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Reinterpreting Sensation: A Bioelectromagnetic Framework for the Nine-Sense Model

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Abstract

The classical five-sense model overlooks key dimensions of human sensory experience, failing to account for internally regulated and bioelectrically resonant modalities. This paper introduces a theoretical Nine-Sense Model that expands conventional frameworks by incorporating four additional sensory circuits: hemoperception (vascular sensing), piloception (electromagnetic hair-field sensitivity), vomeronasal chemodetection, and ultrasonic perception. Grounded in anatomical, neurophysiological, and electrophysiological evidence, these circuits are conceptualized as self-regulating bioelectrical loops operating across somatic and autonomic systems. Rather than being pathological or anomalous, they are presented as latent but functional sensory modules within the general population—supported by findings from sensory plasticity, affective neuroscience, and neuroelectric feedback studies. This model reframes sensation not as passive reception, but as a dynamic resonance process involving phase coherence, bioelectrical entrainment, and nonlinear amplification. Perception is thus reinterpreted as an emergent phenomenon of structured circuit interaction—shifting explanatory paradigms from symbolic representation to systemic physiological resonance. By integrating perspectives from cognitive science, neurophysiology, and biophysical communication, this framework offers a novel account of human sensation as a distributed, recursive, and conscious–nonconscious regulatory system. Its implications extend to neurodiversity, trauma perception, and human–machine interfacing.

Keywords: Nine-Sense Model; Bioelectromagnetics; Unconscious Perception; Multimodal Resonance; Piloception

1 Introduction

Scientific models of human sensation have long centered on the classical paradigm of the "five senses": vision, audition, olfaction, gustation, and tactile perception. While this framework effectively maps major perceptual systems and corresponding neural pathways, it has increasingly been critiqued for its limitations in accounting for unconscious, integrative, and emergent sensory phenomena.

Recent research in cognitive neuroscience, sensory neurophysiology, olfactory genetics, and bioelectrical interface science suggests that human sensory processing extends far beyond conscious stimulus recognition. These findings point toward latent sensory pathways with distinct physiological substrates, indicating the need to expand the traditional taxonomy of senses.

In this context, the present study proposes an extended *Nine-Sense Model*, incorporating four additional sensory modalities beyond the classical five: **Vascular Reception**, an interoceptive modality responsive to micro-vibrations and conductive patterns in systemic blood flow; **Piloception**, a mechanosensory and possibly electromagnetic system mediated by pilomotor units and associated capillary networks; **Vomeronasal System**, a chemosensory olfactory tract implicated in pheromone detection and unconscious affective signaling; and **Ultrasonic Perception**, a resonance-based auditory capacity for processing supra-linguistic high-frequency acoustic inputs.

These modalities are not pathological anomalies but represent latent biological functions embedded within the general population, varying in expression and sensitivity.

Furthermore, this paper proposes that human sensory systems function not as passive receptors but as dynamic bioelectrical loop interfaces, capable of modulating and interpreting environmental energy patterns through resonance, field coherence, and feedback regulation. In doing so, the model moves beyond classical stimulus–response theory toward a distributed, system-level framework for sensory cognition.

2 Structure and Limitations of Classical Sensory Theories

2.1 Overview of Classical Sensory Theory

The earliest formal model of human sensation dates back to Aristotle, who proposed five distinct senses—vision, hearing, smell, taste, and touch—as the principal channels through which humans perceive the external world. This five-sense framework has remained foundational in Western physiology and psychology, informing anatomical classification and sensory mapping for centuries.

Modern neurophysiology continues to reflect this traditional structure, assigning specific receptor organs to each sensory modality. Sensory data are conceptualized as electrical signals transmitted via dedicated neural pathways to discrete cortical regions. For instance, vision involves photoreceptors in the retina transmitting signals through the optic nerve to the visual cortex of the occipital lobe; audition arises from cochlear hair cells that activate the auditory nerve and auditory cortex in the temporal lobe; olfaction is processed via the olfactory epithelium and bulb projecting into the limbic system and orbitofrontal cortex; gustation emerges from taste buds on the tongue transmitting through the medulla and thalamus to the gustatory cortex; and tactile perception relies on cutaneous mechanoreceptors relaying information through dorsal spinal roots and the thalamus to the somatosensory cortex.

This model is rooted in the principle of receptor localization and reflects a linear, feedforward view of perception: external stimuli are converted into electrical signals and transmitted for cortical interpretation. However, with the rise of systems neuroscience in the 21st century, new findings in multisensory integration, peripheral modulation, and autonomic feedback challenge this static, unidirectional architecture.

2.2 Structural Constraints of the Five-Sense Paradigm

The classical five-sense paradigm relies on a one-to-one mapping between sensory organs and perceptual categories. While this approach provides a neat taxonomy, it oversimplifies the complex dynamics of actual human sensation. Contemporary research in affective neuroscience, bioelectrical signaling, and somatic entrainment highlights several limitations of this model.

In particular, the five-sense framework fails to account for cross-modal integration, where perceptual content arises from overlapping sensory domains; unconscious or preconscious sensory mechanisms, which influence cognition and emotion outside of awareness; and bioelectrical and energetic feedback systems, which modulate sensory thresholds based on internal physiological states. These constraints indicate that the human sensory system is not a simple receptor-driven array, but a dynamic network of interacting loops and modulatory circuits, many of which operate beyond conscious detection.

2.2.1 Limitations of the Localized Receptor Model

Classical sensory theories assume that each modality arises from a specific, localized receptor and follows a unidirectional pathway to discrete cortical regions. This linear model has been fundamental to traditional neurophysiology but fails to account for distributed processing and autonomic modulation.

Emerging evidence indicates that sensory acuity is dynamically influenced by broader physiological states and neural network interactions. Examples include heightened tactile or auditory responsiveness under anxiety, reflecting emotionally modulated sensitivity; unconscious environmental detection such as responsiveness to humidity, barometric shifts, or electrostatic fields; and cross-modal phenomena like synesthesia, in which perceptual modalities converge or influence one another.

These findings suggest that sensory perception is not solely receptor-driven, but modulated by systemic variables such as bioelectrical gradients, neurohormonal states, and cardiac–neural entrainment.

2.2.2 Exclusion of Unconscious Sensory Pathways

The classical model emphasizes conscious perception, omitting subsystems that function below awareness. However, several neural and peripheral structures demonstrate clear roles in non-conscious sensory modulation. For example, the vomeronasal organ (VNO) responds not only to pheromonal stimuli but also to shifts in atmospheric ion concentration, modulating emotional and behavioral states without conscious detection. In addition, hair follicles and skin-associated electric fields respond to static charges, ion gradients, and barometric fluctuations—a proposed mechanism for what may be classified as piloception.

These systems are frequently mischaracterized as psychological sensitivity or affective temperament. Yet, they may represent legitimate bioelectrical sensory domains, grounded in autonomic and electrophysiological substrates, and further supported by evidence of human physiological synchronization with geomagnetic field variations (Zenchenko et al., 2024, 2025). Moreover, resonance phenomena such as the Schumann resonance may provide an external oscillatory framework that interacts with unconscious neural activity (Cherry, 2003).

2.2.3 Omission of Nonlinear Coupling Between Sensory, Autonomic, and Affective Systems

Classical sensory theories often depict sensation as a static, feedforward process, underestimating its dynamic coupling with the autonomic nervous system (ANS) and affective regulation. However, real-time modulation of perception is closely tied to internal physiological rhythms and feedback circuits.

For instance, heart rate variability (HRV) has been linked to sensory performance, with high HRV associated with enhanced sensory prediction and emotional regulation, and low HRV correlating with either sensory hypersensitivity or blunted perception. Similarly, autonomic phase transitions from sympathetic to parasympathetic dominance enhance responsiveness of systems like the VNO to subtle social chemosignals. Finally, brainstem–limbic loops such as those linking the reticular activating system (RAS), amygdala, and hippocampus modulate sensory prioritization, shaping perception according to stimulus novelty, intensity, and affective valence.

Together, these patterns underscore that sensory systems operate as predictive, resonant networks that encode environmental information in phase with internal bodily rhythms. Future sensory models must incorporate these nonlinear, feedback-driven architectures, bridging sensory neuroscience with bioelectrical and affective loop theories.

2.3 Limitations of Conventional Sensory Classification and the Need for Reorganization

Despite its enduring influence, the classical five-sense framework presents several limitations that hinder a full understanding of human sensory processing. The receptor-centric model, which associates each sense with a discrete anatomical structure and linear signal processing pathway, fails to capture integrative and unconscious aspects of sensation. Key issues include the lack of ANS–sensory integration, whereby perception is dynamically modulated by physiological rhythms such as cardiac cycles, respiratory entrainment, and endocrine fluctuations, yet classical frameworks omit this interoceptive feedback; the neglect of perisensory awareness, where humans respond to sub-threshold environmental cues—including electrostatic fields, ion gradients, and molecular signatures—that influence emotional valence, decision-making, and intuitive responses; the oversimplification of input–receptor mapping, which overlooks the distributed roles of vascular networks, mucosal surfaces, skin appendages such as hair follicles, and intrinsic bioelectromagnetic fields; and the inadequate integration of sensory, affective, and cognitive domains, since sensory input undergoes rapid tagging, filtering, and modulation in limbic circuits including the amygdala and hippocampus, processes that linear stimulus-to-cognition models fail to capture.

In response to these limitations, we propose a revised taxonomy: a *Nine-Sense Integrative Model*, encompassing both conscious and unconscious sensory modalities. This framework incorporates bioelectromagnetic responsiveness, endogenous resonance, and ionic–neural feedback loops as core components of sensory experience. It invites a reclassification of perception grounded in systems physiology and complex network interactions. (See Appendix B for a detailed mapping of hair-based sensory structures responsive to electromagnetic and microbial signals.)

3 Beyond the Classical Senses: Toward a Resonant Nine-Sense Framework

3.1 Taxonomic Expansion Toward a Resonant Sensory Architecture

Traditional sensory models define perception through five classical modalities, each linked to distinct receptor sites and cortical targets. While anatomically coherent, this classification fails to accommodate emerging evidence of distributed, feedback-driven, and unconscious sensory operations.

Structural shortcomings in the conventional model include the omission of ANS coupling, given that sensory systems function in concert with autonomic patterns such as heart rate variability, baroreflex sensitivity, and circadian endocrine modulation; the exclusion of perisensory mechanisms, since humans are perceptually affected by ambient electric fields, chemical gradients, and vibratory frequencies that shape affective tone and somatic alertness even below perceptual thresholds; the neglect of distributed biological networks, as sensory interpretation arises not only from terminal receptor firing but also through feedback in vascular matrices, body hair arrays, epithelial fields, and endogenous electromagnetic resonances; and the failure to account for nonlinear sensory–limbic–cognitive coupling, in which sensory signals are modulated in real time through affective circuits, with rapid interplay among the brainstem, thalamus, amygdala, and hippocampus, thereby integrating emotional tagging and memory encoding into primary sensory processing.

Given these insights, we propose transitioning from a Five-Receptor Conscious Model to a *Nine-Sense Integrative Framework*, capable of accommodating sensory modalities grounded in both bioelectromagnetic physiology and unconscious loop architecture. This framework enables a more complete and predictive model of sensory cognition that aligns with findings in systems neuroscience, affective physiology, and computational bio-signaling.

3.2 Extended Sensory Modalities: Hemoperception, Piloception, Ultrasonic Perception, and Vomeronasal Resonance

3.2.1 Hemoperception (Vascular Sensory Reception)

Hemoperception introduces a novel form of interoceptive sensing mediated by the dynamic resonance of vascular structures. Rather than functioning purely as conduits for blood flow, anatomical loci such as the aortic arch, carotid sinus, and hypothetical cerebrovascular "loop" systems may act as internal resonance chambers, transducing acoustic and mechanical signals generated within the circulatory system.

These structures exhibit tuning-fork-like resonant behavior, akin to tympanic membranes or cochlear mechanics, yet operate on endogenous signals such as cardiac pulsation, cerebrovascular pressure waves, and EEG-synchronized hemodynamics. In this context, the vascular system functions as a distributed bioacoustic sensor, interfacing with autonomic control and interoceptive awareness through oscillatory feedback and entrainment mechanisms (Craig, 2002).

Hemoperception thus extends the concept of vascular function into a multi-layered biophysical transduction system, participating in emotion regulation, baroreflex coordination, and neurovisceral coherence.

3.2.2 Piloception (Hair-Field Electromagnetic Reception)

Piloception is herein proposed as a distinct sensory modality, independent of classical tactile processing, rooted in the electromagnetic responsiveness of body hair units. The follicular neural plexus, combined with cutaneous field potentials, is highly sensitive to electrostatic gradients, atmospheric ions, and friction-induced microcurrents.

Critically, the medulla of the hair shaft, often overlooked, may serve an analogous function to the medulla oblongata in signal modulation and resonance reception—suggesting architectural convergence across macro- and micro-sensory systems.

Additionally, the skin's biofilm layer, composed of microbial communities, enhances electrochemical sensitivity through ion exchange and dielectric field amplification. This places body hair at the intersection of biological electromagnetism and microbiome–host interactions.

Piloception should therefore be reframed not as a tactile extension but as an electromagnetically tuned, ambient-field-responsive sensor network, capable of non-conscious detection of environmental energies and dynamic gradients.

3.2.3 Ultrasonic Perception

Ultrasonic perception refers to the unconscious detection of high-frequency acoustic waves above 20 kHz, traditionally considered beyond the human auditory spectrum. This system appears to activate preferentially under sympathetic nervous system dominance and is associated with vestibulocochlear regulation and intracranial pressure dynamics.

Its salient properties include sensitivity to barometric pressure shifts and sub-audible vibrations, responsiveness to high-frequency emissions from electronic devices, heightened activation in subjects with hyperacusis or absolute pitch, and engagement of non-canonical auditory pathways including cerebrospinal fluid oscillations and palatal musculature. Importantly, fetal and neonatal responsiveness to amniotic ultrasonic fields supports the hypothesis that this modality is developmentally conserved.

The integration of ultrasonic signals with vomeronasal and piloceptive systems suggests a triadic resonance axis operating beneath conscious awareness, facilitating environmental threat detection, social signal modulation, and bioelectromagnetic entrainment.

3.2.4 Vomeronasal Resonance (Jakobsonian Perception)

The vomeronasal organ (VNO), traditionally dismissed as vestigial in adult humans, is reinterpreted here as a chemosensory resonator capable of detecting pheromonal, hormonal, and ionically encoded biofield cues. Its core features include the reception of low-molecular-weight chemosignals and endogenous semiochemicals, signal transmission via independent pathways in the inferior nasal septum, modulation of affective and intuitive perception particularly during socially or survival-relevant events, and functional synchronization with ultrasonic and electromagnetic sensory loops.

The VNO's sensitivity fluctuates across autonomic states, becoming acutely responsive during transitions between sympathetic and parasympathetic dominance. In such states, subtle chemical cues—otherwise imperceptible—are resonantly encoded and interpreted, often influencing behavior without cortical mediation.

Thus, vomeronasal resonance is not a passive olfactory remnant but a gateway to subcortical affective–sensory integration, mediating unconscious responses to environmental and interpersonal fields.

3.3 Sensory Loop Systems: Interactive Architectures of the Expanded Sensory Model

Traditional sensory frameworks depict the five classical modalities—vision, audition, olfaction, gustation, and tactile perception—as discrete, unidirectional input channels, each linked to localized receptors and linear cortical processing.

However, accumulating evidence in neurophysiology, bioelectric signaling, and affective neuroscience points toward an integrative, feedback-driven model of sensory processing. In this revised framework, sensation is not a terminal response to stimuli but a dynamic resonance loop embedded within autonomic, emotional, and endocrine circuits. We identify three primary loop architectures as foundational structures within the extended Nine-Sense Model.

3.3.1 Ultrasonic–Vomeronasal Loop

This loop represents an integrative interface between ultrasonic sensitivity—the unconscious detection of high-frequency vibratory and pressure waves—and vomeronasal chemoreception, which processes pheromonal and electromagnetic field–linked chemical cues. Together, these systems function as an affective–spatial sensory axis, tuned to environmental and social valence.

Key features of this loop include multimodal integration, in which high-frequency acoustic input combines with chemosensory signals to enhance nonverbal environmental awareness; affective threat detection, enabling the identification of emotional states and the modulation of behavioral responses such as avoidance or alertness; and resilience in low-vision conditions, facilitating situational awareness when visual and auditory inputs are attenuated.

For example, the simultaneous activation of vomeronasal and ultrasonic circuits in environments with low light or intense social stimuli enables real-time decoding of interpersonal intent and environmental risk—even in the absence of conscious perception. The loop also demonstrates sensitivity to high-frequency emissions from electronic devices, shifts in atmospheric pressure, and composite olfactory–electromagnetic cues.

3.3.2 Hemoperception–HRV Loop

The hemoperceptive–cardiac loop posits a bidirectional coupling between vascular resonance structures, such as the aortic arch and carotid bodies, and heart rate variability (HRV), which reflects autonomic nervous system state. This feedback system acts as a real-time oscillator, transducing emotional waveforms and synchronizing affective rhythms with circulatory dynamics (Armour, 2004).

Its core functions include affective modulation, since emotional stimuli can alter HRV, which in turn reshapes vascular resonance and systemic tone; cardioacoustic entrainment, whereby rhythmic auditory inputs such as music or speech prosody entrain cardiac rhythms and reinforce affective states; and endocrine linkage, in which vascular-resonant stimuli modulate neurohormones such as vasopressin and cortisol, thereby influencing arousal and relaxation.

This loop allows for internal coherence tuning, wherein entrainment by rhythmic, affectively salient external stimuli leads to improved emotional regulation and resilience. It demonstrates how physiological rhythm becomes an interpretive substrate for sensation and cognition, consistent with evidence that human HRV can synchronize with geomagnetic field variations both under ordinary conditions and during strong magnetic storms (McCraty et al., 2017, 2018; Zenchenko et al., 2025).

3.3.3 Piloception–Electrostatic Loop

The piloceptive loop involves the detection of electrostatic gradients, ion flows, and proximity-induced microcurrents via hair follicle fields and cutaneous sensory networks. Unlike tactile perception, which depends on mechanical contact, this loop is sensitive to ambient electromagnetic flux and affective–emotional proximity.

Principal mechanisms include electrodermal responses, as sudden field shifts induce skin surface potential changes that manifest as piloerection or localized tingling; proxemic electroperception, in which the detection of human proximity via ionic field overlap contributes to unconscious spatial boundary awareness; and emotional translation, whereby emotional tension or arousal alters electrostatic sensitivity, amplifying piloceptive input and internal readiness.

This loop underlies phenomena such as the “feeling of being watched,” sudden chills in social contexts, or intersubjective tension in confined spaces. These experiences, often misattributed solely to emotion, may instead emerge from bioelectromagnetic entrainment and feedback between organisms in shared environments.

3.3.4 Multidimensional Loop Integration and Neural Redistribution

Each of the proposed sensory loops—ultrasonic–vomeronasal, hemoperceptive–cardiac, and piloceptive–electrostatic—functions not in isolation but as a dynamically interconnected system. These loops interact with both the autonomic nervous system (ANS) and central sensory integration hubs, including the brainstem, thalamus, and cortical regions. The result is an emergent network of composite sensory mappings responsive to internal states and environmental signals.

In functional terms, three representative loop combinations can be identified. The **Ultrasonic–Vomeronasal loop** combines high-frequency resonance with pheromonal and chemical detection, producing affective boundary sensing and mapping of social tension. The **Hemoperception–HRV loop** integrates vascular resonance with cardiac rhythm entrainment, enabling emotional calibration and stress modulation. The **Piloception–Electrostatic loop** responds to electrostatic charge gradients and cutaneous sensitivity, supporting spatial modulation and guiding approach–avoidance prediction.

Moreover, these loops exhibit adaptive reconfiguration in response to sensory deficits or environmental changes. Visual impairments are often accompanied by enhancement of olfactory–auditory–vomeronasal loops; auditory disruption may prompt rerouting via olfactory bulb–pineal–prefrontal pathways; and multisensory imbalance can trigger dynamic RAS-driven sensory reprioritization.

These reorganizations are not evidence of pathology, but rather reflect latent integrative capacities inherent to the human sensory system. The loops function as predictive, non-verbal affective sensors, shaping unconscious appraisal of safety, proximity, and intersubjective cues.

3.4 Language-Mediated Suppression of Sensory Circuits

Although the human sensory system is evolutionarily designed for multidimensional, full-spectrum reception, linguistic development exerts a neurological filtering effect on non-verbal sensory channels. This phenomenon is herein termed *language-mediated sensory suppression*.

While language serves as a highly evolved tool for symbolic thought and interpersonal communication, it also imposes semantic constraints that attenuate or redirect unconscious sensory input. During cognitive development, the brain prioritizes information that can be coded and retrieved linguistically, relegating signals from non-verbal channels—such as hemoperception, ultrasonic sensitivity, and vomeronasal detection—to subcortical or unconscious pathways.

Mechanistically, this filtration is mediated by the Reticular Activating System (RAS), which functions as a neurocognitive gatekeeper, prioritizing stimuli based on novelty, valence, and linguistic relevance. Sensory information that lacks linguistic mapping is often disregarded or attenuated, leading to dormancy in sensory loops that are nonetheless biologically intact.

3.4.1 Developmental Trajectory Example

Pre-verbal infants communicate using affective resonance patterns, such as tonal vocalizations and rhythmic gestures—modes consistent with bioelectromagnetic entrainment. However, as phonological precision and syntactic structure dominate language development, these early resonance circuits are progressively overwritten by language-based encoding.

Yet this suppression is not irreversible. Under certain physiological or environmental conditions—such as autonomic phase shifts, trauma, or environmental electromagnetic exposure—previously dormant sensory loops may reengage, often misinterpreted as pathological hypersensitivity rather than reactivated biological capacity.

3.4.2 Illustrative Case: Sensory Avoidance as Neuroadaptive Compensation

Behaviors typically associated with autism spectrum profiles, such as gaze avoidance, are often mischaracterized as social or communicative deficits. This model proposes an alternative interpretation: such behaviors may reflect electromagnetic hypersensitivity to ocular emissions. The human eye is not merely a passive visual receptor but an active bioelectromagnetic emitter, projecting subtle electrical fields tied to emotional and cognitive states. Direct gaze may overload piloceptive and vomeronasal systems, particularly in individuals with lower RAS thresholds or reduced cortical suppression mechanisms.

This interpretation aligns with colloquial observations such as "feeling someone's gaze" or "the heat of a stare." In this context, sensory avoidance becomes a regulatory strategy, not a deficit—a behavioral manifestation of deeper, unconscious sensory loop modulation in response to affective saturation. These insights challenge prevailing assumptions in sensory neuroscience and open a pathway toward neuro-inclusive models that embrace unconscious perception, distributed cognition, and adaptive feedback-based sensory regulation.

3.5 Multi-loop Integration Map

Traditional theories of sensory cognition rest upon the premise of five discrete modalities—vision, audition, olfaction, gustation, and somatosensation—each corresponding to a dedicated anatomical receptor and functionally isolated neural processing pathway. In contrast, the model presented herein reconceptualizes the human sensory system as a multi-loop, resonance-based network, wherein perception emerges from dynamic, feedback-oriented interactions among multiple sensory–autonomic circuits. This revised framework is visualized as a *Multi-loop Integration Map*, emphasizing the systemic, affective, and electromagnetic coherence underlying unconscious sensory processing.

3.5.1 Coordinate Architecture of Sensory Loops

The proposed integration model organizes perception along two axes: a **Sensory Type Axis**, encompassing auditory, olfactory, tactile, electrostatic, and vascular inputs; and a **Functional Domain Axis**, spanning emotional regulation, spatial mapping, social signaling, and threat appraisal. From this dual-axis organization emerge three primary loop classes.

Physiological loops include hemoperception, defined as vascular resonance detection, and piloception, which provides skin–hair electroreceptive feedback. Affective loops encompass vomeronasal resonance, responsible for social chemosignal processing, and ultrasonic perception, associated with high-frequency vibratory awareness. Resonance loops include HRV–EEG entrainment, which integrates cardiac rhythms, and microelectrical field tracking, involving CSF flow and biofield gradient reception.

These loops converge onto core neural substrates including the brainstem–thalamus–amygdala axis, while also engaging distributed bioelectrical systems such as EEG patterns, CSF oscillations, and lymphatic conduction fields.

3.5.2 Triadic Loop Interaction and Resonance Matrix

Contrary to classical unidirectional models, sensory loops within this framework interact as resonant triads—co-activating multiple circuits in response to electrochemical, spatial, or emotional perturbations. These "loop clusters" form affective sensory circuits, each grounded in physiological organ–nerve–field triads.

Representative examples of such triadic loops illustrate their distinct resonance features and functional outcomes. The **Ultrasonic–Vomeronasal–Olfactory Bulb loop** combines high-frequency vibration with chemical biofield interaction, enabling affective boundary mapping and facilitating emotional synchrony. The **Hemoperception–HRV–Amygdala loop** operates as a cardio-emotional oscillation circuit, supporting autonomic regulation and adaptive stress arousal responses. The **Piloception–Electrostatic–Pineal loop** integrates skin field potentials with photon–ion exchange, providing heightened spatial proximity sensitivity and modulating gaze-related feedback. The **Olfactory Bulb–Fornix–Hippocampus loop** links molecular signaling to memory networks, generating scent-triggered recall and the activation of limbic imprints. Finally, the **Vestibular–Auditory–Eustachian Tube loop** fuses barometric feedback with inner ear pressure calibration, underpinning environmental orientation and equilibrium awareness.

Together, these composite loops allow for flexible phase entrainment—a coherent state in which perception, emotion, and physiology synchronize in response to internal or external resonance stimuli.

3.5.3 Tentacular Sensory Architectures: A Comparative Paradigm

The proposed model reframes human sensory cognition as analogous to non-visual, loop-centric sensory architectures observed in species such as *Octopus vulgaris* (distributed limb cognition), *Onychophora* (velvet worms), and mollusks such as *Helix aspersa*. These organisms exhibit non-centralized, field-responsive sensing through fluidic and electrical tentacles.

In humans, three tentacular systems are proposed. The **Olfactory–Vomeronasal–Amygdala Axis** supports chemical and pheromonal social-emotional decoding. The **Vestibular–Eustachian–Auditory Axis** enables barometric sensing and spatial pressure equilibrium. The **Piloceptive–Electrostatic–Pineal Axis** detects ambient charge fields, photonic gradients, and interpersonal proximity.

These systems operate as non-visible biological antennae, capable of perceiving ionic fluctuations, micro-magnetic and pressure gradients, and electromagnetic or acoustic phase modulations.

3.5.4 Sensory Circuits as Pre-perceptual Filters

A central postulate of this model is that conscious perception is preceded by unconscious sensory loop activation. That is, visual and cognitive perception are not primary but emergent, arriving only after subcortical entrainment of sensory–emotional rhythms, filtering through the Reticular Activating System (RAS), and neural–cardiac–electrical resonance consolidation.

Sensory circuits act as pre-perceptual interpreters, autonomously managing attention shifts, safety detection, social distance regulation, and affective tone adjustments. In this framework, vision functions as a surface-level, post-sensory modality, downstream of more ancient and diffuse sensory loop architectures.

Conclusion of Chapter 3 The human sensory system is redefined not as a discrete input hierarchy, but as a resonant network of multidimensional loops—electrochemical, vascular, affective, and atmospheric—that prefigure perception itself. This model offers a compelling basis for future inquiry into bioelectromagnetic cognition, affective neurophysiology, and multisensory integration.

3.5.5 Diagrammatic Representation of the Integrated Sensory System

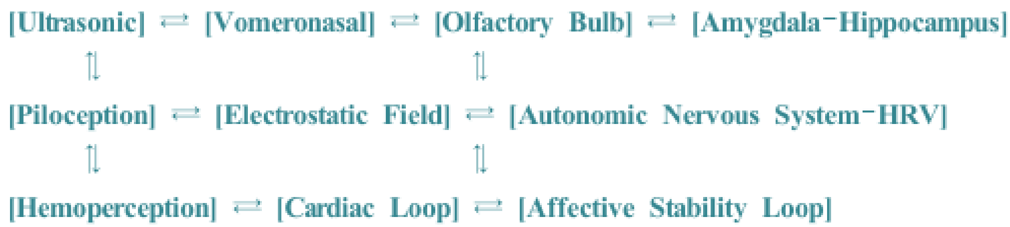

Figure 1: Diagrammatic representation of the integrated sensory system. This schematic illustrates the recursive feedback relationships among ultrasonic, vomeronasal, olfactory, piloceptive, electrostatic, autonomic, hemoperceptive, and cardiac loops, converging into affective stability dynamics.

This integrative map redefines human sensation as a dynamic, resonance-based network. Unlike the classical five-sense paradigm, which emphasizes linear and modality-specific processing, this framework highlights recursive feedback systems that link sensory perception to emotional regulation, spatial encoding, and social signaling.

These interconnected loops function as multi-dimensional information-processing structures, capable of real-time adaptation to internal physiological states and external environmental cues. Rather than being speculative, this architecture provides a coherent neuroscientific substrate for interpreting unconscious perception and affective cognition. It lays the conceptual foundation for future interdisciplinary research in sensory physiology, cognitive neuroscience, and bioelectromagnetic interface theory.

3.6 Information Flow and Resonance Circuit Integration in the Extended Sensory System

3.6.1 Input-to-Output Flow Across Resonant Sensory Pathways

The extended sensory system is not confined to traditional sensory input mechanisms. Instead, it operates as a loop-based transduction matrix, capable of detecting sub-threshold waveforms—such as vibratory pressure, electrostatic gradients, ionic fields, and chemical flux.

In the **input phase**, external stimuli including electromagnetic, chemical, and mechanical signals are detected by expanded sensory receptors such as hemoperception, piloception, ultrasonic sensitivity, and the vomeronasal organ. These inputs undergo biophysical transduction via vascular oscillation, skin conductance, CSF vibration, and chemoreception.

In the **processing phase**, signals are transmitted into resonant neural circuits involving the olfactory bulb, amygdala, hippocampus, fornix, and pineal gland, all modulated by the autonomic nervous system and internal physiological rhythms.

In the **output phase**, sensory processing modulates affective states, respiratory patterns, gaze orientation (via photonic micro-emission), postural reflexes, and electrostatic feedback, such as goosebumps or hair-field activation in social proximity. This sequence forms a closed-loop mechanism wherein resonance replaces reaction and entrainment replaces linear causality.

3.6.2 Resonant Circuitry and Affective Information Architecture

The system does not follow a one-sense–one-pathway logic. Instead, it relies on multi-node, resonance-based integration. Within this framework, several representative circuit axes can be identified. The **Olfactory–Amygdala–Hippocampus** axis couples emotion and memory through chemical signals, thereby enabling affective tagging of environmental cues. The **VNO–Vestibular–Pineal** axis integrates magnetoception, orientation, and circadian alignment, supporting both spatial mapping and temporal synchronization in social contexts. The **Hemoperception–HRV–Cardiac Loop** links vascular resonance with cardiac variability to facilitate emotional entrainment, stress adaptation, and the maintenance of inner stability. The **Piloception–Skin–Atmospheric Electrodynamics** axis detects presence and proximity through electrostatic gradients, contributing to social field awareness and the regulation of spatial safety. Finally, the **Ultrasonic–Inner Ear–Photon Resonance** axis provides visual substitution under occlusion by orienting the individual in environments where conscious visual input is limited.

These interlocking modules are regulated by the Reticular Activating System (RAS) and are selectively activated under altered states of autonomic polarity or in response to contextual shifts in environmental valence.

3.6.3 Multi-Resolution Architecture of Sensory Resonance

The proposed system can be modeled as a tiered resolution framework, stratified by cognitive accessibility and affective depth. This framework may be described across three distinct resolution levels.

At the **high level**, the classical five senses dominate, providing conscious sensory awareness through inputs such as visual stimuli and vocal language.

At the **mid level**, circuits including hemoperception, piloception, and ultrasonic perception operate primarily at the pre-conscious layer. These loops support functions such as threat detection, arousal mapping, social intuition, and environmental vigilance.

At the **low level**, the VNO–Amygdala–Pineal circuits mediate deep affective mirroring and emotional resonance. In this tier, empathic convergence and the modulation of spatial boundaries become salient outcomes of resonance-driven processing.

This structure suggests that the conscious mind is not the primary sensory processor, but rather a late-stage interpreter of pre-conscious affective data streaming through multisensory loops.

3.7 Conclusion

This study presents a radical reinterpretation of the human sensory system, proposing that sensation functions not through discrete, static modalities, but as a network of bioelectromagnetic resonance loops that underlie unconscious perception, emotional cognition, and physiological entrainment.

By extending the classical five-sense model to a Nine-Sense Loop Architecture, the model integrates additional modalities. **Hemoperception** refers to vascular wave detection, **Piloception** describes hair-field electroreception, **Ultrasonic Perception** denotes supra-auditory resonance, and **Vomeronasal Resonance** captures chemo-electromagnetic affective detection.

This framework also enables a novel understanding of sensory-related processes. **Emotion and intuition** can be understood as legitimate sensory functions. **Social proximity** is reconceptualized as an electromagnetic phenomenon. **Perception** itself is reframed as looped entrainment rather than linear signal interpretation.

Future applications and implications emerge from this reorganization. The model suggests a **diagnostic redefinition of neurodivergent hypersensitivity**, including autism and PTSD, as forms of loop hyperactivation. It informs the **development of bio-affective interfaces** in artificial intelligence, robotics, and human–computer interaction. It also provides a foundation for **novel psychophysiological treatments, sensory therapies, and human–environment interaction design**. This integrative model realigns human perception with its resonant biological substrate, laying the foundation for the next generation of affective neuroscience, bioengineering, and sensory cognition research.

4 Extended Sensory-Based Cognition and Interpretive Circuitry

4.1 Limitations of Conventional Cognitive Models: Input Reduction and Interpretive Narrowing

Contemporary cognitive theories—including information processing frameworks and constructivist paradigms—typically assume that sensory input is both consciously accessible and uniformly interpreted. However, three critical limitations undermine this view.

First, **selective sensory filtering** drastically reduces information throughput. The human cognitive system processes less than one percent of incoming sensory data at the conscious level, primarily due to pre-cortical filtration via the Reticular Activating System (RAS) and associated cortical gating mechanisms.

Second, there is a **language-based bias in interpretation**. Conventional cognition privileges verbalizable information, thereby excluding non-verbal phenomena such as spatial intuition, vibrational entrainment, and bioelectromagnetic feedback from interpretive legitimacy.

Third, the **marginalization of body-based cognition** leads to the misclassification of physiological signals. Circadian rhythms, gut sensations, heart rhythms, and skin conductivity are often relegated to categories such as "emotion" or "instinct," dismissed as irrational rather than integrated as components of distributed cognition. These constraints suggest that traditional cognitive models operate on a narrowed bandwidth of human sensory–emotive–physiological intelligence.

4.2 Extended Sensory Cognition: Reinstating Body-Centric Interpretive Systems

This study proposes an expanded model of cognition that restores the physiological body as a legitimate substrate of interpretation, underpinned by parallel processing in unconscious sensory loops. Three key principles define this model.

First, **parallel resonance processing** describes how data from piloception, hemoperception, ultrasonic sensing, and vomeronasal perception is distributed across networks involving the hippocampus, amygdala, brainstem, and prefrontal cortex, often without reaching conscious awareness.

Second, **emotion–physiology–interpretation integration** emphasizes that sensory signals are not merely inputs but are embedded within affective circuits linking autonomic nervous system feedback, emotional waveforms, and memory structures.

Third, **pre-linguistic meaning emergence** highlights that meaning arises somatically and affectively prior to verbal articulation. For instance, bodily withdrawal or affective discomfort often precedes the linguistic statement "I dislike this," demonstrating that embodied cognition constitutes a primary level of interpretation. This reconceptualization acknowledges the preverbal, resonance-based foundation of meaning-making.

4.3 Resonance-Based Interpretive Flow Across Sensory Loops

Extended sensory loops contribute to cognition through distinct pathways of input, resonance, and awareness. The **Ultrasonic loop** processes high-frequency vibrations that manifest as spatial tension or a sense of foreignness, operating largely through unconscious resonance. The **Hemoperceptive loop** is tuned to HRV and vascular rhythms, generating empathic states such as comfort or fear and guiding intuitive judgment. The **Piloceptive loop** responds to electrostatic shifts and gaze flow, supporting presence detection and heightened alertness that culminates in reflexive responses. The **Vomeronasal loop** detects chemosensory–affective signals, giving rise to trust, bonding, or aversion and shaping semi-verbalized appraisals of social contexts. Together, these loops generate meaning below the threshold of consciousness, shaping reflexive and affective responses that in turn influence higher cognition.

4.4 Cognitive Expandability and Neuromodulatory Nature of Sensory Loops

Extended sensory systems are not merely passive input channels. They modulate emotion, perception, survival instincts, and social cognition by operating through resonance-based entrainment with environmental and interpersonal signals.

The **Ultrasonic–Vomeronasal loop** processes high-frequency auditory and chemical–affective inputs in tandem. Ultrasonic tones in confined spaces may elicit heightened vigilance, while stress-related chemosignals from conspecifics promote social withdrawal. When ultrasonic and vomeronasal inputs co-resonate, the result can be affective openness or defensive arousal. These dynamics function independently of conscious processing and in parallel with intact visual–auditory pathways.

The **Hemoperception–Cardiac loop** connects vascular resonance with HRV-based emotional interpretation. Stable rhythms, such as those in music, can entrain HRV and produce affective stabilization or catharsis. Threat stimuli, including harsh tones or sharp gazes, suppress HRV and activate fight-or-flight responses. Conversely, soothing voice prosody can upregulate vagal tone and stimulate oxytocin or vasopressin release. These mechanisms illustrate how internal–external rhythm matching influences perception, emotional judgment, and physiological regulation.

The **Piloception–Electromagnetic loop** enables electroreceptive awareness of presence and proximity. Fluctuations in electromagnetic fields excite hair follicles and trigger alert postures or chills. Gaze-related voltage detection alters skin conductivity and prompts spatial withdrawal. Ultrasonic interference may generate auditory distortions or mental fatigue. This process is not tactile in the classical sense, but rather a non-contact electrostatic sensing mechanism.

Multi-loop emotional operations also emerge from these interactions. For instance, the combined activation of the ultrasonic and vomeronasal loops can produce social bonding or territorial defensiveness. Hemoperception coupled with auditory input supports emotional regulation through rhythmic entrainment. Piloception combined with ultrasonic resonance generates reflexive distancing and environmental alertness, while vomeronasal inputs interacting with the amygdala trigger chemosensory-driven affective appraisals. These mechanisms reflect adaptive survival algorithms rather than sensory overactivity, with their subtlety lying in preconscious operation selectively gated by the RAS.

Finally, sensory sensitivity requires reframing. Conventional terminology such as "hypersensitivity" or "overreaction" risks pathologizing normal neurosensory variation. What is often labeled dysfunction may instead reflect lower RAS thresholds that increase loop accessibility, mismatches between external stimuli and internal rhythms rather than cognitive errors, or the preservation of ancestral circuits that enable advanced resonance detection. From this perspective, sensory sensitivity is better understood within a differentiated taxonomy of sensory cognition rather than through psychiatric pathologization.

4.5 Meta-Frame of Extended Cognitive Circuits

Traditional cognitive neuroscience has predominantly conceptualized human cognition as a linear, hierarchical process of sensory input, central processing, and behavioral output. While foundational, this classical stimulus–response model inadequately captures the multidimensional and dynamic nature of cognition when viewed through the lens of the extended sensory loop system. In contrast, the model proposed in this study reinterprets cognition as a synchronized, bidirectional system governed by resonance-based loops that operate across physiological, emotional, and environmental domains.

4.5.1 Reframing Invisible Circuits

The extended sensory–cognitive model introduces unconscious, non-visual sensory networks as critical components of interpretation and response. These "invisible circuits" remain masked by dominant sensory channels such as vision and audition, yet they constitute the functional core of body-based cognition.

Several defining characteristics distinguish these circuits. They exhibit **bidirectional and resonance-based information flow**, in which cognitive processing emerges not from strict top-down or bottom-up patterns but from phase-aligned oscillatory communication between peripheral and central nodes. They also display **phase-coupled activation**, where responses are governed more by frequency coherence, entrainment, and waveform phase alignment than by raw stimulus magnitude. In addition, they demonstrate **affective–visceral synchrony**, since autonomic rhythms, emotional states, and environmental electromagnetic fields coalesce to establish baseline states of interpretive alignment prior to explicit cognition. Finally, they embody **contextualized resonance rather than discrete input**, mapping waveforms modulated by emotional and environmental fields into bodily meaning rather than isolating input channels. This framework redefines cognition as a systemic phenomenon, one that emerges from whole-body phase resonance rather than localized cerebral computation.

4.5.2 Hierarchical and Cyclical Nature of Sensory Loops

Sensory cognition arises from layered, interwoven loop systems that operate in hierarchical yet recursive cycles. At the level of **primary loops**, vomeronasal and hemoperceptive inputs connect with the hippocampus, amygdala, and the heart to support affective detection and survival-oriented awareness. **Secondary loops**, including ultrasonic and piloceptive pathways, link to skin conductance, vestibular, and auditory circuits, producing environmental sensitivity and electromagnetic awareness. **Tertiary loops**, such as vision and olfactory bulb pathways, are associated with the hypothalamus, pineal gland, and prefrontal cortex, providing interpretive classification and external world assessment. In addition, **cross-loops** form composite resonance structures through the fornix, brainstem, inner ear, and autonomic circuits, enabling deep unconscious integration and systemic affective entrainment. Each tier responds to a specific resonance domain—acoustic, electromagnetic, chemical, or mechanical—and collectively contributes to adaptive cognitive coherence.

4.5.3 Physiological Origins of Cognitive Bias

Conventional psychology often treats cognitive biases as errors in judgment attributed to flawed reasoning or emotional interference. Within a resonance-based framework, however, biases are reconceptualized as frequency–phase imbalances across loop systems. For example, **spatial anxiety** arises from dysregulation in the ultrasonic–vestibular loop and phase instability in inner ear balance. **Social withdrawal** reflects vomeronasal hypersensitivity and amplified chemosignal detection that lead to emotional over-entrainment. **Memory distortion** can result from interference in hemoperception–HRV rhythms, producing noisy encoding within hippocampal–fornical circuits. **Cognitive overload** emerges from excessive piloceptive activation under ambient electromagnetic field saturation, which reduces filtering efficiency. These patterns are not inherently pathological, but instead reflect individual variations in sensory-loop calibration. They signal resonance diversity rather than dysfunction.

4.5.4 Integrating Verbal and Nonverbal Cognition

The extended model provides a framework for integrating nonverbal, resonance-based cognition with language-based processing. As humans develop auditory–visual linguistic structures, resonance loops are often suppressed, though not eliminated, through gating mechanisms of the Reticular Activating System (RAS). Language development prioritizes symbolic encoding and frequently excludes subtle bioelectromagnetic and chemical signals. Nonetheless, nonverbal circuits persist in latent form and can be reactivated during altered physiological states, such as heightened autonomic arousal, environmental changes, or meditative attentiveness. In this light, invisible cognition is not lost but filtered. It remains a reclaimable domain of cognition, particularly under conditions that reduce cortical dominance or enhance bodily resonance awareness. This model thus suggests that the resonant body can be reintegrated into cognitive science not as metaphor, but as a quantifiable, phase-sensitive interpretive structure.

5 Bio-Planetary Magnetic Resonance System

5.1 Earth's Magnetic Field and the Human Nervous System

The Earth's geomagnetic field constitutes a pervasive yet underrecognized environmental force that modulates biological systems across multiple species, including humans. Electromagnetic phenomena such as atmospheric ion gradients and solar magnetic fluctuations have been shown to correlate with key physiological rhythms—particularly EEG oscillations, cardiac variability, and circadian timing (Zenchenko et al., 2024, 2025).

Crucially, the suprachiasmatic nucleus (SCN), pineal gland, and retinal photoreceptors do not function solely as light sensors. Rather, they form a light–magneto-receptive interface capable of transducing photonic and electromagnetic stimuli into endocrine and neurophysiological responses. Melatonin secretion, for example, is not only regulated by light exposure but also shows sensitivity to geomagnetic fluctuations, influencing sleep cycles and emotional homeostasis.

In addition, limbic structures such as the hippocampus and amygdala exhibit modulated activity in response to geomagnetic field disturbances, potentially altering emotional regulation, spatial memory, and stress sensitivity. These findings align with the previously proposed resonant electromagnetic model of the heart–brain axis, which emphasized human synchronization with planetary-scale fields (Lee, 2025; Oh et al., 2025).

5.2 Environmental Response Loops and Atmospheric Architecture

The human sensory system houses an environmentally attuned feedback circuit involving the vomeronasal organ (VNO), olfactory bulb, pineal gland, and fornix—a system that extends beyond olfactory or hormonal signaling. This loop is electromagnetically responsive, capable of entraining with atmospheric ionic distributions and electric field differentials spanning from Earth's surface to the ionosphere.

Rather than functioning as a linear relay, this loop represents a resonant biological architecture capable of synchronizing its electrophysiological rhythms with extrinsic field dynamics. Shifts in the vertical atmospheric potential gradient, modulated by weather patterns or solar activity, can enter phase alignment with internal oscillatory systems, producing changes in mood, intuitive perception, and affective boundary awareness.

Such entrainment is particularly active under conditions of low visual input, autonomic reorganization, or exposure to natural electromagnetic phenomena such as lightning, auroras, or seismic precursors. These effects underscore the human body's receptivity to geophysical cues that exceed conscious detection, providing a foundation for future studies in bio-environmental entrainment and non-classical sensory integration.

5.3 Evolutionary Origins of Biological Resonance Systems

The human capacity for electromagnetic and resonance-based perception is not anomalous but evolutionarily rooted in the sensory systems of aquatic life forms. Numerous species, including the electric eel (*Electrophorus electricus*), skates, and catsharks (*Scyliorhinidae*), possess specialized electroreceptors that enable environmental navigation, prey detection, and intra-species signaling via external electric fields.

Human neural resonance loops represent a phylogenetic continuation of this sensory lineage, adapted to terrestrial conditions but retaining latent responsiveness to bioelectrical and geomagnetic stimuli. Embryological development mirrors this aquatic heritage: the early human embryo exhibits features such as pharyngeal arches, a caudal tail, and buoyant suspension within the amniotic sac—traits indicative of our evolutionary origin in aquatic environments.

Notably, newborn reflexes such as the bradycardic diving response and instinctive swimming motions reflect retained sensory–motor integrations from prenatal aquatic conditions. The postnatal transition from a fluid-filled, low-gravity environment to the air-dense, gravity-bound terrestrial world initiates a reorganization of sensory hierarchies, often downregulating electromagnetic and hydrodynamic perceptual circuits to favor vision and audition.

However, these "suppressed" sensory capacities do not vanish. They persist as background systems, activated in specific autonomic states or environmental contexts. Consequently, the human body remains an integral component of a planetary-scale bioresonant matrix, challenging reductionist sensory models and calling for a new paradigm in which human cognition and affect are entrained within Earth's electromagnetic architecture.

5.4 Phase Entrainment of Bio-Planetary Rhythms

Human physiological oscillations—such as heart rate (approximately 1 Hz), respiration (approximately 0.25 Hz), and neural wave bands from delta to gamma (approximately 0.5–100 Hz)—resonate within the frequency bands of planetary electromagnetic activity. Most notably, these rhythms align with the Earth's Schumann resonance (7.83 Hz), a global electromagnetic standing wave generated by lightning discharges within the cavity between Earth's surface and the ionosphere (Cherry, 2003).

This cross-scale coherence may provide a neurophysiological substrate for phenomena such as emotional regulation, group empathy, circadian entrainment, and even synchronized social behavior in collective settings including audiences, rituals, and group flow states. Conversely, clinical syndromes such as seasonal affective disorder (SAD), mood instability, chronic fatigue, and insomnia may be reconceptualized as bio-environmental phase desynchronization syndromes. These conditions could reflect disruptions in the entrainment between endogenous rhythms and exogenous field dynamics, influenced by solar activity, geomagnetic turbulence, or ionospheric compression.

6 Conclusion: Rethinking Sensation and New Frontiers in Neurophysiology

The human sensory system must no longer be understood as a limited ensemble of five discrete modalities. Instead, it operates as a multi-looped, resonance-based biological interface capable of transducing a diverse array of physical signals, ranging from chemical gradients, electromagnetic fields, and ultrasonic vibrations to pressure waves and electrostatic flux.

This study proposes the Extended Sensory Loop Model, which reorganizes human perception as an interconnected network of conscious and unconscious sensory circuits, deeply interwoven with the autonomic nervous system, affective regulation, and environmental adaptation.

Several key contributions emerge from this model. First, **affective–sensory integration loops** demonstrate that sensory data does not passively await cognitive categorization. Instead, it modulates emotional states and autonomic outputs in real time, forming the substrate for interpretation, bonding, and survival responses. Second, **unconscious sensory circuitry** highlights the roles of pathways such as vomeronasal resonance, piloception, hemoperception, and ultrasonic detection. These circuits operate beneath awareness yet dynamically shape affective decisions, spatial judgments, and social synchrony. They are repressible but not extinguished, and can be selectively reactivated under autonomic transitions, altered attention states, or environmental shifts. Third, the **social semiotics of sensation** reframes sensory signals—such as eye contact, goosebumps, micro-movements, breathing patterns, and thermal gradients—as semiotic codes within unconscious social communication. Through this lens, sensation becomes not only a detection function but also a language of the body, facilitating nonverbal emotional exchange and resonant social presence.

This model transitions the field from a stimulus–response paradigm to a loop-based resonance framework, reframing the human organism as a sentient interface that continuously interprets, adjusts to, and co-regulates with its environment through wave-based interactions. The theoretical scaffold presented here extends the HBAM model (Hierarchical Bioelectrical Affective Mapping) articulated in Part III, positioning Jacobson's organ (VNO) as a central resonant node in planetary-scale sensory navigation. This structure enables triadic coordination among emotional states, memory architecture, and geomagnetic coherence, thereby expanding the scope of sensory neuroscience to encompass bio-planetary feedback systems. As further elaborated in Appendix B, the proposed Hair–Electromagnetic–Bacterial (HEB) Phase Field Model exemplifies how microstructural sensory substrates contribute to resonance-based perception and planetary-scale entrainment.

Ethical Statement

This research offers a non-invasive theoretical model for understanding expanded biological sensation, grounded in principles of bioethical responsibility, sensory pluralism, and ecological humility. No animal testing, biological harm, or invasive procedures were conducted or endorsed. The Extended Sensory Loop Theory is speculative yet anchored in comparative physiology and cognitive neuroscience, aiming to illuminate diverse perceptual modalities across species. Future empirical work derived from this model must rigorously comply with international ethical standards, including the Declaration of Helsinki, the Belmont Report, and ARRIVE guidelines. Researchers must safeguard the sensory integrity, dignity, and agency of all sentient life forms involved in future investigations.

Finally, this work affirms that non-normative sensory perception—whether in neurodivergent individuals or in other species—should not be pathologized. Scientific engagement with sensory diversity must be guided by epistemic humility and by a systems-level appreciation of life's complexity. Through this perspective, human beings can better understand their resonant embeddedness in a planetary system of dynamic biological communication.

A Sensory Modalities Table – Nine Senses and Extended Electromagnetic Organs

No.	Sensory Modality	Function / Description	Primary Organ(s)
1	Vision	Bidirectional exchange of photonic information: light detection and emotional/memory projection	Retina (Photoreceptors and Output Synaptic Spark Fields)
2	Audition (Hearing)	Detection of sound waves, rhythm, and spatial mapping	Cochlea, Auditory Cortex
3	Olfaction (Smell)	Detection of volatile molecules; memory access	Olfactory Bulb, Jacobson's Organ, Fornix
4	Gustation (Taste)	Detection of chemical properties in food (ions, pH)	Taste Buds (Tongue, Palate), Gingiva, Sub-lingual Sensors, Teeth
5	Tactile (Touch)	Detection of pressure, vibration, texture	Skin (Meissner's & Pacinian corpuscles), Hair Root (piezoelectric antenna)
6	Thermoception	Detection of temperature variation	TRP Channels (Skin, Hypothalamus)
7	Nociception (Pain)	Detection of harmful mechanical, thermal, or chemical stimuli	Free Nerve Endings
8	Proprioception	Perception of body position and motion in space	Muscle Spindles, Vestibular System (Semicircular Canals, Otoliths, Eustachian Tube)
9	Magnetoreception	Detection of geomagnetic fields for orientation and navigation	Jacobson's Organ, Vestibular Labyrinth, Pineal Gland, Aortic Arch
–	Electroreception[1]	Detection of electric and magnetic changes via surface structures	Hair Root (piezoelectric), Aortic Arch, Facial Microhairs, Skin EMF Antenna

Table 1: Sensory modalities within the extended Nine-Sense Model with a proposed tenth domain of electroreception.

B Functional Mapping of Human Hair as Electromagnetic–Bacterial Sensory Structures

Body Region	Primary Function	Sensory Inputs Detected	Associated Organs / Systems
Scalp Hair	Pheromone dispersion, ambient electric field detection	Electrostatic charge, geomagnetic variation, memory trace	Vomeronasal Organ, Vestibular Apparatus, Olfactory Cortex
Nasal Vibrissae	Vibrational olfactory sensing, bacterial filtration	VOCs, EMF, thermal gradient, particulate oscillation	Vomeronasal Organ, Nasal Epithelium, Trigeminal System
Periauricular Hair	Resonance amplification, directional sensing	Sound waves, magnetic vectors, micro-vibrations	Vestibular System, Semicircular Canals, Auditory Cortex
Eyebrows / Eyelashes	Pre-stimulus detection, electrostatic shielding	Airflow, dust particles, stimulus potential	Visual Cortex, Frontal Sensory Lobe
Facial Vellus Hair	Micro-current detection, thermosensory flow mapping	EMF, thermal shift, affective waveforms	Trigeminal Nerve, Somatosensory Cortex
Axillary & Inguinal Hair	Pheromonal emission, proximity-induced sensitivity enhancement	Body odor (chemosignals), heat, tactile proximity	Vomeronasal Organ, Endocrine System
Periareolar & Anogenital Hair	Sensory gate protection, intimate contact feedback	Temperature, touch, pheromonal cues	Cutaneous Nerve Terminals, Autonomic Nervous System
Beard / Mandibular Hair	Geomagnetic wave conduction, spatial orientation sensing	Directional fields, EMF, memory-frequency resonance	Mandibular Nerve, Brainstem Circuits
Body Hair (General)	EMF reception, thermal differentials, resonant signal amplification	Heat variation, magnetic flux, electrostatic field	Integumentary System, Aortic Arch, Electrosensitive Receptors

Table 2: Functional mapping of human hair as an electromagnetic–bacterial sensory system.

Hair–Electromagnetic–Bacterial Phase Field Model

The Hair–Electromagnetic–Bacterial Phase Field Model (HEB Model) conceptualizes body hair not as a passive thermoregulatory system, but as an active sensory interface. Each hair acts as a bio-electromagnetic antenna, embedding pheromonal, thermal, and phase-aligned bacterial signals into localized electric fields. These microstructures contribute to navigation, memory resonance, emotional encoding, and geomagnetic alignment, functioning within a distributed multimodal sensory–bacterial loop.

C Multimodal Phase Mapping of Jacobson's Organ

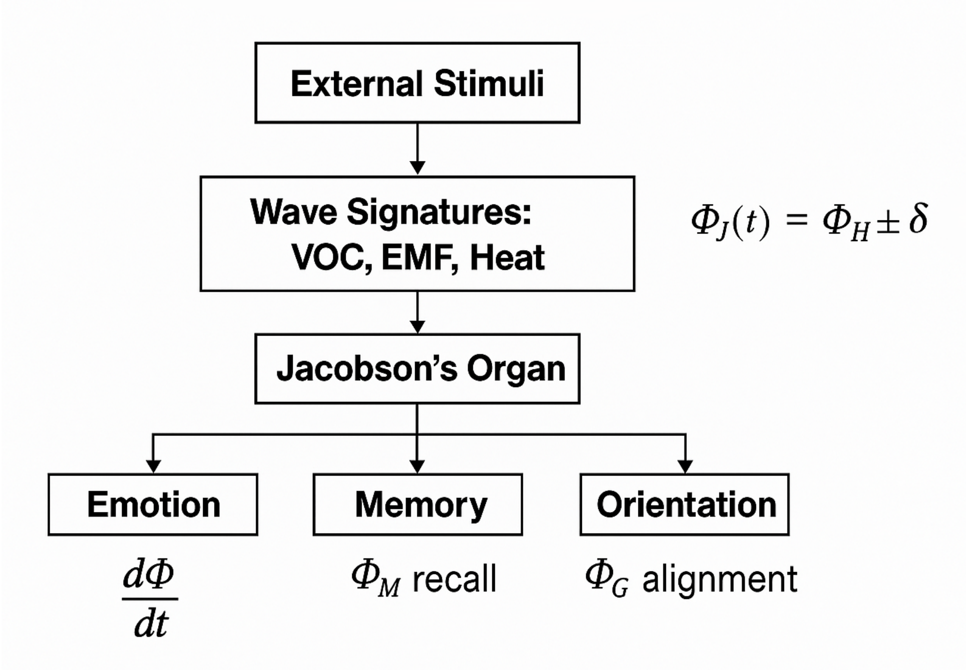

Figure 2: Multimodal phase mapping of Jacobson's organ. External stimuli are transduced into wave signatures (volatile organic compounds, electromagnetic fields, thermal gradients), which are then processed through Jacobson's organ. The outputs are distributed into affective ($\frac{d\Phi}{dt}$), mnemonic (Φ_M recall), and orientational (Φ_G alignment) domains, highlighting its role as a resonant hub for integrating environmental signals into cognitive–affective processes.

List of Abbreviations

Abbreviation	Full Term
HRV	Heart Rate Variability
VNO	Vomeronasal Organ
EEG	Electroencephalography
RAS	Reticular Activating System
SCN	Suprachiasmatic Nucleus
SAD	Seasonal Affective Disorder
EMF	Electromagnetic Field

Table 3: List of abbreviations used in this study.

Declaration

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All data and materials relevant to this study are included within the article.

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Author contributions
D. Lee (Doha Lee) conceived the study, performed the analysis, prepared the manuscript, and approved the final version.

Competing interests
The author declares no competing interests.

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