Do Psychedelics Change Beliefs?

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Abstract:

Renewed interest in psychedelics has reignited the debate about whether and how they change human beliefs. In both the clinical and social-cognitive domains, psychedelic consumption may be accompanied by profound, and sometimes lasting, belief changes. We review these changes and their possible underlying mechanisms. Rather than inducing *de novo* beliefs, we argue psychedelics may instead change the impact of affect and of others' suggestions on how beliefs are imputed. Critically, we find that baseline beliefs (in the possible effects of psychedelics, for example) might color the acute effects of psychedelics as well as longer term changes. If we are to harness the apparent potential of psychedelics in the clinic and for human flourishing more generally, these possibilities must be addressed empirically.

Key Words: psychedelics, belief, affect

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29 **The return of psychedelic science**

30 Since 2016, psychedelic science – particularly with human participants – has seen a
 31 significant revival. Studies administering psilocybin and lysergic-acid-diethylamide (LSD) to
 32 healthy volunteers during functional magnetic resonance imaging promise insights into the
 33 mechanisms of consciousness. Psychedelic psychotherapy may help people with affective
 34 and addictive disorders^{1, 2, 3}. Such benefits can occur for weeks, months, or even years
 35 following initial dosage¹. These changes are posited to harness similar changes in beliefs
 36 (about self and others) that occur with cognitive behavioral therapy⁴. Outside of the clinical
 37 realm, psychedelics appear to change social and political beliefs^{5, 6, 7} and moral decision
 38 making⁸. However, disagreement remains about the locus of these effects in terms of
 39 perceptual and cognitive mechanisms⁸, or if belief change even occurs⁹.

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41 Here we consider if and how psychedelics change human beliefs.

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43 Humans have ingested psychedelic plants for much of our history¹⁰. They appear in
 44 Californian rock art from 500 years ago¹⁰. These plants are implicated in ritual and cultural
 45 practices, including shamanic ceremonies with the expressed purpose of modulating
 46 shamans' beliefs and those of their followers¹¹. Albert Hoffman unwittingly exposed himself
 47 to LSD shortly after first synthesizing it in 1943¹¹. He experienced the first LSD trip,
 48 describing it as both enlightening and frightening¹². US-based scientists later explored LSD
 49 as a psychotherapeutic adjuvant and a model for psychosis – each of which implies an
 50 impact on beliefs and belief updating. With time, LSD became popular amongst the rising
 51 counterculture for its apparent consciousness expanding properties.

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53 This is often assumed to be the main driver of its prohibition as a research tool. However,
 54 the truth is more nuanced¹³. At the time of LSD's greatest cultural impact, interest in its
 55 clinical potential within the company that manufactured the drug began to dwindle, largely
 56 because of the poorly controlled nature of the studies claiming breakthrough
 57 psychotherapeutic effects^{14, 15}. Around the same time, the Central Intelligence Agency
 58 became interested in the utility of psychedelics for mind-control and brainwashing. As part
 59 of their Cold-War efforts, the CIA funded research by Donald Hebb, Ewan Cameron, and

John C. Lilly among others, providing grist for espionage thrillers, science-fiction fantasies and conspiracy theorizing for decades to come¹⁶.

Many years later, it remains unclear if psychedelics can change human beliefs. Given the resurgence of research, the moral and ethical implications of exposing human volunteers to compounds that may alter their beliefs and sense of self, warrant careful consideration. Are beliefs changing? And, given the risks, are we doing the best quality science in our attempts to find out? We believe the answers to these questions depend upon how we define beliefs.

Do psychedelics change beliefs?

The idea that psychedelics change beliefs originates from benefits observed in psychedelic-assisted therapy for treatment of complex psychiatric disorders¹⁷. These benefits occur in patients for whom conventional antidepressants are ineffective^{18, 19}. They include decreased end-of-life depression and anxiety^{20, 21}, and reductions in substance abuse^{22, 23, 24}. Such benefits can persist for weeks^{18, 22}, months^{25, 26, 27, 28}, and even years^{29, 30, 31} following initial dosage (although extreme anxiety and fear can also occur, see³⁰).

On top of the observed effects of psychedelic assisted therapy, people who have consumed psychedelics often report transformative experiences. They describe the experience as profoundly meaningful. Some groups find that a single dose of psilocybin produced the single most meaningful experience of the individual's life or among the top five^{24, 32}. In some cases, these "secondary" effects (i.e., over and above the clinical benefits) are so significant, that the primary clinical outcome effects are considered by the user as the *least* important consequence of administration⁴⁰.

There also appear to be large effects in the non-clinical domain, including increases in altruism and prosociality³¹, connectedness³³, enhanced concern for nature^{6, 28}, (also see⁵) and for other people³⁸, changes in political orientation²⁸, and decreases in pessimistic outlook³⁹. The findings highlight perhaps a fundamental appeal of psychedelic science - core psychological constructs usually considered stable across time seem to change in sometimes drastic ways³⁷. It is perhaps unsurprising then that psychedelics' effects seem to include lasting changes to "beliefs"²⁸, attitudes³³, and personality^{34, 35, 36} (but see³¹).

Here, we aim to unpack extant findings on the changes brought about by psychedelic consumption. Whilst the above effects of psychedelics appear hopeful, and we are desirous of them, we would like to urge caution. Such large changes may have multiple, often indirect, mechanisms. Among them, the fact that people expect these effects *before* consuming them, as well as possible collider bias. Here, we aim to define what beliefs are, and thence the locus of psychedelic effects.

What is a belief?

There is probably no agreed upon definition of belief. Despite that, discerning competing definitions of belief can provide boundary conditions for what is and is not changed following psychedelic consumption. We consider three alternatives: belief as propositional attitude, belief as association, and belief as inference and learning. Following this, we assess if beliefs, according to each definition, change with acute psychedelic administration, or in the aftermath of psychedelic exposure.

Contemporary philosophers often characterize belief as a *propositional attitude*^{41, 42, 43, 44}.

Propositions are generally taken to be whatever it is a sentence expresses. Our attitude towards them captures whether we consider what is expressed in a sentence to be true.

Propositional attitudes encapsulate religious and political beliefs. Yet they also describe more mundane beliefs about the state of the world that can be expressed linguistically.

Propositional accounts can be shared with interlocutors, used to signal group membership, as well as form and benefit from coalitions⁴⁵. Given this, propositional accounts of belief

tend to align believing with having a capacity for language^{46, 47, 48}. However, conceiving of

propositions as causal Bayes nets has drawn some to speculate that propositional attitudes

are not unique to humans (i.e., language is not required to form propositions^{49, 50}), although

not without opposition⁵¹. Having said this, drawing a line between a proposition and simple

association between two or more phenomena is not always entirely clear.

Associative accounts are often held to be in contradistinction to a propositional

account^{54, 55}. An associative account of beliefs holds that believing is a function of the

strength of association between mental features that represent causes, and similar features

that represent effects^{56, 57}. These accounts have much in common with the mechanisms of

associative learning theory, connectionist networks, and more recently deep learning, and find support in behavioral neuroscience^{58, 59, 60, 61}. For example, associations are thought to be strengthened as a function of prediction error minimization: events that violate predictions based on summed associative strength guide updates to that sum in order to minimize future error^{57, 58, 59}. These error signals have been found in dopamine neurons during reward learning in primates^{60, 61, 62, 63}, during the learning of causal structure in rodents^{64, 65, 66}, and during causal belief formation in humans with functional magnetic resonance imaging^{67, 68} (see⁶⁹ for review). Associative and propositional accounts may not actually differ. It remains possible that the structure of propositional attitudes is formed, and/or imputed from simpler associative learning.

A third account of beliefs is derived from an account of the brain as an inference engine. Here, practitioners conceive of neural and psychological processing in terms of beliefs – captured by a central (often Bayesian) calculus that trades off prior beliefs (expectations) with likelihoods (data), to arrive at posterior beliefs (conclusions)^{70, 71}. Crucially, the structure that carries belief here is a *distribution of possible values* some variable could take, with a mean and standard deviation, or precision – which implies a degree of confidence - in the values the belief might take. One means of implementing the computations that sweep from prior to posterior, via likelihood, involves the expectation-maximization algorithm, which allows distinction between inference and learning. Inference is the *best* explanation of sensory data based on the sum of prior beliefs, and learning is how those prior beliefs are updated and how they color future inference. The distinction between **inference** and **learning** is important for meaningful evaluation of psychedelic effects, as they are likely moderating mechanisms behind any changes to broader propositional beliefs^{70, 71, 72, 73, 74, 75, 76}. In prior work we argue that psychedelics and other psychotomimetic interventions (like ketamine infusion or sensory deprivation) might acutely alter inference, without much impinging upon longer-term learning (which lasts beyond the metabolism and excretion of the drug)^{74, 75, 76}. Some argue that psychedelics induce hallucinations by increasing the weighting of priors^{74, 75}.

In sum, there are multiple ways of defining beliefs - including propositions, associations, inference, and learning (see Box 1 for further elucidation). Whether

psychedelics change beliefs critically hinges on which definition of belief is ultimately evoked. It may appear that single doses of psychedelics alter propositional attitudes, but it is more likely that they alter associative learning and the weighting of prior beliefs. Furthermore, we argue that baseline beliefs are critically important, both in terms of who volunteers for psychedelics studies (there may be a **collider bias**) and what expectations they bring to their study experiences. Psychedelic hallucinations could arise from a loosening of the constraining effects of prior beliefs on perceptual inference⁷⁶. It may be that psychedelics broaden the possibility space – inducing entirely new prior beliefs – perhaps expanding the possible beliefs an individual entertains. Below, we examine the extent to which beliefs are changed by psychedelic usage, by considering the evidence of belief change under each definition.

Figure 1. Spatial and temporal priors. (a.) Schematic illustration of contextual effects (*spatial* priors) in reading⁷⁷. We can easily read the phrases: “Jack and Jill went up the hill” and “The last event was cancelled”, although the words “went” and “event” look identical. The context helps identifying the most likely word, i.e., the best explanation of the sensory input. (b.) A graphical representation of the generative model for reading the first phrase in (a.). The spatial prior induced by the semantic context (Z) disambiguates the inherently ambiguous shape (X), giving rise to the most probable interpretation (Y). (c.) In the brain, contextual effects (*spatial* priors) can be implemented as feedback signals from high-level to low-level areas. (d.) A continuous-report test for orientations, in which sequential effects (*temporal* priors) are often reported. (e.) When participants are presented with sequences of gratings, judgements are often biased towards the orientation presented (or perceived) on the previous trial. (f.) Neural implementation of temporal priors: a crucial role is played by the dynamics of local E-I networks.

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182 **Box 1. Do psychedelics enhance or suppress priors?**

Over the past two decades, the description of the brain as an “inference machine” gained significant support^{78, 79, 80, 81, 82, 83}. This framework posits that belief formation and (perceptual) decision making rest upon internal, hierarchical representations of the world, built by the brain over time. These generative models capture the world’s causal structure, allowing the brain to generate prior expectations (priors) regarding future exteroceptive and interoceptive signals. New inputs are combined with the priors and, in turn, update the internal representations through inferences about the world’s (or brain’s or body’s) new state. Crucially, all information is weighted according to its reliability, hence inferences are mainly driven by the most reliable cues. This weighted cue combination, together with the engagement of priors, ensure optimal actions and decisions, even when the sensory evidence is inherently ambiguous. However, an overreliance on priors can result in a detachment from one’s sensations, bringing about aberrant percepts (hallucinations and illusions) and unshaken beliefs^{84, 85, 86}. Could the effects of psychedelics be underscored by such strong priors? Or is the opposite – relaxed priors and overreliance on inputs – true?

To answer, one must first define “priors”. In its most general sense, the term “prior” encompasses any available information about a certain aspect of the world that precedes (is not conditional on) sensory inputs. The very structure of our 4-dimensional world (3 spatial and 1 temporal dimensions) implies that all embodied brains must be

equipped with two general types of priors: spatial (or hierarchical) and temporal priors^{87, 88, 89} Spatial priors rely on causal links between variables of different abstraction and complexity, i.e., variables at different hierarchical levels (Figure 1a, b)^{77, 90}. Those priors include both pure spatial relationships (e.g., contextual effects or statistical properties of natural images; see Figure 1a) and more abstract relationships between variables (e.g., “if there is a cloud, it might rain”). They constitute top-down effects, mediated by long-range feedback connections^{91, 92} and speak to the notion of cognitive penetrability, i.e., the idea that cognition can, in certain cases, affect perception^{93, 94, 95} (Figure 1c).

Temporal priors, unlike spatial priors, do not rely on cross-scale relationships between variables, but rather on the temporal statistics of each variable, laying the foundations for evidence accumulation^{77, 96, 97}. The simplest instance of such a temporal prior is exemplified by a Markov chain (Figure 1e): the hierarchy is reduced to a single variable; whose value depends only on the very recent history (Markov property). Such dynamical models can account for simple sequential effects, including priming (or suppression / repulsion) effects in perception or memory (Figure 1 d, e)^{98, 99, 100, 101, 102}. Importantly, although spatial and temporal priors are not totally distinguishable, the latter most likely rely less on long-range feedback connections and more on alterations in local microcircuits (e.g., neural gain changes or tuning shifts^{92, 102, 103}; Figure 1f). Consequently, a strong (or weak) prior theory of psychedelics does not necessarily imply that spatial and temporal priors are equally affected. Given the present paper’s focus on high-level beliefs, we will restrict ourselves to spatial / hierarchical priors.

Both the acute and the longer-term effects of psychedelics appear compatible with the strong- prior theory. Hallucinations, one of the most striking features of the acute psychedelic experience, have been related to an extreme reliance on prior expectations^{84, 86}. In addition to that, the profound effects of set and setting¹⁰⁴, including the cultural impact on the experience¹⁰⁵, are compatible with enhanced top-down processing and amplified cognitive penetration. Furthermore, strong-prior theory is also in line with the finding that psychedelics do not alter strong pre-existing beliefs and, if anything, further strengthen them. Finally, in-lab experiments also support this theory. For example, psychedelics increase persistence during bistable perception^{106, 107, 108, 109, 110},

an effect that can be attributed to overcounted priors¹¹⁰ (see^{82, 83} for overview of this model of cognition).

Propositional Beliefs and Psychedelics

Propositional beliefs are generally taken to be an attitude toward what a proposition expresses. They often take the form of religious, political, and philosophical beliefs. Several studies suggest changes in each of these domains following initial dosage. Generally, psychedelic usage is linked to more a more positive outlook^{20, 21, 25, 26 32}. Other studies find long-term decreases in political authoritarianism²⁸, more liberal attitudes⁵ and self-reported increases on pro-environmental stances⁶. This has led some to speculate that psychedelics carry potential for inducing long-term belief changes⁴, although this is not without dispute⁹. Propositional beliefs ostensibly changed by psychedelics are those expressed in the social domain - hence appearing as if they represent fundamental changes to belief structures.

Social/Environmental Factors

Propositional beliefs are largely tied to language. Given its importance in social cognition, language is critical for social interactions, so propositional accounts center the social functions of belief. We learn about others' beliefs, and we use that information to weight them as sources for our own belief evaluation on similar topics, and unrelated ones¹¹¹. Belief statements serve to identify individuals as potential friends or foes. Belief formation in the social arena is thus meta-cognitive, in that it entails representing one's own beliefs, our beliefs about those beliefs, and our beliefs about other's beliefs¹¹¹. Given the social function of propositional beliefs, it is worth probing the impact of social setting in which propositional beliefs may be altered in non-psychedelic interventions. If people are shown to change propositional beliefs based on experimenter suggestion (in studies without psychedelics) then parsing whether reported changes occur due exclusively to psychedelic consumptions is paramount.

In non-psychedelic studies, humans show remarkable speed in updating their beliefs. Having been conditioned that a red and a blue square in compound predict an electric shock, that compound stimulus will elicit a galvanic skin response indicative of anticipatory fear. If an experimenter verbally states, "*Blue is safe*" and the squares are presented in

isolation, red will continue to evoke increased skin conductance, whereas blue will not¹¹³. Whilst the precise mechanisms underlying this kind-of learning (associative, propositional, hybrid) and its relationship to conscious report, and the meta-cognitive state of claiming a belief, remain to be determined¹¹³, our point here is that effects of instructed learning parallel those of, and hence provide clues to, the effects of experimenter suggestion and social norms on shaping many of the reported outcomes (such as self-reported changes in beliefs) in psychedelic research.

A recent example provides a useful example. Here, researchers were interested in examining belief-updating under social pressure whilst participants were experiencing LSD or placebo¹¹⁴. Participants judged the aesthetic quality of art pictures. They were then confronted with a group norm (how others in the group typically judged that piece) and were subsequently invited to reevaluate their decision. Technically, these are attitudes, rather than beliefs – since they incorporate a valence judgment about the art, but they are belief-like in that they carry propositional features and are ostensibly based on what the person judges to be true. Based on the evidence discussed thus far, we might expect that conformity to the norm would increase under LSD. This was partially the case. However, not globally. On LSD, participants moved their judgements nearer to the norm, but only for attitudes that were less extreme, and already in range of the norm¹¹⁴. More extreme beliefs did not change under LSD or placebo. These findings show that acute LSD exposure strengthens relatively weak beliefs which are already present. More broadly, this suggests that it is social learning strategies which are subject to change under psychedelics. Assessment of how reliable others are may be perturbed such that we find their beliefs more salient in sculpting our own, more tentative, conclusions. In sum, it could be that we defer to others more in shaping our beliefs after psychedelics, rather than psychedelics changing our beliefs wholesale.

Person Factors

This leads to the next cluster of potential factors explaining observed belief change. Loading on the question of whether psychedelics change propositional beliefs is also whether the beliefs are strongly held. Weaker beliefs appear subject to change following consumption, but strong beliefs that precede consumption appear more resistant¹¹⁴.

Second, when we draw conclusions about the mystical, spiritual, or political revelatory effects of psychedelics we should be mindful of **baseline beliefs**. The types of people who are drawn to volunteer for clinical research into psychedelic effects might be open to experiences and prone to certain beliefs (like alternative medicine and new age ideas) at baseline. Given what we know about task-elicited beliefs, these endogenous ideas and expectations will be the ones that manifest in the acute experience and perhaps strengthen even in the post-drug period. Indeed, recent research suggests LSD enhances suggestibility in healthy volunteers¹¹⁵, without enhancing creative imagination. Its effects on suggestion were greatest in people with higher trait conscientiousness¹¹⁵. That is, the themes and expectations that are primed before and during a psychedelic experience often manifest in the recipient's experiences. This has also been observed with other psychotomimetic drugs like ketamine¹¹⁶.

The drug itself may not even be necessary, as the placebo response is so strong with regards to the expected effects of psychedelics that no drug may be needed to induce them¹¹⁷. This is also true of anthropological studies. Ritual use of psychedelics often primes the experience, colors its aftermath, and infuses post-hoc interpretations, such that beliefs are changed – before and after the experience – though not necessarily through the pharmacological effects of the drug¹¹⁸. These studies further emphasize the importance of what an individual already believes in sculpting subsequent psychedelic experience and underscore the relevance of baseline beliefs when inferring psychedelics' effects on beliefs.

Box 2. Is the subjective experience causally involved?

How central are the acute subjective experiences associated with ingestion of psychedelics in bringing about positive changes? Several studies of psychedelics as therapeutics report correlations between the profundity of the psychedelic experience and outcome measures up to one-year post-exposure^{20, 22, 24, 29, 31, 35, 119, 120}.

Using a combination of clinical interview and survey response instruments such as the mysticism scale¹²¹, the states of consciousness questionnaire¹²², and the hallucinogen rating scale¹²³ participants indicate the degree to which their experience was meaningful, spiritual, or elicited change in their lives. One such example is the

persisting effects questionnaire¹²⁴. The PEQ employs, in some versions, over 140 items exploring changes in attitudes about life and the self, mood, behavior, relationships, and spirituality, that the user attributes to the subjective experience itself. Participants consistently ascribe to the experience positive—rather than negative—changes in attitudes about life, mood, and behavior¹²², that are not only sustained, but increase over time^{29, 124}. The “mysticality” of the experience, broadly characterized by intense feelings of awe, ineffability, transcendence, and profundity¹²⁴, is often measured with the psychometrically validated MEQ30¹²³. Scores on the MEQ30 correlate with reduced anxiety¹²³ and depression scores¹²³ in the weeks following the drug experience. Similar findings have been reported for alcohol¹¹⁸ and smoking dependence¹¹⁷. More profound psychedelic experiences predict reductions in self-reported drinking at one-month follow-up, reduced cravings, and increased self-efficacy in alcohol abstinence²². The personal meaning, spiritual significance, and changes in life satisfaction attributed to the experience also predict smoking outcomes including urinary cotinine levels (a metabolite of nicotine) at 30-month follow-up²⁴.

Changes in personality induced by psychedelics are more varied. Earlier studies found no changes¹²², but when combined with additional data, changes in openness (as measured by the NEO-PI-R) were predicted by the acute intensity of the psychedelic experience³⁵. Notably, these personality changes were sustained at one-year follow-up in those categorized as having a “complete” mystical experience (scoring 60% or higher on each subscale of the SOCQ)³⁵. More recent studies¹¹⁹ find changes in neuroticism and extraversion at 3-month follow-up that were predicted by measures of insightfulness, spirituality, and blissfulness and unity during the experience; whilst other studies find greater reductions in neuroticism at 6-months following ayahuasca ingestion, in those who scored higher on the MEQ30³⁶. Notably, there was no correlation between baseline neuroticism (i.e., measured prior to ingestion) and MEQ scores, suggesting the effect was driven through those experiences captured by the MEQ. Changes in well-being and life satisfaction (as measured via the PEQ) are also predicted at 6-month follow up by scores on the MEQ30^{20, 26}, as are PEQ-measured positive changes in attitude, behavior, and life satisfaction with the intensity of the psychedelic experience at 12-months following LSD³¹.

One possibility for delineating the causal role of mystical and connectedness experiences for the clinical response, would be to administer the psychedelic whilst participants were sedated, unconscious of the mystical experiences, though of course there are safety concerns. Furthermore, the choice of sedative agents will be key – many share neurochemical mechanisms with rapid-acting psychedelic antidepressants, and they may have similar antidepressant effects^{125, 126}.

Ultimately, despite some intriguing correlations between features of the psychedelic experience and clinical outcomes, given the data on suggestion, conformity, and placebo responses (see text), we suggest causal conclusions regarding the role of mystical and connectedness experiences in long-term change may be premature.

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267 **How could Psychedelics change beliefs? Association, Inference and Learning**

268 Whilst we see that the effects of psychedelics on propositional beliefs are tentative, they

269 may have more profound effects on association, inference and learning. Acute intoxication

270 with psychedelics can induce simple and complex visual hallucinations, potentially due to

271 their excitation of 5-HT_{2A} receptors on pyramidal neurons and consequent glutamate

272 release, resulting in altered prefrontal cortex activity^{1, 127, 128}. The longer-term effects of

273 hallucinations, and mystical psychedelic experiences on beliefs remain unclear. These

274 possible lasting effects – beyond acute intoxication – have long been the subject of a moral

275 panic. Do psychedelics induce a persistent psychotic state, characterized by uninvited and

276 frightening flashbacks? The answer is certainly not uniformly. Although in some individuals

277 (typically not those who volunteer for controlled clinical studies, who are pre-screened for

278 safety, but rather those using recreationally) a persistent hallucinatory persistent perceptual

279 disorder (HPPD) does occur^{129, 130}. It comprises simple, often geometric, visual

280 hallucinations (Type I), sometimes with accompanying distress (Type II)^{129, 130}.

281

282 Persistent visual hallucinations suggest that **new** perceptual prior beliefs are created by the

283 psychedelic experience and sustained outside of the acute drug context; but since they do

284 not typically invite narrative conclusions about alternate realities or alien agents, HPPD

285 experiences do not appear to alter propositional beliefs. Indeed, much like the

286 hallucinations that occur in neurological illnesses, most people with HPPD retain insight into

287 the unreality of their hallucinations¹³⁰. They do not invite new metaphysical propositional

288 beliefs, but they might instead reflect associative learning of new (or differently weighted)

289 prior beliefs¹³¹.

290 Intriguingly, in the work previously outlined on belief-updating under social pressure

291 and LSD administration, ketanserin blocked the effects of LSD on conformity bias for beliefs

that were near to (but not far from) the group norm¹¹⁴. This centers the 5HT_{2a} receptor in the norm-conforming impact of LSD (though ketanserin has activity at other monoamine receptors, notably dopamine and noradrenaline^{33, 34, 132, 133, 134, 135}). In recent preclinical work, the 5HT_{2a} receptor in rodent medial prefrontal cortex is identified as a locus of memory reactivation and reconsolidation^{40, 136, 137}. In previous work we argue that memory reconsolidation may underwrite the retention and strengthening of beliefs in the face of contradictory evidence in service of delusion maintenance⁴¹. Thus, the prior beliefs that receive spurious support under psychedelics may do so through mPFC 5HT_{2a} receptor stimulation and reconsolidation mediated strengthening^{136, 137}. The longer-term consolidation and retention of this strengthening is deserving of further clinical and pre-clinical investigation.

Future studies could also assess the impact of psychedelic on social learning strategies more directly: Do psychedelics first impact non-social processes and thence social, or vice-versa? Do they change the relative weighting of social over non-social information? Do they increase the salience of others' beliefs? Do these changes occur as a function of changes in the reliability of social relative non-social information¹³⁸? Likewise, is the dissolution of the usual boundary between us and others, a cause, a consequence, or a correlate of the impact of psychedelics on social learning strategies? Resolving the tension between social and non-social processes will have implications for the clinical impact of psychedelics. For example, individual differences in sensitivity to social and non-social learning strategies and their combination may explain why psychedelics can induce paranoia in some participants,¹³⁹ and resolve anxieties in others. It could be that insofar as psychedelics alter learning strategies, they appear to alter propositional beliefs.

Summary, Challenges, and Future Directions

So far, we've suggested that if psychedelics change "beliefs", they do so largely through experimenter suggestion and the pre-existing psychology of the individual, and further, that the definition of belief one adopts (associative, propositional, inferential) is crucial to addressing the question. We suggest evidence is equivocal as to whether

psychedelics change propositional beliefs directly. However, associations, inference, and learning may fair better.

Given that acute psychedelic experiences seem to alleviate depression, anxiety, and aid smoking cessation, in a manner that correlates with the intensity of acute mystical experiences at the time of drug exposure (see Box 2), it might be argued that these changes are “belief” based. However, they might also be mediated by changes in self-concept^{132, 133, 135}. A salient feature of the psychedelic experience is a loss of sense of self, a dissolution of ego boundaries, and an experience of enhanced connectedness with other people, animals, living organisms, and celestial bodies. The capacity for psychedelics to engender these feelings may be at the core of their therapeutic impact.

The combined effects of self-dissolution and enhanced feelings of connectedness may underlie increases in positive mood and observed increases in openness. Having said this, it is worth remembering that volunteer themselves for psychedelic research may be higher in such traits in the first instance. We must also consider the powerful placebo effects that characterize psychedelic experiences and anti-depressant and anti-anxiety interventions. Appropriate placebo control thus remains a challenge in psychedelic science. These preliminary observations with anesthetics seem to suggest that mystical experiences are not necessary for clinical effects, though we should pay close attention to the experiences people report upon emergence from the anesthesia.

If connectedness experiences do increase under acute psychedelics, and that those experiences sustain a change in beliefs about the connectedness of people and animals, we might expect psychedelics to change participants’ beliefs about pan-psychism: that living and non-living things possess an essence, a varying degree of consciousness, even the inanimate¹⁴⁰. We might expect that people who reach such conclusions following psychedelics would become more inclined to recycle (treating the interconnected world with more respect) or more interested in consuming a vegan or vegetarian diet.

Environmental beliefs have, since the 1990s been more associated with the political left – at least in the US. It may be that people become more left leaning because of their psychedelic experiences. However, the relationships between environmental and new-age interests and political beliefs are not so straightforward. Right-wing groups have historically been

interested in new-age ideas, including yoga, and the Aum Shinrikyo Buddhist cult which began by emphasizing ascetic Yoga practices, with time began to administer psychedelics to its followers, and, as a group began to espouse increasingly right-wing ideas¹⁴¹.

We are not suggesting that psychedelic use leads to cult membership, nor are we asserting that psychedelics induce extreme left- or right-wing belief. Rather, we are questioning whether, based on the empirical and anecdotal data, the suggestions that psychedelics necessarily lead to enlightenment, good outcomes, or more left-wing, collectivist ideals, ought to be taken seriously. We suggest not. Future work might explore the dimension of spiritual narcissism in psychedelic science. Briefly, those drawn to new age practices like yoga, may evince an enhanced self-focus, rather than ego-dissolution. This may manifest in beliefs and actions that are contrary to the tenets of the practice in which they are engaging. People who seek enlightenment through psychedelics might be likewise prone. This should be examined empirically.

CONCLUSION

We have explored whether and how psychedelics facilitate lasting belief change. Whilst we are intrigued and appreciate the potential that brief interventions with psychedelics might have in the psychiatric clinic and for human flourishing more broadly, like Sandoz in the 1960s we are circumspect. We call for better controlled trials that assess baseline beliefs and expectations prior to randomizing individuals to psychedelic interventions, we suggest a broad range of psychoactive control interventions, parametric manipulations of psychedelic settings, and, perhaps the most extreme, interventions in the absence of consciousness, to assay the causal role of mystical experiences in the apparent long-term effects of psychedelics. These compounds retain their fascination for humans precisely because they proffer insights into the meta-physical. To harness those insights most effectively and administer them ethically, we believe much more careful experimentation is necessary.

More fundamentally, we think a systematic assessment of beliefs and belief updating may be enlightening. We have formal mathematical models of beliefs that span computational, algorithmic, and implementational levels of analysis, which can be readily applied to neural and behavioral data gathered before, during, and after psychedelic

infusions. Working within such frameworks will address many of the issues we raise presently. There are rudimentary questions yet to be answered in the neuroscience of belief, central of which, whether brains deal in probabilistic distributions, binary variables, or both. Addressing these questions will yield further means to assert whether associative, propositional, and/or inferential mechanisms are involved. We are hopeful that, much like how cognitive neuropsychiatry illuminates both lesion cases, and healthy function, psychedelic science may likewise inform the mechanisms of belief formation and updating.

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