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Article

Oxytocin & Soma: A Neurobiological Hypothesis Linking Vedic Descriptions of Higher States of Consciousness to Social Neuroendocrinology

Oxytocin as correlate of Soma

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Abstract

Soma is a central yet enigmatic concept in Vedic literature, described as a plant or elixir associated with elevated states of consciousness such as refined perception, inner bliss, reduced fear, and a sense of unity, though its biological basis remains unresolved. In a modern reinterpretation, Maharishi Mahesh Yogi proposed that Soma need not be an external substance but may reflect an internally generated biochemical process arising during states of transcendence, characterised phenomenologically by inner silence, emotional openness, and expanded awareness. Oxytocin is a well-characterised neuropeptide that modulates social bonding, trust, affiliative behaviour, and autonomic stress regulation. Synthesised in the hypothalamus and released both centrally and peripherally during childbirth, breastfeeding, sexual activity, and affiliative social interactions, oxytocin extends beyond attachment to regulate threat processing and emotional salience, modulate self–other boundaries, and promote prosocial behaviour, thereby contributing to reduced stress reactivity, enhanced emotional resilience, and improved psychological wellbeing, with emerging evidence suggesting broader effects on physical health and health span. This paper advances a comparative neurophenomenological hypothesis that selected features attributed to Soma **-** such as reduced fear, enhanced connectedness, and experiential unity **-** may correspond to oxytocin-related neurobiological effects, generating empirically testable predictions through endogenous measurement during meditation and experimental oxytocin administration.

Keywords: consciousness; transcendental meditation; gut-brain axis; microbiome; longevity

Introduction

In the ancient Vedic tradition, Soma occupies a prominent and foundation place. Revered as the divine nectar of consciousness, Soma is celebrated in the Rig Veda, the oldest and most philosophically rich of the four Vedas, not only as a sacred substance but also as a symbolic bridge between individual awareness (the Self), and the outer world (object). The Rig Veda extols Soma as a sacred juice extracted from a now-lost botanical source, believed to awaken vitality, clarity, illumination, and transcendence. When ritually consumed, Soma was said to induce profound states of expanded perception, divine communion, and bliss states in which the boundaries of Self faded into universal intelligence [1–4]. Yet, despite its central role in Vedic tradition, the precise nature and physiological underpinnings of Soma remain poorly understood.

In a modern interpretation of these ancient Vedic texts, **Maharishi Mahesh Yogi**, the founder of Transcendental Meditation (TM), described Soma not as an herb but as a **biochemical substance produced within the nervous system** during deep meditation. He proposed that Soma emerges in

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higher states of consciousness (Supplement Materials) [5], in which the individual gains stable access to pure awareness even while engaged in waking, dreaming, or sleeping states. In higher states of consciousness, the capacity for love and devotion expands, and perception becomes exalted. Perception shifts from purely material to a more subtle, interconnected reality. All sensory experiences become enriched i.e. colors more vivid, sounds more melodious, nature is more alive and vibrant and there is a spontaneous feeling of unity with all creation arises. It is in these states, Soma is abundant, facilitating the experience of bliss, love, and wholeness that transcends ordinary perception. According to Maharishi, in the absence of Soma, perception becomes fragmented and susceptible to stress.

Meanwhile, in modern neurobiology and psychology, oxytocin has emerged as one of the most important modulators of social and emotional experience. Often referred to as "the social hormone" or "the bonding molecule," oxytocin plays a central role in facilitating trust, attachment, empathy, and emotional warmth [6,7]. Oxytocin levels rise markedly during key life events and intimate interactions - most notably during childbirth, breastfeeding, sexual intercourse and orgasm, affectionate touch, and moments of deep interpersonal trust, particularly when we allow ourselves to be vulnerable. It enhances the sense of safety and connectedness, dampens the stress response, and promotes prosocial behaviors such as cooperation, empathy, and generosity. Oxytocin also appears to increase emotional resilience, enabling individuals to endure profoundly challenging experiences such as the pain of childbirth, months of sleepless nights with a newborn, the compromises of marriage, or selfless care for others during times of crisis. It reinforces the emotional glue and empathy that helps us stay connected when the life is hard [7,8]**.** Recent emerging research has also revealed oxytocin's broader influence on cognition, physical and mental health [9–12]. Oxytocin reduces amygdala activity, increases parasympathetic activation and through this, is bringing the body into a state of rest, recovery, and receptivity [9–12].

Oxytocin is not merely a molecule of affection but may serve as a biological foundation for the subjective experiences of warmth, unity, euphoria, emotional resilience, a sense of limitless potential, and unconditional love - qualities traditionally described in contemplative traditions as hallmarks of higher consciousness and expanded awareness. These parallels with Soma invite a deeper inquiry into the shared physiological substrates that may underlie ancient descriptions of inner bliss, connection, and transcendence.

A central challenge in consciousness science is explaining how experiences of connection, self-transcendence, and reduced self-referential processing arise from identifiable neurobiological mechanisms. Despite advances in mapping neural correlates of perception and cognition, affective and relational dimensions of consciousness remain difficult to operationalise and are often excluded from empirical models. Existing frameworks prioritise cortical and cognitive processes, with limited integration of neuroendocrine systems that regulate safety, affiliation, and autonomic state. This creates a gap between structured phenomenological descriptions from contemplative traditions and experimentally tractable biology. This paper addresses this gap by proposing a comparative neurophenomenological framework linking specific phenomenological features of higher states of consciousness to oxytocin-related neurobiological mechanisms. By articulating testable hypotheses and measurable predictions, it aims to advance consciousness research toward integrative models that incorporate affective neurobiology, autonomic regulation, and lived experience.

Within this comparative neurophenomenological framework, the paper examines:

- Maharishi Mahesh Yogi's reinterpretation of Soma as an internally generated biochemical process associated with transcendence and refined states of awareness.
- The role of oxytocin in social bonding, emotional regulation, stress modulation, prosocial behaviour, resilience, and health span.
- Convergent phenomenological features described in both traditions, including internal coherence, reduced fear, enhanced connection, emotional stability, and experiences of unity.

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- The potential influence of consciousness-based practices, particularly Transcendental Meditation, alongside lifestyle factors such as routine and nutrition, on endogenous oxytocin-related physiology and psychophysiological wellbeing.

Soma in the Vedic Tradition

Soma is simultaneously described as a deity and a substance, a sacrament and a symbol. In the Rig Veda, Soma is celebrated as the "drink of the gods," a celestial nectar believed to bestow immortality, divine perception, vitality, and bliss [3,13].

The Vedas are a collection of ancient Sanskrit texts composed between approximately 1500 and 500 BCE, widely regarded as the foundational scriptures of Hindu thought. They comprise hymns, philosophical dialogues, and ritual manuals offering deep insight into early Indian cosmology, metaphysics, and religious practice. More than 120 hymns in the Rig Veda are dedicated to Soma, making it one of the most frequently invoked deities in Vedic literature [3]. These sacred verses often portray Soma as a golden, effervescent liquid extracted from a mysterious plant, ritually prepared and consumed by Vedic priests and deities to invoke altered states of consciousness, divine communion, and transcendental insight [13,14]. In these hymns, Soma is said to elevate consciousness, sharpen the intellect, and expand perception [13,14]. While some scholars have attempted to identify Soma with specific botanical substances (such as Ephedra sinica, Amanita muscaria, or Sarcostemma acidum), its identity remains uncertain [15,16].

Maharishi Mahesh Yogi offered a radically different interpretation and refinement of the Soma concept. According to Maharishi, Soma is not merely a plant-based psychoactive agent, but a biochemical substance produced in the body when the nervous system becomes deeply purified through the regular practice of TM and the TM-Sidhi program (advanced technique of TM) [5]. He taught that in higher states of consciousness, a refined physiology begins to produce Soma as a by-product of transcending. This biochemical substance enhances clarity, compassion, bliss, and love, softening the small self into universal intelligence while dissolving ego-boundaries into unity. At the same time, it anchors awareness in the deeper Self, enabling action from a state of inner stability and expansiveness [5].

To further understand the nature of this refinement, it is helpful to consider Soma in relation to Ojas, another key concept in Vedic physiology. Although interpretations vary, Maharishi viewed the two as essentially unified, with Soma more closely associated with consciousness and Ojas with the body [17]. Extending this perspective, we propose conceptualizing Soma as the refined, bliss-producing internal biochemical that arises from a coherent mind–body system, and Ojas as the stable physiological substrate that enables this refinement to emerge and be maintained [14]. Ojas can be viewed as a state of optimal psychophysiological functioning characterized by high vagal tone, balanced immunity, gut barrier integrity, microbial stability, efficient metabolism, low oxidative stress, emotional resilience, and coherent neuroendocrine signaling [18,19].

Oxytocin in Modern Neurobiology

Oxytocin, often referred to as the "bonding" or "social" neuropeptide, is synthesized primarily in the hypothalamus and released both centrally and into the peripheral circulation via the posterior pituitary. It plays an important role in regulating social bonding, trust, emotional regulation, and prosocial behavior. The aim of this paper is not to provide an exhaustive review of oxytocin biology, but to situate oxytocin within a specific comparative neurophenomenological framework relevant to consciousness research. Accordingly, we acknowledge substantial heterogeneity and ongoing debate in the literature, including strong context dependence of oxytocin's effects (e.g., ingroup versus outgroup interactions), variability in receptor distribution and signaling across brain regions, sex-specific differences in oxytocin function, dissociations between central and peripheral oxytocin measures, and mixed or context-specific findings in studies using intranasal oxytocin administration.

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Physiological Functions

Oxytocin's most well-known physiological roles include:

- Childbirth: Oxytocin triggers uterine contractions during labor [20].
- Lactation: It facilitates milk letdown during breastfeeding by stimulating the mammary glands [21].
- Touch and warmth: Skin-to-skin contact and affectionate touch stimulate oxytocin release and create feelings of safety, trust and warmth [22].
- Sexual intercourse and orgasm: Both women and men release oxytocin during sexual intercourse, especially during climax, but women typically release it in greater quantities and are more sensitive to its effects, amplifying feelings of closeness, bonding, and emotional connection [23].

The Positive Feedback Loop of Oxytocin

A distinctive feature of oxytocin is its action through a positive feedback loop, which plays a crucial role in amplifying and sustaining the biological and emotional processes it supports [24–27]. In childbirth, for example, oxytocin-induced uterine contractions stimulate further oxytocin release, progressively intensifying labour until delivery is complete. Similarly, during breastfeeding, the infant's suckling on the nipple of the breast triggers oxytocin release, which facilitates milk letdown, encouraging continued nursing and nurturing interaction [24].

This feedback mechanism underlies the physiological and affective states associated with orgasm, affectionate touch, and skin-to-skin contact. Its effects manifest biochemically through measurable alterations in hormonal and neural activity, and phenomenologically as increased feelings of warmth, comfort, intimacy, trust, and positive affect. Each affiliative interaction, including close physical contact, eye gaze, or gentle touch, both initiates and augments oxytocin release, progressively strengthening perceived safety and interpersonal trust. This iterative process strengthens bonding and promotes further affiliative behaviours, creating a self-reinforcing oxytocin loop that stabilizes relationships, sustains attachment and reproductive behaviours, and supports emotional and physiological resilience [25–27].

Attachment and Caregiving

Oxytocin plays a central role in the formation and maintenance of attachment bonds across the lifespan. In early development, oxytocin contributes to the establishment of secure caregiver-infant attachment by promoting behavioral attunement, affective regulation, and reciprocal responsiveness [7,8]. Oxytocin facilitates the consolidation of early relational experiences that influence the functional architecture of the developing brain, particularly in circuits governing stress regulation, social cognition, and emotional processing. These early attachment dynamics serve as a foundational template for subsequent relational stability and resilience [28]. In contrast, deprivation of touch in early childhood has been associated with reduced endogenous oxytocin activity and dysregulation of stress physiology (elevated cortisol levels) as well as impaired attention to social cues, resulting in behavioral and socio-emotional difficulties later in life [29,30]. In adulthood, oxytocin continues to support attachment in romantic relationships, enhancing empathy, caregiving behavior, and long-term pair bonding [7,8].

Emerging evidence indicates that olfaction is a key sensory pathway through which these attachment processes are regulated [31,32]. Unlike other sensory modalities, olfactory inputs project directly to limbic structures involved in emotion and memory, including the amygdala, hippocampus, and hypothalamus. Oxytocin receptors are highly expressed throughout the olfactory bulb and related cortical regions, and oxytocin release enhances olfactory sensitivity, social recognition, and the encoding of emotionally salient memories. In both humans and animals, scent cues play a critical role in caregiver-infant bonding, partner recognition, and the perception of safety,

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suggesting that olfactory-oxytocin interactions form a neurobiological substrate for attachment behaviors [31].

Attention, Learning, Memory, and Emotional Salience

Oxytocin plays a critical role in learning and memory processes, particularly within socially and emotionally salient contexts. It modulates neural activity in the amygdala, hippocampus, and prefrontal cortex, key regions involved in emotional processing, memory consolidation, and executive control, thereby enhancing the encoding and retrieval of interpersonal experiences.

In addition to its role in memory consolidation, oxytocin modulates attentional processes by directing cognitive and emotional resources toward socially relevant cues. This selective attentional bias increases the perceived salience of emotionally meaningful interactions, enhancing the processing of faces, vocal expressions, gestures, and trust-related signals. By coupling attentional focus with affective engagement, oxytocin facilitates more robust encoding of socially significant experiences, thereby supporting adaptive social learning. Notably, oxytocin enhances attention to social cues irrespective of group membership, indicating a generalized mechanism for social signal prioritization [33,34].

These mechanisms enable individuals to more effectively identify supportive others, interpret emotional nuance, and form durable patterns of trust and social connection. By coordinating attentional, affective, and mnemonic processes, oxytocin promotes a neurocognitive environment that biases individuals toward trust, empathy, and affiliative engagement rather than fear, hypervigilance, or social withdrawal. In doing so, oxytocin helps establish the conditions necessary for psychological healing, adaptive social learning, and the formation of meaningful interpersonal bonds [9].

Integrating olfactory pathways into this framework adds a further layer of explanatory depth. Because olfactory cues directly activate oxytocin-responsive limbic circuits, familiar scents such as the smell of a partner, infant, or loved one, can rapidly evoke calm, reduce cortisol, and trigger the neuroendocrine cascade that supports endurance, emotional openness, and bonding [32].

Mood, Endurance, and the Sense of Invincibility

Oxytocin exerts significant modulatory effects on mood, perception, and behavioural endurance. During intense emotional contexts, such as childbirth, caregiving, deep affiliative bonding, or romantic intimacy, oxytocin release is associated with enhanced stress tolerance and a subjective sense of increased capacity or “invincibility.” Through its interactions with limbic, autonomic, and reward-related circuits, oxytocin facilitates sustained caregiving behaviour and prosocial motivation even under conditions of physical or emotional strain. This neuroendocrine support underlies the prolonged vigilance, emotional availability, and behavioural endurance observed in demanding relational contexts, such as attending to a newborn through repeated nights of disrupted sleep, providing continuous support to a sick partner or child, or sustaining the heightened intensity of early-stage romantic attachment. In these situations, oxytocin enables individuals to tolerate substantial emotional and physical burdens with relative ease [35].

These states can be experienced as intensely positive, sometimes even euphoric, as if the usual limits imposed by exhaustion, fear, or self-protective responses have temporarily diminished. Individuals may subjectively feel highly energized, emotionally expansive, and deeply present [36,37]. This reflects oxytocin’s unique capacity to override pain, fatigue, and fear, enabling acts of extraordinary compassion, devotion, and resilience that often seem to transcend normal human limits [36,37].

Neuroplasticity and Psychological Healing

Recent research suggests that oxytocin plays a vital role in neuroplasticity and psychological healing, especially in individuals recovering from trauma [38]. Emotional remodelling with oxytocin

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durably rescues trauma-induced behavioral and neuromorphological changes in rats [12]. By modulating neural activity in the amygdala, hippocampus, and prefrontal cortex, oxytocin influences not only the processing of emotional memory but also synaptic plasticity - the capacity of neural circuits to form, strengthen, and reorganize connections in response to experience [38].

Oxytocin enhances the encoding and retrieval of emotionally positive or affiliative experiences, facilitating the recognition of safety and social connection. Concurrently, it supports accurate fear discrimination and promotes adaptive fear responses, helping individuals distinguish between threatening and non-threatening stimuli [39]. It facilitates the extinction of fear-based or aversive memories, thereby reducing hypervigilance and promoting adaptive emotional reprocessing [39]. Together, these mechanisms create a neurobiological milieu that supports healing, resilience, and secure attachment, forming the basis for deep recovery and adaptive transformation in both clinical settings and consciousness-expanding practices.

Trust and Social Bonding

Oxytocin is widely recognised for its powerful ability to enhance trust, generosity, and emotional closeness in the context of social interactions. Pioneering research, including the seminal study by Kosfeld et al. (2005) [40], demonstrated that intranasal administration of oxytocin significantly increases individuals' willingness to trust strangers during economic exchange tasks, underscoring its central role in facilitating prosocial behavior [41]. Importantly, this effect is not confined to financial or transactional settings. Oxytocin has also been shown to increase empathy, promote sustained eye contact, and foster emotional openness, particularly in situations marked by vulnerability, confession or high emotional intensity [42]. These effects contribute to a strengthened sense of mutual understanding and a deepening of interpersonal bonds, positioning oxytocin as a key neurochemical underpinning of cooperation, forgiveness, and social cohesion.

Oxytocin enhances the ability to accurately read emotional expressions, supporting more nuanced and empathic communication, altruistic behaviour and collaboration within social groups, reinforcing group solidarity [26,42]. Furthermore, studies by Zak and colleagues [43,44] highlight oxytocin's role in everyday social rituals such as direct eye contact, hugging, prayer, reinforcing mechanisms for the emotional bonds that constitute the fabric of human connectedness. Through these convergent pathways, oxytocin functions as a neurobiological mediator of trust, attunement and interpersonal closeness, processes that are essential for individual wellbeing and the maintenance of social cohesion.

Oxytocin, Stress, and the Neurobiology of Social Bonding Under Threat

While stress is often linked to fear and defensive reactivity, emerging evidence reveals a parallel biological pathway, largely driven by oxytocin, that fosters social affiliation and caregiving, promoting prosocial behaviour, affiliative motivation, and emotional connection [45].

Taylor et al. [46] proposed the "Tend-and-Befriend" model, showing that oxytocin is released during acute stress particularly in women alongside cortisol. Rather than initiating fight-or-flight alone, this hormonal profile encourages caregiving and social bonding as adaptive survival strategies. These effects appear across genders and are especially strong in collective threats—combat, disasters, pandemics—where rising oxytocin levels foster emotional closeness and group cohesion, reinforcing resilience, altruism, and greater social cohesion during crisis. Palgi et al. [47] found that trauma survivors often report deeper interpersonal bonds and greater empathy after inhalation of oxytocin. Interestingly, synchronised actions such as marching, dancing, singing and chanting, collective rituals, including shared meals and communion, further amplify oxytocin-mediated trust [45,48].

Together, these findings indicate that oxytocin is a key mediator of human morality, prosocial resilience, and social cohesion under stress, fostering empathy, trust, and caregiving that enable groups to withstand and adapt to collective adversity.

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Oxytocin & Health Span

Emerging evidence suggests that oxytocin exerts wide range of health effects and may contribute to improved longevity. Oxytocin has been shown to reduce systemic inflammation and apoptosis, promote wound healing, enhance immune function, and facilitate recovery from illness and psychological stress [36].

Oxytocin may play a an important regulatory role in metabolic, cardiovascular, and neuroendocrine systems, contributing to what could be described as physiological rejuvenation [49–57]. Oxytocin has been shown to reduce cravings for alcohol, nicotine and food, latter resulting in reduced meal size, snack consumption and overall caloric intake [58]. A human study using intranasal oxytocin has been shown to reduce plasma insulin, reduce insulin resistance, increase insulin secretion [49]. Interestingly, oxytocin receptors are present in pancreatic islets and directly support beta-cell proliferation and survival helping to protect against beta-cell loss in type 2 diabetes [50]. In animal studies, oxytocin has been shown to have cardioprotective effects especially in ischaemia-reperfusion setting where it reduces infarct size, decreases inflammation, enhances scar vascularizarion and improves cardiac output through effects on parasympathetic system, nitric oxide, atrial natriuretic peptide and AMP-activated protein kinase pathway (AMPK) and PI3K/Akt pathways [49]. It also stimulates heart stem cells from epicardium to differentiate into cardiomyocytes promoting regeneration of heart muscle [51,52]. Oxytocin has also promising effects in Alzheimer's disease and fronto-temporal dementia. In mice, oxytocin reduced beta-amyloid in hippocampus and attenuated microglial activation and neuroinflammation - key drivers of neurodegeneration [53–56].

Oxytocin has been shown to have anti-proliferative and anti-metastatic potential in some cancers [59], including breast [60,61], ovarian, and gastro-intestinal [62] and in untreatable advanced metastatic disease [63]. However, these effects are not universal. Some evidence indicates that oxytocin may have neutral or even adverse effects in some cancer types, highlighting the complexity of its receptor signaling pathways [64].

Yoon and Kim reviewed evidence showing that the oxytocin system, assessed via blood levels, cerebrospinal fluid measurements, and oxytocin receptor gene regulation, is consistently altered in individuals with anxiety and mood disorders [65]. Individuals with depression or anxiety often show reduced oxytocin activity or changes in oxytocin receptor expression, which may compromise emotional regulation, stress resilience, and social connectedness. Furthermore, oxytocin-related markers hold promise as future biomarkers for diagnosis and treatment response, although more standardized research is needed before they can be used clinically [65]. A recent review highlights its therapeutic potential in stress-related psychiatric conditions including anxiety, depression, and post-traumatic stress disorder by modulating stress-circuit signaling pathways [66].

Oxytocin and Its Relationship with Serotonin, Dopamine, Endorphins, Vasopressin and HPA Axis

Accumulating evidence supports the view that oxytocin interacts with multiple neurochemical systems to promote emotional bonding and reduce anxiety. Oxytocin modulates the **dopaminergic reward pathway**, especially in the ventral tegmental area (VTA) and nucleus accumbens, amplifying the motivation to connect and reinforcing social bonding behaviors [67,68] There is also evidence that oxytocin interacts also with the serotonergic system. An activation of serotonin 5-HT_1A receptors has been shown to stimulate endogenous oxytocin release [69], which is often accompanied by the co-release of β-endorphin. This coordinated release contributes to the anxiolytic and analgesic effects of social contact, as demonstrated in both animal and human studies [69,70]. Endorphins themselves synergize with oxytocin to modulate both emotional and physical pain, producing a affective warmth associated with nurturing behaviors, social touch and bonding, and affectionate interaction [71,72].

Vasopressin is another neuropeptide hormone synthesized in the hypothalamus and released from the posterior pituitary. Closely related to oxytocin in both structure and evolutionary origin, it

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performs complementary yet distinct functions - typically facilitating vigilance, territoriality, male-male bonding, and partner protection - whereas oxytocin predominantly supports nurturance, trust, and affiliative bonding. Interestingly, Lim et al. [73] showed that inserting the prairie-vole vasopressin V1a receptor gene (AVPR1A) into the reward circuitry of normally non-monogamous meadow voles increased vasopressin receptor expression and led them to form strong partner preference and bonding behaviors. This study demonstrates that vasopressin plays a critical role in male pair-bonding and attachment, particularly through receptor-driven sensitivity in reward circuits.

Oxytocin also exerts a profound inhibitory effect on the hypothalamic-pituitary-adrenal (HPA) axis, the body's central stress-response system. In rodents, oxytocin reduced corticotropin-releasing hormone (CRH) expression in the paraventricular nucleus of the hypothalamus and attenuates adrenocorticotropic hormone (ACTH) secretion at the pituitary, resulting in decreased systemic cortisol levels during stress [74,75]. Human studies show that participants who received oxytocin or experienced partner support exhibited significantly lower salivary cortisol responses to stress [76,77].

These combined actions, enhancing reward signaling, attenuating release of stress hormones and endogenous opioids, position oxytocin as a central mediator of safety, social motivation, and emotional resilience. While we propose that oxytocin may represent a primary biological correlate of Soma, it is likely not acting alone; other molecules, including hormones of HPA axis, dopamine, serotonin, vasopressin, endorphins and related neuromodulators, may operate synergistically with oxytocin to generate the constellation of physiological and experiential states described in the Vedic texts as Soma.

Oxytocin, the Gut Microbiome, and the Gut-Brain-Immune Axis

Oxytocin is increasingly recognized as a key modulator within the gut-brain-immune axis, influencing gastrointestinal physiology, microbial-host communication, and the introduction and stabilization of microbial diversity. Through the behaviors it promotes, such as affectionate touch, intimacy, cohabitation, and sexual bonding, oxytocin facilitates partner-to-partner microbial exchange across the gut, skin, oral, and reproductive tract microbiomes, supporting microbial diversity and strengthening immune function, a process that was essential for health and survival in earlier evolutionary environments [78]. At the same time, its anti-inflammatory and mucosal-protective effects create a physiological environment that supports healthy colonisation, strengthens immunity and healing at least in part by regulating T-cell activity, neutrophil recruitment [78], and reinforces the bidirectional feedback loop between bonding, microbiome diversity, and psychophysiological wellbeing.

Experimental and clinical evidence suggest that oxytocin directly enhances gut barrier integrity, supports immune homeostasis, shapes microbial composition, and modulates vagal signaling between the intestine and the central nervous system [78].

The gut microbiome exerts system-wide effects via bidirectional communication pathways that include vagal afferent signaling, immune-mediated cytokine activity, and modulation of hypothalamic-pituitary-adrenal (HPA) axis activity. By modulating vagal tone and reinforcing parasympathetic dominance, oxytocin dampens stress reactivity, stabilizes HPA-axis resulting in reduced gut permeability, improved immune tolerance, and microbial stability, and, in turn, improved mood, cognition, and resilience against depression and stress-related disorders [79]. A recent study showed that the receptor for advanced glycation end-products (RAGE), a key mediator of inflammation and AGE accumulation, also transports oxytocin across the blood-brain barrier [80,81]. However, AGEs, elevated by processed foods and impaired glucose metabolism, bind to RAGE with higher affinity than oxytocin, potentially reducing oxytocin transport into the brain. This competitive interaction offers a mechanistic link between unhealthy diets, diabetes, diminished central oxytocin signaling, and the heightened inflammation and stress vulnerability seen in metabolic disease.

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The human microbiome plays a crucial yet under-recognized role in connecting olfactory processes with oxytocin-mediated bonding. Much of human body scent arises from microbial metabolism, producing volatile compounds that form an individual's olfactory signature. These odor cues are transmitted through primary olfactory pathways that project directly to limbic and oxytocin-responsive regions, where they modulate social recognition, stress regulation, and affiliative behavior [82,83]. Across species, microbially shaped scents support maternal-infant bonding, kin recognition, and partner attachment, illustrating how microbial milieu can influence emotional states and interpersonal connection [83].

Taken together, these findings position oxytocin as a fundamental mediator translating gut physiology into brain effects, helping to explain how microbial milieu and immunity converge to shape overall health.

Oxytocin, the Default Mode Network, and the Experience of Self

Emerging research in neuroscience has begun to elucidate how oxytocin influences large-scale brain networks, particularly the Default Mode Network (DMN) - a neural system involved in self-referential processing, autobiographical memory, and the construction of personal identity [84]. Excessive activity in the DMN is often linked to rumination, anxiety, and overidentification with one's internal narrative. Oxytocin has been shown to modulate this network in several key ways: it reduces hyperactivity within the DMN, thereby diminishing rigid self-focus; it enhances the salience of social cues, increasing empathy and perspective-taking; and it promotes greater integration between the DMN and salience network and the medial prefrontal cortex involved in emotion regulation and social cognition [84].

The effect of oxytocin on these systems is not merely neurochemical - it is experiential. By quieting the inner critic and softening the boundaries of the Self, oxytocin may foster a sense of connectedness, openness, and warmth and a dissolving of isolation that many describe as both healing and transcendent.

Soma and Oxytocin - Cross-Cultural Synthesis

At first glance, Soma and oxytocin appear to belong to entirely separate realms: one a mystical elixir sung in ancient Sanskrit hymns, the other a neuropeptide identified and studied in modern neuroscience. But a closer examination reveals strong parallels that suggest they may be experientially convergent expressions of the same underlying psychophysiological reality.

Both Soma and Oxytocin Are Associated With:

Heightened states of love and connection

In the Rig Veda, Soma is revered as the awakener of divine love, dissolving separation and opening the heart to deep connection with the Self, others, and the outer world, allowing perception to become whole and free from fragmentation. Similarly, oxytocin, the neuropeptide of bonding, deepens emotional and physical closeness, fostering trust, intimacy, and attunement. Released in moments of affectionate touch, eye contact, and shared presence as well as during orgasm, childbirth and breastfeeding, it anchors us in relationships that are loving, caring, safe and meaningful, while supporting a shift toward a more expansive, less self-focused state. In both frameworks, the softening of rigid self-focus gives rise to a more relational, expanded, and unified sense of being.

One of the most ancient routes to embodied connection is olfaction. Because scent signals project directly into limbic and oxytocin-sensitive circuits, familiar odors, such as those of a partner, infant, or loved one, can instantly evoke calm, safety, and closeness. Shaped partly by the human microbiome, these cues serve as biological markers of familiarity and attachment, amplifying oxytocin's effects on bonding and emotional warmth. Within this framework, the Vedic portrayal of Soma as sharpening the senses and dissolving separation finds a clear biological parallel: heightened olfactory-limbic integration could intensify oxytocin-mediated unity. Soma represents a state of

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refined perception in which even subtle scent cues deepen coherence, intimacy, and the felt experience of oneness.

Integration of inner and outer: Transcending "small self" or ego

In Vedic literature, Soma is portrayed as a symbol of expanded consciousness that dissolves the illusion of separation. In this state, the sense of individual ego is transcended, giving way to a direct experience of unity with the universe. This is not annihilation of the self but a form of transcendence in which the rigid boundaries between "I" and "other" give way to an experience of blissful interconnectedness. Within Vedic philosophy, Atman refers to the inner Self or pure consciousness, whereas Brahman denotes the universal consciousness underlying all of creation. The Rig Veda describes that "He who drinks Soma comes to know the truth; he sees the world not as separate, but as One." Building on this understanding, Maharishi Mahesh Yogi described Soma as a subtle, refined substance generated within an increasingly coherent physiology, emerging naturally in advanced meditative states. Soma facilitates the direct experiential merging of subjective awareness with the objective world, dissolving the apparent duality between inner and outer and revealing the underlying coherence of consciousness across all levels of existence.

Oxytocin plays a key role in softening self-other boundaries by dampening amygdala-driven vigilance, modulating self-referential activity in the medial prefrontal cortex, and enhancing perspective-taking networks such as the temporoparietal junction. It also regulates the anterior cingulate and insula, centers of empathy and interoceptive awareness and attenuates DMN activity associated with ego-based rumination. Microbiome-shaped olfactory cues from loved ones feed directly into these oxytocin-sensitive limbic circuits, reinforcing familiarity, safety, and emotional resonance. Together, these mechanisms reduce ego-boundaries and support attunement, embodied presence, and shared awareness, as seen in deep love, parent–infant bonding, orgasm, and transcendental meditation. In both Vedic and neuroscientific terms, Soma and oxytocin appear to function at the threshold where subject and object dissolve, supporting states of unity that are simultaneously physiological, psychological, and transcendent.

Transcendence of Fear and Sense of Invincibility

In the Vedic tradition, Soma intoxicates not through dullness or sedation, but through lucidity, bliss, and expanded awareness. It is said to dissolve fear, not by numbing it, but by illuminating a deeper inner stillness, a state where the fragmented self merges into unity and the perception of danger dissolves in the presence of wholeness. Oxytocin has been shown to reduce activity in the amygdala, the brain's central hub for fear processing. It creates powerful positive effects on mood, perception, and endurance, especially during heightened emotional states, such as childbirth, deep bonding, caregiving, or romantic relationships dissolving exhaustion, fear, or self-protection. This downregulation of threat reactivity promotes a felt sense of safety, openness, emotional receptivity, and strong human connection.

Support for Longevity and Health

In the Vedic tradition, Soma is described as amṛitam - the "nectar of immortality"- a sacred essence believed to nourish vitality, enhance immunity, and promote longevity. The Vedas portray Soma not only as a spiritual catalyst, but also as a rejuvenating force that supports both physiological and transcendental renewal. It was revered as a life-sustaining substance, and its consumption was associated with strength, endurance, and longevity.

Modern scientific research reveals an intriguing biological parallel in oxytocin, which has been shown to exert beneficial effects on health and longevity. Oxytocin reduces systemic inflammation, increases microbial diversity through sharing closeness and through this improves metabolic, cardiovascular, neurodegenerative and mental health outcomes. It has been shown to reduce addictions and have anti-proliferative and anti-metastatic potential in several cancers. These effects are pointing to a shared theme of healing, resilience, and extension of life and health span. In both ancient and modern frameworks, Soma and oxytocin emerge as agents of regeneration of health supporting the flourishing of body, mind, and consciousness.

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Consciousness-Based Practices as Catalysts for Soma - Oxytocin Physiology

Current evidence on whether meditation increases endogenous oxytocin is inconsistent and highly context-dependent. Several forms of contemplative practice, such as loving-kindness meditation and multi-component mental training programs that cultivate compassion and socio-emotional skills, have been associated with changes in peripheral oxytocin concentrations, though the direction and magnitude of these changes vary across studies [85, 86]. Some trials report increased salivary or plasma oxytocin following compassion-based or mindfulness interventions, suggesting enhanced activation of affiliative neurobiology [87], whereas others find no change or even decreases during intensive, silent retreat environments. These discrepancies likely reflect multiple methodological variables, including the heterogeneity of meditation techniques (focused attention vs. compassion vs. open monitoring), timing of biological sampling, individual differences in stress levels [37], and the challenges of reliably measuring peripheral oxytocin as a proxy for central oxytocin activity [79]. Moreover, some studies suggest that while contemplative training can alter oxytocin levels, these biochemical shifts do not necessarily mediate the psychological benefits of meditation such as reduced stress or improved emotion regulation, indicating that oxytocin may be one component of a broader network of neurobiological mechanisms involved in contemplative practice [85, 87]. Interestingly, exogenous intranasal oxytocin can acutely increase self-reported spirituality, implying that the oxytocin system can influence experiences aligned with "expanded awareness" [88]. Emerging research shows that several oxytocin receptor (OXTR) single nucleotide polymorphisms (SNPs) are associated with heightened receptor sensitivity and enhanced oxytocin signaling. These variants have been linked to greater prosocial tendencies, increased empathy, stronger parasympathetic activation, lower stress reactivity, and reduced activity within the amygdala and DMN [89-91]. Such findings raise the possibility that OXTR genetic variation may contribute to individual differences in meditative depth, subjective experiences of interconnectedness, and the progression toward higher states of consciousness.

Transcendental Meditation (TM) wa [85,86s introduced by Maharishi Mahesh Yogi in the late 1950s and1960s, where it rapidly rose to prominence and has since been widely studied. Randomized trials show TM improves key chronic disease risk factors such as lower blood pressure, improved insulin resistance, autonomic balance, and psychological distress in at-risk adults [92]. TM practice was associated with significantly greater reductions in alcohol, nicotine, and illicit drug use compared with conventional prevention or treatment approaches. The analysis concluded that TM not only reduced substance use but also supported sustained long-term abstinence, suggesting preventive as well as therapeutic benefits [93]. TM reduces trait anxiety (with larger effects in highly anxious individuals), psychological distress, burnout and post traumatic stress disorder (PTSD). RCTs reported improvements in cognitive ability and attention over 6–12 months of TM practice. To date, no published human studies have directly measured oxytocin changes pre-/post-TM. Beyond effects on chronic diseases, TM research includes outcomes on self-actualization/ego development. A meta-analysis reported increases in self-actualization across controlled studies, and longitudinal/controlled work in maximum-security prisoners found gains on Loevinger's ego-development scale with concurrent reductions in anxiety and aggression [94] as well as well as recidivism [95,96].

In long-term practitioners of Transcendental Meditation, O'Halloran et al. [97] reported a remarkable 2.6-7.1-fold increase in plasma vasopressin (AVP) during meditation, occurring in a state of deep physiological rest rather than in response to stress which is its usual trigger. This finding indicates that TM can activate neuroendocrine pathways typically linked with focused attention, presence, and commitment. Vasopressin and oxytocin are structurally related "sister neuropeptides" produced in the same regions of the hypothalamus; oxytocin mediates warmth, bonding, and blissful connectedness, whereas vasopressin supports attentive presence, sustained focus, and protective attachment. TM appears to evoke an unusual neurobiological state - restful alertness - in which parasympathetic calm coexists with heightened, inwardly directed awareness. In the conceptual language of the Vedic tradition, this maps onto the experience of Soma as an inner elixir of clarity and integration: vasopressin may reflect the alertness component of transcendence, while oxytocin

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(in theory, though not yet directly measured in this research) may reflect the bliss and relational openness described in higher states of consciousness [97].

Empirical Testing of the Soma - Oxytocin Hypothesis

To test whether oxytocin could be a biological correlate of Soma, two approaches are needed: (1) measuring endogenous oxytocin during consciousness-based practices such as TM, and (2) administering exogenous oxytocin to observe effects on neurophysiological and subjective measures of wellbeing. Former approach, endogenous oxytocin can be quantified via plasma assays under tightly controlled conditions, ideally using LC–MS/MS or solid-phase extraction immunoassays to improve specificity, with standardized time-of-day, fasting status, posture, menstrual phase, recent social contact, and physical activity [98].

Testable Hypotheses

H1 (Endogenous oxytocin): TM practice will be associated with increased endogenous oxytocin levels compared to baseline.

H2 (Network modulation): Increases in endogenous oxytocin will correlate with changes in DMN activity on functional neuroimaging.

H3 (Phenomenology): Changes in oxytocin levels will predict increases in validated measures of social connectedness, emotional openness, and self-transcendence.

H4 (Causality): Exogenous oxytocin administration will reproduce selected experiential features observed in long-term meditation practitioners.

Endogenous Oxytocin Measurement

A randomized controlled trial in TM novices could assess basal oxytocin and acute effects of TM (pre- and post-single practice session) at baseline and again at 3, 6, and 12 months of meditation training, alongside validated self-report measures of positive affect (e.g., Positive and Negative Affect Schedule), social connectedness (e.g., Self-Compassion Scale - Revised- SCS-R), and self-transcendence/expanded awareness (e.g., Temperament and Character Inventory (TCI) - Self-Transcendence subscale). This could be coupled with heart-rate variability, EEG indices of intra/interhemispheric coherence, diurnal and acute (post-mediation) cortisol, vasopressin levels, and optional inflammatory and metabolic markers (e.g., high sensitivity C-reactive protein, interleukin 6, fasting glucose and insulin levels) as well as microbiome assessment.

A complementary cross-sectional study could compare long-term TM practitioners (>10 years) including those practicing TM-Sidhi (advanced technique of TM) with matched non-meditators on basal oxytocin with the same psychophysiological battery of tests. Where feasible, include vasopressin assays to characterize the broader affiliative-vigilance peptide balance, and document potential confounders (sleep, medications, parity, lactation, recent intimacy/touch). If increases in endogenous oxytocin reproducibly track improvements in social connectedness and self-transcendence measures, and align with higher heart rate variability, greater EEG coherence, and lower cortisol, this would support a multi-level physiological correlate of the reported phenomenology, such a pattern would be consistent with, though not proof of, traditional descriptions of an “inner elixir” of wellbeing and integration (Soma).

Exogenous Oxytocin Administration

In contrast, **exogenous pharmacological administration of oxytocin** (e.g., intranasal delivery) provides a means of directly testing the causal effects of oxytocin on neural, experiential and physiological outcomes. A substantial body of evidence demonstrates that intranasal oxytocin can

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modulate amygdala reactivity, increase prosocial emotions, and enhance feelings of spirituality and connectedness. These experimentally induced effects overlap markedly with the qualities traditionally attributed to Soma, including nourishment, social bonding, and the elevation of consciousness. By systematically comparing the neural, physiological, and subjective outcomes produced by exogenous oxytocin with those arising from meditation-related endogenous oxytocin release, such as during TM, researchers can evaluate whether these pathways converge on shared mechanisms. This approach offers a rigorous empirical strategy for testing the proposed correspondence between Soma and oxytocin.

Integrative Research Strategy

The most rigorous test of the Soma–oxytocin hypothesis would involve parallel studies that (i) measure endogenous oxytocin dynamics in TM practitioners and correlate these patterns with subjective experiences resembling those described in Vedic texts, and (ii) administer exogenous oxytocin to matched control subjects, tracking whether comparable neurophysiological changes and experiences arise. If the patterns align, such as enhanced vagal tone, reduced amygdala hyperactivity (functional MRI), increased cortical coherence (EEG), and heightened feelings of unity, this would support the view that oxytocin mediates, at least in part, the physiological substrate of Soma. Conversely, any divergences would highlight additional neurochemical or systemic factors involved, suggesting that Soma is a more complex neuroendocrine construct than oxytocin alone. By combining **endogenous measurement and exogenous manipulation**, modern science can empirically test whether oxytocin accounts for the transformative experiences attributed to Soma in the Vedic tradition.

Limitations of Current Research

Despite the promising parallels outlined in this paper, several important limitations must be acknowledged when interpreting oxytocin as a biological correlate of Soma. First, the measurement of peripheral oxytocin remains technically challenging, with substantial variability across assays and only modest reliability. Second, peripheral concentrations are an imperfect proxy for central oxytocin activity. Third, oxytocin's behavioral influence is strongly context-dependent: it promotes prosocial behavior primarily in environments perceived as safe, familiar, or affiliative. Fourth, much of what is known about oxytocin's mechanisms comes from animal research, where both receptor distribution and behavioral responses differ across species, limiting the direct translation of these findings to human subjective experience.

Conclusions

This paper brings into dialogue phenomenological descriptions of elevated conscious states from the Vedic literature with contemporary neurobiological research on oxytocin. Despite their distinct historical and epistemological origins, both converge on the observation that experiences characterised by connection, reduced fear, and emotional openness are supported by identifiable physiological processes within the nervous system. Together, they point toward a model of consciousness in which affective integration, autonomic regulation, and social neurobiology shape lived experience.

Importantly, oxytocin is not proposed as a sufficient or exclusive substrate of Soma. Rather, it is examined as one empirically tractable component within a broader neuroendocrine and network-level framework that may contribute to the phenomenology described in contemplative traditions. Framed in this manner, the Soma–oxytocin hypothesis does not claim explanatory closure but provides a testable model for investigating how affective neurobiology participates in altered states of consciousness.

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