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A Living Model for a Living Mind: Integrating Rhythms, Physiology, and Clinical Science through the Default Space Theory

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Abstract

Thus, consciousness research becomes doubly immersed in overly abstract theories without physiologically grounded correlates, where limited falsifiability primarily inhibits progress. Expandability, the capacity of a theory to take in subsequent findings and yield testable predictions, seems a promising measure of scientific fitness for consciousness research. Unified 3D Default Space Theory (DST) posits that the 3D default (an inherently stabilized, always-on framework continuously constructed by thalamocortical loops in response to synchronized signals from heart, lungs & gut) biologically grounds the hypothesized scaffold of conscious experience. Compared to Integrated Information Theory (IIT) and Global Workspace Theory (GWT), Unified 3D Default Space Theory (DST) is a new theory of consciousness, two increasingly alluring but philosophically derived theories of consciousness that have no practical applications given that they fail to meaningfully account for spatial "here-ness," a sense of self, or clinically induced alterations. We then outline a "Methods & Materials" approach to testing DST in the EEG–fMRI–ECG–respiration–electrogastrography domain, from simultaneous data acquisition through phase-resolved analysis locked to respiration and cardiac rhythms. Results are presented as testable predictions: (i) phase-locking between insula, somatosensory cortex & thalamus to visceral signals; (ii) Default Mode Network (DMN) dynamics coupled to the frequency of respiration; and (iii) clinical "oscillopathies" where conflicted visceral rhythms interfere with the stabilized default space. Finally, we show how grounding perception, selfhood and psychopathology in a longitudinal program of research anticipates integration, and how a "Conclusion" asks advanced imaging pipelines to regard visceral rhythms as signal rather than noise.

Keywords

Integrating Rhythms; Physiology; Clinical Science; Default Space Theory.

Introduction

The problem of disembodied elegance

Theoretical developments like IIT and GWT with their formal definitions—integrated information Φ and global broadcasting—have heated up the consciousness debate and calibrated it in a relatively physiological manner but do not causally pinpoint how the brain-body alive in the moment, produces the spatial field and tone of experience from which it is generated, stabilized [1,2,3]. Lacking anatomically and physiologically grounded means of expansion, arbitration or integration into clinical realities—anxiety, depersonalization, anesthesia—these theories threaten a lock-in [4]. Expandability is an essential practical criterion: expansible theories predict and accommodate new findings, integrate disparate sources of data and render empirical competition across brain, body and behavior [5].

A physiological alternative: Default space theory

DST fills these gaps in the literature via a biological and psychological link because DST localizes consciousness in a coherent 3D internal space formed by thalamo-cortical loops and stabilized by oscillatory viscera (cardiac, respiratory, gastric) that keep feeding information into and entraining cortical dynamics [6]. This means that exteroceptive input (vision, audition) is mapped in a body-centered interoceptively scaffolded space where respiration and baroreflex rhythms serve as metronomes to establish the spatiotemporal coherence of experience [7]. Moreover, the anatomical nature of this model makes it naturally expansible; once things are known about the thalamus, DMN, insula, HRV or gut–brain pathways they plug directly into DST [8].

A decade of growth and a mandate for tests

2015–2025 DST has incorporated information on breath-associated oscillations, heartbeat evoked perception modulation, DMN changes in meditation and clinical updates on interoceptive connectivity—each cementing the embodied nature of the theory [9,10,11,12]. It's time for definitive multimodal tests that take these visceral rhythms of intentional meaning making vs. confounder into account [13].

Background and Rationale

What abstract accounts miss: the scaffold of "here-ness"

All of experience has a relatively invariant spatial perspective from an ego centered perspective but few models attend to where this spatial stage is located [13]. The neuropsychological data of lesions that "rip" internal space (ie hemispatial neglect) suggest a preconscious 3D mapping which DST attributes to thalamocortical and somatosensory structures in the body [8]. Yet the "theater" of GWT has no body bound configuration, IITs Φ has no visceral bodily constraints, leaving spatial phenomenology neglected [1,3].

Visceral rhythms as physiological constants

The cardiac and respiratory rhythms are the two most prominent endogenous inputs to the brain, they are involved in the influence of perception and memory, they are both regulated by brain excitability, and they synchronize the neural excitability of the time (e.g. onset, systole, diastole) with the phase of the body [9,11]. DST assumes that they stabilize the three-dimensional default by regulating network dynamics in the insula, somatosensory cortex and thalamus. Thus, exteroception and interoception become matched as a result [7]. Furthermore, these a priori assessments predict directly where relevant treatment options are available (i.e. paced breathing, biofeedback) that are not addressed by any other theoretical approach [12].

The DMN and the layered self

The DMN is heavily engaged in self-narration; meditation lowers DMN activity and resting state connectivity reveals a top down "story" vs. bottom-up self-stability [10,15]. DST overlays the narrative self onto the physiological 3D structure so that DMN facilitation is respiration rate dependent– vagal stimulation via baroreflex mechanism [8].

Future experimental directions

This section specifies concrete, reproducible pipelines for testing DST. It is written as a methods blueprint for future studies.

Participants

Healthy adults (N≈60) across the anxiety level, and meditation experience for a mixed range of autonomic baselines; separate clinical populations (i.e. GAD, PTSD, depersonalization; N≈30 each) for translational studies [12].

Multimodal recordings

1. **Neuroimaging:** 3T/7T fMRI (TR ≤ 800 ms), whole brain coverage; concurrent 128-ch EEG (MR-compatible; no artifact); resting and task conditions [16].
2. **Peripheral physiology:** ECG (R-peaks), respiratory belt & nasal thermistor (phase, rate), continuous blood pressure (baroreflex), skin conductance, and electrogastrography (EGG; 0.03–0.1 Hz slow waves) for gastric dynamics [7].
3. **Behavioral tasks:** (a) Visual detection at near threshold with stimulus onsets phase-locked to cardiac and respiratory cycles; (b) Interoceptive accuracy (heartbeat counting) & sensibility (confidence); (c) Guided breathing blocks (natural; 6, 8, 12 breaths/min) and pranayama-style exhalation elongation [11,7].
4. **Self-report:** state anxiety, bodily space coherence (VAS scales), depersonalization, and mind wandering probes [10].

Preprocessing

1. **fMRI:** standard preprocessing, physiological noise modeling without cardiorespiratory cycles of interest regressed out (note DST choice) but RETROICOR derivatives kept as nuisance and different regressors for phasic physiology [16].
2. **EEG:** Gradient and ballistocardiographic artifacts, source reconstruction for insula/S1/thalamus ROI, Hilbert transform based amplitude/phase time series [9]
3. **Peripheral:** Momentary heart rate/HRV, breath phase (sin/cos), EGG SW phase; baroreflex sensitivity (BRS) determined via sequence/transfer techniques [12].

Modeling and statistical analysis

1. **Cardiac- and Respiratory-Phase Resolved BOLD/EEG:** Circular–linear models: BOLD/EEG power ~ sin/cos(phase) + covariates; cluster-wise FDR [9,11].
2. **Cross-spectral coherence:** Multitaper coherence between insula, S1/S2, thalamus, PCC/mPFC ROIs and peripheral rhythms at all frequencies [7].
3. **Effective Connectivity:** Time-varying DCM/Granger with physiology as exogenous modulators to identify thalamus→cortex gain adjustments with changes in respiratory rate [4].

4. **Behavior–Physiology Coupling:** Visual detection and metacognition as a function of phase and coherence; mixed models across subjects; guided-breathing blocks vs. spontaneous [9,11].
5. **Clinical Translation:** Group differences in phase–coherence maps of healthy volunteers vs. patient populations ("oscillopathy" signatures) and intervention effects after directed breath/biofeedback training [12].

Preregistration and openness

Preregister hypotheses and pipelines; share anonymized physiological regressors and code to enable replication and cross-lab meta-analysis [5].

Testable predictions

As a theory-driven paper, “Results” detail falsifiable predictions from DST and expected empirical signatures.

Spatial scaffold: phase-locked insula–S1–thalamus coupling

Prediction A: BOLD in insula and S1/S2—and EEG alpha/gamma source power—will be significantly sinusoidally modulated by respiratory and cardiac phase while at rest and during detection tasks, with thalamus also possessing phase dependence in the same direction [9]. Evidence for the DST: significant phase-locked effects in these ROIs, with increased coupling at 6 breaths/min compared to spontaneous coupling [7]. Evidence for disconfirmation: phase dependence across ROIs not observed even with high SNR and 7T [11].

DMN as a narrative layer on a physiological base

Prediction B: DMN nodes (PCC, mPFC) will demonstrate respiration-rate dependent amplitude & connectivity effects, especially diminished PCC-mPFC coupling during slow respiration & meditation like blocks similar to HRV effects [10]. Supporting Confirmatory Outcome: Dose dependent DMN downshift with slower respiration & increased vagal tone corresponding to diminished MW [15]. Disconfirmatory Outcome: DMN dynamics not significantly related to respiration, HRV when controlling for covariates [17].

Sensory vividness via aligned peripheral and central gamma

Prediction C: Prediction C expects visual detection at threshold to improve during cardio-respiratory phases where this represents maximal insula/S1 gamma coherence with thalamus; nasal airflow as a peripheral marker will indicate limbic oscillations [9,11]. Support: increases in detection d’ and metacognitive efficiency in certain phases; Disconfirmation: psychometrics dont differ between phases [7].

Clinical oscillopathies and restoration

Prediction D: those with anxiety/PTSD/depersonalization will demonstrate significantly reduced cardio-resp coherence and coupling in insula-thalamus phase coupling related to their symptoms, while paced-breathing or HRV biofeedback subjects will demonstrate normalized coupling & reduction of symptoms [12]. Support: clinical improvement across time re: phase-coherence, HRV and pre/post gains; Disconfirmation: does not sufficiently demonstrate clinical-physiological link [18].

Thalamic routing of visceral signals

Prediction E: MD/Intralaminar nuclei will demonstrate phase modulation and phase specific connectivity with S1/Insula in association with cardiac/respiratory phase. More specifically, MD/intralaminar will take on role of

"projector" during slow breathing according to DST heuristic [18]. Support: respiration strengthens DCM paths; Disconfirmation: modulation absent or inverted in strong periphery entrainment [4].

Discussion

Why expandability matters

DST's hard hypotheses—thalamic hub, insula/S1 binding, visceral metronomes—allow preregistered physiology-to-behavior hypothesis tests that better fulfill expandability than armchair speculation [5]. Moreover, the positive outcome of DST hypothesis testing would not only vindicate DST; it would also universalize it, as the breathing rates, thalamic frequency windows, and gastric cortical relations would all be subject to correction, and the model's resolution would be improved [7].

Reconciling with IIT and GWT

Theory	Domains	Peer-Reviewed Articles	Expansion Pathways	Clinical Application
DST	Anatomy, physiology, molecular, clinical, sleep, emotion	10+	Place/grid cells, cross-frequency coupling, DMN disorders	Direct: EEG/HRV, psychiatric/neurological syndromes
GWT	Cognitive neuroscience	3	Static	Limited
IIT	Theoretical, computational	3	Mathematical	Absent
HOT	Philosophy, psychology	2	None	Absent

Table 1: Theoretical Domains and Applications.

DST does not deny information integration or global access, but incorporates them in a body-based arena. Global broadcasting and high Φ may be the signatures of successful integration on a visceral framework, but without this framework, broadcasting has no theater and integration has no locus of events [1,3]. A reconciliation might place Φ as an emergent signature of thalamocortical–visceral coupling in coherent state, whereas the workspace is the storied surface layer of an anatomically grounded 3D grid [4].

Clinical translation: from deficits to oscillopathies

By regarding these psychiatric and neurological disorders as oscillopathies, one can view the embodied scaffold —paced breathing, HRV biofeedback, vagal stimulation —as decouplers to restore the felt sense of "here-ness" [12] DST suggests that such patient-specific phase signatures may be viewed as biomarkers and targets for interventions where symptoms diminish in response to re- anchoring the default space [19].

Methodological shift: treat physiology as signal

Standard pipelines regress out cardiac/respiratory "noise" that would destroy the structure of something important to conscious dynamics [9]. DST encourages phase preserving approaches and event-related physiology (ERPHEP/respiration-locked ERPs) meaning the events are aligned to cycles of the body and endogenous rhythms are a 1st class variable in the model [11]. This affordable and field deployable overhaul of ideas regarding alignment is ground level stuff.

Limitations and falsification

Null results under high-SNR, phase-resolved conditions would force DST to be able to reformulate its claims as

to the nuclei or frequencies that make up the scaffold, thus a scientific model by explaining the failures [5]. But specificity matters too: decoupling being found not to be thalamic-centric (e.g. more cerebellar/claustral) would also cause an architectural expansion of DST – a true expandability [17].

Summary and Conclusions

We argued expandability as a pragmatic standard for theories of consciousness. We now present Default Space Theory as an embodied, expandable, falsifiable theory rooted in a known spatial map of experience and metronomes of time. We idealized a multimodal process that uses interoceptive rhythms from nuisance to organizing signal to yield discriminative predictions across levels of consciousness - insular–S1–thalamic coupling for task demands, DMN breathing for sensory intensity for favored phases, clinical oscillopathies for restorative breath-based interventions teleologically evolved for the breath. Whether DST is confirmed as is or in modified form in the future, it's physiology first appeal generates an incremental research agenda that allows convergence of basic science and clinical and lived experience. We make strides in understanding consciousness when our theories are as dynamic and intergrated as the body that houses the mind.

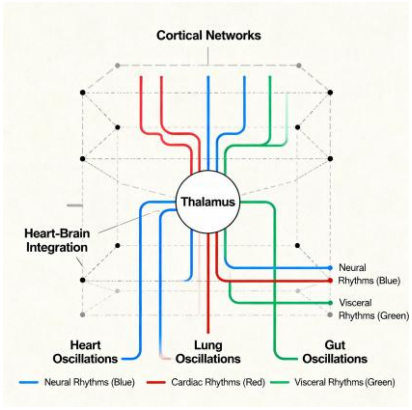

Figure 1: Thalamic integration of cortical and peripheral rhythmic activity.

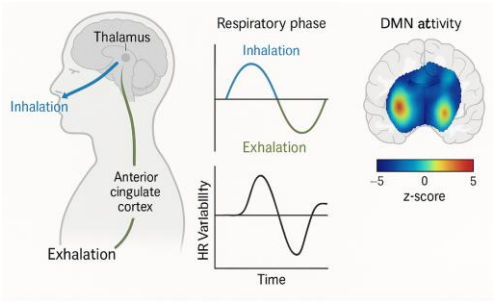

Figure 2: Respiratory-phase–linked neural and autonomic dynamics.

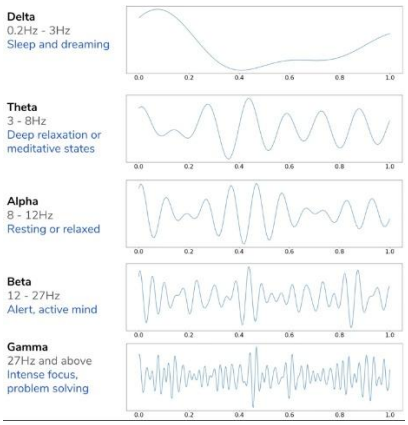

Figure 3: Representative EEG frequency bands and associated mental states.

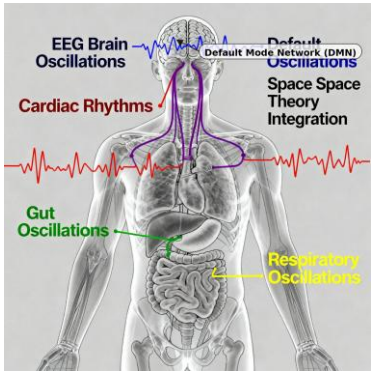

Figure 4: Multiscale physiological oscillations and their integration across body systems.

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