Journal of Scientific Exploration
Anomalistics and Frontier Science

ESSAY

Reissner's Fiber at the Intersection of Neuroscience and Mysticism: An Evolutionary Perspective

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SUBMITTED August 28, 2023
ACCEPTED October 23, 2024
PUBLISHED December 31, 2024

https://doi.org/10.31275/20243172

HIGHLIGHTS

An overlooked and mysterious structure within the center of the brain might be the physical basis of higher states of consciousness.

ABSTRACT

During their evolutionary transition from apes, *Homo sapiens* developed the capacity to create mental worlds. While conferring a selective advantage and leading to wondrous intellectual achievements and transformative technologies, this capacity set humankind on a historical trajectory that is approaching the potential for its extinction. The genetic and anatomical basis of humankind's unique mental capacities is unclear. However, the perinatal regression of Reissner's fiber (RF) in humans, an enigmatic, strategically located filament originating from the center of the brain, is a likely factor. This study explores the hypothesis that the originators and transmitters of religious mystical traditions were rare individuals whose RFs persisted into adulthood. They perceived the fiber with its surrounding sensory neurons and experienced higher states of consciousness generated by it. Those perceptions have been transmitted in prescientific, mythological, symbolic language as the "subtle body," the supposed intermediary connection between humans and the divine, bridging the gap between materiality and immateriality, and expanding consciousness beyond the limits of reason. Ultimately, this connection is the purported means of redemption. The secrets of mystical religious traditions are lost under the dust of fallen Babel. However, the identification of RF with the central axis of the "subtle body" presents a path toward their rediscovery. Emerging biotechnologies offer the potential to reverse RFs perinatal regression. Advanced technologies, such as real-time neurofeedback using quantum models, present exciting opportunities for the scientific study of consciousness and have the potential to revolutionize our understanding of spirituality and reality.

KEYWORDS

Neurocosmology, neurofeedback, neurotheology, Reissner's fiber, subtle body, quantum biology.

INTRODUCTION

During the evolutionary transition from apes to *Homo sapiens*, natural selection favored the perinatal regression of an enigmatic, strategically positioned, and evolutionarily conserved structure: Reissner's fiber (RF), *an ever-growing filament found within the neural canal* (Munoz et al., 2019; Reissner, 1860). Consequently, the persistence of this fiber into adulthood has become extremely rare. Although emerging biotechnologies have the potential to reverse this regression (Cowan et al., 2020; Merling et al., 2016; Ortiz-Alvarez et al., 2019; Redmond et al., 2019), the potential consequences of such a reversal remain uncertain

Herein, I propose that such a reversal could lead to the rediscovery of lost secrets of what various mystical traditions call the "subtle body"; this concept refers to the purported connection between humans and the divine, between materiality and immateriality. The originators and transmitters of those traditions were extremely rare individuals whose RFs persisted into adulthood. They "saw" the fiber with the visual sensory system that surrounds it. Therefore, descriptions of the "subtle body" are more related to neuroanatomy than myth. The fiber stimulated surrounding receptors that mediate entheogenic experiences, thereby facilitating feelings of connectedness to a higher power. Most importantly, to paraphrase William Blake (1994), RF cleansed the doors of perception, allowing man to see everything as it truly is—Infinite.

Those doors have recently been partially cleansed by entheogens and modern physics. Neuroimaging studies suggest that entheogens increase brain entropy, thereby breaking down rigid conceptual filters of perception (Carhart-Harris et al., 2014). Experiments with entangled subatomic particles have shown that they lack definite measurable properties before they are observed. Prior to being observed, "quantum objects" are conceived as superpositions of possibilities and probability clouds. To paraphrase John Stewart Bell (1980), whose analysis of quantum entanglement showed that local realism is untenable (Bell's Theorem), would it not be very interesting if, when a formulation of quantum mechanics beyond all practical purposes is attempted, we discovered an "unmovable finger obstinately pointing outside the subject, to the mind of the observer, to the Hindu scriptures, to God, or even only Gravitation?" Given RF's hypothesized identification with the central axis of the "subtle body " and its suitability as a site for quantum biological behaviors, it provides an intriguing empirical path for exploring the realms toward which that unmovable finger points.

Reversing the typical perinatal regression of the fiber in many individuals has the potential to transform private, ineffable religious experiences into consensus realities. Innovative techniques, such as real-time neurofeedback using relativistic, quantum, and neurobiological models, can provide synergies that integrate traditional spiritual practices with neuroscientific methodologies. The mutually exclusive, popularized parallels between mysticism and physics (Capra, 1978) would converge. The following section presents descriptions of the central axis of the "subtle body" from yogic, Kabbalistic, and Taoist traditions; an account of current knowledge about RF; and a synthesis of the two based on that knowledge and speculative relativistic-quantum models of the fiber. A key objective is to inspire research on this neglected structure.

RF- A REVIEW

RF is an ever-growing filamentous aggregation of glycoproteins that flows through the central passageways of the brain, the third cerebral ventricle, cerebral aqueduct, fourth ventricle, central canal (CC), terminal ventricle (TV), and filum terminale. It primarily forms through secretions from the embryonic floor plate and the subcommissural organ (SCO) (Abolitz & Montiel, 2021; Munoz et al., 2019). Additionally, secretions from other circumventricular structures, including the preoptic region of the hypothalamus, contribute to its formation (Enami, 1954; Knowles, 1969; Rodriguez et al., 1999; Zyo et al., 1976).

The secretory activities of the structures that contribute to the formation of RF are intricately regulated by complex neural networks. The SCO, for example, is primarily innervated by serotonergic neurons, but gamma-aminobutyric acid, dopamine, noradrenalin, oxytocin, vasopressin, substance P, alpha-neuroendorphin, and galanin are also involved (Jiminiez et al., 2001) Furthermore, while environmental temperatures have significantly influenced the fiber's growth rate (at 24 °C, approximately 70% of the fiber is renewed, while at 18 °C, the renewal rate decreases to 40%), the influence of light and darkness is small (Diederen, 1973, 1975).

In fresh specimens, the fiber is hollow (Erbel-Rothe, 1951). Electron microscopy shows that it consists of parallel 5–10-nm-diameter filaments embedded in a complex, variable matrix. This matrix contains nanosized spheres surrounded by a tri-layered membrane, which resemble exosomes, and it projects filaments to the ventricular surface (Kohno, 1969).

RF plays a role in regulating the production and hydrodynamics of cerebrospinal fluid (CSF), and its involvement has been suggested in the pathogenesis of hydrocephalus (Perez et al., 2001; Rodriguez et al., 2007; Woolam, 1982). Because it binds to various substances,

including mono-aminergic neurotransmitters, it has been hypothesized to be a "detoxifier" of the CSF (Ermish et al., 1970; Hess, 1972; Perez et al., 2001). Additionally, the fiber regulates the embryological development of a straight body axis; therefore, it has been implicated in the pathogenesis of scoliosis and the regulation of locomotion (Driever, 2018; Hubbard et al., 2016; Orts-Del'Immagine et al., 2020; Troutwine et al., 2020). The primary constituent of RF is SCO-spondin, an evolutionarily conserved giant glycoprotein (5000+ residues) found in the CSF and extracellular matrix (ECM) of the central nervous system. SCO-spondin is involved in neurogenesis, differentiation, proliferation, and axonal guidance (Creveaux et al., 1998; El Bitar et al., 2001; Gobron et al., 2000; Meiniel et al., 2001) and has been implicated in the pathogenesis of schizophrenia (Li et al., 2020; Vilkov et al., 1984), Alzheimer's disease (Le Douce et al., 2021), and transpersonal states of consciousness (Wile, 2016, 2020).

The fiber descends through the CC of the spinal cord to a triangular dilation at the base of the canal, known as the TV (Choi et al., 1992; Wislocki et al., 1956), where it coils (Studnicka, 1899). The TV is surrounded by secretory cells, forming the intraspinal organ, whose activity correlates with reproductive activity (Motavkin & Bakhtinov, 1990). This intraspinal organ is a homolog of piscine urophysis (Fridberg & Bern, 1968), which secretes urotensin. Urotensin II, the most potent vasoconstrictor, is expressed in various human tissues (Ong et al., 2005), and its receptor is linked to rapid eye movement sleep (de Lecea & Bourgin, 2008; Huitron-Resendiz et al., 2005). The contribution of the intraspinal organ to the production of urotensin is unclear.

The fiber dissolves in the TV, and its constituents pass through a narrow passageway in the filum terminale (Molina et al., 2001). While the filum terminale is generally considered a fibrous band that anchors the distal spinal cord to the coccyx, it contains nerve fibers of unknown function (Klinge et al., 2022). Proximal to the terminal organs of RF is the glomus coccygeum, a small spheroid composed of blood vessels, myofibrils, glomus cells, and sympathetic nerve fibers with nearby Pacinian corpuscles. Although the glomus coccygeum is generally considered a vestigial structure, it anatomically represents the inferior termination of the sympathetic nervous system (Conti et al., 2000). The pineal gland, once classified as vestigial, is the superior termination. The glomus coccygeum plays a role in neuroimmunomodulation, thermoregulation, hemopoiesis, and sexuality (Conti et al., 2000; Jin et al., 2017).

Considering that the SCO secretes glycoproteins both apically into the CSF and basally into the ECM (Biosca & Azcoitia, 1989; Kimble & Møllgård, 1973), and RF projects filaments to the ventricular surface, the fiber can be conceived as the center of the ECM in the central nervous system. Mechanical signals transmitted by the ECM, mediated by integrins, regulate various neural functions (Wang et al., 2001). Given that the fiber is under tension and oscillates, it could potentially orchestrate these mechanical signals (Bellegarda et al., 2023).

RF has been evolutionarily conserved, with its first production 770 million years ago in a single cell lining the inner surface of the brain of a millimeter-long gelatinous sea squirt called *Oikopleura* (Gobron et al., 1999). It is present in adult primates (Castenholz & Zöltzer, 1980; Erhardt & Meinel, 1983; Hofer et al., 1980; Horsely, 1908). The SCO typically regresses perinatally in humans (Carmona-Calero, 2022). However, a fully developed SCO has been observed in a 60-year-old man (Gomez et al., 1961). RF has been observed in human embryos (Keene & Hewer, 1935) and a 14-year-old teenager (Agdhur, 1922). Owing to its rapid postmortem disintegration, RF can only be observed in fresh or freshly preserved specimens. Furthermore, its small diameter makes it inaccessible for observation with current endoscopic or neuroimaging techniques in live individuals. Therefore, it is likely that other exceptions to the rule that RF does not exist postnatally in humans have gone unnoticed.

The genetic variations responsible for the perinatal regression of RF during the transition from apes to *Homo sapiens* is unclear. However, given the fiber's presence in human embryos and the stem cell potential of the ependymal cells that produce it, reversal of that regression, in a manner analogous to the reversal of thymic involution, is feasible.

Subtle Body

Yoga

The central axis of the "subtle body" is best described in Hatha and Tantric Yoga (Feurstein, 1998). They describe four concentric channels (*nadis*) that ascend from a triangular structure at the base of the spine (*Mooladara chakra*) through a series of psychophysical centers (*chakras*) to the brain. Through various yogic practices, including meditation, sacred sexuality, postures (*asanas*), rhythmic breathing, and breath holding (*pranyamas*), combined with forceful muscular contractions (*bandhas*), a coiled, divine feminine energy (*Kundalini*) ascends through seven energy centers (*chakras*). When *Kundalini* reaches the sixth *chakra* (*Ajna*), paranormal powers (*siddhis*) are attained. Ultimately, when *Kundalini* reaches the seventh *chakra* (*Sahasrara*), the soul (*Ataman*) unites with the masculine aspect of divinity, liberating itself from cycles of birth and rebirth (*samsara*) and uniting with the

Infinite (*Brahman*).

The nadis progress from the grossest and outermost to the subtlest and innermost, namely, the *Sushumna*¸ *Vajra*, *Chittra,* and *Brahma nadis.* The *Shatchakra-nirupana* ("Description of and Investigation into the Six Bodily Centres"), written in 1526 and translated by Sir John Woodroffe in 1927, writing under the pseudonym Arthur Avalon, provides indications of the diameters of the innermost *nadis* (Avalon, 1927/2017). In the second verse, the following is mentioned: "Inside the *Vajra* is *Chittra* . . . She is subtle as a spider's thread." The 48th verse states that the *Brahma randhra*, the entrance to the *Brahma nadi* inside the *Chittra nadi*, is "extremely subtle and like unto the ten-millionth part of the end of a hair."

The secrets of Yoga are intrinsic to the Vedas, which were transmitted through a lineage of *rishis* who received them directly through divine revelation. The meanings of those revelations were experienced as resonances among the vibrations of Vedic hymns and mantras, the *chakras*, and the cosmos. Over time, this knowledge, known as *Śruti,* was preserved, reinterpreted, and elaborated upon in the form of *Smritis*. Patanjali, around the second century CE, compiled and further developed yogic knowledge, based on both the *Śruti* and the *Smritis.* This tradition of expansion and development continued through a lineage of mystics, gurus, and sages.

Taoism

The central axis of the "subtle body" has a prominent role in Chinese mystical traditions. In *Qigong* and acupuncture, which are applications of Taoism, the flow of *Qi* along the "microcosmic orbit," formed by the Governing and Conception Vessels, corresponds to the ascent of *Kundalini* through the central *nadis* (Yu, 1999). Through meditation, breathing exercises, and sacred sexuality, *Yin,* the feminine aspect of *Qi,* is harmonized with its masculine aspect, *Yang,* to unite with the infinite Tao. Along the path to oneness with the Tao, the practitioner attains paranormal powers. Similar to Yoga, Chinese mystical traditions can be traced back to prehistoric times. The mythical origins trace back to The Yellow Emperor (2711-2599 BCE). His legend was developed into a historical narrative during the Warring States period, beginning in 475 BCE. During the Han Dynasty (206-220 CE), the *Yellow Emperor's Classic of Internal Medicine* was published. During the Ming Dynasty (1368-1644), *The Great Compendium of Acupuncture and Moxibustion* was compiled by Yang Jizhou (1522-1620) (White & Ernst, 2004).

Kabbalah

References and allusions to the central axis of the "subtle body" in Jewish mystical traditions are based on the descriptions of Adam Kadmon, an androgynous unmanifest cosmic/spiritual image of human beings. Additionally, they draw from the concept of the *Sephirot,* which consists of 10 interacting vessels aligned along three vertical columns representing the attributes involved in the interaction between humans and the divine (Scholem, 1995). The framework for the neurocosmological interpretation of the Kabballah used here was developed in the 16th century by Isaac Luria (Fine, 2003). He proposed that Adam Kadmon and the Sephirot originated from the self-contraction (*Tzimtzum*) within the Infinite (*Ein-Sof*). This process resulted in the emanation of an infinite ray called "*kav,*" which possesses an inner dimension known as the "the thread" (*chut*) responsible for weaving creation, and an outer dimension referred to as "the line of measurement" (*kav hamidah*), which defines boundaries. *Kav* flows through the spine of Adam Kadmon and the "central pillar" of the *Sephirot*.

During six 25,567,500,000-year-long spiritual, cosmic cycles (*Shmita*), the vessels of the *Sephirot* shattered (*Shevirah*), and *Kav* was severed (Kaplan, 1993). In 3761 BCE, Adam Ha-Rishon, who lived on earth, began the seventh, final, material 7,000-year-long cycle. He was poised to repair the severed connection to Adam Kadmon. However, the first bite from the fruit of the Tree of Knowledge resulted in a further descent of the spiritual realm into materiality. Adam's "garments of light" were transformed into "garments of skin" (*Bereishit Rabbah* 20:12).

Humankind's challenging journey to repair the shattered and fallen cosmos (*tikkun olam*) and unite the exiled feminine aspect of the divine (*Shekinah*/*Malkuth*) with its masculine counterpart (*Yesdod*), began and, according to the Hebrew calendar, is expected to end no later than the nightfall of September 16, 2240. According to late modern kabbalists, such as Moshe Chaim Luzzatto, Elijah ben Solomon Zalman, and Shlomo Eliyashiv, *tikkun olam* would be achieved through a synthesis of Kabbalah and science (Bakst, 2008). This proposition is based on an interpretation of a verse from the *Zohar,* the foundational text of Kabbalah:

> In the six hundredth year of the sixth millennium (5600 = 1840 CE), the gates of wisdom above [Kabbalah], together with the wellsprings of wisdom below [science], will be opened up, and the world will prepare to usher in the seventh millennium." *Zohar* (*VaYeira* 177a) (as cited in Bakst, 2008, p. 38).

Kabbalah traces its origins to Adam, who received kabbalistic secrets from the angel Raziel. According to

Kabbalistic lore, these secrets are subconsciously inscribed in every developing fetus. Lailah, the Angel of Conception, places a lighted candle at the head of each unborn infant as it grows in the womb to illuminate the secrets of Kabbalah. Consistent with the perinatal regression of the fiber, these secrets are lost at birth but are imprinted on the perinatal unconscious.

Adam transmitted these secrets to his son Seth, who began a chain of transmission that included Eonch, Noah, Abraham, and Joseph. Fulfilling a divine promise, Moses retrieved the book that was buried with Joseph on the banks of Nile. Moses passed on the kabbalistic secrets to Joshua, the 70 elders, and high priests. The book retrieved from the Nile was carried along with the Tabernacle of the Israelites in the desert and was placed in the Holy of Holies in King Solomon's Temple.

Additionally, Ahijah of Shiloh received this knowledge, and he taught Elijah, the only Old Testament prophet, other than Moses, known to have fasted for 40 days and 40 nights and to have ascended Mt. Sinai to receive divine revelations. Following a miraculous transportation to heaven in a fiery chariot, akin to Enoch's earlier fiery ascent and transformation into the heavenly angel Metatron, and Ezekiel's later vision of a chariot ascending to heaven, Elijah appeared through revelations or apparitions known as *Gillum Eliyyahu*. He aimed to promote the transmission and development of kabbalistic secrets and to proclaim the arrival of the Messiah (Matt, 2022).

Kabbalistic secrets were closely guarded. The secrets of creation, known as the "Work of Creation" (*Ma'aseh Bereishit*), could not be taught to more than one student at a time. Similarly, the secrets of heavenly ascents, known as the "Work of the Chariot" (*Ma'aseh Merkavah*), based on Ezekiel's vision, were so closely guarded that "One may not expound . . . the *Ma'aseh Merkavah* not even to one student unless – he is wise and can understand these matters by himself" (*Mishna Chagigia* 2:1). The transmission of kabbalistic secrets via an exclusive lineage supports the hypothesis that only rare individuals whose RFs persisted into adulthood could grasp those secrets.

An early identification of *kav* with what is now known as RF can be found in the *Commentary on the Talmudic' Aggadot* by Rabbi Ezra ben Shlomo, a student of Issac the Blind (1160-1235), who is considered the "father of Kabbalah." He states, "For it is the middle line, the drawing down of vitality and watering, which extends from the brain to the spinal cord, extending from there to the sinews in all directions" (Idel, 2008). This line is described as an eroticized connection between Zion and Jerusalem, representing the highest *Sephirot*, *Keter*, which draws the divine will from the infinite *Ein-Sof*, and the lowest *Sephirot*, *Malkuth*—the feminine aspect of the divine will that translates thought into action and paradoxically connects to *Keter*. While this early kabbalistic reference to a line extending from the brain to the spinal cord aligns with the proposed anatomical connection between humans and the divine, it has remained obscure because Kabbalah has primarily focused on language. The letters of the primordial Torah are conceived as divine energies that constitute Adam Kadmon and the *Sephirot*. Thus, in the words of Elliot Wolfson (2005), Jews have "textualized the body."

Christian Kabbalah developed from the belief that Jesus was the Messiah, the hypostatic union of humanity and divinity. During the Second Temple era in Jerusalem, Jesus proclaimed, "For truly I say to you, until heaven and earth pass away, not the smallest letter or stroke (one iota or one tittle) shall pass from the Law (Torah) until all is accomplished" (Matthew 5:18) and "I am the law, and the light" (3 Nephi 15:9). In Jesus, "The Word became flesh and made his dwelling among us" (John 1:14). During the Transfiguration, described in the synoptic gospels (Matthew 17:1–8, Mark 9:2–8, Luke 9:28–36), Moses and Elijah appeared before Jesus, and he "was transfigured before them; his face shining as the sun, and his garments became white as the light" (Matthew 17:2). Jesus's resurrected body was the realization of the "subtle body," a paradoxical unity of spirit and flesh.

According to perennialism, Indian, Chinese, and Hebrew mystical traditions originated from a transcendent and universal religious experience facilitated by the "subtle body" (Albahari, 2019; Schuon, 1984; Smith, 1987). While the nature, and even the existence, of the experiential basis of perennialism remains uncertain, the association of RF with the central circuit of the "subtle body" should inspire further investigation.

RF and Quantum Neurobiology

The immaterial, entangled, nondeterministic nature of the quantum world presents intriguing correlates of consciousness (Bohm, 1990; Schwartz et al., 2005). RF's 5-nanometer diameter filaments are well suited for constructing quantum neurobiological models that incorporate features of current models.

Stuart Hameroof and Roger Penrose proposed that entangled quantum coherences among neuronal microtubules can spread through gap junctions. "Orchestrated objective reductions" of these coherences are non-algorithmic processes attuned to the Platonic mathematical forms. The resulting perception of Platonic forms can transcend the boundaries of logic, as proven by Gödel's Incompleteness Theorem (Penrose, 1994). Quantum coherences in microtubules have been proposed as sites of

quantum computation and volitional control of the brain, and as a solution to the mind-brain problem (Hameroff, 1998, 2012). The potential extension of quantum states of RF through gap junctions in CSF-cNs and the ECM warrants further investigation.

Fredric Beck and Sir John Eccles (1992) proposed that the will can selectively trigger the release of neurotransmitters from synaptic vesicles in the premotor cortex via quantum tunneling through the barrier of the metastable state of the presynaptic vesicular grid. Volitional control of the quanta constituting RF, enhanced by real-time neurofeedback, could facilitate quantum tunneling or other quantum effects.

For 20 years, my team, under the leadership of Alexander Sergienko, made extensive efforts to find potential quantum coherences in the photon emissions from RF within transparent zebrafish larvae. We used cutting-edge technologies, including a novel correlation time-resolving infrared microspectroscope with a scanning confocal microscope, superconducting single-photon detectors, and femtosecond pulsed lasers. However, regrettably, we recently made the difficult decision to discontinue our project as our attempts to overcome the challenge posed by the inherent noise in biological systems were unsuccessful.

History

In 1860, Ernst Reissner discovered the eponymous fiber in the CC of the spinal cord in a lamprey. For 40 years, most anatomists dismissed his discovery as an artifact. In the spring of 1899, Porter Sargent (1904) observed the fiber, also in a lamprey. After searching the scientific literature, he was astounded that "so peculiar and conspicuous a structure as Reissner's fiber, which is of so great importance in the nervous anatomy as to persist throughout the vertebrate series, should've remained so little known for forty years after its discovery." Similarly, he was dismayed that the ventricles, including their lining and content, had been almost entirely dismissed.

Sargent established that the fiber is a biological structure. Based on anatomical and experimental investigations, he concluded that the fiber is a unique high-speed conduction pathway. Although Sir Victor Horsley (1908) declared, "the greatest deference is due to the opinion of Sargent, who has essentially made this subject his own," and Sir Charles Scott Sherrington (1906) accepted Sargent's hypothesis, it soon fell into oblivion. In his 1904 paper, Sargent mentioned, "The conclusions and the discussion of the results and bearings of this research are reserved for the second part of this paper dealing with the higher vertebrates. This is already well advanced, and it is hoped will appear in about a year." However, he abruptly abandoned his scientific career to become a self-described poet, world traveler, and educator.

The fall of his hypothesis was largely the result of the limitations of anatomical methods and the resulting ambiguity of anatomical terminology. In 1902, Rudolph Albert von Kölliker, who provided the first proof that axons were extensions of neurons and coined the term "axon," investigated RF. He was unable to decide whether it was an axon, an artifact of preservation, or a "crystallization of biological secretions." When the 1906 Nobel Prize in physiology or medicine was awarded to Ramon Y Cajal and Camillo Golgi, the debate about whether the brain was made of discrete cells or of a continuous web of fibers had not yet been completely settled. Nevertheless, although Sargent distinguished the "axons" that formed RF from "ordinary axis cylinders," described the fiber as a "highly specialized conduction path," and contrasted the "very thin medullary sheath" surrounding the fiber with the sheath surrounding "ordinary nerves," he mischaracterized RF as a coalescence of axons. Seizing on this error, George Nicholls (1909, 1917), who mischaracterized RF as a "coalescence of cilia-like processes springing from cells," hypothesized that it transmits changes in its tension to sensors located in the SCO to regulate fish flexure.

Subsequently, both Sargent's hypothesis and RF itself fell into oblivion. Indeed, two notable historians of neuroscience, Regis Olry and Duane Haines (2003), have dubbed RF the "Devil according [to] Baudelaire" (p. 73) whose "loveliest trick . . . is to persuade you that he does not exist!" (Baudelaire, 2017, p. 1). This trick of concealment was largely due to studies that reported the absence of RF in humans postnatally. Additionally, as the emerging neuroscientific paradigm coalesced around neurons, RF became invisible.

While RF was being rendered invisible, the dismissal of the lining and content of the ventricles that had dismayed Sargent was being addressed. In 1913, Dimitri Tretjakov proposed that CSF-contacting neurons (CSF-cNs) and RF formed a "central sense organ" analogous to the otoliths of the inner ear. In 1921, Walter Kolmer compared RF to the gel-like tectorial membrane of the inner ear, which lies beneath Reissner's membrane of the inner ear. He suggested that the fiber stimulates CSF-cNs to form a sensory system, which he named "sagittal organ." However, as RF's invisibility became established, the "central sense organ" and "sagittal organ" faced a similar fate.

Central and Sagittal Organs Revisited

Although the CSF within the ventricles has generally been understood to function primarily as a waste re-

moval system, and the inner surface of the brain has been largely overlooked, recent investigations suggest that the content and lining of the ventricles deeply affect consciousness. Various psychoactive substances circulate in the CSF (Veening, 2010) and activate neural pathways by stimulation of chemoreceptors. A recently identified CSF-contacting nucleus receives inputs from the prefrontal, orbital, and cingulate cortex nuclei, suggesting that it participates in the regulation of cognitive and affective functions (Song et al., 2020). Considering that CSF-cNs surrounding RF are structurally similar to sensory cells found in the retina and inner ear (Vigh, 2004) and that they project to the visual and auditory pathways (Guillery & Sherman, 2002; Song et al., 2020), the generation of visual and auditory interoceptions by the fiber is indeed feasible. Not only is the inner surface of the brain lined with CSF-cNs, but there are also seven specialized sensory and secretory structures located outside the blood–brain barrier, grouped along the midline of the third and fourth ventricles, including the SCO, known as the circumventricular organs (Benarroch, 2011).

Importantly, in the present context, the interactions of RF with CSF-cNs projected from the dorsal raphe nucleus, periaqueductal gray (PAG), and hypothalamus align with its hypothesized identity as the central pathway of the "subtle body." Serotonergic CSF-cNs projecting from the dorsal raphe nucleus (Agajanian, 1978) are a key site of action for entheogens (Agajanian, 1968; Halaris et al., 1982) and provide neural inputs to the SCO. Considering that the fiber binds amines, such as the endogenous entheogen N, N-dimethyltryptamine (DMT) (Caprile et al., 2003; Ermisch et al., 1970; Hess & Sterba, 1973), it may transport molecules directly to synaptic membranes. This mechanism could explain how low concentrations of endogenous DMT, secreted by the adjacent pineal gland, can produce effects similar to those produced by exogenous sources (Nichols, 2018). Furthermore, entheogenic potency is correlated with the energy of the drug's highest filled molecular orbital, rather than the strength of its binding to receptors (Snyder & Merril, 1967); therefore, RF might facilitate similar, perhaps amplified, quantum chemical effects.

Considering that the PAG is a brain circuit that mediates spirituality (Ferguson et al., 2022), interactions between RF and the CSF-cNs lining the ventricular surface of the PAG are an enticing prospect for future neurotheological investigations. Moreover, considering the role of the hypothalamus in mediating libido and orgasmic feelings, the branch of RF connecting the SCO to CSF-cNs projecting from the preoptic region of the hypothalamus is an alluring target for exploring the connection between sexuality and spirituality.

RF and the Subtle Body: A Synthesis

The hypothesis that descriptions of the central axis of the "subtle body" and its effects are based on interoceptions generated by RF is supported by compelling evidence. However, the hypothesis that RF can facilitate the transcendence of the known limits of perceptions and powers of the mind rests on a speculative foundation. This review will explore the evidence supporting the identification of RF with the central "axis" of the "subtle body" and the speculative foundation for the claims of paranormal powers.

Evidence Supporting the Identification of RF With The Central Axis Of the "Subtle Body"

Strong evidence supporting the hypothesis that the descriptions of the central axis of the "subtle body" found in texts from mystical traditions are based on interoceptions generated by RF is the uncanny resemblance between the RF anatomy and the yogic anatomy. The *Sushumna nadi* corresponds to the CC. The *Vajra, Chittra,* and *Brahma nadis* correspond to the gross, microscopic, and immaterial features of the fiber, respectively.

The first documented identification of RF with a central *nadi* was made in 1927 by Dr. Vasant Rele. In the glossary of his book, *Mysterious Kundalini: The Physical Basis of the "Kundali (Hatha) Yoga" in Terms of Eastern Anatomy and Physiology,* Dr. Rele defines the *Vajra nadi* as "A nerve fibre said to exist inside the spinal canal called *Chittra.* It is the fibre of Reissner. Its function is not yet known. It is also known as "*Brahma-nadi.*" (Rele, 2007, Appendix IV) . Presumably, because RF was not mentioned in the text, which identified the central pathway of *kundalini* with the right vagus nerve, and the glossary entry erroneously stated that the *Vajra nadi* is inside the *Chittra nadi,* the *Vajra nadi* is known as the *Brahma-nadi,* and RF is a nerve. Rele's identification of RF with the central *nadi* was overlooked.

In 1940, Theos Bernard, a famous scholar-practitioner of Yoga and the first American ever initiated into Tantric Yoga practices by the highest Lama in Tibet, refined the identification of RF with a central *nadi.* In his book *Heaven Lies Within Us* (1940), Bernard wrote, "Inside this central (*Sushumna*) nadi, the Yogi identifies an invisible nadi known in the West as the fiber of Reissner, but which is known here as *Chittra* (the Heavenly Passage, in Sanskrit)." While Bernard corrected the mischaracterization of RF as a nerve, his identification of the fiber with "an invisible nadi" may have inadvertently contributed to its later identity as the "Devil according to Baudelaire."

The triangular-shaped *Mooladara chakra*, where *Kundalini* coils, corresponds to the triangular-shaped intraspi-

nal organ within which RF coils. The correlation between the activity of the intraspinal organ and sexuality is consistent with the concept of *Kundalini* as a transmuted form of sexual energy. The *Mooladara chakra*'s connection with the filum terminale was established by Avalon in 1919 (1974) and reexamined by Richard Maxwell in 2009.

Experimental evidence supporting the identification of RF with the central "channel" of the "subtle body" comes from investigations into the anatomical basis of traditional Chinese medicine. In the 1960s, Kim Bonghan (1963) conducted pioneering research, where radioactive phosphorous (P^{32}) was injected into acupuncture points on a rabbit's abdomen corresponding to the Governing Vessel. The subsequent tracing, using autoradiography, revealed a thread-like structure inside the CC of the spinal cord. It is worth noting that Bonghan made no reference to RF and named the labeled structure the "neural Bonghan duct."

At the turn of the 21st century, neuroscientists reinvestigated Bonghan's findings using modern anatomical techniques, including fluorescent magnetic nanoparticles and confocal laser scanning microscopy (Soh, 2009). They reported the discovery of a "novel thread-like structure in the cerebral ventricles and CC in a rabbit" (Lee, 2008). This structure was hypothesized to potentially function as an optical channel for coherent biophotons (Soh, 2004). However, notably, the researchers claimed that this structure could be distinguished from RF without performing a direct comparative analysis by showcasing both structures in parallel. Given that the CC is very narrow and RF projects filaments onto its walls, it is likely that the researchers misidentified the structure they observed because of cellular debris that typically adheres to RF.

The identification of RF with the central "channel" of the "subtle body" can be integrated with other neuroscientific models of the "subtle body." For example, Maxwell (2009) suggested that the *Sushumna nadi* is a column of gap junctions in cells that remain in the region where the edges of the neural crest join to form the neural tube; this tube opens from the filum terminale to the brain as *Kundalini* rises. RF could interact with this column of gap junctions in a manner similar to that hypothesized to occur with microtubules (Hameroff & Marcer, 1998). Joseph Loizzo (2016) proposed that contemplative practices have provided an interoceptive map of the central nervous system that can contribute to their integration with neuroscience. While this proposal motivates meditation researchers to explore the neural basis of meditation's benefits, it excludes the suprasensory and paranormal claims of yogic traditions. It also involves complex central nervous networks and their connections to other organ systems, which pose challenges for practical applicability, especially as it relates to neurofeedback. Identification of RF with the central axis of the "subtle body" and the potential for the fiber to form a long macroscopic quantum system can overcome these limitations.

Further evidence supporting the identification of RF with the central axis of the "subtle body" lies in the congruence between traditional mystical practices and the growth and development of the fiber, as well as its enhancing effects on consciousness. Yogic practices, such as rhythmic breathing and breath holding (*pranyamas*), combined with forceful muscular contractions (*bandhas*) and postures (*asanas*), can produce pressurized waves of CSF directed toward the opening of the CC to open the normally occluded CC (Yasui et al., 1999; Zhang, 2014). Moreover, neuroimaging studies have demonstrated that meditation reduces exteroceptive sensory processing in the brain, allowing attention to be focused on interoceptions related to RF (Miller, 2009).

Thus, there is compelling evidence that descriptions of the central axis of the "subtle body" found in texts from mystical traditions are based on interoceptions generated by RF, as well as that the fiber induces spiritual experiences through its connection with the raphe nucleus, PAG, and hypothalamus. The roles of the filum terminale, glomus coccygeum, and pineal gland warrant further investigation.

The biblical accounts of Moses, Elijah, and Jesus surviving 40-day fasts align with the idea that they possessed robust RFs. The primary attachment of RF, the SCO, plays a role in regulating salt and water balance (Severs et al., 1993) and aldosterone (Geerling & Loewy, 2009) (a blood pressure elevator). The fiber is also connected to the brain's two key biological clocks: the preoptic region of the hypothalamus and the pineal gland (Kalsbeek et al., 2000). The former is a thermoregulatory center. The fiber's termination in the intraspinal organ is a potential source of urotensin. Thus, RF could have facilitated Moses,' Elijah's, and Jesus' protection from dehydration, hypovolemic shock, and heat stroke. Additionally, RF could potentially slow metabolism, inducing a state akin to suspended animation.

RF and Transcendence

A key question entailed by the identification of the central axis of the "subtle body" with RF is whether the altered states of consciousness potentially generated by the fiber represent transcendence or psychosis. Did visual and auditory perceptions, as well as enhanced entheogenic experiences generated by RF, disconnect key religious figures from reality or open the doors of perception

to higher planes of reality? While the present neuropsychiatric paradigm supports the diagnosis that religious figures were grandiose, charismatic psychotics (Murray et al., 2012), relativistic-quantum mechanical models of RF suggest that they were exceptional individuals whose RFs endowed them with suprasensory perceptions of realities that cannot be perceived, or even conceptualized, by individuals who lack the fiber. RF provides a potential empirical path for following the unmovable finger, pointing obstinately outside the subject of quantum mechanics for all practical purposes.

Physicists studying quantum mechanics have been obstructed from following the unmovable finger that may be pointing obstinately to the mind of the observer, Hindu scriptures, or God for various reasons. First, there is the unsolved "measurement problem"; how does the quantum wave function that represents probability clouds transition into definite, classical physical reality?

Physicists are divided regarding the ontology of quanta between realists and antirealists. Realists, famously represented by Einstein, believe that new concepts can completely grasp quanta. Antirealists such as Niels Bohr and Werner Heisenberg believe that our knowledge of quanta is necessarily limited. Bohr advised scientists, "When it comes to atoms, language can be used only as in poetry" (quoted in Pranger, 1972). Heisenberg believed that the metaphorical use of classical concepts is rooted in our biological nature, "It makes no sense to discuss what could be done if we were other beings than we actually are" (quoted in Pangle, 2014).

We are denied perception of quanta because somewhere, somehow, and sometime along their path through a measuring apparatus and along the neural pathways to conscious perception, they collapse, decohere, or split into parallel universes. RF could open the doors of perception to quanta by bypassing the causal chain, leading to subjective perception. Direct consciousness of the fiber's subatomic constituents could fulfill its hypothesized role as the neural substrate of suprasensory perceptions of ultimate reality.

Such direct consciousness could be facilitated by organizing the quanta constituting the fiber into a macroscopic quantum system. Unlike physical objects in external reality perceived by exteroceptors, which almost instantaneously entangle with their environment and decohere into classical systems, RF, surrounded by nerve endings connected to the most powerful information processing system in the known universe, could persist as a macroscopic quantum system. Recently developed methods of quantum feedback and control have shown that macroscopic quantum systems can be created with cavity quantum electrodynamic devices using quantum feedback and control. These devices have illustrated that the hindrances to creating a macroscopic quantum system, Schrodinger's cats, are technical rather than conceptual (Wineland, 2013). RF, interacting with the surrounding nerve endings, is a biological analog of cavity quantum electrodynamic devices (Vannucchi et al., 2019; Wu & Austin 1978, 1981). Efferent CSF-cNs could emit electromagnetic signals based on feedback from afferent CSF-cNs. Based on the estimated 100 billion neurons, and 100 trillion synaptic connections operating within milliseconds, the human brain can carry out about 100 petraflops. This information processing power would be exponentially exceeded if quantum computation in microtubules or other structures is involved. Next-generation supercomputers could provide comparable feedback. Volitional control of RF's quantum behaviors could operate in manner analogous to Eccles' model of volitional control of quantum tunneling, Hameroff's model of volitional control quantum coherences in microtubules, and volitional control of EEG frequencies and coherence (Albarrán-Cárdenas et al., 2023), and single motor neurons (Basmajian, 1963; Bräcklein et al., 2022).

Strings and branes that have been posited in unified theories of quantum mechanics and gravity add another barrier to the observability of quanta. Are strings and branes only parts of equations, or parts of reality that are compacted into dimensions too small to be seen? Similarly, parallel universes are postulated by the many-worlds interpretation of quantum mechanics, but there are no known traversable routes to reach them. Condensates of strings constituting RF could facilitate their manifestation and perceptibility. Casimir effects within the fiber's hollow core could transform it into a wormhole to a parallel universe (Garattini, 2019).

Second, physicists are not equipped to travel the road from quantum mechanics for all practical purposes to Hindu scriptures and God because the language of physics and the deepest levels of the languages of the Vedas and Torah are ontologically different (Holdrege, 1996). Suprasensory perceptions generated by RF could be the neural substrate of understanding the profound depths of the Vedas and Torah. Similar to how an intact Wernicke's area is necessary for understanding ordinary language, an intact RF might be necessary for understanding language as divine energies. Because the postnatal regression of RF can be reversed, it is reasonable to discuss what could be done if we were different beings.

Third, consideration of the "subtle body" as a neural substrate of suprasensory perceptions or transrational cognitins has been deemed to be inadmissible by scientists because of prejudices about the truth value of religion. These prejudices have historical roots in the Age of

Enlightenment and childhood development. As Sigmund Freud (1928) observed, "The truths contained in religious doctrines are after all so distorted and systematically disguised that the mass of humanity cannot recognize them as truth." A child does not recognize the symbolic nature of religious truths. He hears only the distortion and feels that he has been deceived. Einstein exemplifies this mistrust of religion. He went through a period of religiousness, following kosher dietary laws and singing self-composed songs praising God. However, at the age of 12, after reading popular science books, he concluded that much in the stories of the Bible could not be true. The result was the "crushing impression" that he had been intentionally deceived by lies. Thus, when Einstein wrote to Maurice Solovine expressing his belief that the capacity of freely created mathematical systems to reveal a hidden order that defies expectations based on naïve sensory experience is a "miracle," he further stated that the miracle cannot be legitimately approached lest his friend think that, weakened by age, he had "fallen prey to the clergy" (Einstein, 1987, p. 118)

Quantum Mysticism

The following section will explore relativistic-quantum mechanical models of RF in the context of mystical religious traditions. The literal interpretation of Adam and Eve's creation and exile from Paradise has served as a wedge between science and religion. However, the kabbalistic interpretation of Adam as the first individual to enter the cycles of material existence, where his "garments of light" transformed into "garment of skin," aligns with an account of the loss of RF and the transition to consciousness dominated by exteroception. The ascents of Enoch, Elijah, and Ezekiel, as well as the radiance of Moses' transitions to consciousness, are dominated by RF.

The suprasensory perceptions attributed to mystics include the transcendence of time. Ordinary temporal perception operates under what Einstein, in a famous letter to the sister of his recently deceased friend Michele Besso, called the distinction between past, present, and future, a "stubbornly persistent illusion." Relativistic conduction could allow perceptions to penetrate that illusion. Wormholes connecting different regions of the space-time continuum could also accomplish the same. Beyond the range of temporal and spatial events is the transtemporal, transgeometric realm corresponding to *Brahman, Tao,* and the *Ein-Sof.* The activity of compacted dimensions and quantum fluctuation of space-time that physicists describe within the 1.6×10^{-35} m diameter core of RF, identified as the *Brahma nadi* or *kav*, provides a neural substrate for the interface with the highest plane of reality.

Mystical religious traditions involve suprasensory perceptions as well as paranormal powers. However, scientific evidence of paranormal powers has been tainted by fraud (Pinch, 1979) and has remained difficult to detect statistically (Jahn & Dunne, 1986). Consequently, mainstream science has rejected it. Macroscopic quantum systems embodied by RF could amplify the effects of psychokinesis. Quantum systems embodied by RF could potentially exploit the paranormal properties of the quantum world—superposition, tunneling, and entanglement. This could lead to the creation of improbable macroscopic quantum systems that are indistinguishable from magic. Furthermore, RF may have the ability to manipulate the creation and annihilation of virtual particles and particles in the physical vacuum, essentially generating something from "nothing."

While suitable test subjects and technologies to measure RF are currently unavailable, and evidence of paranormal powers demonstrated by historical religious figures is unverifiable, the image on the Shroud of Turin is a possible exception. Initial carbon dating suggested that the Shroud of Turin was a Medieval forgery, but subsequent studies using X-ray dating and recalculations of carbon dating based on sample contaminants have yielded results consistent with a much older origin, dating back approximately 2,000 years (de Caro et al.,2022). Theories explaining the creation of the image by a finely tuned burst of radiation have been presented, accounting for the features of the image (di Lazarro et al., 2010; Fanti, 2010; Jackson et al., 1984). However, the challenge lies in the astronomical odds against configuring the subatomic constituents of the human body into a mechanism capable of emitting such a burst of radiation. RF provides a potential avenue to overcome these odds and offers a novel perspective on these phenomena, potentially bridging the gap between science and the miraculous.

The ultimate attainment of the "subtle body" is the Kabbalistic doctrine of *Tikkun Olam.* In cosmological terms, the shattering of cosmic harmonies is expected to be repaired during a new cosmogenesis by 2240. Based on measurements of the rate of cosmic expansion and the cosmic microwave background, the previous cosmogenesis is calculated to have occurred 13.7 billion years ago. According to calculations based on measurements of the Higgs boson and top quark at the Large Hadron Collider, the observable universe is currently in a metastable state. This state is described as a false vacuum separated from a lower-energy true vacuum by an energy barrier that can be penetrated by quantum tunneling, thereby initiating a new cosmogenesis (Devoto et al., 2022; Rafleski & Bir-

rell, 2015). While the odds of such an event occurring by random quantum fluctuations are vanishingly small, it potentially could be engineered using quantum feedback and control of RF, with the facilitation of neurofeedback (Bi & Song, 2013; Shukla et al., 2020; Zhang et al., 2014, 2017). Despite the scientific consensus deeming a new cosmogenesis resulting from tunneling through this barrier as the ultimate catastrophe (Coleman, 1977; Tegmark & Bostrom, 2005), uncertainties, including the potential unfolding of compacted dimensions, leave open the possibility that it could also lead to cosmic redemption.

CONCLUSION

Evolutionary Crossroads

Homo sapiens evolved the unique capacity to create mental worlds, communicate them with language, and use them to achieve practical goals. This capacity conferred a variety of selective advantages. Lying confers an advantage over competitors. Political and religious systems promote social cohesion. Understanding the physical world enhances survival. Considering that natural selection favored the perinatal regression of the strategically located RF during the evolutionary transition from apes to *Homo sapiens*, the loss of the fiber was likely a factor in creating the neural foundation for that transition.

I propose that the evolutionary loss of RF is analogous to the breakdown of the "bicameral mind" described by Julian Jaynes (2000). He proposed that humans, as recently as three thousand years ago, were organisms bound by stimuli and that their behavior was governed by command auditory hallucinations transmitted from the right side of the brain to the left via the anterior commissure. According to the model proposed here, RF transmitted the transtemporal, transgeometric constituents of consciousness to the ECM, ion channels, and microtubules to create unity between inner and outer reality. Similarly to the "bicameral mind," this unity broke down when previously isolated cultures clashed (Wile, 2018).

Now, after 300,000 years, according to conventional evolutionary theory, or 3,000 years according to Jaynes, the accelerating expansion of mental worlds and their consequent effects pose a threat to human survival. The postmodern age began replacing truth with power struggles. The information age is overwhelming human cognitive capacities. Artificial intelligence holds the potential for exacerbating those dangers. In fact, Frederic Jameson (1992) argues that this new danger, "stands as something like an imperative to grow new organs, to expand our sensorium and our body to some new, yet unimaginable, perhaps ultimately impossible, dimensions."

Mystical traditions have proposed that developing the central axis of the "subtle body" can lead to a harmonious connection between the human microcosm and the divine macrocosm. Based on this analysis, it is suggested that reversing the perinatal regression of RF, integrating it into neuropsychological functioning, and enhancing fiber activity through real-time neurofeedback can fulfill this vision.

The exploration of whether a neurocosmology organized around RF can fulfill the perennial vision of mystical traditions is alluring to some but repulsive to others. The group that finds this repulsive either dismisses mystical traditions as myths, superstitions, or products of hallucinatory confusion, or regards "quantum mysticism" as pseudoscience. Regardless of the camp to which one belongs, RF is an enticing enigma, and the starting point of the exploration of RF's potential effects on human consciousness is the same, i.e., the investigation of persons whose fibers persist postnatally.

Considering the potential role of RF in preventing or treating scoliosis, hydrocephalus, schizophrenia, and Alzheimer's disease, the first step in investigating RF as a neural correlate of human consciousness is likely to involve reversing the fiber's perinatal regression through cellular reprogramming. Whether individuals with regenerated fibers will be harbingers of an era of expanded consciousness and revelations of truth or misguided challengers of natural selection remains to be seen. Meanwhile, empirical and theoretical evidence supporting the hypothesis that RF is the means to achieve the goals of mystical traditions can assuage the intellectual bad conscience of people of faith who have been criticized for holding beliefs unsupported by reason or evidence and illuminate new fields of scientific exploration, especially the nascent field of quantum neurobiology.

IMPLICATIONS AND APPLICATIONS

Investigations of Reissner's fiber using cellular reprogramming, cognitive neuroplasticity quantum neurobiology, and neurofeedback could contribute to the fields of neurophysiology, neuropathology, neurotheology, transpersonal psychology, and transhumanism. The eschatological implications of this paper could contribute to a constructive dialogue between science and religion.

ACKNOWLEDGMENTS

The author thanks Rüdiger Land, PhD for his valuable comments, and the Taylor & Francis Editing Service for improving the paper's clarity.

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