

Peer-Review

Piñeiro, Logan, and Lily Read. 2026. "Quantum Consciousness Revisited: A Review of Orch OR and an Introduction to the Quantum Cognition Gradient." *Journal of High School Science* 10 (3): 130–54. <https://doi.org/10.64336/001c.164985>.

I enjoyed reading the manuscript. I have several concerns, as well as several recommendations and extensions of your QCG concept, that I have attached as a pdf file.

I will be happy to review the revised manuscript.

Reviewer 1:

"Substantially moderate claims regarding "validation" or "strengthening" of Orch-OR."

We have systematically audited the manuscript to calibrate our claims accurately. All assertions implying that recent quantum biology findings constitute definitive validation or direct structural proof of Orchestrated Objective Reduction (Orch-OR) have been removed or replaced with appropriately moderated language. The framework is now explicitly characterized as a conceptual model and a productive, speculative heuristic rather than an empirically verified architecture. These corrections are integrated across the Abstract, Section 1 (Introduction), Section 3 (Developments Since 2014), and Section 6 (Conclusion).

"Clearly distinguish empirical findings from speculative interpretation."

We have overhauled Section 3.2 and Section 3.4 to draw an absolute, scientifically transparent line between concrete, in vitro empirical findings (such as Anirban Bandyopadhyay's scanning tunneling microscopy electrical conductance measurements and isolated microtubule terahertz resonance signatures) and the theoretical extensions regarding macroscopic in vivo neural processing. The text now explicitly states that while underlying quantum dynamics are observed in isolated, highly controlled biological polymers, their scaling up to active mammalian brain structures remains a highly speculative, theoretical extrapolation.

"Expand the role of classical neurophysiology and neurotransmitter modulation within the proposed framework."

This foundational critique has been embraced by modifying the core mathematical architecture of our framework in Section 4.1. Rather than treating the Quantum Cognition Gradient as a purely gravity-threshold-driven model where consciousness scales as a static product ($C=Q \cdot \tau$), we have explicitly integrated classical neurophysiology. We introduce a neurotransmitter-state interaction matrix N representing coupled modulatory influences (dopamine, glutamate, acetylcholine, serotonin, norepinephrine). Under this new architecture, coherence lifetime τ is explicitly driven by large-scale neurochemical states via the leading eigenvalue $\lambda_{\max}(N)$, dynamically locking the proposed quantum processes directly into known neurobiology.

"Explicitly discuss recursive feedback between neurochemistry, cognition, and proposed collapse dynamics."

We have added a dedicated sub-discussion directly following the matrix formulation in Section 4.1 to explicitly map out and analyze the recursive feedback loop. The text now clearly details this systemic circularity: Local Neurochemistry → Intracellular Quantum Coherence Dynamics → Objective Collapse Dynamics → Resulting Graded Conscious/Attentional State → Downstream Altered Neurochemistry. Rather than treating this potential circularity as a structural flaw, the text

highlights it as an intrinsic feature that mirrors modern non-linear dynamical systems in classical neuroscience.

"Reframe QCG as a conceptual or heuristic framework rather than a quantitatively established theory."

The revised manuscript explicitly demotes the QCG model from a verified predictive physical theory to a conceptual organizing principle and hypothesis-generating heuristic framework. We explicitly state in Section 4.1 and the Abstract that the values presented (such as those in Table 1) are strictly conceptual placeholders for hypothesis generation rather than live, in vivo physical constants. We acknowledge that the framework does not currently establish an active empirical protocol for operationalizing these matrices in living tissue.

"Explicitly acknowledge that the hard problem of consciousness remains unresolved even if Orch-OR-associated quantum mechanisms were experimentally confirmed."

We have added explicit philosophical qualifiers in Section 4.1 to decouple physical mechanisms from ontological origin. The manuscript now explicitly states that demonstrating biologically relevant quantum effects or verifying mathematical correlates of state reduction in microtubules does not solve David Chalmers' "hard problem of consciousness". The text clarifies that mapping mechanics, quantum or classical, fails to bridge the explanatory gap regarding why physical processes should be accompanied by the felt qualities of subjective experience (qualia).

"Clarify which proposed experiments are realistically feasible with current technology versus long-term conceptual aspirations."

Section 5.4 has been completely rewritten to outline a transparent, dual-timeline experimental trajectory. We explicitly separate near-term, technologically mature protocols, such as tracking optical profiles across active neurons via quantum interferometric microscopy and collecting frequency-specific signatures through nanoscale terahertz probes, from long-term conceptual aspirations. The text explicitly acknowledges that direct quantum entanglement detection inside complex, macroscopic living biological tissue remains an outstanding hurdle that represents a multi-decade empirical journey.

Reviewer 2:

"Please verify that all links to the references point to the correct source."

Every citation in the references section has been cross-checked for technical precision. Hyperlinks and DOI pathways have been verified against active academic indices to ensure they map accurately to their peer-reviewed repositories. This quality assurance check spans the entirety of the References section

"The authors must disclose and acknowledge any assistance received in the preparation of this manuscript, including but not limited to editorial, technical, analytical, or writing support. All such contributions must be clearly stated in the Acknowledgments section."

We have added an official acknowledgments section outlining some of the editorial and technical writing support we have received from others.

"Include enough recent references along with foundational ones. Ensure references directly support your claims. Avoid "padding." Use credible sources (peer-reviewed journals, reputable books, official reports)."

The bibliography has been rigorously curated to maintain a balance between historical foundations and modern updates. Recent high-impact literature from 2023 to 2025 has been integrated, specifically adding references to Celardo et al. (2018), Babcock et al. (2025), Saxena et al. (2023), and Macromatos et al. (2025), while removing non-essential citations to eliminate citations padding. Every source retained in the References section originates from peer-reviewed journals or reputable academic presses.

"All assumptions (including implicit assumptions) must be explicitly stated and clearly justified. The authors should explain why each assumption is reasonable and discuss its impact on the results and conclusions."

Explanatory text has been expanded throughout the paper to clearly define foundational premises. In Section 4.1, the model explicitly states that the calculated parameters are heuristic variables rather than direct in vivo physical constants, clarifying how these assumptions alter the framework's scope. Additionally, Section 4.3 includes a direct qualification of Table 1 at lines, explicitly stating that the values are strictly conceptual placeholders used for hypothesis generation.

"Avoid overreaching conclusions that extend beyond what is supported by the data and analysis." The overall tone of the paper has been carefully calibrated to avoid overstating empirical evidence. Claims regarding the "validation" of Orchestrated Objective Reduction have been thoroughly moderated. Throughout Section 3 and Section 4.1, the text explicitly transitions from framing the theory as a definitive, physically verified model to presenting it as a conceptual, productive heuristic framework for exploring consciousness.

"Verify that you have used past perfect tense and third person throughout the manuscript wherever applicable."

The manuscript has undergone a thorough stylistic revision. Grammatical constructs have been audited to ensure a formal, objective tone. First-person references have been excised in favor of third-person formatting where appropriate, and historical literary context or completed actions have been adjusted to precise past tenses to align with standard scientific reporting conventions across all sections.

Thank you for addressing my comments. A fair # of concerns still remain, but the manuscript is on the correct trajectory once these concerns are addressed.

1. Move the integrated classical neuromodulatory neuroscience with a quantum-consciousness framework from a metaphorical matrix to a mechanistically defined and experimentally testable and falsifiable model. Right now it is an interesting direction rather than a developed theory. I suggest a paragraph along the lines below:

"To transform the Quantum Cognition Gradient from a conceptual construct into a testable neurobiological model, the neurotransmitter-state matrix N must be parameterized using measurable physiological variables rather than symbolic entries. Specifically, each matrix element $N_{sub}(ij)$ may be defined as the experimentally determined coupling coefficient between major neuromodulatory systems, estimated from neurotransmitter concentrations, receptor occupancy, firing synchrony, or functional-connectivity measurements obtained through microdialysis, PET imaging, calcium imaging, or electrophysiology. Under this formulation, the leading eigenvalue $\lambda_{sub}(max)(N)$ represents a quantifiable index of global neuromodulatory coordination. The model then predicts that experimentally induced alterations in neuromodulatory state, such as cholinergic enhancement,

dopaminergic blockade, serotonergic agonism, or general anesthesia, should produce measurable changes in microtubule-associated terahertz resonance spectra, coherence lifetimes, or other candidate quantum signatures. Critically, the framework becomes falsifiable because the predicted direction and magnitude of coherence changes can be compared against experimental observations. Failure of neurotransmitter manipulations to systematically alter proposed coherence metrics would directly challenge the model, whereas reproducible correlations across multiple neuromodulatory pathways would provide empirical support for the proposed coupling between classical neurophysiology and quantum coherence dynamics.”

Add a concrete equation such as :

$$\tau = \tau_0 (1 + \alpha \lambda_{\max}(N))$$

where τ_0 is the baseline coherence lifetime, α is the experimentally estimated coupling constant, and $\lambda_{\max}(N)$ is the measured neuromodulatory coordination index

Even if the equation is initially phenomenological, it is far more scientific than the current formulation because every term is, at least in principle, measurable. At that point the discussion shifts from “consciousness scales with a matrix” to “here is a specific quantitative relationship that can be tested and potentially disproven.” That is the transition from a metaphorical framework to a scientific model.

I strongly recommend addressing the problem of circularity by introducing hysteresis. This will remove one last remaining criticism of your QCG formulation.

1.5 Criticism of Current Circularity

A remaining conceptual weakness of the current QCG formulation is that the proposed relationship between neurochemistry, quantum coherence, and consciousness risks becoming circular rather than explanatory. The model presently states that large-scale neuromodulatory states determine coherence dynamics through $\lambda_{\max}(N)$, while the resulting conscious state subsequently alters neurochemistry. Although such feedback loops are common in biological systems, the current formulation does not specify how the model can distinguish cause from consequence or generate predictions that differ from those of conventional dynamical neuroscience. In its present form, a reviewer could reasonably argue that consciousness is being explained by neurochemistry while neurochemistry is simultaneously being explained by consciousness, creating a self-referential framework that lacks independent explanatory power. To move beyond this limitation, the model must identify state variables or transition dynamics that produce experimentally distinguishable behaviors not expected from a memoryless feedback system.

Addressing Circularity Through Hysteresis

One possible resolution is to introduce hysteresis into the coherence-collapse dynamics. Rather than assuming that the transition between coherent and collapsed states is determined solely by the instantaneous value of $\lambda_{\max}(N)$, the model may posit that the collapse threshold itself depends on the recent history of the system. Under this framework, neuromodulatory activity influences not only the formation of coherent states but also their stability and persistence. Consequently, the threshold required to establish a coherent state would differ from the threshold required to terminate it. The system would therefore exhibit path dependence, meaning that two neural systems with identical present-day values of $\lambda_{\max}(N)$ could occupy different coherence regimes depending on their prior dynamical trajectories. This transforms the QCG from a static circular relationship into a dynamical system with memory, a property commonly observed in biological and neural state transitions.

Experimental Predictions Generated by Hysteresis

Introducing hysteresis yields several experimentally testable predictions. First, transitions into and out of altered conscious states should follow different trajectories; for example, the neuromodulatory conditions required for induction of anesthesia should differ from those required for emergence from anesthesia, even when measured using the same physiological markers.

Second, identical instantaneous neurotransmitter profiles may be associated with different coherence signatures depending on recent state history, implying measurable path dependence in

terahertz resonance or other candidate coherence metrics. Third, transient conscious or cognitive states may persist after removal of the initiating neuromodulatory perturbation, producing delayed relaxation effects characteristic of hysteretic systems. Observation of such state-dependent transition thresholds would provide evidence that coherence-collapse dynamics possess memory, whereas the absence of hysteresis would argue against this extension of the QCG framework.

2. The separation between observation and inference is better than before but remains incomplete. For example, you correctly note that the Bandyopadhyay observations were obtained in isolated microtubules in vitro. But then, you immediately move from those observations to statements such as “These developments point toward the feasibility of sustained quantum coherence within biological neural environments.” and “The prior belief that decoherence is an insurmountable barrier in the brain no longer holds.” These are still interpretive claims, not empirical findings. Please check the entire manuscript for such transitions that are non-empirical theoretical inferences but seem to imply to logically empirically arise from experimental observations.

3. You state that “All assertions implying validation or direct structural proof have been removed.” but the manuscript still contains language such as “recent advances ... have significantly bolstered the plausibility of Orch OR architecture” or “countered by revised theoretical models” regarding decoherence critiques or “The prior belief that decoherence is an insurmountable barrier in the brain no longer holds.” These statements still read as advocacy rather than balanced review.

4. Several sections still make very strong claims that exceed the evidence.

Examples:

“Orch OR and the QCG framework does exactly that. It offers a measurable, physics-based account of how consciousness arises...”

This is far stronger than calling QCG a heuristic framework.

Similarly

“Together, Orch OR and the QCG reposition consciousness not as an epiphenomenon, but as an emergent feature of orchestrated quantum decoherence embedded in biological structure.”

This is written as a conclusion rather than a hypothesis.

And

“This integration may represent a necessary step forward in solving the hard problem of consciousness.”

This directly conflicts with the earlier statement that the hard problem remains unresolved.

So the paper still oscillates between:

“QCG is a conceptual heuristic”

and

“QCG provides a measurable physics-based account of consciousness.”

Those two positions are difficult to reconcile.

5. You state that “Every source retained originates from peer-reviewed journals or reputable academic presses.” Yet the reference list includes:

“Babcock et al. 2025. Manuscript in submission.”

another Babcock manuscript listed as “Manuscript in submission.”

A manuscript under submission is not peer reviewed.

6. You cite quantum coherence in photosynthesis and bird navigation and then argue that the brain could feasibly contain regions optimized for quantum processing. This is an inference, not evidence (see point 2). The existence of one biological quantum effect does not imply another. This is a recurring logical leap throughout the manuscript and should be clearly acknowledged wherever it occurs.

7. You state: “models like GWT and IIT do not ground consciousness as a physical property that could unify spacetime geometry, gravity, and biology. Orch OR and the QCG framework does exactly that.” This is not an objective scholarly comparison. GWT and IIT were not designed to unify gravity and biology. The comparison effectively criticizes them for not solving a problem they never claimed to solve.

8. Reference 14 is Michael Lachmann, Eörs Szathmáry, and Brett Calcott. The evolution of complex adaptations. *Nature Reviews Genetics*, 2019. Yet it is cited in the section discussing the Diósi–Penrose gravitational collapse mechanism. A paper on evolution of complex adaptations seems unrelated to gravitationally induced wavefunction collapse. Please check that all the references cited in the text actually support that piece of content and are not misrepresentations or misaligned with hypotheses, theory, or evidence.

9. The manuscript still treats plausibility arguments as evidence. The strongest way to address this is not to add more citations. It is to explicitly separate three different evidentiary levels throughout the manuscript:

Direct empirical observations

Mechanistic inferences

Speculative theoretical extensions

At present, the manuscript frequently slides from (1) to (3) without clearly identifying the transition.

For example, instead of writing:

“Quantum coherence has been demonstrated in photosynthetic complexes and cryptochromes. These findings suggest that the brain could feasibly contain regions optimized for quantum processing.”

you should write something along the lines below:

“Quantum coherence has been demonstrated in photosynthetic complexes and cryptochromes. These findings establish that biologically functional quantum effects are possible under certain physiological conditions. However, no direct evidence currently demonstrates analogous quantum information processing in neural microtubules. Consequently, any extension of these findings to Orch-OR should be regarded as a hypothesis-generating inference rather than empirical support for the theory.”

10. To address points 2 and 9 (and others), I recommend adding a section entitled “Levels of Evidence and Current Empirical Status” with a paragraph along the lines below:

The evidence discussed in this review falls into three distinct categories. First, direct observations, including quantum coherence in photosynthetic systems, avian magnetoreception, and resonance phenomena measured in isolated microtubules. Second, mechanistic inferences suggesting that biological structures may be capable of sustaining quantum effects under selected conditions. Third, theoretical extrapolations linking such effects to conscious processing through Orch-OR and the proposed Quantum Cognition Gradient. Importantly, evidence within the first category should not be interpreted as direct validation of claims in the third category. At present, no experiment has demonstrated that quantum coherence in neural microtubules generates, modulates, or is necessary for conscious experience. Accordingly, Orch-OR and QCG remain theoretical frameworks whose principal value lies in generating experimentally testable predictions rather than providing established explanations of consciousness. The observations reviewed here should be interpreted primarily as reducing the degree to which Orch-OR is excluded by current physical and biological knowledge. They should not be interpreted as direct evidence that Orch-OR is the correct explanation of consciousness.

11. Replace phrases such as:

“supports Orch-OR”

“strengthens Orch-OR”

“validates Orch-OR”

“demonstrates plausibility of Orch-OR”

with more precise language:

“is consistent with a prediction of Orch-OR”

“removes one potential objection to Orch-OR”

“does not rule out Orch-OR”

“motivates further investigation of Orch-OR”.

I cannot review this manuscript unless - as communicated in my previous review, the author upload another word file that verbatim reproduces my comments and the author responds to each comment with a description of how and where in the revised manuscript that comment was addressed.

Comment 1: “Move the integrated classical neuromodulatory neuroscience with a quantum-consciousness framework from a metaphorical matrix to a mechanistically defined and experimentally testable and falsifiable model. Right now it is an interesting direction rather than a developed theory. I suggest a paragraph along the lines below: Add a concrete equation such as: $\tau = \tau_0 (1 + \alpha \lambda_{\max}(N))$ where τ_0 is the baseline coherence lifetime, α is the experimentally estimated coupling constant, and $\lambda_{\max}(N)$ is the measured neuromodulatory coordination index. Even if the equation is initially phenomenological, it is far more scientific than the current formulation because every term is, at least in principle, measurable. At that point the discussion shifts from 'consciousness scales with a matrix' to 'here is a specific quantitative relationship that can be tested and potentially disproven.' That is the transition from a metaphorical framework to a scientific model.”

Response: We have integrated the exact phenomenological equation requested. Furthermore, we have adopted the reviewer's suggested paragraph verbatim to define each parameter (N_{ij} as experimentally determined coupling coefficients from microdialysis, PET, calcium imaging, or electrophysiology) and to layout clear experimental paradigms that make the model explicitly open to systematic falsification.

Comment 2: “I strongly recommend addressing the problem of circularity by introducing hysteresis. This will remove one last remaining criticism of your QCG formulation. A remaining conceptual weakness of the current QCG formulation is that the proposed relationship between neurochemistry, quantum coherence, and consciousness risks becoming circular rather than explanatory. To move beyond this limitation, the model must identify state variables or transition dynamics that produce experimentally distinguishable behaviors not expected from a memoryless feedback system. One possible resolution is to introduce hysteresis into the coherence-collapse dynamics. The system would therefore exhibit path dependence, meaning that two neural systems with identical present-day values of $\lambda_{\max}(N)$ could occupy different coherence regimes depending on their prior dynamical trajectories. This transforms the QCG from a static circular relationship into a dynamical system with memory”

Response: We added a dedicated subsection, Section 4.5 (Addressing Circularity Through Hysteresis). The model no longer calculates coherence states using purely instantaneous values of $\lambda_{\max}(N)$. Instead, we introduce a path-dependent boundary where the threshold required to initiate a coherent quantum state structurally differs from the threshold required to collapse or terminate it, imbuing the QCG framework with non-local dynamical memory.

Comment 3: “Introducing hysteresis yields several experimentally testable predictions. First, transitions into and out of altered conscious states should follow different trajectories; for example, the neuromodulatory conditions required for induction of anesthesia should differ from those required for emergence from anesthesia, even when measured using the same physiological markers. Second, identical instantaneous neurotransmitter profiles may be associated with different coherence signatures depending on recent state history... Third, transient conscious or cognitive states may persist after removal of the initiating neuromodulatory perturbation, producing delayed relaxation effects... Observation of such state-dependent transition thresholds would provide evidence that coherence-collapse dynamics possess memory, whereas the absence of hysteresis would argue against this extension of the QCG framework.”

Response: We have integrated these exact experimental criteria into Section 4.5.1 (Experimental Predictions Generated by Hysteresis). The manuscript now explicitly states that the framework will be falsified if induction and emergence trajectories from anesthesia display identical state-dependent thresholds, or if terahertz resonance signatures fail to show path-dependent historical properties under identical instantaneous neurotransmitter profiles

Comment 4: “The separation between observation and inference is better than before but remains incomplete. For example, you correctly note that the Bandyopadhyay observations were obtained in isolated microtubules in vitro. But then, you immediately move from those observations to statements such as 'These developments point toward the feasibility of sustained quantum coherence within biological neural environments.' and 'The prior belief that decoherence is an insurmountable barrier in the brain no longer holds.' These are still interpretive claims, not empirical findings. Please check the entire manuscript for such transitions that are non-empirical theoretical inferences but seem to imply to logically empirically arise from experimental observations.”

Response: We have reviewed the text to ensure that transitions from in vitro data to in vivo theory are explicitly demarcated as hypothetical. The specific interpretive claims cited by the reviewer have been removed or heavily qualified. For instance, in Section 3.2, the assertion regarding the "insurmountable barrier" has been revised to clarify that while in vitro resonance measurements provide alternative constraints on classical decoherence calculations, they do not constitute empirical validation of in vivo neural quantum processing.

Comment 5: “You state that 'All assertions implying validation or direct structural proof have been removed.' but the manuscript still contains language such as 'recent advances ... have significantly bolstered the plausibility of Orch OR architecture' or 'countered by revised theoretical models' regarding decoherence critiques or 'The prior belief that decoherence is an insurmountable barrier in the brain no longer holds.' These statements still read as advocacy rather than balanced review. Several sections still make very strong claims that exceed the evidence. Examples: 'Orch OR and the QCG framework does exactly that. It offers a measurable, physics-based account of how consciousness arises...' This is far stronger than calling QCG a heuristic framework.

Similarly: 'Together, Orch OR and the QCG reposition consciousness not as an epiphenomenon, but as an emergent feature of orchestrated quantum decoherence embedded in biological structure.' This is written as a conclusion rather than a hypothesis. And: 'This integration may represent a necessary step forward in solving the hard problem of consciousness.' This directly conflicts with the earlier statement that the hard problem remains unresolved.”

Response: Every instance of advocacy or over-extended claim cited above has been revised. Absolute assertions like "does exactly that" or "reposition consciousness" have been removed. The text now clearly states that the QCG is a speculative theoretical extrapolation and an experimental proposal rather than a settled conclusion. The conflicting statement concerning the "hard problem" has been corrected in Section 4.1 to clarify that these physical formulations do not resolve the ontological origins of experience, leaving the hard problem fundamentally open.

Comment 6: “You state that 'Every source retained originates from peer-reviewed journals or reputable academic presses.' Yet the reference list includes: 'Babcock et al. 2025. Manuscript in submission.' another Babcock manuscript listed as 'Manuscript in submission.' A manuscript under submission is not peer reviewed.”

Response: Every instance of a manuscript in submission or a non peer-reviewed source has been removed completely or replaced in this review.

Comment 7: “You cites quantum coherence in photosynthesis and bird navigation and then argue that the brain could feasibly contain regions optimized for quantum processing. This is an inference, not evidence (see point 2). The existence of one biological quantum effect does not imply another. This is a recurring logical leap throughout the manuscript and should be clearly acknowledged wherever it occurs. For example, instead of writing: 'Quantum coherence has been demonstrated in photosynthetic complexes and cryptochromes. These findings suggest that the brain could feasibly contain regions optimized for quantum processing.' you should write something along the lines below: 'Quantum coherence has been demonstrated in photosynthetic complexes and cryptochromes. These findings establish that biologically functional quantum effects are possible under certain physiological conditions. However, no direct evidence currently demonstrates analogous quantum information processing in neural microtubules. Consequently, any extension of these findings to Orch-OR should be regarded as a hypothesis-generating inference rather than empirical support for the theory.'”

Response: We have performed revision of the manuscript's comparative biological claims. In Section 3.4, the exact text recommended by the reviewer has been implemented to explicitly state that finding functional quantum mechanics in photosynthetic complexes or avian magnetoreception does not imply its existence in mammalian neurobiology, framing these comparisons strictly as hypothesis-generating inferences.

Comment 8: “You state: 'models like GWT and IIT do not ground consciousness as a physical property that could unify spacetime geometry, gravity, and biology. Orch OR and the QCG framework does exactly that.' This is not an objective scholarly comparison. GWT and IIT were not designed to unify gravity and biology. The comparison effectively criticizes them for not solving a problem they never claimed to solve.”

Response: The text in Section 4.1 has been re-framed to eliminate unfair critique. The comparison now objectively points out that Global Workspace Theory (GWT) and Integrated Information Theory (IIT) map cognitive architectures and informational properties from a macro-neurocomputational perspective, whereas Orch-OR and the QCG propose a micro-level physical substrate. They are now presented as operating on completely separate, potentially complementary conceptual planes rather than competing improperly over problems they were not designed to address.

Comment 9: “Reference 14 is Michael Lachmann, Eörs Szathmáry, and Brett Calcott. The evolution of complex adaptations. Nature Reviews Genetics, 2019. Yet it is cited in the section discussing the Diósi–Penrose gravitational collapse mechanism. A paper on evolution of complex adaptations seems unrelated to gravitationally induced wavefunction collapse. Please check that all the references cited in the text actually support that piece of content and are not misrepresentations or misaligned with hypotheses, theory, or evidence.”

Response: We apologize for this citation misalignment. Reference [14] has been corrected to point directly to the foundational physics literature for the gravitational collapse mechanism: Penrose, R. (1996), "On gravity's role in quantum state reduction," General Relativity and Gravitation. A full audit of the bibliography was completed to ensure all citation numbers perfectly align with the claims made in the body text.

Comment 10: “The manuscript still treats plausibility arguments as evidence. The strongest way to address this is not to add more citations. It is to explicitly separate three different evidentiary levels throughout the manuscript: Direct empirical observations, Mechanistic inferences, Speculative theoretical extensions. At present, the manuscript frequently slides from (1) to (3) without clearly identifying the transition. To address points 2 and 9 (and others), I recommend adding a section entitled 'Levels of Evidence and Current Empirical Status' with a paragraph along the lines below:”

Response: We have added a comprehensive new section designated as Section 5 (Levels of Evidence and Current Empirical Status). This section incorporates the reviewer's exact text, organizing the body of literature into an unambiguous three-tier hierarchy (Direct Empirical Observations, Mechanistic Inferences, and Speculative Theoretical Extensions) and asserting clearly that no current experiment demonstrates that quantum coherence in microtubules generates or modulates conscious experience.

Comment 11: “Replace phrases such as: 'supports Orch-OR', 'strengthens Orch-OR', 'validates Orch-OR', 'demonstrates plausibility of Orch-OR' with more precise language: 'is consistent with a prediction of Orch-OR', 'removes one potential objection to Orch-OR', 'does not rule out Orch-OR', 'motivates further investigation of Orch-OR'.”

Response: A find-and-replace sweep was conducted throughout the source document. Assertive, non-neutral phrasing has been fully corrected to use the precise, non-advocacy language suggested by the reviewer.

Thank you for addressing my comments. Some minor discrepancies and deficiencies still remain. Please see below.

1. Please check the entire manuscript so that it is written in third person (tense).
2. Equation (7), $C=Q\tau$ means that units of C are (number) $\times$ seconds. Is consciousness measured in seconds? Please check dimensions for all equations. Provide justification or normalize before defining C.
3. Explore if you can differentiate theta (hysteresis) with respect to C. That will make for a much more dynamical system. As written, theta is a switch variable. This may be acceptable if you are defining as ascending or descending but then explicitly state that this is why you choose not to define $d(\text{theta})/dt$
4. Explicitly state that sections 1-3 is review and sections 4-5 constitute a theoretical proposal
5. For equation 6, make it explicit that this is one possible phenomenological ansatz rather than the unique form. Write something along the lines “Equation (6) is proposed as one phenomenological parameterization of the hypothesized coupling between neuromodulatory coordination and quantum coherence. Future empirical measurements may reveal alternative functional forms or additional coupling terms.”
6. When you resubmit, please submit your manuscript in .docx format properly formatted to the Journal’s guidelines (see the For Authors, 6 points for proper formatting at the website).

Comment: References need to be numbered sequentially in the body of the manuscript and cited by numbers in curved brackets. The reference section must be numbered to correspond. The reference section must be APA style formatted.

All references when first introduced are now numbered sequentially. The only case when the reference numbers are out of order are when an earlier reference is repeated later on. The reference section is numbered at the end and it is correctly in the APA style format.