On the degrees of freedom worth having: psychedelics as means of understanding and expanding free will

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What is free will?

What do we mean when we talk of “free will?” What are the “varieties of free will worth having” (Dennett, 2003), and to what extent can we be said to possess such capabilities? While preferred definitions may vary across individuals and situations, we may perhaps find broad agreement that free will indicates a capacity for conscious intentions to meaningfully cause actions, which could be considered to be synonymous with agency (Safron, 2021). Free will may further be said to involve a certain open-endedness wherein agents can explore alternative possibilities and pivot based on novel information (Hills, 2019). In these ways, the meaning of free will is linguistically transparent as a capacity for both “willing” and “freedom.” Others may want a freedom of will in which conscious intentions may be said to be the sole determinants of

action without additional causal factors. While this may appear to entail a self-contradictory metaphysics involving “uncaused causes,” one may even find support for this more “libertarian” free will as well if it is the case that action selection is influenced by forms of causation that solely exists at intermediate levels of organization at which selfhood and agency emerge (Sinnott-Armstrong, 2019; Safron, 2021), or perhaps even in terms of consciously-experienced intentionality being influenced by stochastic (in terms of limited predictability) processes.

In what follows, I suggest all these forms of free will constitute real patterns that have been (and continue to be) selected over the course of evolution and development. I go on to describe how these mechanisms may overlap with serotonergic signaling pathways mediating the effects of psychedelic compounds, potentially helping to explain adaptive significances of these biophysical phenomena. Finally, I explore how this perspective on psychedelics (in terms of altering various degrees of freedom) may help to identify some of the most important sources of variation both across and within individuals.

Free will from free energy?

[Please note: This section is particularly dense and technical, and can be safely skipped by readers who are less interested in this abstract theoretical background and more interested in neurophenomenology.]

According to the Free Energy Principle and Active Inference (FEP-AI) framework, brains are most fundamentally understandable as cybernetic control systems that predictively model the world (Seth, 2014; Safron, 2021; Safron and DeYoung, 2021). The FEP-AI framework understands these modeling efforts as governed according to a singular objective function that evaluates patterns of action selection and updating according to their ability to minimize overall prediction-error and maximize parsimony (analogous to respective thermodynamic enthalpy and entropy, hence “free energy”). The predictions of FEP-AI agents will tend to involve the achievement of desirable goal-states, including the foundational goal of maximizing evolutionary fitness through occupying states that enhance survival and reproduction. In attempting to minimize prediction error with respect to these preferred (or attracting) states, an agent’s free-energy-minimizing actions can be said to be goal-oriented. The more uncertain an agent’s predictions, the more its dynamics will be shaped in the direction of trajectories (as patterns of action selection) that minimize this free energy.

However, these agentic trajectories through value space take the form of actions whose consequences lie in the future (Friston et al., 2017a), hence FEP-AI agents find themselves minimizing free energy with respect to the anticipated (counterfactual) outcomes of patterns of action selection. In this regime of temporally-deep and counterfactually-rich generative modeling, the free energy objective function takes a form in which agents minimize prediction error with respect to the extrinsic value of occupying preferred (and fitness enhancing) states of being, as well as a more exploratory process by which agents select actions expected to allow for model refinement, or the intrinsic value of information-gain. Agents that are initially uncertain regarding world-structure will tend to first optimize for intrinsic value, followed by a switch to greater optimization for more exploitative modes of pragmatic action selection as extrinsically valuable paths are discovered. However, as agents find themselves more certain regarding their predictions of occupying these preferred states, the expected free energy objective function will then return to being primarily driven by more exploratory modes of action selection (Friston et al., 2017b).

In these ways, expected free energy can be said to index both the magnitude of optimization gradients (which in some cases may entail “will”) as well as degrees of freedom with respect to predictive modeling (which in some cases may entail the phenomenology of open-ended exploration) (Kiverstein et al., 2019; Kiefer, 2020). And just as in the seeming paradox of free will as involving a dynamic tension between both directed and undirected ways of being, FEP-AI agents are required to navigate these same kinds of tradeoffs to comply with the normative principles of what a cybernetic system must do if it is to survive and thrive in a complex and changing world. If this kind of flexibly balanced agency is a precondition for self-persistence as claimed by FEP-AI, then perhaps it is not too surprising that this is precisely what people seem to (almost paradoxically) want in describing the “varieties of free will worth having” (Dennett, 2003; Hills, 2019).

A hierarchical predictive processing model of readiness potentials

Within FEP-AI, support is accumulating for an associated process theory of hierarchical predictive processing (HPP) as a unified principle of neural functioning (Clark, 2013; Bastos et al., 2020; Walsh et al., 2020). In HPP, all brain areas generate top-down predictions over bottom-up inputs, where information is only passed upwards (as prediction-error) if it fails to be predictively inhibited. Support for a common cortical algorithm is evidenced by theoretical considerations (e.g. efficiency), and is consistent with common architectural principles reflected throughout cortex (Mountcastle, 1997). HPP suggests both perception and action are inherently interrelated and fundamentally similar: perception minimizes prediction-error via updating internal models, and action realizes this objective by updating world states to better match predictions. Thus, action selection is understood as the (complementary) inverse of perception: perceptual hierarchies are updated via ascending prediction-errors, and action hierarchies are updated via descending predictions (Pezzulo et al., 2018). Particular actions are selected as more complex/abstract predictions from higher areas cause cascades of more fine-grained lower-level predictions, ultimately driving motion via spinal motor pools and associated reflex arcs with skeletal muscles (Adams et al., 2013).

HPP (and FEP-AI more generally) may represent a “Rosetta stone” for neuroscience (Hawkins and Blakeslee, 2004), allowing new interpretations of previously ambiguous phenomena, potentially including the nature of readiness potentials (RPs) associated with seemingly voluntary movement decisions (Schurger et al., 2021). This multi-level conceptual framework may prove invaluable in investigating the functional significances of RPs and associated brain measurements (Brunia et al., 2011). On functional and algorithmic levels of analysis (Marr, 1983), FEP-AI/HPP would understand these slowly-building potentials as evidence accumulation with respect to predictive models, which may be accompanied by non-linear phase transitions in large-scale updating of implicit (and sometimes explicit) Bayesian beliefs (Parr and Friston, 2018; Safron, 2020a; Whyte and Smith, 2020; Safron, 2021). On mechanistic implementational levels of analysis, RPs may be biophysically realized via accumulating recurrent neural activity in different levels of frontal-parietal (action-oriented) proprioceptive body maps, coupling with cingulate-insula salience networks, with patterns of enaction released when critical thresholds are surpassed in control hubs (e.g. pre-supplementary motor area) (Frith and Haggard, 2018). I propose this threshold-crossing may be understood as an “ignition event” as described by Global Neuronal Workspace Theory (Castro et al., 2020; Safron, 2020a; Whyte and Smith, 2020), so constituting one (of multiple) means by which consciousness may enter causal streams leading to actions. Further, conscious intentions (as

conjoined beliefs-desires) may contribute to ramping activity via affectively-driven mental simulations (Dohmatob et al., 2020; Hesp et al., 2020; Safron, 2021), consistent with dopaminergic discharges as well as decreasing variance and larger magnitude waveforms preceding volitional actions (potentially indicating value-based control processes) (Hamilos et al., 2020; Travers et al., 2021).

Neurophenomenologically (Figures 1,2), the feeling of “urge” preceding action may correspond to (non-linear) positive feedback interactions between frontal action hierarchies (Pezzulo et al., 2018), posterior body-space-affordance hierarchies, (Cisek, 2007) and insulo-cingular (interoceptively-grounded) salience hierarchies (Rueter et al., 2018). These feelings may be more than mere epiphenomena, influencing degrees of attentional selection for affective states, thereby modulating degrees of effective connectivity between these networks (Seth et al., 2011; Belin-Rauscent et al., 2016; Safron, 2021). The stream of consciousness may further contribute to action selection via the counterfactual processing (e.g. simulated movements) and imaginative planning enabled by the hippocampal system (Kaplan and Friston, 2018; Koster et al., 2018; Faul et al., 2020; Kay et al., 2020; Safron, 2021; Safron et al., 2021; Çatal et al., 2021), including with respect to “Type 1” planned or “Type 2” capricious RPs (Frith and Haggard, 2018). These systems also contribute to imagining/predicting the consequences of more complex (and potentially meaningful) decisions (Maoz et al., 2019), which would involve greater hierarchical depth and multiple realizability via particular actions (Sinnott-Armstrong, 2019). At these higher levels of abstraction, maximal explanatory power may be found in terms of more coarse-grained descriptions such as personhood and self-consciousness (Elton, 2000; Hoel et al., 2016; Prinz, 2017; Rueter et al., 2018), providing further neurocomputational grounding of agency.

Figure 1, a: Experience deciding to stand from sitting in order to make tea. The individual alternates between a) perceiving sitting with an empty cup, and b) imagining actions related to achieving the desired goal of obtaining tea. As possible actions are imagined/rehearsed, feelings of "urge" build across multimodal body maps, which peak accompanying the overt enactment of standing.

Figure 1, b: Experience deciding to move one's hand in a Libet paradigm. The individual alternates between a) perceiving one's hand and the clock, and b) imagining button pressing. As possible actions are imagined/rehearsed, feelings of "urge" build across multimodal body maps, which peak accompanying the overt enactment of button pressing.

Readiness potential reflecting the accumulation of urge from simulated actions

Figure 2,a: Neural processes accompanying decision to stand. Imaginative simulations (alpha oscillations, blue shading) are hippocampally orchestrated via theta oscillations (yellow shading) and cross-frequency phase coupled nested gamma. Imaginings cause an accumulation of expectation (beta oscillations, red shading) for the value of potential actions, with corresponding buildup of recurrent activity in body maps, resulting in overt enaction once critical thresholds are surpassed.

Readiness potential reflecting the accumulation of urge from simulated actions

Figure 2,b: Neural processes accompanying decision to press a button in a Libet-type experiment. Imaginative simulations (alpha oscillations, blue shading) are hippocampally orchestrated via theta oscillations (yellow shading) and cross-frequency phase coupled nested gamma. Imaginings cause an accumulation of expectation (beta oscillations, red shading) for the value of potential actions, with corresponding buildup of recurrent activity in body maps, resulting in overt enaction once critical thresholds are surpassed.

A potentially valuable approach to testing these models would involve attempting to differentiate between other slowly building brain potentials associated with RPs, such as the contingent negative variation (CNV) and stimulus preceding negativity (SPN) (Brunia et al., 2011). While RPs are associated with preparing self-generated actions, CNVs involve preparing to receive information for immediately deciding on actions, and SPNs involve preparing for relevant information without requiring an immediate response. The particular kinds of belief dynamics accompanying these seemingly heterogeneous phenomena may be as follows: a) RPs indicate updating beliefs over proprioceptive poses, which through HPP mechanisms constitute self-realizing predictions passed down cortical hierarchies for enaction (Adams et al., 2013); b) CNVs indicate both attentional selection and action-preparation utilizing hierarchically higher portions of those same networks (Cisek, 2007; Rizzolatti and Craighero, 2010; Marvel et al., 2019; Holmes et al., 2021; Safron, 2021); and c) SPNs indicate belief-updating regarding anticipated salience, which potentially could involve a broad variety of “mental actions” including both attentional preparation and imagining situationally-relevant behaviors (Parr and Friston, 2017). While beyond the scope of the present exploration, a research program disentangling the precise mental processes involved with these different measures would likely be a fruitful approach for future work. Although in what follows, I will focus on RPs through the lens of psychedelic mechanisms as a source of potential insights and with respect to these mysterious phenomena and of the ways they may vary both across and within individuals.

On the varieties of agentic experiences

A neurocognitive model for the variable degrees of coherence in the stream of consciousness and thought as covert behavior

Figure 3 depicts cognition during decision-making in a Libet-type task in an unaltered state, as well as under different levels of 5-HT_{2a} agonism. Each row shows ~1-3 seconds of experience within the experiment, where an individual decides to press a button while watching a clock-like timer to track the time of deciding when to move their hand. Depictions of the brain show alpha oscillatory complexes (in light blue) over the posterior medial cortices, corresponding to mental imagery. Although not visible in these depictions, these alpha complexes also extend to lateral parietal cortices, corresponding to perceptions of bodily poses (including orientation of sensors), attentional states, and their relationships to the visual field. In line with previous accounts of predictive processing (Bastos et al., 2020; Safron, 2020b, 2020a), beta oscillatory complexes (in red) correspond to top-down predictions. One beta complex on each brain image is shown as nested within the posterior alpha complex, and another is shown centered on the supplementary eye fields, potentially indicating attentional (and intentional) selection of percepts via a control hierarchy over oculomotor systems (Rizzolatti and Craighero, 2010; Safron, 2021). Orchestration of these oscillatory bands by theta rhythms (yellow shading) from the hippocampal complex is also represented, potentially involving attentional selection as amplification of gamma synchrony—presumed to mediate predictions—via cross-frequency phase coupling (Canolty and Knight, 2010).

In each row, as each time sequence progresses and possibilities for moving the hand are imagined/rehearsed, feelings of “urge” accumulate across body maps (represented in posterior lateral cortices). As described above, this feeling may correspond to (non-linear) positive feedback interactions between frontal action hierarchies, posterior body-space-affordance hierarchies, and insulo-cingular (interoceptively-grounded) salience hierarchies (not depicted here). This feedback between frontal action hierarchies and posterior body-space-affordance

hierarchies is shown using red arrows that get darker with increased urge and increased coupling of frontal and posterior lateral areas.

“Cognitive maps” in the hippocampus are depicted underneath each brain as hexagonal tilings of space, through which potential future trajectories are indicated as green shaded hexagons, with present-estimated trajectories indicated by red hexagons. Two hippocampal maps are shown beneath each brain image to indicate potential functional divisions between anterior and posterior portions of the hippocampus, which respectively more strongly couple to frontal and posterior cortices (Faul et al., 2020). Anterior maps show multiple potential routes through space (in green), which are selected at each moment (darkest green) based on the expected value of choosing that route (Kay et al., 2020). This hippocampal orchestration of dynamics can be viewed as the highest level of action selection in the brain, indicating overall integrated functioning of attracting states for the organism. Posterior maps, in contrast, show a single route through space, corresponding to the perceived path taken and encoded in memory, with the most intense red shading indicating estimates for the present moment of experience, and with this activity gradually fading across preceding timesteps. Notably, while these trajectories are most commonly understood with respect to navigation in the narrow sense, it is increasingly suspected that this core system for localization and mapping was repurposed for the sake of high-level cognition navigating through generalized space (including conceptual spaces) (Safron et al., 2021; Çatal et al., 2021). And here, we are considering hippocampal orchestration of large-scale neural dynamics to represent the shaping of and navigation through streams of experience within real and imagined worlds.

Below these hippocampal maps, two frames of experience are depicted, each corresponding to one alpha cycle. [Please note, these alpha-synchronized experiential frames are not meant to directly align with theta from the hippocampal maps above them; while the first frame would be more likely to be influenced by counterfactual imaginings orchestrated by the anterior hippocampus, each particular moment of experience could be a function of either imagination or perception depending on a multitude of factors (e.g. degree of driving inputs from the senses).] The number of theta cycles (i.e., depicted as a sequence of brains with active different hippocampal place fields being active at subsequent time points) in each row indicates tilings of (generalized) space along which trajectories may be planned and recorded in memory, which are shown as variable length sequences due to different levels of 5-HT_{2a} agonism. These chunked sequences could be understood as Edelman’s “remembered present” or James’ “specious present” where “now” has inherent temporal thickness as past moments both contextualize and are recontextualized by future moments of experience (Varela, 1999; Edelman, 2001). The precise extent of these trajectories through mind space would be influenced by “circuit-level” functional properties such as degrees of neuromodulation (ul Haq et al., 2016; O’Callaghan et al., 2021), with both 5-HT_{1a} and 5-HT_{2a} receptor stimulation having been observed to inhibit the sharp-wave ripple events indicative of retiling space for different modes of sense making with alternative sets of potential actions. Alternatively, such hippocampal resetting could occur via surpassing thresholds for cumulative prediction error, such as might be expected as uncertainty builds with respect to the ability of a given set of behavioral policies to be effectively realized through enaction. 5-HT_{2a} agonism may impact the extent of these predictive and remembered ‘task’ sets both by inhibiting hippocampal resetting mechanisms directly, as well as by allowing for more or less coherent sequences of perception, so influencing degrees of overall prediction error accompanying mental simulations. Various forms of metacognition and self-consciousness may be made possible to varying degrees based on the

extent of these cognitive sequences (Safron, 2021), where richer contextualization of experiences influence the extent to which such percepts are “accessible” (and potentially reportable) both within and across epochs.

This neurocognitive account is compatible with multiple models of psychedelic action, such as those emphasizing opening “thalamic gates” over (the doors of) perception (Preller and Vollenweider, 2018; Preller et al., 2019), or of claustrum-mediated decoupling of frontal cortices (Doss et al., 2021). This later model of altered cortico-striatal thalamo-cortical coupling might be particularly relevant with respect to agentic phenomena in providing a source of either anomalous efference copies from frontal action hierarchies, or by compromising meta-cognitive processes whereby such sensations from imagined actions might be coherently tracked. Theoretically, disruption of either of these processes by which corollary discharges from motoric imaginings are generated or contextualized could provide a source of hallucinatory phenomena in ways that may relate to compromised agentic control. It is also possible that excessively precise modes of action selection could lead to a potentially different class of hallucinations and delusions wherein individuals are more likely to associate percepts with imagined actions, so resulting in a sense in which individuals may become overly inclusive in viewing processes as controllable or related to intentions. However, if the account of predictive processing described above is accurate in describing the imagination (or prediction) of desirable outcomes as part of the mechanism by which goal-oriented action selection is realized, then the inference of controllability may become a self-fulfilling prophecy in terms of both shaping short-term behavior as well as longer-term learning of agentic control. Theoretically, causal pathways involving either greatly relaxed or greatly strengthened agency could potentially contribute to senses of “unity” or “oneness,” albeit with likely substantially different phenomenological characteristics.

Modifications of agentic cognition under different psychedelic regimes

Figure 3 depicts the ways in which cognition may be modified under different levels of 5-HT_{2A} agonism. Sequences of experience of different intensities and extents are modified with varying doses, showing imaginative rehearsals that may contribute to readiness potentials, feelings of having “decided”, and overt enaction of button pressing in a Libet paradigm. Above these sequences, hypothesized brain processes are shown with yellow, blue, and red shading indicating respective theta, alpha, and beta frequencies. Red arrows indicate degree of coupling between increasingly powerful complexes of beta-synchronized neural activity, which we propose both reflect and contribute to the perceptual vividness of imagined actions. In between these brains and depicted experiential frames, hippocampal/entorhinal tilings of space are shown along which predicted (left) and estimated (right) trajectories unfold along respective anterior and posterior portions of the longitudinal axis of the hippocampus. Increasing perceptual vividness is shown as increasing across all doses, with imagined and sensed percepts becoming increasingly similar with greater degrees of 5-HT_{2A} agonism. Length of hippocampally-orchestrated sequences is shown as initially increasing up until moderate (substantially psychedelic) doses are reached, but then decreasing as the coherence of cognition begins to decline. This hypothesized mechanism is consistent with findings that 5-HT_{1A} and 5-HT_{2A} receptor stimulation has been shown to inhibit hippocampal sharp-wave ripple events, which are here interpreted as indicating establishing new tilings of space with different associated behavioral (including the covert behavior of cognition) repertoires. However, prediction error has also been shown to facilitate re-mapping events, and as such decreasing cognitive coherence

(and potentially also low-level mechanisms) may promote shorter (but more potentially vividly experienced) sequences with higher doses.

For each dose, Time 1 and Time 2 indicate sequences separated by a remapping event, with degrees of informational continuity being a function of the vividness and coherence of experiences both within and across epochs. At the end of the second epoch (Time 2), overt button pressing occurs, with the degree of conscious accessibility of imaginings, strength of neural ramping, and proximity between peak negativity for readiness potential and perceived decisions all varying as a function of dose. Our overall hypothesis is that the 5-HT_{2a} system was initially selected by evolution to enhance imagination and volitional control within the low-dose regime, but where this pattern may reverse in the high-dose regime, which may potentially allow for highly novel patterns of behavior and learning under extreme circumstances. While the model depicted below may seem to imply “inverted U” effects with respect to modulation of cognitive functions, the precise dose-response function of different levels of 5-HT_{2a} receptor agonism may be highly idiosyncratic, perhaps especially for levels corresponding to moderate doses of psychedelics. That is, moderate levels of psychedelic effects could result in a strengthening of the coherence for imaginative planning in some cases, but weakening in others—and sometimes both strengthening and weakening in different combinations with respect to different processes—with particular experiences observed being a function of set, setting, and substance.

Figure 3 (split across three images with explanations interspersed below): Hypothetical response preparation in a Libet experiment as potentially modulated by different levels of 5-HT_{2a} receptor agonism. Please note, the following hypotheses are all highly tentative, as particular response tendencies are likely to vary widely across individuals (perhaps especially for the moderate ranges of 5-HT_{2a}R stimulation).

Cognition with different doses of 5-HT_{2A} agonism

Unaltered: Imaginings gradually increase in perceptual vividness from very low levels, which begin to come closer to the clarity of sensation as thresholds for overt enaction are reached. Non-task related mind wandering is indicated by images of a tree. Increasingly dark shading for the hand is meant to indicate increased feelings of urge. [This hand shading is made darker when the hand of the clock-timer points downwards, where this strange (but reliably observed) phenomenon is interpreted as potentially involving either a directing of attention or some kind of cross-modal spillover of activity between the downward motion of the clock and the hand movements that would be used in button pressing.] While every frame is meant to indicate conscious states, these may or may not be consciously accessible to individuals (in terms of reportable knowledge) if such experiences are unable to be contextualized in some kind of coherent (e.g. causal) unfolding.

Microdose: This is similar to the Unaltered condition, except individuals have somewhat increased perceptual vividness and slightly extended sequences within epochs. They also show partially reduced mind wandering as they begin to find their task-related images to be more vivid, compelling, and potentially absorbing. We also begin to see individuals feeling sensations of breath in their bodies (shaded torsos), where exhalations have been associated with action selection and stronger readiness potentials in Libet paradigms (Park et al., 2020). While the breath is visually depicted in experiential frames to illustrate these effects, these visualizations may or may not correspond to the subjective experience of subjects.

Threshold dose: Here we see even greater increases in vividness and sequence lengths, with even deeper trait absorption. Sensations of the breath are depicted as being more intense, with potentially greater contributions to shaping imaginings and eventually overt enaction. Greater awareness of somatic signals could potentially be driven by 5-HT_{2a} receptors that are found to be concentrated at the top of the (anterior) insular hierarchy (Santangelo et al., 2019). Theoretically, such comingling of interoceptive and proprioceptive/exteroceptive inferences may also contribute to the phenomenology of body ownership and agency (Suzuki et al., 2013; Safron, 2021). Under such conditions, it might perhaps be said that agents have enhanced capacities for willing, but with degrees of freedom potentially being of a more typical variety.

Medium dose: While perceptual vividness is even greater, more distracting imaginings and reduced inter-frame coherence results in somewhat attenuated sequences. On the neural level, this is depicted as somewhat reduced alpha power and less strong ramping in the beta band before the button is pressed. As noted above, this is only one of multiple possible responses to stimulation of psychedelic pathways. Some individuals might exhibit slightly reduced coherence in imaginative-planning/mental-simulations, but with others showing precipitous declines in coherence, and possibly with others showing non-linear increases.

Heroic dose: While perceptual vividness (and psychedelic phenomenology) is even higher, cognitive coherence is reduced to an even greater extent, accompanied by even more reduced sequences and less strong ramping activity. An external hand is sensed as guiding the act of button pressing (not necessarily consciously visualized), potentially arising as a function of inability to contextualize efference copies from frontal action hierarchies. This could be thought of as the beginnings of a “psychotomimetic” regime.

Extreme dose: These sequences have the greatest vividness, unusual character, and least cognitive coherence. Rather than the potentially vague perception of some kind of guiding hand in the heroic dose, in this regime a full external entity is visualized as pressing the button. Self-consciousness is nearly completely disrupted, and readiness potentials are completely absent, which are patterns that has also associated with schizophrenia. However, in this case psychedelics would be introducing a transient psychosis in which agency and core selfhood are only temporarily absent. Under such conditions, it could perhaps be said that an agent has maximal freedom, but at the expense of much reduced capacities for coherently directed will.

Conclusions and directions for future work

While many details remain to be determined, hopefully it has been made clear that conscious intentions enter into causal streams leading to action in ways where we may say that we have many of the “varieties of free will worth having.” This issue has been explored in the abstract with respect to the foundational premises of the Free Energy Principle and Active Inference framework, which may provide the first unified paradigm for the mind and life sciences. With hierarchical predictive processing and descriptions of specialized subsystems of the brain (and associated psychological processes), we have also considered detailed mechanistic accounts of experiments that seemingly disprove the reality of free will, but which may instead demonstrate precisely the opposite: even seemingly trivial patterns of choice behavior may be driven by our affective responses to (value-driven) imaginings, so conjoining beliefs and

desires in ways that can be said to be intentional in important respects. We then evaluated how these processes might be impacted by different levels of psychedelic action, with low-to-moderate doses potentially reflecting enhanced capacity for coherently directed will, and moderate-to-high doses potentially reflecting enhanced capacity for exploring degrees of freedom. It may be the case that both these mechanisms reflected (and continue to function as) separate sources of selective pressures over the course of evolution and development. In this way, framing psychedelics in the context of agency may help to explain core aspects of their phenomenology, as well as the biophysical and entailed emergent psychological mechanisms that mediate these altered states. The significances of these sources of variation may be difficult to overstate, as altering the natures of conscious (and unconscious) processing and the fundamentals of goal-oriented behavior may be the most impactful modifications imaginable for a living being, potentially constituting strongly explanatory and predictive variables with relevance for computational psychiatry, biological anthropology, and more. Finally, to the extent that such investigations help to shed light on the nature of the micromechanics of agentic control, then it may indeed be the case that psychedelics may be able to provide a “microscope” for studying the most fundamental natures of mind, in addition to providing potentially invaluable tools for expanding our degrees of freedom as meaning-driven persons.

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