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Title: Belief changes associated with psychedelic use

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Abstract

BACKGROUND: Psychedelic use is anecdotally associated with belief changes, although few studies have tested these claims.

AIM: Characterize a broad range of psychedelic occasioned belief changes.

SURVEY: A survey was conducted in 2,374 respondents who endorsed having had a belief changing psychedelic experience. Participants rated their agreement with belief statements before and after the psychedelic experience as well as at the time of survey administration.

RESULTS: Factor analysis of 45 belief statements revealed five factors: “Dualism”, “Paranormal/Spirituality”, “Non-mammal consciousness”, “Mammal consciousness”, and “Superstition”. Medium to large effect sizes from before to after the experience were observed for increases in beliefs in “Dualism” ($\beta=0.72$), “Paranormal/Spirituality” ($\beta=0.90$), “Non-mammal consciousness” ($\beta=0.72$), and “Mammal consciousness” ($\beta=0.74$). In contrast, negligible changes were observed for “Superstition” ($\beta=-.18$). At the individual item level, increases in non-physicalist beliefs included belief in reincarnation, communication with the dead, existence of consciousness after death, telepathy, and consciousness of inanimate natural objects (e.g. rocks). The percentage of participants who identified as a “Believer (e.g. in Ultimate Reality, Higher Power, and/or God, etc.)” increased from 29% before to 59% after.” At both the factor and individual item level, higher ratings of mystical experience were associated with greater changes in beliefs. Belief changes assessed after the experience (an average 8.4 years) remained largely unchanged at the time of survey.

CONCLUSIONS: A single psychedelic experience increased a range of non-physicalist beliefs as well as beliefs about consciousness, meaning, and purpose. Further, the magnitude of belief change is associated with qualitative features of the experience.

Keywords: Psychedelics, beliefs, 5-HT_{2A} receptor agonist

Belief Changes Associated with Psychedelic Use

Introduction

Psychedelic substance use has been often associated with religious, spiritual, animist or other “non-physicalist” forms of belief, defined here as claims that parts of reality and/or consciousness are not reducible to matter. Such beliefs, which are not unique to psychedelic use and exist the world over, varying tremendously from folk-psychological notions of mind-body dualism (Bloom, 2007; Kelemen et al., 2021; Weisman et al., 2021), to divination (Hong and Henrich, 2021), to conceptions of unseen agentic forces, such as spirits, deities, and the evil eye (Murdock, 1980; Singh, 2018, 2021; White et al., 2021).

Peoples in diverse cultures have often interpreted psychedelic experiences in non-physicalist frameworks. Through insufflation of DMT, Yanomamö shamans of Brazil and Venezuela believed they gain the ability to battle and manipulate illness-causing spirits (Chagnon et al., 1973). Similarly, the Shuar, indigenous people from Ecuador and Peru, use ayahuasca to speak to ancestor spirits to obtain information about the future (Karsten, 1935). In the United States, early psychedelic research was highly associated with religious/spiritual forms of meaning-making (Hartogsohn, 2020). In contemporary contexts, psychedelic use is often anecdotally associated with beliefs and practices derived from indigenous cultures holding non-physicalist world views.

Consistent with these observations, converging lines of research suggest that psychedelic use is associated with experiences of spirituality and non-physicalist belief change. Prospective studies demonstrate that psilocybin induces acute mystical-type experiences as well as enduring increases on a spirituality scale that assessed a broad sense of meaning and connectedness to humanity, life, and the God of their understanding/ultimate reality (Davis et al., 2021; Griffiths et al., 2011, 2016). A prospective randomized study of psilocybin in beginning

meditators showed similar effects at four months after administration including significant increases in a participant-rated death transcendence scale and observer-rated spiritual/religious sentiments for months after sessions, again defined broadly to reflect beliefs and feelings of connectedness, universality, and closeness to the god of their understanding (Griffiths et al., 2018). Likewise, cross-sectional studies have reported increases in broadly defined spiritual-type beliefs after psychedelic use (Davis et al., 2020; Griffiths et al., 2019; Yaden, Le Nguyen, et al., 2017).

Despite growing research interest, few studies have examined the types of beliefs that are changed by psychedelic use. A recent prospective survey and separate randomized trial showed that belief changes after psychedelic use increased a range of metaphysical beliefs that formed a single factor termed “non-physicalist beliefs” (Timmermann et al., 2021). They found increased beliefs in: panpsychism (the belief that mind is inherent in all things), the existence of other realms of existence, dualism (the belief that reality is separable into physical and mental components), and idealism (the belief that the world is generated by the mind), and decreased belief in materialism (the belief that reality is only composed of matter). However, the 13-items in the non-physicalist beliefs factor are single-item philosophical propositions that do not include specific non-physicalist beliefs anecdotally associated with psychedelic use, such as the existence of disembodied spirits or telepathy (Harner, 1973; Shanon, 2002).

To address this gap and to explore a wider range of belief changes, an online retrospective self-report survey was conducted among individuals who reported belief change following a single psychedelic experience. The survey included 45 belief change statements encompassing a broad range of non-physicalist beliefs as well as beliefs about meaning, purpose, and consciousness. Analysis of individual items and mean factor scores (after

dimensionality reduction) showed robust increases after the psychedelic experience in beliefs about mind-body dualism, paranormal/spiritual phenomena, and consciousness.

Methods

Procedure

In this study, an online survey was conducted among individuals who endorsed having a belief-changing psychedelic experience, were at least 18 years of age, and were able to read, write, and speak fluent English. Participants answered questions based on a single experience with one of several classic psychedelic substances (e.g. psilocybin mushrooms, LSD, ayahuasca).

Participant recruitment

Subjects were recruited by word of mouth, email invitations, newsletters, and posts on Twitter, Facebook, and banner advertisements on Erowid.com (a website frequented by psychedelic users). Participants were invited to complete an anonymous internet survey of individuals who reported taking a psychedelic substance that resulted in changes in their beliefs. The belief changes were intentionally described vaguely. Specifically, participants were invited to take the survey if “You have had changes in your beliefs that you attribute to a psychedelic experience.”. Participants were informed that their participation was anonymous and that they could leave the survey at any time. On the survey landing page, subjects were provided with information about the study and a consent document. The Institutional Review Board of the Johns Hopkins University School of Medicine approved all study procedures (IRB00256742).

Survey administration

The survey was designed to take roughly 50 minutes and to be completed in one sitting. The survey was hosted on Qualtrics.com, a widely used website with suitable security and privacy features for research. There was no compensation.

The survey included questions about demographics, psychedelic use, personality, and scientific knowledge and attitudes. Most of the survey questions focused on belief changes associated with a single psychedelic experience. Results from an analysis of the belief statements about the attribution of consciousness to other entities from the initial 1,606 participants who provided completed data have been reported elsewhere (Nayak and Griffiths, 2022)

Details of the belief-changing psychedelic experience

Similar to prior surveys (Davis et al., 2020; Griffiths et al., 2019), participants were asked to answer questions about belief changes based on a single reference psychedelic experience. In this case, participants were asked to answer questions based on the psychedelic experience “that you feel led to the greatest belief change.” Participants were asked about which psychedelic they took (psilocybin mushrooms, LSD (Acid), ayahuasca, N,N-DMT (other than ayahuasca), 5-MeO-DMT, mescaline-containing cacti, or other), an estimated dose, whether and what other psychoactive drugs were taken, their age at the time of the experience, when this took place relative to the time of survey administration, and whether it was their first psychedelic experience.

Beliefs

Participants rated their agreement with 45 belief statements at three time points relative to the reference psychedelic experience: “Before (e.g. a month),” “After (e.g. a month),” and “Now”. These response options were presented on a 7-point scale ranging from Strongly disagree (-3) to Strongly agree (+3). See Table 1 for verbatim wording of these 45 belief statements.

All 12 items of the Reflective Dualism subscale of the Mind-body Relationship Scale, which is believed to assess mind-body dualism were included (Riecki et al., 2013). One verbatim and three modified belief statements were from the 13-item Metaphysical Beliefs

Questionnaire (Timmermann et al., 2021). Six verbatim and five modified belief statements were from the 26-item Revised Paranormal Belief Scale (Tobacyk, 2004). One verbatim belief statement was from the 5-item Determinism subscale of the the Free Will Inventory (Nadelhoffer et al., 2014). The remaining 17 items were created for the purpose of this study. These items focused on beliefs about the existence of: hidden meaning and purpose in the world, continuance of consciousness after death, consciousness of the universe, free will, the capacity for some people to influence physical events through non-physical processes, and nine items about the capacity of various living and non-living entities to have conscious experience. These nine items were presented in what was assumed to represent a descending likelihood of attribution of conscious experience: self, other human beings, non-human primates, quadrupeds, insects, fungi, plants, and inanimate objects.

Two additional questions about beliefs did not use the 7-point response option scale. One question asked participants “How would you characterize your overall spiritual or religious belief systems,” providing three response options “Non-believer (e.g. atheist),” “Agnostic,” and “Believer (e.g. in Ultimate Reality, Higher Power, and/or God etc)”. Another question asked if the participant believed “your belief-changing experience and your contemplation of that experience altered your fundamental conception of reality?” Response options were “Yes,” “No” or “Don’t know”.

Retrospective ratings of qualities of the experience at the time of the experience

Mystical-type experiences

Participants completed the 30-item Mystical Experience Questionnaire (MEQ30) (Barrett et al., 2015) according to their feelings, thoughts, and experiences during the reference psychedelic experience. “Complete mystical experience” was defined as $\geq 60\%$ of the maximum score on each of the 4 subscales, and was coded as a binary variable (Barrett et al., 2015). “Total score”

was expressed as a percentage of maximum possible score. This score was included to examine the effect of MEQ on belief change (see regression models below).

Psychologically challenging experiences

As in previous survey and laboratory studies with psychedelics (Davis et al., 2020; Griffiths et al., 2019) participants rated “How psychologically challenging were the most psychologically challenging portions of the experience?” on an 8-point scale from 1=*No more than routine, everyday experiences* to 8=*The single most difficult or challenging experience of my life*. This measure was used as a covariate for examining the specificity of the effects of MEQ (see Statistical analysis section).

Statistical Analysis

Factor analysis

Of the 2,374 participants who provided useable data, 500 were set aside for confirmatory factor analysis (CFA) following exploratory factor analysis (EFA). EFA was performed on agreement ratings of belief statements on a 7-point scale at all three timepoints. Polychoric factor analysis (given the use of ordinal variables) with an oblique rotation (promax) was used, as it was anticipated that the factors would correlate with one another.

Three criteria were used to determine the appropriate number of factors to extract: examination of scree plot, Kaiser criterion, and parallel analysis. Factor loading cutoffs of 0.4 were used as the criterion for inclusion in a factor. EFA was performed for all three timepoints. In each case, maximum number of stable and reliable factors was extracted using standard reliability metrics (Cronbach’s alpha). Items that reliably loaded onto one or more factors at all three timepoints were retained. Cronbach’s alphas were then computed for each factor at each timepoint. Using the factor structure obtained from EFA, CFA was then performed on the 500

participants that had been set aside in order to test model fit on a separate sample.

Comparative fit index (CFI) and Root Mean Square Error of Approximation (RMSEA) were used to assess fit. Mean factor ratings for each factor (with items that negatively loaded onto the factor reverse-scored) were computed.

Analysis of factor scores

Regression analyses examined differences in belief change across time as well as the effects of MEQ and whether the experience was the first psychedelic experience. For each of the three factors, a linear mixed model using the sum of belief scores (reverse-scored items were inverted prior to summing) for individual subjects (standardized to have mean 0 and SD 1) as the outcome variable was performed with 2 independent variables as variables of interest: MEQ and whether the psychedelic experience was their first. Both included interactions by time. The following independent variables were included as controls: age at time of experience, psychological challenge, sex, and race (a binary variable consisting of non-white and white). Random intercepts for subject were included to account for repeated measures. Effect sizes for timepoint and MEQ are reported as standardized β and interpretable similar to a “covariate-adjusted Cohen’s d.” Items that loaded onto more than one factor, and items that changed factor loadings between timepoints were dropped. Cronbach’s alpha were computed for each factor at each timepoint.

To examine possible effects of country, similar regression models were performed for each factor including a country \times time interaction (restricted to those countries with at least 20 subjects). Significance was assessed with Type II Wald chi-square tests using the Anova function from the R package car (Fox and Weisberg, 2019).

Analysis of individual belief statements

Linear mixed models (identical to the regression analyses described above for factor scores) were performed for all 45 individual belief statements with agreement ratings as the outcome variable in order to test for effects of time and MEQ after adjusting for the four previously described control variables.

For ease of interpretation, agreement with individual belief statements is expressed as the percentage of participants rating any agreement with the belief statement (i.e. Slightly agree (+1) to Strongly agree (+3)) at each time point (Table 1). Because large sample sizes can detect statistically significant differences at trivially small effect magnitudes when computing p-values against point-null hypotheses, comparisons between time-points were conservatively designated as meaningfully different in the present analysis if they were statistically significantly different ($p < 1 \cdot 10^{-5}$ for differences from Before to After in the above regression) and differed by at least 10%. This p-value is equivalent to Bonferroni correction of 1000 tests (far less than were performed), and sets an arbitrarily high significance threshold to minimize false positives in this large sample.

A similar linear regression analysis was performed for the question about characterization of overall spiritual or religious belief system to investigate the effect of MEQ on this. The response options of Atheist, Agnostic, and Believer were coded -1, 0, and 1, respectively and used as the dependent variable.

A similar logistic regression was performed on the dichotomized response to the statement about whether the “experience altered your fundamental conception of reality” to investigate its relationship with MEQ. This question was only assessed at one time point, so time was not included in the model.

Results

Survey completion

Respondents were recruited from August 2020 to July 2021. In total, 16,054 participants arrived at the survey landing page, 7,336 indicated that they would like to participate, and 3,487 completed the survey. After excluding participants based on the criteria described below, a total of 2,374 participants were available for analysis.

A total of 660 were ineligible and did not proceed with the survey because they indicated that (a) they did not read, write, and speak English fluently ($n = 263$) or (b) they had not had a belief changing psychedelic experience ($n = 397$).

Respondents who completed the survey were excluded from analyses because they (a) requested their data be discarded ($n = 24$); (b) failed one or both attention checks ($n = 55$); (c) indicated taking a psychedelic other than psilocybin (including mushrooms), LSD, ayahuasca, DMT (other than ayahuasca), 5-MeO-DMT, or mescaline (including peyote and San Pedro cacti) ($n = 121$); (d) indicated use of another psychoactive drug with the psychedelic (excepting caffeine and nicotine) ($n = 902$); (e) indicated their age at the time of the experience was below 10 ($n = 2$); (f) indicated an age at time of experience less than their reported age of their first experience ($n = 9$).

Respondent characteristics

The final participant population ($N=2,374$) had a mean (SD) age of 35.1 (14.0) years at the time of the survey and were 67% male. Almost half of the sample (43%) indicated that the reference belief-changing psychedelic experience was their first psychedelic experience. The reference experience occurred a mean (SD) of 8.4 (12.9) years before the survey. A sizable minority of participants (25%) indicated that their reference experience occurred in the past year. See Table S1 for detailed participant characteristics. Nearly half (48.7%) of participants met a priori criteria for a complete mystical experience.

Factor analysis

Exploratory factor analysis

Bartlett's Test of Sphericity was performed and indicated that factor analysis was warranted. At all three timepoints, examination of screeplot, Kaiser criterion and parallel analysis each suggested 5 factors. For all three timepoints, testing a 6-factor solution led to a sixth error factor which only contained 2 items. Thus, five factors were chosen to represent the data. Eight belief statements were removed because they did not consistently load onto any factor at all three timepoints. One belief statement met criteria for loading on to two factors (see Table 1).

These factors were internally consistent, and the minimum Cronbach's alpha for all factors across all three timepoints was 0.80. The factors appeared to have construct validity and were termed 1) Dualism, 2) Paranormal/Spirituality, 3) Mammal consciousness, 4) Non-mammal consciousness, and 5) Superstition. Factor loadings are shown in Table 2. The Dualism (Factor 1) factor was comprised of 12 belief statements reflecting classic dualism which holds that the mind and the body are separate. The Paranormal/Spirituality was comprised of 14 belief statements which included belief in paranormal phenomena (predicting future events, telepathy, telekinesis, people who can influence physical events through non-physical processes, the mind leaving the body, the existence of non-physical conscious entities, communication with someone who has died, reincarnation, continuity of consciousness after death, consciousness of the universe, hidden or deeper meaning to everyday events, and hidden or deeper purpose to life. The Mammal consciousness (Factor 3) factor comprised 4 items concerning the capacity of conscious experience in oneself, other humans, primates and quadrupeds. The Non-mammal consciousness (Factor 4) factor comprised 5 items concerning the capacity of conscious experience of plants, fungi, insects and inanimate objects. The Superstition factor (Factor 5)

was comprised of the three belief statements about black cats, breaking mirrors and the number 13 bringing bad luck.

One item, “The consciousness of myself does not die with my physical body,” consistently loaded onto both Dualism (Factor 1) and Paranormal/Spirituality (Factor 2).

Confirmatory factor analysis

CFA revealed adequate fit indices at all three timepoints: Before (CFI: 0.904; RMSEA 0.068 [90% CI 0.064, 0.071]), After (CFI: 0.887; RMSEA 0.067 [90% CI 0.064, 0.072]), and Now (CFI: 0.900; RMSEA 0.066 [90% CI 0.062, 0.070]).

Total item scores from the first two factors were highly correlated with each other ($r = 0.82$).

Changes in beliefs reflected in mean factor scores

Mean factor scores for each factor at each timepoint are shown in Table 3 and Figure 1. Multiple regression models showed large, positive effect sizes from timepoints Before to After for Dualism, Paranormal/Spirituality, Mammal consciousness, and Non-mammal consciousness, but with minimal change for Superstition. The effect of MEQ showed small positive effect sizes from Before to After in change in Dualism, Paranormal/Spirituality, Mammal consciousness, and Non-mammal consciousness, but not Superstition. None of the differences from After to Now met criteria for being meaningfully different. Effect sizes for timepoints Before to Now are omitted as they are substantially similar to those for Before to After. First experience had minimal and statistically insignificant effects across all three factors, with the largest effect of this being $\beta = -0.15$.

There were 65 unique countries represented in this dataset, although only 6 had at least 20 participants (USA, Canada, UK, Australia, Germany, and Sweden). These 6 countries

represented 86% of the sample. Within this, there were no significant effects of country on Dualism ($p = 0.96$), Paranormal/Spirituality ($p = 0.04$), Mammal consciousness ($p = 0.15$), Non-mammal consciousness ($p = 0.85$), or Superstition ($p = 0.75$).

Changes in agreement with individual belief statements

Table 1 shows the percentage of participants endorsing any agreement with each belief statement at each of the three timepoints. The percentage of participants endorsing agreement showed meaningful changes from the timepoint “Before (e.g. a month)” to “After (e.g. a month)” for all but 4 of 34 belief statements loading onto the Dualism, Paranormal/Spirituality, Mammal consciousness, and Non-mammal consciousness factors. Furthermore, regression analysis of agreement ratings expressed as continuous variables showed that higher scores on the Mystical Experience Questionnaire (MEQ) were associated with greater increases in beliefs for all the items in Table 1 that showed meaningful changes from timepoints Before to After (not shown).

In contrast to the changes on statements from the four factors described above, the three belief statements in the Superstition factor did not meaningfully change. Of the eight belief statements that did not consistently load onto a factor, changes from Before to After: meaningfully increased for three statements (philosophical idealism, panpsychism, and determinism); meaningfully decreased for two statements (belief in scientific method and philosophical materialism); and showed no meaningful change for 3 statements (free will, existence of the abominable snowman, and existence of the Loch Ness monster).

Table 1 also shows that, in contrast to the significant changes in belief endorsement from Before to After, the differences from “After” to “Now” (i.e. at the time of the survey) did not meet criteria for being meaningful different for any items.

Changed fundamental conception of reality

Not shown in Table 1, 86.5% of participants endorsed “Yes” to the belief that the experience changed their fundamental conception of reality, with 7.2% and 6.2%, respectively indicating “No” change or “Don’t know”. A logistic regression showed that MEQ was positively associated with an affirmative response to this statement ($p < 1*10^{-10}$).

Belief in Ultimate Reality, Higher Power, and/or God

Identification as a “Non-believer (e.g. atheist)” changed from 35.8% Before to 13.0% after. Identification as “Agnostic” changed from 35.3% before to 28.2% after. Identification as a “Believer (e.g. in Ultimate Reality, Higher Power, and/or God, etc.)” changed from 28.8% before to 58.8% after. A regression analysis found that MEQ was positively associated with greater change towards “Believer” at both timepoints ($p < 1*10^{-10}$).

Discussion

The present study identified specific and substantial before to after changes in beliefs in individuals rating a single belief-changing psychedelic experience.

Factor analysis revealed 5 categories of belief concerning beliefs in dualism, paranormal/spirituality, attribution of conscious experience to non-mammals, attribution of conscious experience to mammals, and superstitious beliefs. Participants reported increases in all these categories except for superstitious beliefs which did not change. The changes in beliefs were apparent when controlling for various demographic variables, and the magnitudes of these changes were associated with higher ratings of mystical experience. Also, the belief change from Before to After (e.g. a month) remained unchanged as assessed at the Now timepoint which occurred an average of 8.4 years after the experience. That psychedelic occasioned belief-changes endure has been reported in prospective studies of psilocybin administration in healthy participants and in patients (Griffiths et al., 2008, 2016).

Notably, several items which did not load consistently on any factor did show meaningful changes from Before to After, including increases in philosophical idealism, panpsychism, and determinism and decreases in faith in science and materialism.

The great majority of participants (87%) reported that the experience changed their fundamental conception of reality. Furthermore, the percentage of participants who identified as a “Believer (e.g. in Ultimate Reality, Higher Power, and/or God, etc.)” increased (from 29% before to 59% after). Similar ratings about changes in conception of reality and in believer status have been reported in a survey study of entity encounter experiences after inhaled DMT (Davis et al., 2020).

The psychedelic occasioned belief changes observed in the present study are generally consistent with findings of Timmermann et al. (2021) which showed increased non-physicalist beliefs in two groups of participants in which belief ratings were assessed prospectively from before to after a psychedelic experience. In concordance with Timmermann et al. (2021), belief in determinism increased while belief in free will remained unchanged. The present study expands substantially on the kinds of non-physicalist beliefs that are altered by including a variety of beliefs that are both anecdotally associated with psychedelic use and characteristic of non-physicalist beliefs the world over.

Mechanisms of belief change

Why would psychedelics induce belief changes? According to the REBUS (RELaxed Beliefs Under pSychedelics) model of psychedelic effects, psychedelics enhance learning, partly due to a relaxation of high-level priors (Carhart-Harris and Friston, 2019). In the case of belief change, then, psychedelics may simply decrease any strongly held belief. Consistent with this view, the belief that science is the most useful tool for “understanding the nature of the universe and enduring factual truths” decreased. However, the results showed increases in a specific

direction—towards dualism, paranormal/spirituality, increased attribution of conscious experience to other entities, and away from physicalism—without any change in superstition and belief in free will. Moreover, beliefs in religious agnosticism decreased, indicating that belief changes may not simply result from greater uncertainty of deeply held beliefs.

Thus, the REBUS model alone cannot explain the directional change observed both here and by Timmermann et al. (2021). At least three other factors may contribute to the directionality of belief change: 1) cultural context and expectancy; 2) unmasking of underlying cognitive biases; 3) experiential learning through compelling subjective experiences of non-physicalism.

Context and expectancy

The relaxation of high-level priors assumed under REBUS could allow contextual factors, such as cultural context or other expectancies, to move beliefs in one direction or another. From this perspective, the consistent direction of belief change apparent here and in Timmermann et al. (2021) may be explained by context or expectancy (i.e., “set and setting”). This view predicts that manipulating context, such as by priming ideas of materialism, should induce belief change in the opposite direction, which should be an interesting direction for future research. This view is consistent with conclusions in a recent review suggesting that psychedelic associated belief changes are importantly determined by “experimenter suggestion” (i.e., context) (McGovern et al., 2022).

McGovern et al. further suggest that “induce belief change primarily if they are only weakly held, and hence already amenable to change.” We did not test this, though this is an area for future study.

Anecdotal and empirical observations provide some support for the role of context and expectancy in influencing belief change. In the United States, psychedelic experiences are often

associated with religious/spiritual traditions (Hartogsohn, 2020). This shared interpretive framework could affect belief change, producing the patterns documented here. Among professors of philosophy, who subscribe less to such spiritual frameworks, there was no association between psychedelic use and non-physicalist beliefs, suggesting that prior beliefs may impact psychedelic-induced belief change (Yaden and Anderson, 2021).

The importance of context and expectancy in guiding belief change has important therapeutic implications, especially for mitigating undesirable belief changes. Benny Shanon describes an ayahuasca experience which, “for a while, made me believe in some sort of paranormal information transfer.” He describes subsequently logically reasoning through the experience and arriving at the conclusion that no paranormal event occurred (Shanon, 2002: 257). Thus, it is plausible that culturally undesirable belief changes with psychedelics can be managed in a structured clinical context, either through manipulating expectancy by preparation and setting or by structuring how individuals interpret the experience afterwards with support from a therapist. However, there remain a variety of ethical and cultural considerations concerning these unique belief-changing agents (Letheby, 2021).

Despite indications of the importance of context and expectancy, several observations suggest that cultural context alone does not explain the changes observed here and by Timmermann et al. (2021). First, the present study did not show any differences between countries. Although the analysis was limited to 6 Western countries, and similarities across countries might be explained by shared expectations in an interconnected, global psychedelic community, the findings nevertheless demonstrate that similar kinds of belief changes occurred across cultural contexts. Second, there are impressive similarities in the types of non-physicalist beliefs in many cultures around the world and those seemingly engendered by psychedelics. These include beliefs in mind-body dualism (Chudek et al., 2018; Weisman et al., 2021), the existence of spirits and deities (Luhmann et al., 2021), and beliefs in afterlife (Thalbourne,

1996). These similarities suggest that mechanisms aside from cultural context or expectancy contribute to the observed belief change.

Unmasking innate cognitive biases

Another mechanism that might account for the direction of psychedelic occasioned belief change is the unmasking of underlying innate cognitive biases. The relaxed high-level priors assumed under the REBUS model may allow for low-level priors (i.e. innate cognitive biases) to exert greater influence. Research in the cognitive science of religion suggests that three sets of cognitive predispositions—those towards mentalizing, dualism, and teleological thinking—may contribute to non-physicalist beliefs (White et al., 2021; Willard et al., 2020; Willard and Norenzayan, 2013). All may be relevant to understanding the possible effects of psychedelics on belief change.

“Mentalizing” is the capacity to perceive intentions, emotions, agency, and other features of other minds (Baron-Cohen and Wheelwright, 2004; Hoekstra et al., 2011). According to various hypotheses, mentalizing contributes to non-physicalist belief because people detect features of minds, especially intentions and agency, in otherwise inanimate objects (e.g. rocks) and naturally occurring phenomena (e.g. weather). Consistent with these hypotheses, predispositions to mentalize predict a range of non-physicalist beliefs, including paranormal beliefs, religiosity, and beliefs in God and karma, across different cultural samples (White et al., 2021; Willard et al., 2020; Willard and Norenzayan, 2013; Yaden, Haidt, et al., 2017). Mentalizing is also associated with mystical experience in a sample of meditators (Coleman et al., 2017). Psychedelics do acutely enhance emotional empathy, a facet of mentalizing (Preller and Vollenweider, 2019), though it is unclear the extent to which this relates to subsequent belief change.

Tendencies towards dualism and teleological thinking are associated with mentalizing and may also contribute to non-physicalist belief. Dualism, which arises cross-culturally at a young age, appears to be a feature of human minds whereby information about the mental and the physical are intuitively experienced as separate (Chudek et al., 2018; Weisman et al., 2021). Dualism is associated with belief in God, karma, paranormal beliefs, and afterlife beliefs (Riecki et al., 2013; White et al., 2021; Willard et al., 2020; Willard and Norenzayan, 2013). Tendencies toward teleological thinking seem similarly intuitive and are associated with beliefs in the paranormal, God, and karma as well as mentalizing (Banerjee and Bloom, 2014; White et al., 2021). Thus, as learned priors may be weakened during psychedelic use, the cognitive biases underlying mentalizing, dualism, and teleological thinking could be unmasked, thus producing the directional belief change documented in this study.

Experiential learning

Another possibility is that psychedelics change beliefs by producing unusually compelling experiences. Importantly, a common feature of psychedelic experiences is a “noetic” quality that the experience is often felt to be authoritatively true (e.g. “more real than real”) (Barrett et al., 2015; Yaden, Haidt, et al., 2017). Thus, commonly reported psychedelic experiences of deep or hidden meaning, the living presence of all things, telepathic communication, entity and spirit encounter, leaving one’s body, and death and rebirth (Davis et al., 2020; Griffiths et al., 2019) may result in fundamental changes in the conception of reality and enduring increases in beliefs toward dualism, spirituality, and paranormal phenomena.

Although regression analysis did not show an effect of first experience in this sample, it is noteworthy that 43% reported on their first experience as their most belief-changing psychedelic experience. In a sample with 22 mean lifetime uses and 10 median lifetime uses,

first experiences are very over-represented. This suggests first experiences may be particularly likely to lead to belief change.

Limitations

There are several limitations to this study. First, this was an online convenience sample, which may not be representative of the wider population of psychedelic users. Second, a majority (69%) of the sample was from the United States. Third, the survey was cross-sectional, relying on retrospective self-report.

Another limitation was that the study was advertised as a “psychedelic belief change survey”. It is possible that the current cultural connotations associated with “belief change” is in a religious/spiritual (i.e., non-physicalist) direction, biasing these results. While we intended to recruit participants who changed their beliefs in any direction, those who adopted beliefs of a non-physical kind may have self-selected into the sample at higher rates.

A final limitation of this study is the use of some ad hoc and unvalidated measures (chiefly in the Paranormal/Spirituality factor), although this was mitigated by in-sample validation and criterion validity. Ultimately, a prospective study in diverse samples assessing a broad range of beliefs is an important future line of research.

Conclusion

This study suggests that a single psychedelic experience increased a wider range of non-physicalist beliefs than has been previously shown as well as beliefs about consciousness, meaning, and purpose. Further, the magnitude of belief change was associated with particular subjective features of the experience. Future research is needed to investigate the roles of brain circuitry, context, innate dispositions, and experiential mechanisms underlying such belief changes.

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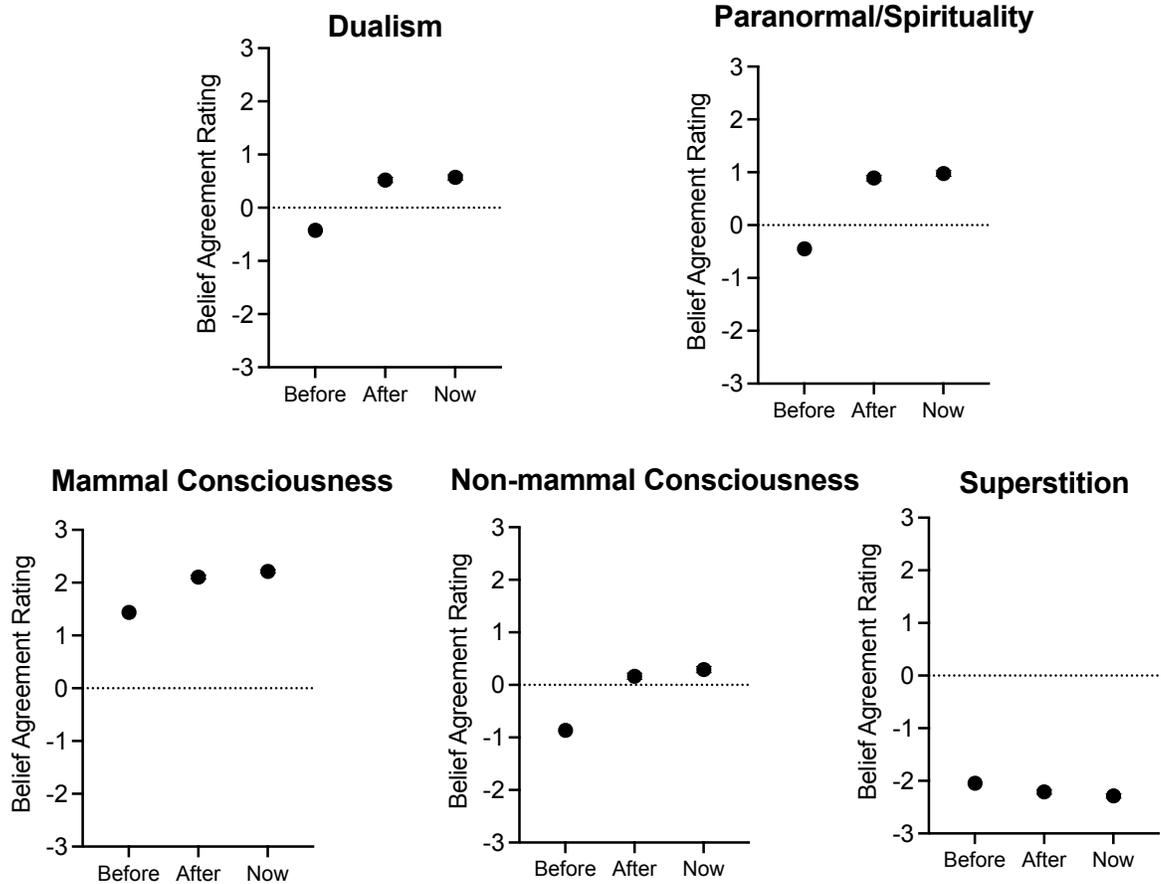


Figure 1. Agreement ratings with beliefs on Dualism, Paranormal/Spirituality, Mammal Consciousness, and Non-mammal Consciousness factors increase from before to after the psychedelic experience in contrast to beliefs on the Superstition factor which did not. Y-Axes: mean factor belief agreement ratings (range of possible scores was -3=Strongly disagree to +3=Strongly agree, with 0=Neither agree nor disagree. X-Axes: rating timepoint Before the experience (e.g. a month), After the experience (e.g. a month), and Now (at the time of the survey). Data points show means with 95% CI (brackets) (N = 2374) for ratings for each of the three belief factors at all three timepoints.

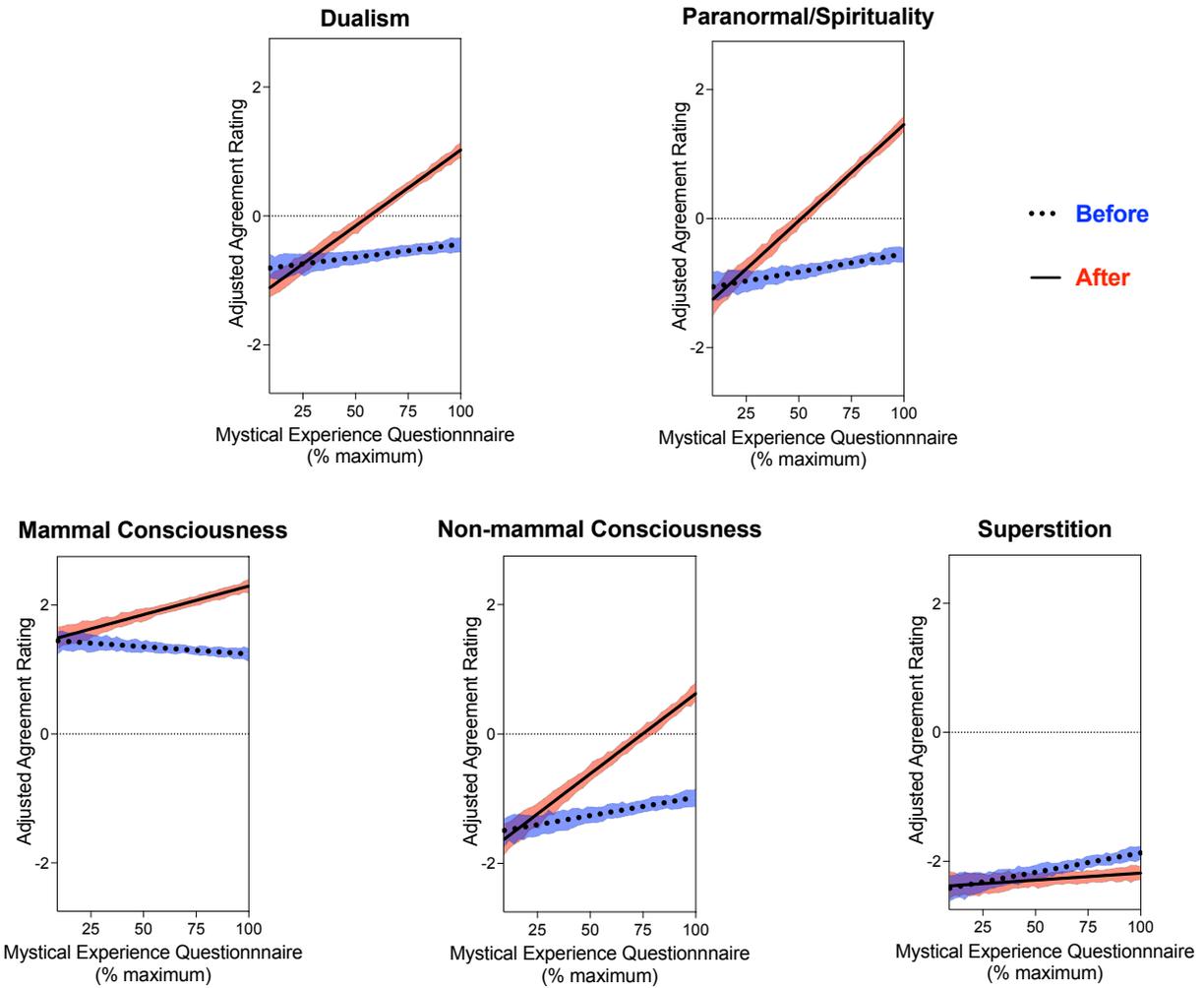


Figure 2. Higher Mystical Experience Questionnaire ratings are associated with greater increases in agreement with beliefs on Dualism, Paranormal/Spirituality, Mammal Consciousness, and Non-mammal Consciousness from before to after the psychedelic experience in contrast to beliefs on the Superstition factor which did not. Y-Axes: Adjusted mean factor belief agreement ratings (range of possible scores was -3=Strongly disagree to +3=Strongly agree, with 0=Neither agree nor disagree. X-Axes: Mystical Experience Questionnaire (MEQ) rating; actual scores ranged from 9 to 100. Regression lines show agreement ratings as a function of MEQ scores at timepoints Before (e.g. a month) and After (e.g. a month) the belief-changing psychedelic experience. Shading around the regression lines represents bootstrapped 95% CI of the adjusted mean score. These are calculated from linear

mixed-effects models. The analysis controlled for: age at time of experience, psychological challenge, sex, and race (a binary variable consisting of non-white and white), and whether the psychedelic experience was their first such experience.

Table 1. Percentage of participants endorsing agreement in each belief statement, organized by dominant factor loading (N=2374) ¹

Factor Names and Belief Statement ²	Percentage Agreeing		
	Before	After	Now
<u>Dualism</u>			
The mind is not part of the brain, but it affects the brain. ^D	20%	49%*	52%
The body is material and the mind is immaterial. ^D	36%	60%*	61%
Some mental processes have no connection to brain processes. ^D	19%	43%*	45%
The mind and the brain are totally different things. ^D	24%	50%*	52%
The mind as a whole is made up of substance and material processes. ^D	44%	33%*	33%
Thought processes cannot be just brain processes. ^D	28%	58%*	60%
The body belongs to the world of material and natural laws. The mind is a different kind of existence, a spiritual way of being. ^D	33%	66%*	67%
The mind is a special form of energy, currently unknown to humanity, that is in contact with the brain and affects it. ^D	23%	59%*	61%
The mind is immaterial and it works with the brain to generate our behavior. ^D	28%	51%*	53%
Minds are in principle independent of bodies, to which they are only temporarily attached. ^D	25%	56%*	57%
Mental states are activities of my nervous system. ^D	60%	53%	55%
The consciousness of myself does not die with my physical body. ^{D, f}	33%	62%	63%
<u>Paranormal/Spirituality</u>			
It is possible for some people to predict future events. ^{P, †}	30%	50%*	53%
Non-physical conscious entities (e.g. souls, angels, spirits) exist. ^O	39%	68%*	69%

Communication between minds (telepathy) is possible. ^{P,†}	30%	62%*	64%
Some aspect of me (e.g. consciousness, soul, some form or awareness) will continue to exist after the death of my physical body. [○]	38%	74%*	74%
Some people can move physically distant objects with their mind (i.e. telekinesis). ^{P,†}	11%	20%	23%
Some people (e.g. shamans, gurus, psychics, etc.) are able to influence physical events (e.g. the probability of rain or the course of physical illness) through non-physical processes. [○]	19%	40%*	44%
There is a hidden or deeper purpose to life and all of existence about which many people are unaware. [○]	49%	85%*	84%
It is possible to communicate with someone who has died. ^{P†}	25%	42%*	45%
There are hidden or deeper meanings to everyday events beyond both simple factual explanations and more complicated scientific explanations for understanding the world. [○]	50%	87%*	87%
There exists another separate realm or dimension beyond this physical world that can be experienced and visited. ^M	32%	77%*	78%
Your mind, soul or consciousness can leave your body and travel. ^{P†}	30%	70%*	72%
Reincarnation does occur. ^P	23%	49%*	51%
The universe is conscious. [○]	33%	80%*	81%
The consciousness of myself does not die with my physical body. ^{D, f}	33%	62%	63%
<u>Mammal consciousness</u>			
Some (if not all) non-human primates (e.g. chimpanzees) are capable of having conscious experience. [○]	64%	83%*	85%
Other human beings are capable of having conscious experience. [○]	79%	94%*	95%
I (the person taking the survey right now) am capable of having conscious experience. [○]	82%	97%*	98%
Some (if not all) four-legged animals (e.g. cats, dogs) are capable of having conscious experience. [○]	62%	80%*	83%

Non-mammal consciousness

Plants (e.g. trees, flowers) are capable of having conscious experience. ^o	26%	62%*	65%
Some fungi (e.g. mushrooms) are capable of having conscious experience. ^o	21%	57%*	62%
Inanimate natural objects (e.g. rocks) are capable of having conscious experience. ^o	8%	27%*	29%
Inanimate man-made objects (e.g. chairs, buildings) are capable of having conscious experience. ^o	4%	15%*	17%
Some insects (e.g. ants, flies) are capable of having conscious experience. ^o	34%	59%*	61%

Superstition

If you break a mirror, you will have bad luck. ^p	10%	5%	3%
Black cats can bring bad luck. ^p	7%	4%	3%
The number "13" is unlucky. ^p	7%	3%	3%

Belief statements that do not consistently load on a factor

The scientific method is the MOST effective way of understanding the nature of the universe and enduring factual truths. ^o	68%	44%*	44%
There is just one primary reality: the physical. The mind (and/or consciousness) is just created through physical/functional properties of the brain which have an entirely material explanation. ^{M, t, a}	45%	16%*	14%
There is just one primary reality: the mind (and/or consciousness). All material things derive from the mind (and/or consciousness). ^{M, t, b, e}	18%	35%*	35%
Primary reality cannot be completely reduced to either the physical or the mind (and/or consciousness). They are not separate. Mind (and/or consciousness) is fundamentally part of all matter. ^{M, t, c, e}	35%	71%*	75%
Everything that has ever happened had to happen precisely as it did, given what happened before. ^{F, d, e}	31%	50%*	51%
People have free will; that is, they have the ability to choose between alternative actions. ^{o, e}	73%	73%	71%

The abominable snowman of Tibet exists. ^P	7%	8%	9%
The Loch Ness monster of Scotland exists. ^P	10%	10%	10%

¹ Data in this table show the percentage of participants rating any agreement (Slightly agree (+1) to Strongly agree (+3)) with the belief statement at each time point.

² Verbatim wording of belief statements sequenced by factor loadings shown in Table 2; Factor designations are in bold font.

* Asterisks indicate that the difference from "Before" to "After" met the criteria for designating a meaningful difference (a difference of at least 10% and a statistically significant difference ($p < 1 \times 10^{-5}$)). None of the differences from "After" to "Now" met these criteria (Supplemental Materials).

^D This statement was derived from the Reflective Dualism subscale of the Mind-Body Relationship Scale (Riekkii et al., 2013).

^P This statement was derived from the Revised Paranormal Belief scale (Tobacyk, 2004).

^M This statement was derived from the Metaphysical Beliefs Questionnaire (Timmermann et al., 2021).

^F This statement was derived from the Free Will Inventory (Nadelhoffer et al., 2014).

^O The wording of this statement is original.

[†] The wording of this statement was modified from the original wording in the published citation.

^a This statement was included to represent philosophical materialism.

^b This statement was included to represent philosophical idealism.

^c This statement was included to represent philosophical panpsychism.

^d This statement was included to represent philosophical determinism.

^e This statement did not meet criteria for loading onto any single factor at any of the three timepoints.

^f This statement met criteria for loading on to two factors

Table 2. Factor loadings of each belief statement ¹

Factor Names and Belief Statements ¹	Factor Loadings ²				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
<u>Dualism (Factor 1)</u>					
The mind is not part of the brain, but it affects the brain.	0.82	-0.02	-0.03	0.07	0.01
The body is material and the mind is immaterial.	0.77	-0.01	0.07	-0.13	0.06
Some mental processes have no connection to brain processes.	0.76	-0.04	-0.04	0.1	0.01
The mind and the brain are totally different things.	0.74	-0.11	0.01	0	0.08
The mind as a whole is made up of substance and material processes.	-0.72	0.12	0.09	-0.1	0.02
Thought processes cannot be just brain processes.	0.68	0.11	0.01	0.05	0.01
The body belongs to the world of material and natural laws. The mind is a different kind of existence, a spiritual way of being.	0.68	0.25	0.07	-0.13	0.06
The mind is a special form of energy, currently unknown to humanity, that is in contact with the brain and affects it.	0.67	0.16	0.03	0.01	0.01
The mind is immaterial and it works with the brain to generate our behavior.	0.67	-0.03	0.05	-0.04	0.04
Minds are in principle independent of bodies, to which they are only temporarily attached.	0.57	0.22	0.04	-0.05	0.04
Mental states are activities of my nervous system.	-0.54	0.13	0.17	-0.13	-0.06
The consciousness of myself does not die with my physical body.	0.49	0.42	0.00	-0.09	0.07
<u>Paranormal/Spirituality (Factor 2)</u>					
It is possible for some people to predict future events.	-0.11	0.84	-0.03	0.05	0.10
Non-physical conscious entities (e.g. souls, angels, spirits) exist.	0.07	0.83	-0.06	-0.13	0.08

Communication between minds (telepathy) is possible.	-0.09	0.80	-0.03	0.13	0.07
Some aspect of me (e.g. consciousness, soul, some form or awareness) will continue to exist after the death of my physical body.	0.14	0.79	-0.02	-0.15	0.00
Some people can move physically distant objects with their mind (i.e. telekinesis).	-0.14	0.79	-0.09	0.15	0.17
Some people (e.g. shamans, gurus, psychics, etc.) are able to influence physical events (e.g. the probability of rain or the course of physical illness) through non-physical processes.	-0.07	0.79	-0.05	0.11	0.12
There is a hidden or deeper purpose to life and all of existence about which many people are unaware.	0.16	0.67	0.01	-0.08	-0.10
It is possible to communicate with someone who has died.	0.15	0.63	-0.04	0.07	0.15
There are hidden or deeper meanings to everyday events beyond both simple factual explanations and more complicated scientific explanations for understanding the world.	0.12	0.62	0.03	0.03	-0.13
There exists another separate realm or dimension beyond this physical world that can be experienced and visited.	0.21	0.59	0.03	0.03	-0.04
Your mind, soul or consciousness can leave your body and travel.	0.28	0.5	0.05	0.10	0.02
Reincarnation does occur.	0.21	0.5	0.02	0.10	0.10
The universe is conscious.	0.2	0.43	0.08	0.32	-0.13
The consciousness of myself does not die with my physical body.	0.49	0.42	0.00	-0.09	0.07
<u>Mammal consciousness (Factor 3)</u>					
Some (if not all) non-human primates (e.g. chimpanzees) are capable of having conscious experience.	-0.06	-0.04	0.87	0.21	0.07
Other human beings are capable of having conscious experience.	0.01	0.07	0.86	-0.14	0.03
I (the person taking the survey right now) am capable of having conscious experience.	0.01	0.06	0.83	-0.14	-0.01

Some (if not all) four-legged animals (e.g. cats, dogs) are capable of having conscious experience.	-0.06	-0.06	0.83	0.32	0.10
<u>Non-mammal consciousness (Factor 4)</u>					
Plants (e.g. trees, flowers) are capable of having conscious experience.	0.09	0.1	0.15	0.8	-0.14
Some fungi (e.g. mushrooms) are capable of having conscious experience.	0.1	0.01	0.23	0.79	-0.09
Inanimate natural objects (e.g. rocks) are capable of having conscious experience.	-0.01	0.23	-0.06	0.79	-0.08
Inanimate man-made objects (e.g. chairs, buildings) are capable of having conscious experience.	-0.04	0.22	-0.10	0.75	-0.07
Some insects (e.g. ants, flies) are capable of having conscious experience.	0.05	-0.16	0.59	0.62	0.06
<u>Superstition (Factor 5)</u>					
If you break a mirror, you will have bad luck.	0.08	-0.01	0.1	-0.14	1.01
Black cats can bring bad luck.	0.12	-0.08	0.08	-0.12	0.97
The number "13" is unlucky.	0.1	-0.04	0.08	-0.15	0.95

¹ Verbatim wording of belief statements sequenced by factor loadings; Factor names are in bold font.

² Factor loadings are from the exploratory factor analysis at timepoint "Before."

Table 3. Belief agreement ratings for each of three factors at all three timepoints (N=2374)

Factor	Belief agreement ratings (Mean, SD) ¹			Effect size (Before to After)	
	Before	After	Now	β [95% CI] ²	β_{MEQ} [95% CI] ³
Dualism	-0.4 (1.2)	0.5 (1.2)*	0.6 (1.3)	0.72 [0.67, 0.76] [†]	0.26 [0.23, 0.29] [†]
Paranormal/Spirituality	-0.4 (1.4)	0.9 (1.3)*	1.0 (1.4)	0.90 [0.86, 0.94] [†]	0.28 [0.25, 0.30] [†]
Mammal consciousness	1.4 (1.2)	2.1 (0.8)*	2.2 (0.8)	0.74 [0.69, 0.79]	0.19 [0.15, 0.22]
Non-mammal consciousness	-0.9 (1.3)	0.2 (1.4)*	0.3 (1.5)	0.72 [0.68, 0.77]	0.22 [0.19, 0.25]
Superstition	-2 (1.3)	-2.2 (1.1)	-2.3 (1.1)	-0.18 [-0.22, -0.14]	-0.06 [-0.08, -0.03]

¹ Mean factor belief agreement ratings for each individual were computed for each factor by summing the agreement ratings of the items of those factors (reverse-scored items were inverted prior to summing) and then dividing by the number of items in that factor. The overall mean factor score was calculated as the mean of all participants. The range of possible scores was -3 (Strongly disagree) to +3 (Strongly agree), with 0=Neither agree nor disagree.

* Asterisks in the After column indicate that the difference from Before to After met the criteria for designating a meaningful difference (an effect size of at least 0.2 and a statistically significant difference ($p < 1 \times 10^{-5}$). None of the differences from After to Now met these criteria.

² Effect size comparing timepoints Before and After is presented as standardized β , and interpretable similar to a “covariate-adjusted Cohen’s d”. These effect sizes are adjusted for age, psychological challenge, sex, white race, whether the psychedelic experience was their first, and MEQ.

³ β_{MEQ} adjusts for the same covariates, and shows the effect of a 1 SD increase in the Mystical Experience Questionnaire (MEQ30) on the mean factor score in SD units.

[†] Daggers indicate that the effect size met criteria for a meaningful difference (i.e. an effect size of at least 0.2 and a statistically significant difference ($p < 1 \times 10^{-5}$)). Effect sizes comparing timepoints Before to Now are omitted because they were nearly identical to those for Before to After.