and is accompanied by an eight-item Ego-Inflation measure. Examples of items are, respectively: "I lost all sense of ego" and "I felt especially self-assured". Participants in this project responded to the items whilst thinking back to the experience they had just described using a five-point Likert scale as per the Awe Experience scale (again from -2 "Strongly Disagree" to 2 "Strongly Agree"), rather than the visual analogue scale employed by the EDI's developers. The EDI scale had adequate internal consistency in this sample (Cronbach's α =.81), as did the ego inflation measure (Cronbach's α =.78).

Empathy Components Questionnaire (ECQ). The 27-item ECQ (Batchelder et al. 2017) was developed to incorporate the aforementioned distinctions between drive and ability to engage in empathy, in addition to more classical distinctions between cognitive and affective empathy. It has a five-factor structure comprising affective empathetic drive, affective empathetic ability, cognitive empathetic drive, cognitive empathetic ability and affective empathetic reactivity. A 20-item version of the scale, excluding the affective reactivity sub-scale, was used for this study. Examples of the four subscales are: "I always try to consider the other fellow's feelings before I do something." (affective drive); "Friends usually talk to me about their problems as they say that I am very understanding." (affective ability); "I try to look at everybody's side of a disagreement before I make a decision." (cognitive drive); "I am good at predicting what someone will do." (cognitive ability). Participants responded to the items using a five-point scale (again, from -2 "Strongly Disagree" to 2 "Strongly Agree"), rather than the four-point scale used in the original version. In this sample, the scale showed good overall internal consistency, Cronbach's α=.86 (for the four subscales together), though two subscales individually performed slightly below the level of 0.7 conventionally seen indicating an

acceptable level of reliability (Kline 2013) (affective drive, Cronbach's α =.60; cognitive drive, Cronbach's α =.63; cognitive ability, Cronbach's α=.70; affective ability, Cronbach's α =.79).

Connectedness. We used a five-point version of the Inclusion of Other in the Self Scale (IOSS; Aron et al. 1992), a pictorial measure of connectedness to others measured through a choice of increasingly overlapping circles. We adapted this scale for the present study to measure the currently experienced degree of connection felt to nature, humanity and the universe, respectively. The pictures were accompanied by the following instructions (taking the nature target as an example): "Please think now about how you currently perceive your relationship with ALL OF NATURE. Which of the following pictures best represents how you perceive your relationship to ALL OF NATURE" (for the pictures, see Figure ESM.1 in Online Resource). Scores ranged from no overlap (a score of '0') to full overlap (a score of '4'). The scores for the three targets together approached adequate levels of internal consistency (Cronbach's α =0.68).

Narcissistic Personality Inventory 13 (NPI13). The NPI13 (Gentile et al. 2013) is a 13-item short-form of the NPI (Raskin and Terry 1988), which measures trait narcissism. It consists of forced-choice items, each one offering a narcissistic answer (e.g., "I expect a great deal from other people"), which is scored 1, and a non-narcissistic answer (e.g., "I like to do things for other people"), scored 0. The score on this scale is calculated by summing all answers. This measure was chosen over the more widely-used short-form version of the NPI, the NPI-16 (Ames et al. 2006), because the NPI-16 was designed as a unifactorial measure and has not been found to have a stable multifactorial structure, whereas the NPI13 was designed to reflect the three-factor structure of the NPI identified by Maxwell et al (2011). Its three subscales are *Entitlement-Exploitativeness* (EE), which was used as the study's measure of maladaptive narcissism, *Grandiose-Exhibitionist* (GE) narcissism, and *Leadership-Authority* (LA) narcissism. Note that a survey error led item six (from the LA subscale) to be incorrectly worded, requiring responses to this item to be excluded. Analysis of the full NPI13 results was therefore conducted on a 12-item version, and of the LA sub-scale on a three- rather than four-item version. Gentile et al. (2013) found the NPI13 to have adequate consistency overall (Cronbach's α =.82) and as regards its subscales (Cronbach's α =>.7), with the exception of the EE-subscale (Cronbach's α =.52). They note that despite this, NPI-EE subscales nonetheless show evidence of good criterion validity, correlating with important external criteria. The overall scale as employed here showed poorer overall consistency than in previous studies, Cronbach's α =.59, falling below conventional acceptability levels (Kline 2013). Subscales also performed more poorly: LA, Cronbach's α =.52; GE, Cronbach's α =.62; EE, Cronbach's α =.35.

Brief Sensation Seeking Scale. The brief Sensation Seeking scale (Hoyle et al. 2002) is an eight-item short-form version of the 40-item Form V of the Sensation Seeking Scale. This scale was included in the survey as a control measure, as sensation seeking is both predictive of drug use (Jaffe and Archer 1987) and correlated with trait narcissism (Miller et al. 2009). Participants responded to

the items using a five-point scale (again, from -2 “Strongly Disagree” to 2 “Strongly Agree”). In this sample the scale maintained acceptable internal consistency, Cronbach’s α = .74.

Demographics, spirituality and drug use questions. A set of questions about demographics, spirituality, and drugs was devised for the study, primarily for the purpose of measuring potential confounding variables. Participants were asked to provide demographic information – gender (male, female or other), country of residence and religious affiliation - and to indicate on seven-point scales ranging from 0 “not at all” to 7 “extremely so” how spiritual, and how religious, they considered themselves. The drug use element of this questionnaire was based broadly on the Demographics and Drug Use Questionnaire (Lyvers and Meester 2012), and asked participants who had taken CSPs in the past five years approximately how often they had taken the CSPs on a six-point scale ranging from 1 “rarely” to 2 “monthly”, 3 “fortnightly”, 4 “weekly”, 5 “several times a week” and 6 “daily”, and what typical dose they had taken on a five-point scale running from 1 “very low dose”, to 2 “low dose”, 3 “medium dose”, 4 “high dose” and 5 “very high dose”.

2.2 Participants

Five hundred and eighteen participants (age range 18-78 years old, age *M* = 31.9, *SD* = 12.3) completed our online survey on the secure survey platform Qualtrics, of which 366 (70.7%) identified as male, 138 (26.6%) as female, and 14 (2.7%) as other. 414 participants (age range 18-78 years old, age *M* = 30.0, *SD* = 11.5) of these participants had had an experience with classic serotonergic psychedelic drugs (henceforth CSP users), and filled out the survey for the most awe-inspiring, impressive, significant, or emotionally intense experience they had had while under the influence of psychedelics over the past 5 years. Of the CSP users, 310 (74.9%) identified as male, 91 (22.0%) as female, and 13 (3.1%) as other.

Of the CSP users, for the psychedelics experience they described in the survey, 179 had taken psilocybin (45.0%), 129 LSD (32.4%), 32 DMT (8.0%), 21 Ayahuasca (5.3%), 5 mescaline/peyote (1.3%, results were combined because mescaline is the psychoactive ingredient of peyote), 2 5-MeO-DMT (0.5%), and 16 other (4.0%; including 2CP and 4-HO-MET). In addition, 12 had taken a combination of CSPs (3.0%), and 13 had taken a combination involving another, non-CSP drug in addition to the CSP (3.3%). Due to low numbers for mescaline/peyote and 5-MeO-DMT, we decided to classify these together with ‘other’ for subsequent analyses. A majority (251; 60.6%) of these participants indicated residence in the USA, 50 (12.1%) in the UK, 23 (5.6%) in Canada, 13 in Germany (3.1%), and 11 in Australia (2.7%), with remaining participants divided amongst 31 other countries of residence (with fewer than 10 participants in each country). As regards their religious or spiritual affiliation, the largest group of participants were those identifying as spiritual but not religious (161; 38.9%), followed by 52 atheists (12.6%), 48 ‘nones’ (no religion, 11.6%), 39 agnostics (9.4%), 24 Christians (5.8%), 16 indifferent (3.9%), 13 secular humanists (3.1%), 9 Buddhists (2.2%),

6 (neo-)Pagans (1.4%), 2 Jewish (0.5%) and 44 'other' (11.6%). Self-reported spirituality and religiosity was measured on a scale from 0 ("Not at all") to 6 ("Extremely so"), with numbers as options in between. Mean spirituality was 3.37 (*SD* = 1.72), and mean religiosity 0.80 (SD = 1.23).

The participants were recruited through online advertisements and advertisements on email lists. Participants were not offered incentives for taking part. Ads for the survey were posted on psychedelics-related online forums; principally psychedelics-related sub-forums ("sub-reddits") of www.reddit.com, and psilocybin-focused psychedelic forum The Shroomery. Three psychedelics-focused organisations also tweeted advertisements for the survey, and ads were placed on several psychology-related online sites such as the Social Psychology Network, and on other social media.

The project was reviewed and approved through Coventry University's formal research ethics procedure. Participants were required to read a participant information sheet and to declare their informed consent to participate. Given the socially undesirable nature of narcissism, participants were not informed of the exact nature of the personality measures in the survey prior to completing it. Following completion, participants were provided with a debrief that included an explanation of the main topic under research as well as providing information regarding sources of help relevant to the topics under study. All data were anonymous; no names, residential addresses, dates of birth, IP-addresses, or other information by which participants could be identified were collected.

2.3 Preregistration

The hypothesised model was pre-registered (see: https://osf.io/nmh74/), together with the proposed hypotheses and analyses (see this link also for the survey materials). In this article, the same model, hypotheses, methods, and analyses have been used, except for the use of the control group in the mediation analyses. We only collected data from 104 non-CSP users and accordingly our study was underpowered to compare CSP to non-CSP awe experiences. As our main hypotheses were specific to the use of CSP (see Introduction), we only conducted the analyses for the CSP group which are reported below.

3. Results

3.1 Narcissism

	NPI all	**NPI LA**	**NPI GE**	**NPI EE**
Range	0-12	0-3	0-5	0-4
All (n=518)	2.71 (2.08)	.80 (.94)	1.37 (1.37)	.53 (.79)
CSP (n=414)	2.78 (2.06)	.79 (.95)	1.50 (1.37)	.49 (.75)

Non-CSP (n=104)	2.44 (2.13)	.87 (.92)	.88 (1.24)	.68 (.89)

Table 1: Overview of descriptive statistics of Narcissistic Personality Inventory (NPI) scores for classical serotonergic psychedelic (CSP)-users and non-CSP users. NPI LA=Leadership-Authority subscale; NPI GE=Grandiose-Exhibitionist subscale; NPI EE=Entitlement-Exploitativeness subscale.

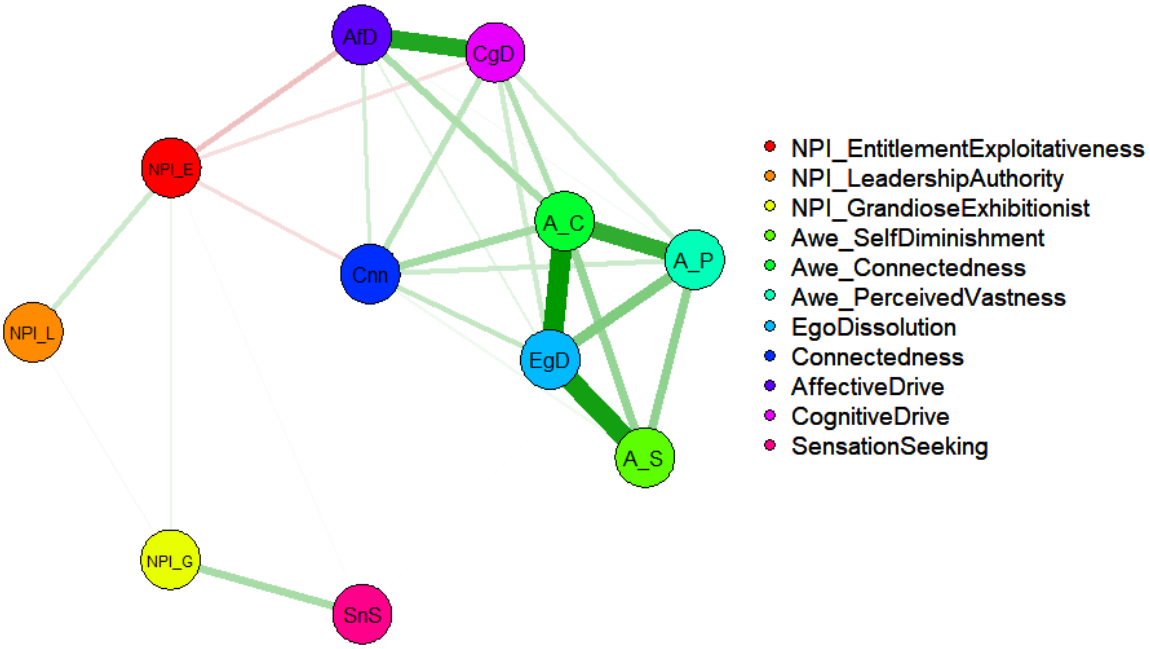

Figure 2: Correlation plot representing the correlations between narcissism subscales, AWE-S subscales, ego dissolution, ECQ subscales, and sensation seeking. All scores are standardized. Line thickness and opacity reflect the magnitude of the correlation (thicker, more opaque lines indicate stronger correlations) and the colour reflects the valence of correlation (green is positive, red negative).

First, we examined our relevant measures of narcissism –see Table 1 for an overview of descriptive statistics of the scores– and how they were associated with empathetic drive and ability, by plotting a correlational plot, see Figure 2. Next, we investigated these relationships further, using linear regressions, to verify that these were all as expected; see Table 2 (for overall narcissism and exploitative-entitled narcissism; see Table ESM.1 in Online Resource for leadership-authority and grandiose-exhibitionist narcissism regressions). In line with previous findings regarding narcissism and affective empathy (Urbonaviciute et al. 2017) and empathy drive (Hepper et al. 2014a), we found that, for all participants together, affective empathy drive (which combines the two) is the strongest

predictor out of the four most basic ECQ sub-scales (affective drive, cognitive drive, cognitive ability and affective ability) of both overall NPI narcissism and the NPI EE subscale. Contrary to previous research, overall NPI is also – though to a smaller extent - significantly *positively* predicted by affective empathetic ability, and exploitative-entitled NPI significantly negatively predicted by cognitive empathetic drive. The latter finding suggests that it may be overall drive to engage in empathy, rather than affective drive specifically or affective empathy more generally, that is related to maladaptive narcissism.

NPI *total*	**β**	**95% CI**	***t***	***p***	***fit***
Cognitive ability	<.01	[-.02, .20]	1.65	.10	R^2 = .055**, 95% CI = [.02, .09]
Cognitive drive	<-.01	[-.20, .01]	-1.70	.09	
Affective ability	.18	[.06, .29]	3.03	.002	
Affective drive	-.19	[-.30, -.09]	-3.59	<.001	
NPI - EE	**β**	**95% CI**	***t***	***p***	***fit***
Cognitive ability	<.01	[-.02, .20]	1.63	.10	R^2 = .053**, 95% CI = [.02, .09]
Cognitive drive	-.11	[-.21, <-.01]	-2.02	.04	
Affective ability	<-.01	[-.12, .11]	-.08	.94	
Affective drive	-.18	[-.28, -.07]	-3.32	<.001	

*Table 1: Regressions of the components of the ECQ (cognitive empathetic ability/drive & affective empathetic ability drive) on overall narcissism (NPI total) and exploitative-entitled narcissism (NPI EE). *p<.05, **p<.01, ***p<.001.*

In terms of connectedness, we ran a regression model predicting exploitative-entitled narcissism by the three measures of connectedness that together make up our measure of 'current levels of connectedness' and found that it was connectedness to nature (b = -.12, 95% CI [-.23, -.01], p = .03) and connectedness to humanity (b = -.14, 95% CI [-.25, -.04], p = .007), but not connectedness to the universe (b = .05, 95% CI [-.06, .15], p = .38) that predicted lower levels of exploitative-entitled narcissism (overall model R^2 = .04**, 95% CI = [.01, .08])(see Table ESM.2

Online Resource for an overview of correlations between NPI total and subscales and the connectedness measures).

Next, we ran a correlation of sensation seeking with overall NPI and NPI EE for the whole participant sample and found that, as expected, sensation seeking was positively and significantly correlated with overall NPI (r=.26, 95% CI [.18, .34], p<.001) and NPI GE (r=.33, 95% CI [.25, .40], p<.001), but not NPI EE (r=.04, 95% CI [-.05, .12], p=.38) or NPI LA (r=.06, 95% CI [-.02, .15], p=.15).

Within the CSP users group, we investigated whether NPI EE, our main narcissism measure of interest, was significantly affected by age, gender, and sensation seeking. We found that NPI EE scores did not differ significantly between the genders (male, M = .49, SD = .77, female, M = .48, SD = .69, other, M = .69, SD = .85, F(1,411)=.47, p = .63, ηp^2 =.002), but that it was significantly correlated with age (r=-.10, 95% CI [-.20, -.01], p = .04) and sensation-seeking (r=.11, 95% CI [.01, .20], p = .03). Unsurprisingly, age and sensation-seeking correlated significantly with each other, as well (r=-.37, 95% CI [-.45, -.28], p < .001), with younger adults scoring higher on sensation-seeking than older adults. When running partial correlations however, we found that the effects of age and sensation-seeking on NPI EE partially cancelled each other out: when controlling for sensation-seeking, the partial correlation between NPI EE and age was r = .07, p = .18; when controlling for age, the partial correlation between NPI EE and sensation-seeking was r = .08, p = .12. Given our a priori hypotheses about the role of sensation seeking in CSP use and narcissism, we retained sensation-seeking as a control variable for subsequent analyses.

For CSP users only, when examining the different drugs that the CSP users took for their experience, we found no differences in the experience of awe (F(6,386)=1.13, p = .35, η_p^2 =.02) or ego dissolution (F(6,386)=1.19, p = .31, η_p^2 =.02) as a result of the drug they took (see Table ESM.3 in Online Resource for estimated marginal means).

3.2 Awe, ego dissolution, connectedness, and empathy

Our main research question was whether CSP 'trips' lead to experiences of awe and ego dissolution, and whether this is associated with reduced levels of maladaptive narcissism through increased feelings of connectedness and affective empathetic drive. We ran a multiple mediation model to test this; see Figure 3 (and Table ESM.4 in Online Resource for the full statistics). The mediation model included two predictor variables (awe experience & ego dissolution), two mediators (connectedness & affective empathetic drive), one outcome (exploitative-entitled narcissism), and one control variable (sensation-seeking). The model was run on standardized variables and was bootstrapped (n=5000). Importantly, there were two significant indirect effects: from experiencing awe during the CSP trip to currently lower levels of maladaptive narcissism via currently higher levels of feelings of connectedness (b = -.03, p = .05, orange line in Figure 3), and from experiencing awe during the CSP

trip to currently lower levels of maladaptive narcissism via currently higher levels of affective empathetic drive (b = -.04, *p* =.01, turquoise line in Figure 3). These two indirect pathways were not significantly different from each other (*b* = .01, *p* = .53). Neither indirect pathway from experiencing ego dissolution during the CSP trip to currently lower levels of maladaptive narcissism via connectedness and affective empathic drive were significant (b = -.01, *p* =.20, green line and b < -.01, *p* =.57, purple line in Figure 3, respectively).

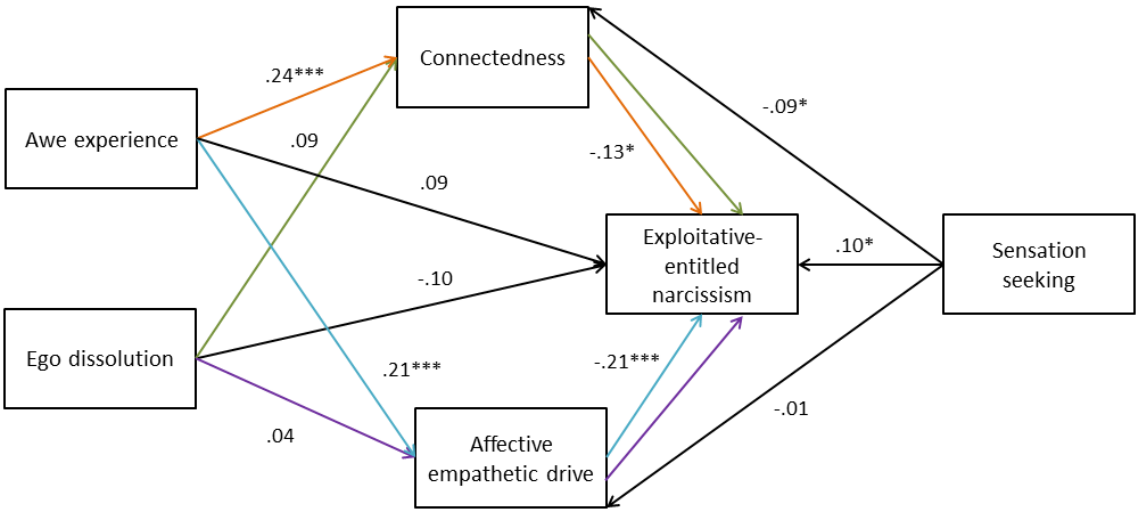

Figure 3: *Multiple mediation model from the experiences of awe and ego dissolution to exploitative-entitled narcissism via connectedness and affective empathetic drive in CSP users, with sensation-seeking as a control variable. Four colours (orange, green, turquoise, and purple) represent indirect effects. Numbers represent standardised beta values. *p<.05, **p<.01, ***p<.001.*

Following up on this mediation model, we examined whether it mattered how long ago the CSP trip took place, since our measures of the experience of awe and ego dissolution refer to the experienced CSP trip, whereas the measures of connectedness and affective empathetic drive (as well as narcissism and sensation-seeking) refer to current levels. To this end, we ran two regressions with moderators where we measured the effect of time having passed since the trip on the relationship between the awe experience and affective empathetic drive and connectedness, and found that the moderation effect was not significant in either case (affective empathetic drive by how long ago the CSP trip was, b < .01, *p* = .20, connectedness by how long ago the CSP trip was, b < .001, *p* = .78).

Next, we checked whether the frequency of taking CSPs, or the size of a typical dose, influenced the effect of the awe experience on affective empathetic drive and connectedness (see Table ESM.5 in Online Resource for frequency of scores on these two questions). First, we ran two ANOVAs to

investigate whether levels of affective empathetic drive and connectedness differed between participants depending on their intake frequency. We found that the frequency of taking CSPs did not affect current levels of affective empathetic drive ($F(5,403)=.72$, $p = .61$, $\eta p^2 = .009$) or connectedness ($F(5,403)= 1.18$, $p = .32$, $\eta p^2 = .01$), nor did the typical dose of CSPs affect current levels of affective empathetic drive ($F(4,404)= .62$, $p = .64$, $\eta p^2 = .006$) or connectedness ($F(4,404)= 2.08$, $p = .08$, $\eta p^2 = .02$). To make sure there was no effect on the indirect pathways from awe experiences to narcissism, we ran additional moderator analyses and found that frequency of taking CSPs in the past 5 years also did not significantly influence the relationship between the awe experience and affective empathetic drive (b = .08, $p = .12$) or connectedness (b = .03, $p = .53$), nor did the typical dose of CSPs influence either affective empathetic drive (b = .01, $p = .80$) or connectedness (b = -.03, $p = .58$).

Finally, we explored what it is about awe that might drive the positive effect on both affective empathetic drive and connectedness that in turn is related to decreased maladaptive narcissism. We ran two regressions to investigate which of the awe subscales was most strongly related to this effect. We found that affective empathetic drive is significantly predicted by the connectedness subscale of AWE-S (b=.28, 95% CI [.17, .39], $p<.001$), and not the perceived vastness subscale (b=-.02, 95% CI [-.13, .09], $p=.70$) in an overall significant model ($R^2 = .072$**, 95% CI = [.03, .12]). This was also the case for our IOSS connectedness measure (AWE-S connectedness (b=.25, 95% CI [.14, .35], $p<.001$), AWE-S perceived vastness (b=.07, 95% CI [-.04, .18], $p=.19$) in an overall significant model ($R^2 = .084$**, 95% CI = [.04, .14]). This driving effect of AWE-S connectedness on empathy and felt connectedness held if the self-diminishment subscale of the AWE-S was also included in the regression (see Table ESM.6 in Online Resource). An additional exploratory analysis demonstrated that AWE-S connectedness experienced during the CSP trip was in turn significantly correlated with the extent to which participants perceived the trip to be a spiritual experience ($r=.51$, $p<.001$) and a religious experience ($r=.27$, $p<.001$).

4. Discussion

This study investigated a hypothesised (negative) relationship between psychedelic use and maladaptive narcissism. We expected that psychedelic-occasioned experiences of awe and ego dissolution would be related to lower narcissism, mediated by increased empathetic affective drive and feelings of connectedness. Our main finding is that feelings of awe, but not ego dissolution, during recent CSP experiences were associated with increased feelings of connectedness and empathy, which in turn were associated with decreased levels of maladaptive narcissism. These findings, though demonstrating associations rather than causality, provide support for the hypothesis that psychedelics can positively affect narcissistic personality traits, through their awe-inducing potential.

Specifically, we found that affective empathy drive is the strongest predictor (out of four facets of empathy) of both overall narcissistic personality and exploitative-entitled narcissism. These findings are in line with previous research showing that the relationship between empathy and narcissism is driven by the emotional facet of empathy (Urbonaviciute et al. 2017; Wai and Tiliopoulos 2012), via their relationship with maladaptive facets of narcissism in particular. Our findings also corroborate research showing that narcissists appear to lack the drive rather than the ability to engage in empathy (Hepper et al. 2014b), with similar findings for other empathy-related traits and psychological disorders such as psychopathy (Meffert et al. 2013).

In this study, awe was measured by two subscales of the Awe Experience Scale (AWE-S; Yaden et al. 2018): connectedness and perceived vastness. Measures of affective empathetic drive and connectedness (to nature, humanity, and the universe) were significantly predicted by AWE-S connectedness over AWE-S perceived vastness and AWE-S self-diminishment. This finding is in line with other recent research showing correlations between measures of (social and nature-related) connectedness and feelings of oneness, and empathy (Edinger-Schons 2019; Zhang et al. 2014). The observation that awe-related feelings of connectedness also predict -via empathy and enduring feelings of connectedness - lower narcissism, is also in line with other recent research showing that increased empathy mediates the negative relationship between connectedness (here nature-relatedness specifically) and psychopathy (Fido and Richardson 2019). It also supports the previously noted suggestion that (a lack of) connectedness to others may be central to narcissism (Twenge and Campbell 2009), but also points to the importance of connectedness to other elements of existence external to the self (especially nature).

Moreover, an exploratory analysis showed that AWE-S connectedness experienced during the CSP trip was significantly and positively correlated with perceived spirituality and religiousness of the trip. This corroborates previous findings of positive relationships between spirituality and nature connectedness (Trigwell et al. 2014) and that spirituality as a construct can be conceptualised as emotional connectedness not only to the divine, but also to nature and other people (Johnstone et al. 2012). We found that specifically connectedness to nature and humanity rather than connectedness to the universe predicted lower levels of exploitative-entitled narcissism in psychedelics users. This might result from the more abstract nature of the notion of connectedness to the universe compared to the other two scales, and is in line with other research suggesting a link between psychedelics and increases in relatedness or connectedness to nature (Lyons and Carhart-Harris 2018).

The finding that AWE-S connectedness rather than ego-dissolution predicted affective empathetic drive and enduring feelings of connectedness was counter to our hypothesis. In our study the AWE-S self-diminishment sub-scale also turned out not to be a significant predictor of the model, while the connectedness sub-scale was positively associated with empathy. These findings make sense in light of the theoretical suggestion that awe may constitute the primary mechanism of action

underlying psychedelic drugs' therapeutic effects, by fostering stronger feelings of connection to others and the environment (Hendricks, 2018).

One arguable limitation of our study is that there is a degree of conceptual overlap between the Awe Experience Scale (AWE-S) connectedness subscale and ego-dissolution as measured by the Ego-Dissolution Inventory (EDI). However, AWE-S connectedness items imply the continued existence of a bounded self that feels greater connectedness to what is beyond the self, while ego-dissolution as measured by the EDI focuses largely on the dissolution and disintegration of the self and/or its boundaries. Similarly, there are also likely to be some conceptual overlaps between other constructs analyses, such as AWE-S connectedness and general connectedness, or aspects of empathy and connectedness. More broadly, the problem of the "common method bias", in which variance in the dependent measures may to an extent result from the use of the same type of measurement tool (in this case, self-report measures)(van Elk et al. 2016), may also represent a challenge to the validity of some our findings. Nevertheless, we used validated measures for each of these constructs and the results demonstrating that each construct had distinct effects.

A further limitation of this study is that it is a cross-sectional rather than longitudinal study. As such, we cannot draw any causal inferences regarding the effects of psychedelics on narcissistic personality traits. A repeated measures within-subjects design (e.g., using pre- and post-measurement in relation to a psychedelic retreat or in a controlled experiment) would be optimal for determining the causal effect of psychedelics and trait narcissism. In such a study, it would also be important to include an appropriate control condition (e.g., a meditation or a yoga retreat) to determine to what extent the observed effects of awe and connectedness are unique to psychedelics or extend to other experiences as well. Moreover, in the present study, we had to rely on participants' recall of their experience. We asked for their peak (psychedelic) experience of the past five years, which is likely significant enough to be well-memorized. When we checked in follow-up analyses, we found that the amount of time having passed since the experience, the frequency of taking classic serotonergic psychedelic drugs, nor the size of a typical dose had an effect on the relationship between the awe experience and affective empathetic drive and connectedness. This suggests that the effects of a highly significant psychedelic experience can have enduring effects. It should be noted, however, that participants were asked to average both indications of frequency of taking drugs and of the size of a typical dose over the span of five years. As a result, the answers are likely less precise than is desirable and are skewed towards the 'Rarely' option of frequency (nearly 60% of all answers) and to 'Medium' and 'High' of typical doses (together nearly 80% of all answers), thus showing little variance. This should be considered a limitation of the survey. Indeed, participants were asked to reflect on their peak psychedelic experience of the past five years. This is a substantial amount of time, and it should be noted that this timespan may have facilitated memory errors such as source confusion, clustering, interference, or imagination inflation. However, memories of so-called 'peak experiences' (intense, positive experiences) have been found to be associated with rich memory

representations (D'Argembeau et al. 2003; Talarico et al. 2004), which speaks to the validity of the research.

One other limitation of the current research is the gender imbalance; around 70% of respondents to this survey were male. It is perhaps notable that our participants (both CSP users and non-CSP users) had what in absolute terms appear to be low scores on NPI-13 exploitative-entitled narcissism (well below 1 out of a maximum of 4). While we are not aware of studies reporting levels of NPI-13 exploitative-entitled narcissism in (representative samples of) the general population or in populations with similar demographic characteristics to our participants, the present scores were also notably lower than found for participants in other recent studies that also used the NPI-13. Our participants scored an average of 0.53 out of 4, while German participants in three studies reported by Brailovskaia, Bierhoff and Margraff (2019) respectively scored 1.41, 1.20 and 1.12 – in all cases more than twice as high as our participants. Differences in demographic group characteristics may explain such differences (German versus mostly American and British, mostly female versus mostly male). Nevertheless, the fact that associations between CSP experiences, levels of connectedness and levels of exploitative-entitled narcissism were detected despite participants appearing overall to be scoring low on narcissism arguably underscores the robustness of the finding.

Since the publication Griffiths et al.'s (2006) study demonstrating psilocybin's ability to occasion mystical experiences that have lasting positive effects, there has been a renaissance of such experimental research, accompanied by an increase in observational and epidemiological research interest. There are many potential advantages to using psychedelic drugs in both research and mental health settings: many of these psychedelic drugs have low toxicity (Nichols 2004), are not habit-forming (Nichols 2004), and reliably induce peak experiences (Nichols 2016), even in laboratory settings (Holze et al. 2020; Liechti 2017; Turton et al. 2014). Moreover, while the actual psychedelic experiences are relatively brief, the duration of the effects can persist for months or years (Griffiths et al. 2008; MacLean et al. 2011; Schmid and Liechti 2018). While the current study was a cross-sectional survey study, its findings encourage future research on psychedelics and maladaptive narcissism involving experimental and longitudinal settings. An additional topic that could be investigated in future research is the involvement of the brain's so-called default mode network: Neuroimaging research has shown that psilocybin reduces activity in the brain's default mode network (Carhart-Harris et al. 2012; Müller et al. 2018) and higher activation of the DMN has been hypothesised to increase narcissism (Jankowiak-Siuda and Zajkowski 2013). It could thus be determined whether psychedelic experiences result in lasting changes in DMN network activity or connectivity, which in turn could be related to a reduced focus on self-focused processing.

This cross-sectional survey study showed that classic serotonergic psychedelic drug experiences are positively related to feelings of connectedness and affective empathetic drive, and through these mechanisms may be negatively associated with maladaptive narcissism. Furthermore, while the narcissism scale employed in the current study, the Narcissistic Personality Inventory

(Gentile et al. 2013; Raskin and Terry 1988), is a measure of a personality trait rather than a clinical measure of mental illness, together with previous research, this study adds to the evidence that use of classic serotonergic psychedelic drugs may be associated with substantial, enduring and often positive effects on wide-ranging aspects of both mental health and personality.

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Broadening Your Mind to Include Others: The relationship between serotonergic psychedelic experiences and maladaptive narcissism

Online Resource: Supplementary Materials

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Figure ESM.1

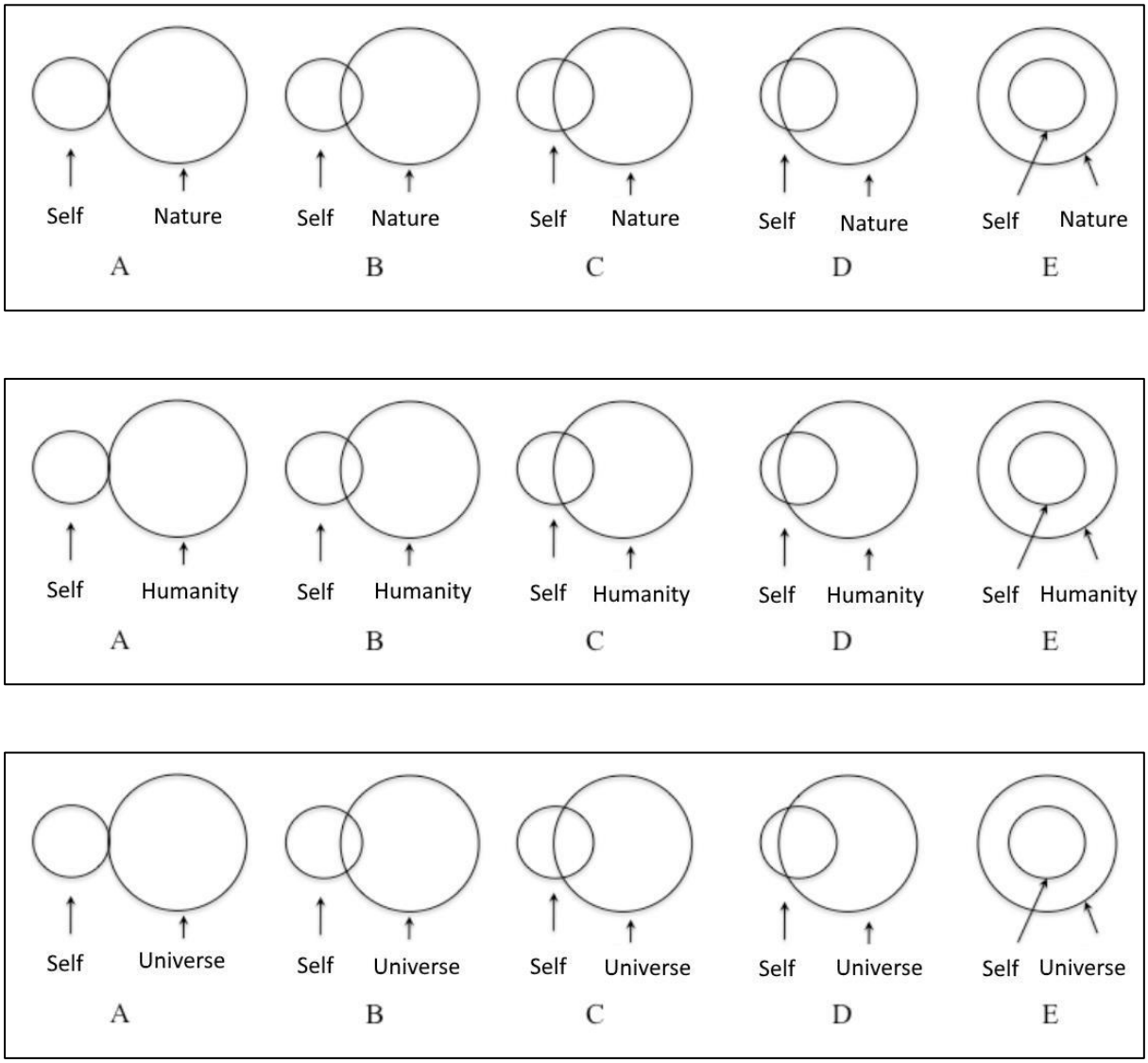

Figure ESM.1: Connectedness measures adapted from the Inclusion of Other in the Self Scale (IOSS; Aron et al. 1992).

Table ESM.1

NPI - LA	**β**	**95% CI**	***t***	***p***	***fit***
Cognitive ability	.21	[.10, .31]	3.73	<.001	R^2 = .041**, 95% CI = [.01, .07]
Cognitive drive	-.07	[-.18, .03]	-1.37	.17	
Affective ability	<.01	[-.10, .13]	.21	.83	
Affective drive	-.11	[-.21, <-.01]	-2.01	.04	
NPI - GE	**β**	**95% CI**	***t***	***p***	***fit***
Cognitive ability	-.06	[-.16, .05]	-1.02	.31	R^2 = .041**, 95% CI = [.01, .07]
Cognitive drive	-.03	[-.13, .08]	-.46	.65	
Affective ability	.26	[.15, .38]	4.46	<.001	
Affective drive	-.11	[-.22, <-.01]	-2.13	.04	

Table ESM.1: Linear regressions predicting NPI LA (Leadership-Authority) and NPI GE (Grandiose-Exhibitionist) from ECQ cognitive ability & drive and empathetic ability & drive.

Table ESM.2

	NPI *total*	**NPI LA**	**NPI GE**	**NPI EE**
IOSS Connectedness (Nature)	-.01 [-.11, .08]	-.02 [-.12, .07]	.08 [-.02, .18]	-.15** [-.24, -.05]
IOSS Connectedness (Humanity)	-.06 [-.16, .03]	-.05 [-.15, .04]	.04 [-.06, .13]	-.17** [-.26, -.08]
IOSS Connectedness (Universe)	.01 [-.08, .11]	-.01 [-.10, .09]	.05 [-.05, .15]	-.05 [-.14, .05]

Table ESM.2: Correlations between NPI total and NPI subscales and connectedness measures.

Table ESM.3

	Awe experience	Ego dissolution
Psilocybin (n=179)	1.00 (.77)	0.50 (.86)
LSD (n=129)	1.09 (.73)	0.69 (.71)
DMT (n=32)	1.24 (.60)	0.67 (.87)
Ayahuasca (n=21)	1.11 (.78)	0.41 (.88)
Non-CSP combination (n=13)	1.14 (.64)	0.68 (.78)
CSP combination (n=12)	1.36 (.73)	0.85 (.78)
Mescaline/5-MEO-DMT (n=7)	1.36 (.41)	0.68 (.72)

Table ESM.4: Differences in average awe experience and ego dissolution scores between the experiences of various CSPs. Awe experience scores included the connectedness and perceived vastness subscales, but not the self-diminishment subscale due to the overlap with the ego dissolution inventory. Non-CSP combination indicates a combination of a CSP drug with one or more non-CSP drugs; CSP combination indicates a combination of various CSP drugs only. Means (standard deviations) reported, scores range from -2 to 2.

Table ESM.4

		Estimate	SE	95% CI	z-value	*p*-value
Y ~						
M1	(b1)	-0.13	0.06	[-0.24, -0.02]	-2.26	**.02**
M2	(b2)	-0.21	0.05	[-0.30, -0.12]	-4.59	**<.001**
X1	(c1)	0.09	0.06	[-0.02, 0.21]	1.53	.13
X2	(c2)	-0.10	0.05	[-0.20, <.01]	-1.87	.06
C	(c3)	0.10	0.05	[<0.01, 0.19]	2.08	**.04**
M1 ~						
X1	(a1)	0.24	0.06	[0.12, 0.35]	3.96	**<.001**
X2	(a2)	0.09	0.06	[-0.02, 0.20]	1.62	.11
C	(a5)	-0.09	0.05	[-0.18, <0.01]	-1.99	**.05**
M2 ~						
X1	(a3)	0.21	0.07	[0.08, 0.33]	3.22	**.001**
X2	(a4)	0.04	0.06	[-0.08, 0.16]	0.59	.56
C	(a6)	-0.02	0.05	[-0.11, 0.08]	-0.31	.76
indirect1		-0.03	0.02	[-0.07, -0.01]	-1.95	.052
indirect2		-0.04	0.02	[-0.08, -0.02]	-2.57	**.01**
indirect3		-0.01	0.01	[-0.04, <.01]	-1.30	.19
indirect4		-0.01	0.01	[-0.04, 0.02]	-0.57	.57
total1		0.02	0.06	[-0.10, 0.14]	0.33	.74
total2		-0.11	0.05	[-0.22, -0.01]	-2.16	**.03**
total3		0.11	0.05	[0.02, 0.20]	2.36	**.02**

Table ESM.5: Multiple mediation analysis, predicting exploitative-entitled narcissism (Y) by the experience of awe (connectedness and perceived vastness; X1) and of ego-dissolution (X2), mediated by current feelings of connectedness (M1) and affective empathetic drive (M2), taking into account covariate sensation-seeking (C). Indirect pathways are: indirect1= [X1 → M1 → Y]; indirect2 = [X1 → M2 → Y]; indirect3 = [X2 → M1 → Y]; indirect4 = [X2 → M2 → Y]. Total pathways

are: total1 = [(X1 →Y) + (X1 →M1 →Y) + (X1 →M2 →Y)]; total2 = [(X2 →Y) + (X2 →M1 →Y) + (X2 →M2 →Y)]; total3 = [(C → Y) + (C → M1 → Y) + (C → M2 → Y)]. Bootstrap draws=5000; p-values below threshold of .05 in bold.

Table ESM.5

Rarely	Monthly	Fortnightly	Weekly	Several times a week	Daily
248 (59.9%)	102 (24.6%)	18 (4.3%)	26 (6.3%)	14 (3.4%)	1 (0.2%)

Table ESM.5 A: Frequency of CSP use averaged over the past five years

Very low dose	Low dose	Medium dose	High dose	Very high dose
19 (4.6%)	44 (10.6%)	211 (51.0%)	119 (28.7%)	16 (3.9%)

Table ESM.5 B: Typical dose of CSP over the past five years

Table ESM.6

IOSS Connectedness	**β**	**95% CI**	***t***	***p***	***fit***
AWE-S Self-diminishment	.03	[-.07, .13]	.62	.53	R^2 = .085**, 95% CI = [.04,.13]
AWE-S Connectedness	.24	[.13, .35]	4.24	<.001	
AWE-S Perceived vastness	.07	[-.05, .18]	1.17	.24	
Affective empathetic drive	**β**	**95% CI**	***t***	***p***	***fit***
AWE-S Self-diminishment	<.01	[-.10, .10]	.05	.96	R^2 = .041**, 95% CI = [.01, .07]
AWE-S Connectedness	.28	[.17, .39]	4.90	<.001	
AWE-S Perceived vastness	-.02	[-.13, .09]	-.39	.70	

Table ESM.6: Linear regressions predicting connectedness and affective empathetic drive by AWE-S subscales.