

From Coherent Mass to Conscious Content: A Scaling Hypothesis for Psychedelic Experience and the Limits of a Quantum-Coherence Account

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Abstract

A companion manuscript proposes that classic serotonergic psychedelics act as “reverse anaesthetics” at the microtubule level, expanding rather than contracting the coherence-protected subradiant states of the tubulin tryptophan network, but declines to address the *content* of conscious experience. Here we take up that layer, distinguishing two routinely conflated questions: *amount* (how rich an experience is) and *form* (why it has the particular perceived structure it does). We advance a scaling hypothesis for amount, that experiential richness co-varies with the mass of coherence-protected quantum degrees of freedom recruited into orchestrated reduction, and with the frequency of those reductions, and identify a measurable proxy for it in the psychedelic signal-diversity literature (Schartner et al., 2017; Timmermann et al., 2019; Carhart-Harris et al., 2014). The hypothesis is conditional on a fork decidable by experiment: whether the long-lived dark states psychedelics are proposed to populate (Babcock et al., 2024) are *recruitable* into reduction or *inert*. For form we make a scoped claim: visual psychedelic phenomenology is already largely accounted for at the classical cortical level (Ermentrout and Cowan, 1979; Bressloff et al., 2001; Klüber, 1966), reducing any quantum-coherence account, for vision, to a gain parameter rather than a form-generator; non-visual content, especially entity-encounter phenomena, remains open. We marshal the sensory-deprivation literature (Krill et al., 1963; Dell’Erba et al., 2018) as evidence that amount and form dissociate, and propose one decisive, never-performed experiment: inhaled DMT in congenitally blind participants, probed for entity content: testing whether entity phenomenology is separable from cortical visual machinery. The hypothesis inherits every load-bearing assumption of the substrate account, and the metaphysical interpretation of any confirmed scaling relation is empirically underdetermined and lies outside the claims of this paper.

1 Introduction

The reversible abolition of consciousness by anaesthesia has given the physical study of conscious states a rare directional anchor, and a companion manuscript, posted concurrently as a preprint, exploits it: general anaesthetics bind tubulin and reduce tryptophan-mediated electronic energy

migration in microtubules (Kalra et al., 2023), and the symmetric hypothesis is that classic serotonergic psychedelics act in the opposite direction at the same substrate. That companion paper is written narrowly. It concerns only the photophysics: whether the migration length that anaesthetics contract is one that psychedelics expand, and it states plainly that it does not, and cannot, address the content of psychedelic experience: “there is no principled mapping from the state space of a chromophore network to perceived form.”

This paper takes up precisely the layer the companion paper declines. It asks what, if anything, a quantum-coherence account of psychedelic action can say about the *experience*: its richness and its structure, and it is written in the same register of explicit hedging, because the claims here are more speculative than those on the substrate side and we prefer to mark that than to disguise it. We make no attempt to solve the hard problem of consciousness, and we do not assert that microtubule coherence explains experience. We attempt something narrower and, we hope, correspondingly defensible: to state what a coherence account *would* predict about conscious content if its substrate assumptions held, to separate the parts of that prediction that are testable from the parts that are not, and to identify the experiments that would discriminate them.

The organising move of the paper is a distinction (Section 2) between two questions that are persistently run together in this literature: how much experience there is, and what shape it takes. We argue that a coherence account has genuine, testable purchase on the first (Section 3), that its purchase on the second is real but far more limited and, for vision, largely pre-empted by an existing classical theory (Section 4), that the two axes can be shown to dissociate empirically (Section 5), and that a single feasible experiment would sharpen the open part of the form question (Section 6). Section 7 is a frank account of what the framework cannot do, including the assumptions it inherits wholesale from the substrate account and the interpretive questions on which it must remain silent.

2 Two axes: amount and form

We distinguish the *amount* of an experience: its richness, intensity, the quantity of differentiated content present in a conscious moment (from its *form*) the specific perceived structure that content takes, the lattices, spirals and tunnels of a visual field, the felt geometry of distorted time, the sense of a present other. The distinction matters because a quantum-coherence account has, we will argue, quite different standing on the two, and treating them as one question is what produces both the overclaims and the easy refutations that have characterised this area.

The amount axis is, in principle, a scalar or low-dimensional quantity, and it is the natural target of any account in which experience scales with some physical resource. The form axis is high-dimensional and structural; it is a question about a *mapping* from physical organisation to perceived organisation, not about a magnitude. Confusing a magnitude claim with a mapping claim is the central error we wish to avoid: to show that richness scales with a coherence variable would say nothing whatever about why a given experience has the particular geometry it has, and conversely, a successful account of visual geometry (which, as we discuss in Section 4, already exists at the

cortical level) settles nothing about amount.

3 The scaling hypothesis for the amount axis

3.1 Statement of the hypothesis

We state as a hypothesis, not a result, that the amount of conscious content in a moment co-varies with two quantities the coherence account makes available: the mass of coherence-protected quantum degrees of freedom recruited into an orchestrated reduction event, and the frequency of such events. In Orch OR the reduction of a tubulin conformational superposition is an objective event on a timescale $\tau \approx \hbar/E_G$, set by the gravitational self-energy E_G of the superposition (Penrose, 1996; Hameroff and Penrose, 2014). A larger recruited coherent mass corresponds to a larger E_G and hence, other things equal, to more frequent reductions; the proposal is that both the size and the rate track the richness of the moment. We do not derive a functional form, and we regard the linear reading (“richness proportional to coherent mass”) as a placeholder for a relationship whose actual shape is unknown. The claim at this stage is directional and ordinal: more recruited, protected coherent mass, more differentiated conscious content.

This is deliberately weaker than an identity claim. We do not assert that conscious content *is* the coherent mass, only that it co-varies with it under the account’s assumptions. The distinction is not pedantic: an identity claim would require the bridge from physical to phenomenal that no one, ourselves included, has supplied, and we return to it in Section 7.

3.2 The recruitable/inert fork

The scaling hypothesis is not merely unproven; its very *sign* is contingent on a physical question that is presently open, and stating that question precisely is one of the few concrete contributions we can make here. Organised tryptophan networks in microtubule architectures are modelled and, in part, measured to support collective states spanning many orders of magnitude in lifetime: short-lived bright (superradiant) states and long-lived dark (subradiant) states on the scale of tens of seconds (Babcock et al., 2024). The companion account proposes that psychedelics expand the population of the long-lived dark manifold. But a dark state is, by construction, one that couples weakly to its environment, that is precisely why it is long-lived, and this raises a fork that determines whether populating it helps or hurts the amount axis.

On the first horn, which we will call *recruitable*, the protected dark states remain coupled to the orchestrated-reduction process: they constitute a reservoir of coherence that survives decoherence and is then drawn into reduction, so that expanding the manifold increases the coherent mass reaching each event, and richness rises. On the second horn, *inert*, the dark states are protected *because* they are decoupled from everything, reduction included: expanding the manifold then sequesters coherent mass away from the active process, and the predicted effect on richness is null or negative. The two horns share a mechanism and make opposite predictions. The scaling hypothesis requires the recruitable horn.

Crucially, this fork is decidable by the same experiment that the companion paper identifies as decisive for the substrate symmetry: the exciton-migration assay of [Kalra et al. \(2023\)](#) run with psychedelics in place of anaesthetics, read with an additional observable. If psychedelics increase migration length *and* the increase is accompanied by the subradiant spectroscopic signature (reduced steady-state fluorescence yield with lengthened lifetime), the protected population is being expanded; whether it is recruitable rather than inert is then addressed by whether that expansion tracks, across compounds and conditions, an independent index of processing such as signal diversity (Section 3.3). A dissociation, expanded protected population with no corresponding change in the processing index, would favour the inert horn and would count against the scaling hypothesis while leaving the substrate symmetry intact. We regard making this fork explicit, and tying it to an existing feasible assay, as more useful than asserting the recruitable horn by default, which informal treatments tend to do.

3.3 An existing measurable proxy for the amount axis

The amount axis has an advantage the form axis lacks: a measurable stand-in already exists and is already correlated with subjective intensity, independent of any commitment to microtubules. Work on the neural signatures of psychedelics has converged on an increase in the diversity or entropy of spontaneous brain signals under classic psychedelics: [Schartner et al. \(2017\)](#) reported increased spontaneous MEG signal diversity for psychoactive doses of LSD, psilocybin and ketamine, and the framing of psychedelic action as an increase in the entropy of cortical dynamics is the core of the entropic-brain proposal ([Carhart-Harris et al., 2014](#)). For DMT specifically, [Timmermann et al. \(2019\)](#) found that multivariate EEG signal diversity rose with the drug and tracked the intensity of the experience, and subsequent EEG-fMRI work extended the characterisation of DMT’s whole-brain effects ([Timmermann et al., 2023](#)).

We propose signal diversity as a candidate empirical proxy for the amount axis: the quantity that a coherence account predicts should rise with recruited coherent mass is, plausibly, the same quantity that signal-diversity measures already index. This is a proxy, not a measurement of coherent mass, which cannot at present be measured in a living human brain, and it carries its own confounds (signal diversity is a coarse, macroscopic statistic with many possible generators). But it makes the amount axis addressable now, with existing data, in a way the form axis is not.

The same literature disciplines a common but mistaken intuition about the difference between compounds. It is tempting to read DMT’s greater subjective intensity, relative to LSD, as evidence that DMT drives “more” of the brain into the relevant regime by a different or stronger mechanism. The pharmacological and electrophysiological evidence points instead at time-compression of one shared process. DMT, LSD and psilocybin produce the same qualitative signature (broadband reductions in oscillatory power with increased diversity) and for DMT the rise in diversity tracks the plasma concentration of the drug over minutes ([Timmermann et al., 2019](#)), consistent with a broader concentration-dependent EEG response to DMT ([Eckernäs et al., 2023](#)). DMT’s rapid pharmacokinetics compress that shared process into a window of minutes; LSD’s slow receptor

kinetics spread a comparable process across hours. On the scaling hypothesis, then, DMT and LSD move the amount axis in the same direction, differing in the amplitude and time-course of the excursion rather than in kind, and the apparent “more” of DMT is largely the same total effect delivered faster.

4 The form axis and the neuron-to-structure problem

The form axis is where a coherence account is weakest, and where honesty is most important, because it is the axis on which such accounts most often overreach. To explain why a given experience has the perceived structure it does, one needs a principled projection: a rule mapping features of the physical organisation to features of the perceived organisation. For a chromophore-network account, that would be a map from the state-space structure of the exciton network to perceived form. No such map exists, and we do not supply one. We refer to this as the neuron-to-structure (N→S) problem, and we treat it as unsolved.

Two things can nonetheless be said, and their combination defines the scope of what a coherence account may honestly claim about form.

First, for *visual* form specifically, the problem is already largely solved: at a different level of description. The classical theory of geometric visual hallucinations derives the catalogued form constants of Klüver (1966) (the lattices, honeycombs, spirals and tunnels) from the intrinsic symmetry of primary visual cortex together with the retinocortical map (Ermentrout and Cowan, 1979; Bressloff et al., 2001). On that account the perceived geometry is produced by a symmetry-breaking instability in cortical dynamics, pushed past threshold by increased excitability, and mapped to the visual field by a known anatomical transform. The form is drawn by the cortex. The consequence for a coherence account is sharp and, we think, clarifying: *for vision*, the account is not required to explain form at all. Its possible role reduces to a single scalar: a gain or excitability parameter that pushes the already-understood cortical system past its threshold, which is exactly a quantity of the amount axis (Section 3). The visual instance of the N→S problem is thereby not solved by the coherence account but *dissolved into the amount axis*, with the classical model carrying the structural work.

Second, this dissolution does not generalise. The entity-encounter phenomenon: the experience of a present, autonomous other, reported by a majority of inhaled-DMT users in survey research (Michael et al., 2021), with its phenomenology characterised in detail in a large-scale survey of self-reported encounter experiences (Davis et al., 2020): is not a geometric form constant, and there is no classical cortical symmetry model that produces it. Non-visual content generally (the felt structure of distorted time, the qualitative character of synaesthetic crossover) is likewise untouched by the Bressloff-type account. For these, the N→S problem is fully open: neither the coherence account nor any classical model currently supplies the mapping. We therefore restrict any claim of the coherence account, on the form axis, to the role of gain for visual geometry, and we mark the rest as unsolved.

5 Evidence that the two axes dissociate

The amount/form distinction is not merely a conceptual convenience; the sensory-deprivation literature provides evidence that the two axes come apart in fact, which is a precondition for the scaling hypothesis to be coherent. The relevant contrast is developmental. [Krill et al. \(1963\)](#), administering a hallucinogen to totally blind subjects, found that the presence of visual hallucinatory content depended on prior visual experience: subjects blinded after normal visual development reported visual phenomena, whereas those without a history of patterned vision did not. [Dell’Erba et al. \(2018\)](#) reported the same pattern in detail for a congenitally blind individual given a psychedelic: no visual hallucinations at all, but a rich and profoundly altered experience: multisensory and synaesthetic, with cross-modal content of a “visual-like” character delivered through the intact senses.

The interpretation we draw is deliberately narrow. On the form axis, these findings support a *generation* reading of visual content specifically: the geometric visual field requires a visual cortex that has been calibrated by developmental visual experience, consistent with the classical cortical model (Section 4); it is not received from outside a brain that never built the relevant machinery. On the amount axis, and this is the point that matters for the present paper, the richness and depth of the experience were undiminished by the absence of vision: the alteration was profound, merely routed through other modalities. That is exactly the dissociation the scaling hypothesis needs: the amount of experience and the visual form of experience are separable, the former surviving intact when the latter is absent. We note, without resting anything on it, that the anatomical locus of even the visual component is not fully settled: a retinofugal contribution has been proposed ([Tipado et al., 2024](#)), but that is a question about *where* in the visual pathway the geometry originates, not about whether it is generated rather than received, and it does not bear on the amount/form dissociation.

6 A decisive experiment for the open part of the form problem

The one part of the form axis that the classical cortical account does not reach (entity content) admits a clean and, to our knowledge, never-performed test. The blind studies above used LSD and did not probe for entity phenomena, and entity encounters are in any case overwhelmingly a DMT phenomenon rather than an LSD one ([Michael et al., 2021](#)). The experiment is therefore direct: administer inhaled DMT to congenitally blind participants and probe specifically for entity content (the sense of a present other) rather than for visual imagery.

The logic is a dissociation test. If congenitally blind participants, who do not experience the geometric visual field, nonetheless report entity encounters, then entity phenomenology runs on machinery separable from the cortical visual-rendering apparatus, and the coherence account’s “gain” role for vision does not extend to it; entity content would then be a distinct target requiring its own explanation on either a coherence or a classical account. If they do not report entity encounters, that would suggest entity content is more tightly bound to the visual machinery than the geometry alone: though we stress that a null result would be suggestive only, given that the realistic sample

size for such a study is very small. An informal and, we emphasise, anecdotal parallel points the same way as the positive outcome: reports of entity encounters under DMT by individuals who lack voluntary visual imagery (aphantasia) would, if borne out in controlled work, indicate that the entity experience does not require the imagery system, but we are not aware of peer-reviewed evidence establishing this, and we cite it only as a motivating observation, not as support.

Either outcome is informative, and the experiment is feasible with existing DMT-administration protocols. We regard it as the natural companion, on the content side, to the exciton-migration assay that is decisive on the substrate side.

7 Limitations and unresolved gaps

We state the framework’s limits plainly, and several of them are severe.

Everything here inherits the substrate account’s load-bearing assumptions. The scaling hypothesis presupposes that microtubule quantum processes are involved in consciousness at all: a minority position that is not established, and it presupposes the bridge that the companion paper identifies as its deepest gap: the resource we invoke is *electronic* coherence in the tryptophan network, whereas the reduction of Orch OR acts on *conformational* (mass) superpositions, and no derivation connects protection of the former to extension of the latter. If either assumption fails, the scaling hypothesis loses its mechanism. We do not repair these gaps here; we inherit them, and the reader should treat the entire amount-axis proposal as conditional on their resolution.

The scaling relation is directional only, and its sign is contingent. We do not derive a functional form relating coherent mass to richness, and as Section 3.2 sets out, whether the relation is even positive depends on the unresolved recruitable/inert fork. “Richness proportional to coherent mass” is a placeholder, not a law.

“Richness” is not rigorously defined, and the proxy is coarse. We use richness informally, and signal diversity as its proxy is a macroscopic statistic with many possible generators; a correlation between signal diversity and subjective intensity is consistent with the scaling hypothesis but does not establish it, and does not distinguish it from non-quantum accounts of the same correlation.

The general form problem is unsolved. The coherence account’s only honest claim on the form axis is as a gain parameter for visual geometry, with the structural work done by the classical cortical model. Entity content and non-visual qualia have no mapping on offer from either the coherence account or a classical model. The proposed experiment (Section 6) would locate entity content relative to the visual machinery, but locating a phenomenon is not explaining it.

The interpretive layer is empirically underdetermined. A confirmed scaling relation would say that experience *co-varies with* a physical resource; it would not say whether the brain *generates*

that experience or *filters*/samples a wider field, still less license any stronger metaphysical reading. These interpretations are empirically indistinguishable by any within-brain measurement: a system that produces more and a system that admits more look identical on every such measurement, and they are best regarded as interpretations of one formalism rather than as rival empirical claims. We note the underdetermination only to forestall over-reading of any positive scaling result, and we place the metaphysical discussion explicitly outside the empirical claims of this paper.

8 Discussion

The contribution of this paper is a set of distinctions and one experiment, not a theory of consciousness. The useful work, if there is any, is done by separating the amount question from the form question and then treating each honestly: the amount question is given a hypothesis with a directional prediction, a decidable physical fork, and an existing measurable proxy; the form question is, for vision, handed almost entirely to the classical cortical model, leaving the coherence account the modest role of gain, and is left frankly open for entity content and non-visual qualia. The blind-subject evidence shows that these two axes dissociate in fact, which is what makes the separation more than terminological. And the proposed congenitally-blind DMT experiment attacks the one open corner of the form problem that admits a clean test.

We regard the most likely honest outcome, on present evidence, to be that a coherence account earns a real but bounded claim on conscious content: a defensible hypothesis about the *amount* of experience, contingent on substrate assumptions it cannot itself secure and on a fork an experiment can decide; and, on the *form* of experience, a single gain parameter for a visual geometry that a classical theory already explains, with the remainder unsolved. That is a smaller claim than a quantum theory of experience, but it is one the evidence can be made to bear on, and it has the virtue of saying clearly where the physics ends and the interpretation begins.

9 Conclusion

Separating how much experience there is from what shape it takes lets a quantum-coherence account of psychedelic action make one testable claim and honestly disown several untestable ones. On the amount axis it yields a scaling hypothesis with a directional prediction, a decidable recruitable/inert fork, and an existing proxy in the signal-diversity literature. On the form axis it yields, for vision, only a gain parameter atop an existing classical model, and, for entity content, an open problem with a clean proposed test. The framework inherits the unresolved assumptions of the substrate account and remains silent on the metaphysical interpretation of any scaling relation it might confirm. The claim we can defend is not that the quantity of the brain's protected coherence *is* the richness of experience, but that the two may co-vary in a way a feasible program of measurement could confirm or refute, and that this modest, bounded claim is the most the current evidence will support.

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Conflict of Interest

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