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Where Do Feelings Reside? A Neurophysiological Map from Default Space Theory

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Abstract

Where do we feel emotions in the body and why do those sensations congregate in certain places? Research increasingly supports that feelings are not just computational within the brain, but instead, embodied states manifesting in regions of the chest, gut and head, part of physiological and lived language and cross-cultural phenomenology. Default Space Theory (DST) suggests that consciousness and feeling emerge from phase-locked oscillations spanning cortical, autonomic and enteric systems, phenomenologically experienced as a space of default, extension, rather than a pin point brain location. This article bridges the bodily-mapped evidence (culturally/socially specific narratives of feelings and associated body parts), interoception studies across the lifespan and cultures, predictive-processing references to imagery and aphantasia, reflexes and peripersonal space, heart-brain coupling and polyvagal theory, respiration as an ultimate synchronizer, gut-brain communication for a collectively bioelectric map of where feelings are. An appeal to everyday life—as in idioms that talk about sites of feelings: “joy in my heart,” “my heart goes out,” “heartbroken,” “a breath of fresh air” and “a sigh of relief”—suggests relative physiological hubs where oscillations come together most often—and where breath can either sustain (synchronizing with the oscillation), or extinguish (exhalation-biased parasympathetic entrainment) emotions through prolonged engagement or release. This theoretical model has clinical (breathwork, HRV biofeedback, interoception training) and research (real world, multimodal recordings of clients/patients) applications. Instead of asking where feelings reside, we can begin to pinpoint how they come together based on DST—a testable theory of embodied affect and applicable theory with mental health translation.

Keywords

Neurophysiological map; Default Space Theory; Peripersonal space.

Introduction

Most prevailing models of consciousness emphasize cortical activation patterns or neural correlates associated with discrete sensory events. DST challenges this sensory-first paradigm, proposing instead that the brain's primary task is to generate a coherent internal spatial framework—a default space—before populating it with perceptual content. This space integrates visual, auditory, somatosensory, and visceral information into a unified, continuously updated field within tens of milliseconds, forming the basis for perception, thought, memory, and imagination.

Yet contemporary affective neuroscience acknowledges an embodied nature of feelings (e.g. tightness in the chest, a twisting stomach, a warm heart); however, the predominant models remain cortico-centric, exploring amygdala, insula, prefrontal structures. Therefore, there exists a disparity between phenomenological versus physiological localization for feelings. Default Space Theory (DST) offers a compelling explanation for such an occurrence by attempting to bridge the divide with consciousness as a distributed, phase-locked oscillatory field—the "default space"—that connects exteroceptive and interoceptive systems, the heart, the lungs, the gut. The default space fields are experienced as extended from one's body externally, which phenomenologically makes it difficult to "pinpoint" a specific location for feelings; however, empirical and phenomenological studies rely on chest–gut–head as global salient centers of where feelings make their home.

Ordinary language further suggests such connections. The heart plays a significant role in positively valenced states—"joy in my heart," "heart holds me up," "warm feelings in the heart," "compassion—my heart goes out to you." Loss corresponds with "breaking my heart" or when euphoric relief/anew is meant as a result of "sighing" one's way back into former balance—"that's a sigh of relief"; "that's a breath of fresh air." Such metaphorical mappings are more than coincidental. They represent stable cultural mappings of interoceptive awareness and align with findings from physiology that show dominating heart–lung phenomena responsible for feelings.

This article formulates an integrated neurophysiological mapped understanding of feelings relative to DST involving: (i) cross-cultural maps of the body; (ii) interoception across the lifetime and cultures; (iii) predictive processing and aphantasia; (iv) reflexes and peripersonal space; (v) heart–brain connections and polyvagal theory; (vi) respiration as harmonizer and (vii) gut–brain interactions. We conclude with future research paths and clinical implications for anxiety, depression, PTSD, and psychosomatic disorders.

Methods and Materials

Design and rationale

This is a theory-building review (conceptual synthesis) because findings across human behavior, neurophysiology, and formal theories converge to construct a testable bioelectric theory of where feelings occur in the body (DST) (Jerath & Beveridge, 2020). We conducted this review to demonstrate that (i) findings are dispersed across subfields that rarely cite one another (e.g., interoception, autonomic neuroscience, breathing, gut–brain studies, predictive processing) and (ii) DST is making spatial–oscillatory predictions that are best supported by triangulating various modalities instead of one experimental approach.

Scope and sources

The six streams of evidence we prioritized included:

1. Body mapping of where people experience emotions/cross-cultural studies (cornerstone evidence for topographical subjectivity).
2. Interoception: Accuracy, sensibility and metacognition through cardiovascular, respiratory, gastrointestinal, endocrine and immune axes.
3. Autonomic neuroscience: HRV, RSA, neurovisceral integration and polyvagal.
4. Respiration: Resonant breathing, baroreflex resonance, phase coupling and cortical excitability/emotion regulation.
5. Gut–brain axis: Enteric rhythms and microbiome signaling that influence affect.
6. Mechanistic integration through theoretical models like DST and predictive processing.

Search and selection strategy

We conducted structured literature reviews in PubMed and Google Scholar with intersecting terms (for example, interoception AND accuracy/sensibility/metacognition; HRV AND emotion; respiration AND slow breathing; electrogastrography AND emotion; bodily maps AND emotion). We prioritized high impact primary research, systematic reviews and programmatic theoretical papers from 2007-2025 with the addition of seminal papers pre-2007 only when necessary for establishing a foundation. Articles were included if they (a) empirically identified relationships between bodily signals and emotion, (b) provided a mechanistic rationale to the signal relative to oscillatory integration, or (c) formally predicted anticipated results based on DST. We excluded papers that either (a) possessed dubious methods (nonvalidated emotion induction, HRV/EGG/EEG preprocessing not reported for appropriate reliability/stability) or (b) speculative commentary without empirical tether.

Operational definitions

- Interoceptive accuracy: objective performance on detection tasks (e.g., heartbeat tracking/counting).
- Interoceptive sensibility: self-reported awareness of bodily sensations.
- Interoceptive metacognition: confidence–accuracy calibration regarding bodily perception.
- Coherence (DST): cross-frequency, cross-organ phase locking (cortex–heart–lungs–gut) that maintains an invariant felt experience.
- Default space: spatially extended, phase-locked oscillatory field that constrains exteroceptive and interoceptive streams.

Data Items and Abstraction

The following was synthesized across the sources used: (a) task context (film, images, resting-state), (b) signals recorded (EEG, fMRI, HRV, respiration, EGG), (c) indices (e.g., HEP amplitude, RMSSD/SDNN for HRV, respiration rate, EGG dominant frequency), (d) emotion induction/labels, (e) topography (e.g., chest/gut/head from body maps), and (f) directions of main effects (e.g., slow breathing increases \uparrow HRV; exhalation increases \uparrow HEP). These elements were categorized relative to DST nodes (cortical, cardiac, enteric, integrative) in order to create a synthesis matrix by compiling similar information across.

Synthesis approach

We applied a narrative–mechanistic synthesis: empirical relationships observed were placed within the structure of DST to ascertain whether changes observed in real life (i.e. HRV increases with slow breathing), plausibly represent greater cross-node coherence and whether predicted hubs are aligned with subjective

localizations (chest/gut/head). In areas where multiple causal avenues exist (predictive coding, DST, etc.), we narrowed the distinction between them by making a claim in our predictions (Section 3/Discussion), especially those with substantiated differentiating factors.

Quality and bias considerations

Since findings can be skewed by signal processing decisions (length of HRV windows, respiratory confounds), for HRV in particular, we favored studies with clear preprocessing and artifact monitoring with correct statistical approaches (respective of respiration gains when making conclusions about HRV). For bodily maps, we relied on the strength of cross-cultural replication and stimulus variety although assessed awareness can be limited by self-report. To control for publication bias, we reported null or mixed results only if there was rigorous application of the methods.

Proposed Multimodal Protocol (for future empirical tests)

To transition from synthesis to testing, we offer a plausible multimodal design that aligns with DST:

Participants: 120 adults (gender balanced; stratified at age bands of 18–35, 36–55, 56–75) to assess developmental impacts
 Tasks: (i) Emotion induction task with videos of matched arousal/valence; (ii) Bodily-map coloring task (continuous tablet-based coloring); (iii) Respiratory pacing blocks (spontaneous breath, 0.1 Hz slow breathing, exhalation-biased breathing).
 Signals: 64-ch EEG, HR (HRV time/frequency domains), respiratory belt and airflow, EGG for gastric momentum; fMRI optional subsample for DMN/insular coupling.
 Outcomes: (a) Coherence measures (phase-locking value) across head-chest-gut signals; (b) HEP amplitude relative to breathing phase; (c) Density of bodily-map in chest/gut/head relative to signal coherence; (d) Moderation by interoceptive accuracy/sensibility/metacognition. .
 Hypotheses: (H1) Slow, exhalation-biased breathing will increase coherence across nodes and shift maps toward chest; (H2) Disgust induction will increase gut association and coherence; (H3) Greater interoceptive accuracy will predict tighter coupling between physiology and map.

Results

Interoception across the lifespan and cultural variability

Interoception involves accuracy (objective interception), sensibility (subjective interception), and metacognition (metacognitive awareness of interception), with each dimensional element developing and varying across culture and gender. For example, older adults may less possess high accuracy yet possess maintained sensibility as they rely more on context and life experience; thus, findings based on nostalgia or social dynamics instead of interoceptive detail are understood Cultural socialization can foster increased interoceptive sensitivity through body practices (e.g., meditation and body-scanning); however, norms that favor emotional suppression reduce interoceptive sensitivity, indicating the need for cross-cultural and ecologically valid assessments that go beyond heartbeat detection in quiet labs Ultimately, such findings suggest that the default space is something that develops (and can change) over time and across cultures, regulating where in the body one feels and reports feelings relative to experience.

Interoceptive precision, mental imagery, and aphantasia

Predictive processing assumes perception is comprised of top-down predictions integrated with bottom-up sensory evidence; the precision of interoceptive signals adjusts this integration. The predictive view of aphantasia suggests that decreased interoceptive precision diminishes the effectiveness of high-gain top-down

predictions blunting imagery and feeling integrative construction; the insula and ACC can adjust gain of prediction errors that become conscious. Relative to DST, decreased interoceptive precision attenuates oscillatory coherence in the default space, reducing feeling vividness; training or vagal stimulation that increase precision increases the likelihood of strengthened imagery and emotion, predicting positive correlations with HEP amplitude, insula–DMN coupling and HRV.

Reflexive mechanisms, peripersonal space, and pre-conscious processing

Defensive reflexes (startle, nociceptive withdrawal) occur over 20–150ms, involve spatial representation of a threat and these reflexes filter conscious attentional processes but are contextually modulated, suggesting a feedback loop of a spatial nature with reflex pathways and higher functions. According to DST, such reflex loops are rapid oscillatory sub-circuits embedded in the default space which protect the body and communicate with conscious assessment, meaning that the biased perception via reflex can alter the spatialized appeal of the feelings.

Geography of emotion: evidence from bodily maps and language

Participants in a 2014 study which took place in multiple conditions indicated where they experienced emotions relative to certain film clips, pictures, and words—anger and fear were located in the chest/head region in similar areas for people across cultures, disgust was located in the stomach, sadness brought in fewer limb activations but still activated the heart center, and happiness was mapped as a whole body activation. Likewise, common metaphors map specific locations: happy feelings are “joy in the heart,” “heart uplifted,” “warm feelings in my heart,” “my heart goes out to you” while negative feelings are “break my heart”; breathing is a location for regulation as “a sigh of relief” or “that’s a breath of fresh air,” mapping on to again the heart (cardio-respiratory) and stomach (enteric) areas. Yet because the most common space is usually externalized (as it contains emotions) and many have a hard time identifying exact spots of feeling, the exact locations may vary—yet consistently, the heart, gut and head are identified as the top three regions of intersection for interoceptive and exteroceptive flows.

Oscillatory allocation of feelings: cortical, cardiac, enteric, and integrative nodes

- Cortical (head): Rapid beta–gamma oscillations foster labeling, orientation, and reappraisal; thalamic relay synchronizes sensory information entry to the competitive coupling of cortical resources.
- Cardiac (chest): Increased HRV signifies vagal–sympathetic predominance; increased HRV correlates with resilience and flexible regulation while decreased HRV suggests susceptibility to stressors.
- Enteric (abdomen): Gastric slow waves correspondent with cortical rhythm; altered gastrointestinal motility due to stress; metabolites of the microbiome influence mood and stress response.
- Integrative node (DMN–thalamo-cortical hub): DMN integrates autobiographical significance with interoceptive information; thalamocortical loops establish a shared global timing that serves as a substrate for cohesive feeling.

Heart–brain coupling, polyvagal theory, and respiration as master synchronizer

The central autonomic network (insula, ACC, medial PFC, brainstem) combines bottom up cardiac/gut signaling

with top-down modulation via the vagus; higher HRV implicates flexible adaptability and ventral-vagal pathways facilitate rapid inhibitory control (the “vagal brake”) necessary for social connectedness and emotional regulation. Breathing into a state of high HRV (~6 breaths/min) supports increases in parasympathetic tone while also facilitating shifts in cortical excitability; inhalation promotes sympathetic preparation while exhalation facilitates vagal dominance which explains how breathing can extend an emotional experience through frequency alignment or inhibit the experience through an exhalation adjusted entrainment.

Discussion

The chest–gut–head triad in DST

These are the predictive areas of feeling for DST, where the cross-frequency coupling is strongest for cortical, cardiac, respiratory and enteric oscillators—head, chest, abdomen—and the exact places where body maps and language suggest feelings. The intimate proximity to the heart from which so many say they feel assessments of positive and negative feelings (like “joy in my heart”, “warm heart”, “my heart reaches out”, “heartbreak”) further suggests that the heart is the source, as does the language of respiration (i.e. “breath of fresh air”, “sigh of relief”) that helps facilitate transitions of state, pitting polyvagal theory and HRV in the fray.

Predictive processing meets DST

Predictive coding suggests that affect emerges from interoceptive predictions fulfilled or disconfirmed by incoming bodily information; precision across interoceptive systems controls the certainty of such information and the top-down emergence of conscious affect. DST adds the spatial underpinnings—where a field exists for coherence of precision weighted signals to cohere: the more coherent and localized, the more acute and certain an affective sense the more diffuse and incoherent, the more uncertain and unstable an effective response—which connects to aphantasia and dulled imagery.

Developmental and cultural modulation

Interoceptive accuracy, sensibility, and metacognition change over the lifespan and are dependent on culture; where contemplative traditions might train sensibility, norms of suppression might dull it, suggesting that both the plasticity of default-space geometry and the localization of feeling are malleable through development and socialization.

Research gaps and methodological standards

Many studies only register a single interoceptive channel (e.g., cardiac accuracy) and in low-ecological settings; future research should employ combined EEG–HRV–EGG and ecological momentary assessment and cross-cultural sampling to measure levels of coherence from the head–chest–gut triad that correspond to similar real-world sentiments. DST hypothesize should be directly compared to cortico-centric models with well-controlled, preregistered studies and advanced multimodal coupling measures.

Clinical Implications of DST Interventions

Breath-paced interventions, heart rate variability (HRV) biofeedback, and interoceptive awareness training represent accessible, low-cost strategies to restore coherence in the respiratory-cardiac-cortical dynamics disrupted in various mental health conditions. For anxiety disorders, these approaches activate the parasympathetic nervous system, reducing sympathetic overdrive and associated symptoms like rapid heartbeat and hyperventilation through techniques such as diaphragmatic breathing. In depression, HRV

biofeedback enhances vagal tone, leading to improved mood regulation and reduced anhedonia by increasing high-frequency HRV power and normalizing autonomic imbalance.

Post-traumatic stress disorder (PTSD) benefits from these interventions by mitigating hyperarousal and intrusive memories, with meta-analyses showing HRV biofeedback reduces PTSD symptoms in military veterans by enhancing emotional regulation and resilience against stressors. Somatic symptom disorders (SSD), characterized by distressing physical complaints without clear medical cause, respond to interoceptive awareness practices that reframe bodily sensations, decreasing symptom amplification via mindfulness-based stress reduction integrated with breathwork. Overall, these methods align with Default Space Theory (DST) by promoting unified awareness of the chest-gut-head triad, where enhanced coherence correlates with symptom alleviation across conditions.

Gastrointestinal-focused interventions, including dietary modifications and probiotic supplementation, modulate enteric rhythms to influence affective valence and gut-brain signaling, particularly relevant for comorbid somatic and mood disorders. High-prebiotic diets rich in fiber improve anxiety and stress by fostering beneficial microbiota that produce short-chain fatty acids, enhancing barrier function and reducing inflammation-linked depressive states. Probiotics, such as strains from *Lactobacillus* and *Bifidobacterium*, alleviate negative mood over time by altering microbiota composition, with daily self-monitoring revealing reductions in anxiety and improvements in sleep quality. In PTSD and SSD, these gut-directed approaches mitigate visceral hypersensitivity, linking enteric coherence to broader triad integration as posited in DST.

DST posits that symptom reduction in anxiety, depression, PTSD, and SSD stems from synchronized oscillations across the chest (respiratory-cardiac), gut (enteric), and head (cortical) regions, achievable through combined breath-HRV-gut strategies. Clinical trials demonstrate that such coherence not only lowers physiological markers like low HRV but also enhances metacognitive awareness, offering a unified framework for personalized interventions. Future research should explore synbiotic protocols (prebiotics plus probiotics) alongside breath pacing to optimize triad harmony in these conditions.

Summary and Conclusions

Emotions are distributed oscillatory events that people feel best in their own hearts, guts, and heads—all places where Nummenmaa's bodily-maps studies and commonplace idioms plant them. Default Space Theory substantiates this relative to a spatially extended field—perceived as outside of oneself—in which interoceptive and exteroceptive rhythms align to constitute feeling. Heart is the most literal node in reference to feeling—“heart of joy,” “heavy heart,” “heart leaps,” “heart goes out” and “heartbroken”—while breath is a master regulator as vagal-mediated respiration can align across systems to extend emotions or exhale to minimize through a “sigh of relief” or “breath of fresh air.” Methodologically, we advocate for multimodal, naturalistic and cross-cultural approaches to measure default-space coherence and derive emotion fingerprints from relative subjective maps, physiology and subsequent neuroscientific dynamics. Clinically, breathing, HRV, and interoceptive awareness stabilization present tangible means for affect regulation, recasting treatment approaches to restore the bioelectric harmonics that integrate mind and body. Reinterpreting where feelings reside as how they come about propels scientific inquiry toward a holistic, biologically verifiable account of emotional embodiment that champions lived experience as much as mechanistic fidelity.

