# An Immortal Stream of Consciousness

The scientific evidence for the survival of consciousness
after permanent bodily death


An essay by

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## Introduction

The concept of a soul or vital force is consistent across scientific, medical, theological, and philosophical thought[1]. The soul is often described as contained within specific organs but separate from the body, and it is unsurprising that its location has been a subject of great debate throughout history[2]. Despite much contention, those historically in search of the soul have generally agreed that it is the essence of a person – their true and immortal self[1,3]. Indeed, when confronted with the challenge of identifying themselves, most people point to their chest or, approximately, their heart. This cardiocentric model of who we are is described in humanity's earliest writings from the third millennium BCE, indicating that Ancient Egyptians believed souls were immortal and located within the hearts of impermanent bodies[4]. The related idea of the pneuma – ancient Greek for breath, spirit, or soul – represents one among many similar beliefs about the essence of human life[5]. Consistent with the heart's exalted status throughout history[6], and until very recently, irreversible cardiac arrest was considered the medical standard for death[7-9]. Which is to say, when your heart stopped beating, you stopped being. However, the importance of other bodily organs did not go unnoticed by our ancestors. Notable philosophers such as Plato and Descartes championed the brain as the locus of the soul[10-13] and modern definitions of death rest squarely on the structural and functional integrity of the brain, not the heart[7,8].

A fascination with the brain is also present in Ancient Egyptian writings as evidenced by the lucid descriptions of agnosias, automatic behaviors, and emotional disturbances associated with head injuries as reported in the Edwin Smith Papyrus[14]. Around 200 BCE, the famous Greek physician Galen noted that stimulating the heart induced no cognitive or perceptual response but that the same procedure applied to the brain had marked effects[5]. Some prehistoric human skulls, discovered to be over 5000 years old, feature holes with tapered edges that suggest they were formed and allowed to heal while the person was alive[15,16], which is evidence of a surgical technique called trepanation that is still used today to relieve increased intracranial pressure that can cause altered mental states and death[17]. Unsurprisingly, our ancestors noticed that our heads and their contents are major anatomical correlates of how we feel, what we do, and who we are[18]. As they would have observed frequently in soldiers returning from war, getting hit in the head could change someone's personality and behavior, as well as erase their memories[19-21]. As modern clinicians know, a person suffering a head injury then would have, in their own words, reported feeling "like a different person"[22]. Beyond brain injury, the most extreme changes would be associated with death, including a loss of speech and all movement by which we infer thought and experience or "consciousness". Then, like now, people might have seemed to live behind their eyes until they could no longer open them and the care with which burial and cremation practices were carried out tens of thousands of years ago[23] suggests that when faced with the death of loved ones, our ancestors likely wondered where they had gone and if they would ever meet again.

That timeless question concerning the survival of human consciousness after permanent bodily death remains as relevant today among religious and non-religious people alike[24,25]. In centuries past, we turned to both scientific and religious institutions with questions about the afterlife or lack thereof, receiving incomplete and deeply dissatisfying answers that failed to quell the human fear of annihilation. *In this essay, I will demonstrate that a contemporary scientific understanding of life,* *death, consciousness, and its survival is possible and that the best available evidence for the survival of human consciousness after permanent bodily death is empirical*. Beyond religion and philosophy, the scientific method, bolstered by our modern technological instruments, has already addressed questions of survival in significant ways that are not immediately obvious. Whereas one might expect near death experiences (NDEs) and related subjective reports to carry the burden of proof for survival research, a review of the literature published between 1945 and 2013 demonstrated that NDEs often fall short of providing investigators with explanatory hypotheses or testable mechanisms[26]. Therefore, unintuitively, NDEs are important but may not represent the *best* available scientific evidence for the survival of consciousness after death. Instead, scientists have formulated testable hypotheses on the bases of pervasive cultural ideas of psychic energy to found what is now a nascent but empirical study of consciousness as a force that interacts with the brain but is independent of it[27-32]. If brains are conduits or vessels rather than generators of consciousness, death may represent a significant change to the individual but certainly not an end.

In this essay, I will outline why the survival of consciousness after brain death is not only possible, but probable beyond a reasonable doubt. I will also demonstrate that our understanding of brain function has changed radically over the past century and now includes biophysical mechanisms which can explain not only survival, but also related observations which have classically been categorized as "psi" phenomena. For example, while it is true that the putative telepathic and remote-viewing abilities of unique individuals such as Sean Harribance[33-35] and Ingo Swann[36,37] are not easily explained by older models of brain function that treat endogenous activations as the sole sources of cognition, new models that place consciousness at least partly outside the brain can explain them. In fact, the latest evidence indicates that our brains readily interact with electromagnetic fields (EMF) from natural and artificial sources[38-43]. Not only do brain cells signal wirelessly to each other by means of their own weak electric fields[44-46], but the Earth's magnetic field has been repeatedly shown to influence, cohere, and resonate with human brain activity in real-time, with profound consequences on neurocognitive and behavioural output[43,47]. Using principles of electromagnetic induction, we now employ technologies such as transcranial magnetic stimulation (TMS) to change brain activity[48], assess and treat neurological disorders[49-51], and even subvert free will[52]. Our brains' EMFs, which can be detected using biomedical devices such as magnetoencephalography (MEG)[53], are all immersed in a shared geomagnetic medium that oscillates with periodicities that match the frequency patterns of our own brain waves[47,54,55]. As will become clear, it is possible that the information content of our experiences and memories can be uploaded or downloaded to and from spaces external to our brains, existing independently after we die[56]. On the bases of these and other discoveries, I will instruct and elucidate a comprehensive model of brain function that characterizes consciousness as a transmitted signal or force with at least a partial existence outside the head.

Before I elaborate on these lines of evidence, I want to briefly emphasize two important points. First, the question of whether or not consciousness survives permanent bodily death is fundamentally a scientific one. We must remember, after all, that the natural world is filled with phenomena that confound our intuitions and, before scientific inquiry, appear magical, other-worldly, or divine. When we are finally able to measure, quantify, and subject said phenomena to independent replication, we inevitably realize that what seemed unrealistic was simply a misunderstood feature of the natural world. If consciousness is a physical and reproducible phenomenon that can be measured albeit indirectly, we should be able to design experiments to detect its presence within or without the body after death. Indeed, the final section of this essay will make concrete experimental suggestions for doing exactly that, including the measurement of death-related light emissions[57,58] and creating lab-engineered brain tissues to tease apart mind from matter[59]. Second, the question we are concerned with is of tremendous importance to the human species. Great religions, cultures, and scientific institutions throughout history have dedicated enormous amounts of attention and resources to the study and contemplation of life after death. People are willing to fight and die to maintain their cultural belief systems[60,61], which often provide coherent and anxiolytic frameworks for life and death[60,62]. Contemplating mortality is a feature, not a bug of the human condition. Some of the most beautiful poetry and devotional art that our species has ever produced has been shaped along the boundaries of life and death. Standing on the shoulders of countless thinkers throughout history, I am humbled to find myself addressing this timeless question. Most of what I will discuss will be curated rather than created; however, I will supplement my case with some of my original published research in the field of neuroscience to support the central thesis: consciousness survives death.

## Section 1: The butterflies of the soul and how they die

To describe how the consciousness of a living human can survive death, several important terms will first need to be defined, beginning with a review of "life". In his 1944 book entitled "What is life? The Physical Aspects of the Living Cell", Erwin Schrödinger[63] provided the theoretical groundwork for the scientific study of life, anticipating among other things the "aperiodic crystal" structure of DNA and the role of mutation in evolution[64]. Most notably, Schrödinger emphasized that life, as with all products of physical laws, is dependent upon "order-from-disorder". That is, from the percolating chaos and disorder of the quantum world emerges – not as an accident or coincidence but as a property of the conditions themselves – highly ordered molecular structures that give rise to living organisms. Schrödinger's speculations provided a new and exciting path from fundamental particles to life and are recognized as foundational to the field of molecular biology. He even discussed the relationships between life, free will, and consciousness. His insightful unification of non-living matter and energy with life and conscious experience was an important acknowledgement of the continuous and inseparable chain of interactions that connect the microscopic and macroscopic worlds. Since Schrödinger, there has been an explosion of information about the fundamental nature of life but the primary role of the cell as its structural and functional unit is among the least controversial facts in the field of biology[65].

Cells are approximately 10 millionths of a meter wide[66], mostly water by volume[67] and surrounded by a thin, gated membrane that maintains order by keeping certain molecules in and others out[68]. The cell membrane acts as a selective bridge between the inside of the cell, where chemical reactions are highly controlled, and the outside of the cell, where they are largely spontaneous or random. Because membranes can separate charged particles – also called ions – cells store an electric charge, like a battery, that can be actively discharged to help them divide, proliferate, or communicate with their neighbors[69-71]. The boundary of the membrane is what distinguishes the living cell from its non-living environment. Consider that viruses must cross the important threshold of the cell membrane to suddenly become activated and "life-like", with disastrous consequences to our bodies[72]. When membranes are dissolved, cells and their environments become assimilated, and life becomes nonexistent. Life is therefore a state of ordered conditions maintained by a thin and delicate cell membrane that divides the world into living and non-living parts: "order-from-disorder". As its direct negation, death, to reverse Schrödinger's formulation, is "disorder-from-order". More generally, death is the disorder that a living system experiences when its boundaries dissolve and it is no longer distinguishable from its environment.

Not all cells are equally relevant to the death of the individual. That is, when considering the essence of a person, we are not preoccupied with cell death in the gallbladder or kidneys. Where life, death, and consciousness interact is, as we understand it, the brain. And while the human body is a highly interconnected system, and the heart might be necessary for its function, the brain is the only known organ in the human body that is sufficient for consciousness[73]. Indeed, there is no reason to suppose that a brain supported by a series of artificial organs could not sustain consciousness. There are, after all, many such examples in modern medicine including circulatory pumps, ventilators, and dialysis machines that sustain conscious life. But what do I mean by the word "conscious"? A system is conscious if there is something that it is like to be it[74]. That is, *consciousness is pure subjective experience and the entry point for everything we know and can know about the external world and our internal states*. It is the stream of mental chatter that defines our point of view relative to events in the world. Consciousness is, fundamentally, the thing we refer to when we say the words "I" and "me". For all practical purposes, it is the soul under a different name. However, just as the phlogiston theory of combustion led to the discovery of oxygen, the ancient idea of the soul has given way to a focused science of consciousness and its relationship to the essence of human life[75].

While consciousness and the related mechanisms that allow experience or internal representations to arise from matter are not fully understood, its existence is certain. Indeed, it was Descartes who famously pointed out that thought is the original ground truth and the foundational argument for personal existence[76]. Today, philosophers and scientists alike generally agree that human consciousness exists and is a function of the brain[73,77]. Therefore, if the question at the core of this essay is "Can consciousness survive the death of the body below the neck including the heart?", the answer is an uncontroversial and emphatic "yes". However, without addressing brain death, the significance of the question at the core of this essay is completely lost. Therefore, any proposed solution for the survival of consciousness after bodily death must account for its persistence following brain death in particular.

To appreciate the significance and implications of brain death, I will now provide a brief overview of the living brain's structure and function. The human brain is approximately 1350 cubic centimeters of water, fat, and protein with lesser concentrations of metals and other molecules[78-81] (**Figure 1A**). Its outer structure, the cerebrum, resembles a raveled knot of hills and valleys – gyri and sulci – which are connected like a wrinkled but continuous sheet. The one-to-four millimeter outer shell of the cerebrum, which is appropriately called the "cortex" or the Latin word for tree bark, is generally considered to be the most important structural correlate of consciousness within the brain[82-84]. It receives information from sensory organs that define vision, hearing, taste, smell, touch, and other perceptual modalities[85,86]. The cortex also governs language[87], voluntary movement[88], decision-making[89], reasoning[90], moral judgements[91], emotional regulation[92], and countless other brain functions. Most neural correlates of consciousness (NCCs) are fundamentally cortical including high-frequency (gamma) synchronous activity[93]. Further, distinct activations of the cerebral cortices are apparent in near-death experiences (NDEs)[96], out-of-body experiences (OOBEs)[95], and God experiences (GEs)[96,97], which are frequently cited in survival research. Finally, the clinical criteria for brain death hinge on specific diminishments of cortical activity as inferred by brain imaging[98,99]. Therefore, the cerebral cortices are undoubtedly areas that we must focus on if we are going to address the survival of consciousness after death.

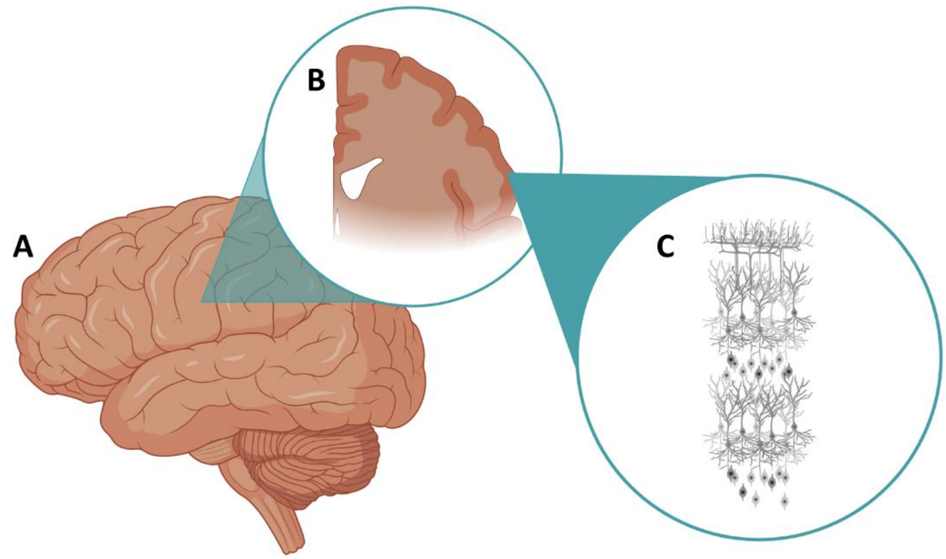


**Figure 1. The macroscopic and microscopic structures of the brain.** A) Gyri and sulci divide the cerebrum (lateral view) into gross anatomical regions with unique functions. B) The cerebral cortex is the 1-4 millimeter layer of tightly-packed cells near the outer surface of the brain. C) Cells are organized into complex, laminar "architectures" that reflect the complexity of cortical function. Created with BioRender.com.

The cerebral cortices (**Figure 1B,C**) are composed of 10 to 100 billion cells which includes both neurons – the definitive brain cell – and the supportive glial cells. Originally described as "the butterflies of the soul" by the great neuroscientist Santiago Ramón y Cajal[100], neurons maintain an electric charge across their membranes like other cells. However, unlike most cells, they are specialized to be highly polar and rapid communicators[101]. The brain is considered an electrochemical organ and neurons reflect this duality by signaling to each other by both electrical and chemical means[102]. The quintessential signal of the neuron is the action potential: an all-or-nothing, 1 millisecond discharge of electromagnetic energy that results in the release of chemicals called neurotransmitters that trigger downstream action potentials in turn[102]. Every time a neuron discharges its membrane potential, it briefly reverses its charge from internally negative to positive, crossing an important electrical threshold of 0 millivolts, which indicates the cell and its environment are electrically indistinguishable[102]. Under normal circumstances, neurons readily re-polarize themselves and continue signaling; however, for a very brief but real moment they are electrically neutral: this is a property of dead and dying cells[103]. As far as modern neuroscience is concerned, an uncharged neuron is incapable of generating cognition. In other words, every time a neuron is activated, it crosses the electrical equivalent of the life-death boundary and then comes back again. Of course, this state is transient, but it is important to realize that neurons operate on the edge of life and death. Indeed, over 85,000 neurons die and are never replaced as a normal part of brain aging every single day[104]. Unlike most other organs, brains are in a constant state of incremental degeneration, though what connections remain become increasingly efficient and define the individual's personality and memory. But what happens when brains become *irreversibly* non-functional?

As was previously discussed, a still heart is no longer the gold standard definition of death in medicine. In recent years, the consensus has moved toward brain death and detailed criteria have been put forward to guide clinical assessment. One technical definition, for example, specifies the amplitude of electroencephalography (EEG) voltage should be below 2 microvolts for over 30 minutes[98,99]. However, beyond black-and-white definitions of life and death is a more accurate view of what actually occurs when consciousness appears to stop. Death is usually understood to be a fixed time that can be reported on a medical chart; however, this is clearly not the case. Living and dying are processes, not events, and processes take time. Furthermore, the boundaries of processes are always blurry or undefined. We now know that when the heart stops pumping oxygen- and nutrient-rich blood to the head, the brain remains functionally active for 3 or 4 hours post-mortem[105,106]. Because the means by which we detect brain activity such as EEG depend on the synchronous activity of thousands of cells working together[107], there is likely asynchronous neural activity that persists undetected well-beyond that – the random beating wings of a billion dying butterflies. Organotypic slice cultures, which are pieces of brain tissue from mice and other laboratory animals that are maintained artificially in a dish, can functionally persist for weeks given the right environmental conditions[108]. Death is by no means a moment. Rather, dying, as evidenced by the brain's normative state of persistent degeneration, is a lifelong process that becomes suddenly accelerated after heart death. Indeed, brain death is likely only a meaningful concept when the brain has become physically dissociated following cellular breakdown and is actively decomposing. It should also be noted that the longer a person's brain is deprived of oxygen, the less likely they are to ever regain consciousness[109]. For example, following cardiopulmonary resuscitation, the likelihood of recovering consciousness after 24 hours, 72 hours, and 5 days is 34%, 25%, and 20% respectively[109]. Brain death is clearly a process, and we can expect its interaction with consciousness, including survival, to track those changes over time.

Though I have now defined the major terms of life, death, and consciousness as they relate to the brain, one additional consideration should be addressed. When discussing the survival of consciousness after permanent bodily death, we are often implicitly talking about more than just a capacity for experience or awareness. Across cultural traditions, conceptions of an afterlife are often (but not always) personal, and what survives is thought of as an imprint or engram of the formerly living person complete with memories and even desires, fears, and love[110]. Of course, some cultural traditions have provided versions of survival that are distinctly impersonal[111], and the view that we are all one mind or soul divided across bodies that return to a common origin upon death is well-subscribed[110,112]. However, it is certainly worth considering the possibility of memory surviving death. Consistent with modern neurobiology, memories are stored as patterns of connections between cells in the brain, punctuated by protruding spine-like membrane structures along the tree-like branches of neurons[113]. Each cell is connected to thousands of others in what has been described as an "enchanted loom"[114] (p. 172) which weaves a network in excess of *one hundred trillion* connections[115]. We know that memories are not stored in any one particular area, but rather are distributed isotropically across the surface of the cerebral cortex[116]. If you remove a part of the brain, no particular memory is erased but many or all memories will incur a loss of resolution or detail[116]. While we may naturally lose up to 10% of our brain cells over a lifetime[117], what we gain is the benefit of an incredible orderliness to our connections within which our personalities and past experiences are encoded. Despite lifelong brain degeneration, with age we tend to know more about the world as information accumulates within our neural networks. What happens to these connections upon death? Conventionally, it is assumed that as the cellular structure of the brain decomposes, so too do these connections, and the individual as represented by their neural patterns is forever lost. It is conceivable that the survival of consciousness is independent of memory and that brain decomposition erases the only physical representation of the individual. However, in light of new models of brain function that will be discussed later in this essay, we will consider both the post-mortem survival of consciousness and, to a lesser but significant degree, memory.

Now that the question has been appropriately framed and before offering a solution to establish survival, I will outline what does and does not constitute scientific evidence in support of my thesis. In Edgar D. Mitchell's influential 1974 book entitled "Psychic Exploration: A Challenge for Science, Understanding the Nature and Power of Consciousness", the prominent psychical researcher William Roll addressed this very question in his chapter on survival research[118]. Based upon decades of work on the subject, he summarized his view on the hierarchy of evidence in the following statement:

> *When we ask whether consciousness continues after death, we usually assume that a surviving self will exist in some kind of body and will include the personality familiar from waking experience. In the course of their work, however, psychic researchers have encountered mediumistic communicators and apparitions that were apparently created by the living but not inhabited by their consciousness. These communicators and apparitions are indistinguishable from those representing the dead. It does not seem possible, therefore, to discover whether there is a continuation of experience after death by the study of communicators, apparitions and other surviving residues of the living. We must look elsewhere for evidence of the survival of consciousness. Since the consciousness that may continue after death presumably exists before, we may explore it in the living. An examination of parapsychological research with living subjects suggests that consciousness is not private to any individual but can be shared by others. If a person's consciousness does not "belong" to him, it is unlikely that it will disappear at his death.* (p. 397)

Roll went on to suggest that if consciousness can survive death, it will display three major characteristics: 1) there will be evidence of experiences of the self that can extend beyond the body, 2) this extended self will be able to interact with events and objects in the world, and 3) it will be able to function independently of the central nervous system[118]. To reiterate the main points, William Roll argued that if consciousness survives death it must not be private, can be shared, and can interact with the world independently of the central nervous system. He explicitly singled out information acquired by mediumship and apparitions as unproductive or weak forms of evidence given our inability to distinguish them from identical phenomena that can apparently be conjured by the living. Roll considers OOBEs and the ability of consciousness to affect events at a distance as strong supportive evidence of the possibility of survival. He also suggests exploring survival in the living rather than attempting to access consciousness post-mortem since any consciousness that survives death is one that formerly existed in the living.

One reasonable interpretation of this summary is that a sufficiently sophisticated understanding of consciousness would test and potentially validate the survival hypothesis. More specifically, *if we were to discover that the brain functions of living people including consciousness could be shared, accessed, projected, transmitted, or channeled to transfer information or deliberately affect events, then survival after death would be quite likely because we would have verified its independence of and ability to extend beyond the nervous system*. These putative properties of consciousness effectively describe classical psi phenomena such as telepathy, remote viewing, and psychokinesis. In other words, if consciousness interacts with but is independent of the brain, it will likely both survive brain death and explain other previously unexplained phenomena which are only conceivable as realistic under the new constraints. In fact, they may share fundamental mechanisms that remain to be fully elucidated.

I will, however, offer a partial criticism of Roll's criteria in the interest of maintaining a high scientific standard and to address the elephant that is not in the room. That is, though it might be tempting to base an argument in support of the survival hypothesis on vivid personal accounts of an afterlife, experiences should only be included sparingly as an integral but minor part of the grand explanatory narrative. This point should not be interpreted as a dismissal of the validity or importance of individual experience. Indeed, Roll's criteria identified experiences as essential to the big picture, and it can never be said that a particular experience of the afterlife is false since verification is impossible. However, it is for this same reason that I claim we can never exclude the possibility of illusion or hallucination. Furthermore, if experiences can be shared, how might we distinguish the subjective accounts of one person from the channeled accounts of another? That is, subjective experiences can be both meaningful and true and still not qualify as *strong* scientific evidence. Therefore, I submit that experiences can only partially corroborate but never fully validate survival since the content of experience cannot be empirically measured yet. Of course, there may one day be a technology that measures the raw content of experience in real-time; however, no such technology currently exists.

There are at least three additional concrete reasons why subjective accounts such as NDEs, OOBEs, and GEs should only be used sparingly in pursuit of a scientific approach to understanding survival. First, scientific evidence demands replicability for independent verification which is not possible for individual subjective experiences. And while collections of similar experiences reported by many individuals may constitute evidence of a sort, they can always be explained by conserved brain structure-function relationships across the human species[60]. In his book entitled "Neuropsychological Bases of God Beliefs", notable neuroscientist Michael Persinger explains that because brain structure is highly conserved across the billions of humans on the planet, similar experiences associated with death are expected[60]:

> *The fact that similar allusions to death (from people who have almost died) exist in many human cultures does not prove the validity of these experiences. Similar near-death reports may only reflect the similar construction of the human brain. They may indicate only that human brains undergo similar sequences as bodies slowly die. This is certainly not surprising and would even be mundane if any other part of the human body was involved. Manifestations*

*of muscle deterioration, for example, follow more or less the same sequence no matter what human culture has reported it.* (p. 91)

The most striking example of this involves the pervasive NDE of "the light at the end of the tunnel"[119]. This visual experience can be explained by the highly conserved structure of the occipital cortex[120] and its anatomical relationship with the posterior cerebral artery[121]. Upon loss of blood flow during cardiac arrest or ischemic stroke, peripheral vision becomes impaired before central vision, producing a visual window: the archetypal experience of a darkened tunnel with light at its center[119]. While the labels that describe the tunnel phenomenon might vary from culture to culture, the common perceptual features reflect the common functional anatomy of the brain and its arteries. In other words, the assumption that shared glimpses of an afterlife across multiple near-death reports constitute evidence for the existence of a genuine space beyond life can always be undermined by the alternative hypothesis that humans share a conserved brain structure with conserved experiential correlates. Similarly, entoptic phenomena[122], which are visual experiences caused by the structures of the eye itself that appear universally throughout history including in paleolithic art motifs[122], illustrate the fundamental problem of relying on convergent subjective reports as a form of evidence.

The second reason for the sparing use of subjective accounts is the following: NDEs, OOBEs, and GEs are, by definition, brain activations that are reported in the living state and the same neuropsychological correlates have been reported in individuals who did not die or nearly die[124]. Because NDE-type experiences – including the sensation of floating away from the body, entering another plane of existence, or encountering supernatural beings[124] – are reported independent of death[125-127], the assumption that recondite information from an afterlife is being relayed to the living state is only one of many possible explanations. The third and final reason is that all of these experiences can be reproduced experimentally in healthy, living subjects in the laboratory[128]. Indeed, mystical, religious, transcendent, euphoric, rapturous, and conversion-type experiences have been elicited by direct stimulation of the brain and the temporal lobes in particular[97,129,130]. Since the early stimulation experiments with surgical patients[131], non-invasive replications with healthy individuals using applied electromagnetic fields have been performed with similar results[128]. These include the sensed presence, OOBEs, and visitations by post-mortem apparitions and deities[128]. That what appear to be reports from the afterlife can be reproduced experimentally in the laboratory should arouse a healthy skepticism in the scientifically minded. Of course, there will always be the possibility that the act of stimulating areas of the brain that induce experiences of an afterlife is, in fact, allowing the individual to experience a genuine reality that can only be accessed in particular altered states of consciousness – like a virtual path through the looking-glass[132]. However, for the reasons listed above, the contents of subjective experiences should not be regarded as strong forms of scientific evidence.

With these caveats in mind, we turn to the proposed solution that I claim will, beyond a reasonable doubt, support the survival of consciousness after bodily death. As will be discussed throughout the remaining sections, the way in which the brain functions and interacts with consciousness is central to the survival hypothesis. Drawing on extensive experimental evidence, I will demonstrate that brain functions including consciousness are not fully explained by the conventional neurophysiological model. Brain function is at least partly determined by and can interact with natural, physical forces outside of the head – a model of consciousness that was first articulated over a century ago by one the most significant figures in the history of psychology.

**Section 2: A blueprint for human immortality**

The Ingersoll Lectures, which have been hosted by the Divinity School at Harvard University since the 1890s, are delivered every year between the end of May and the beginning of December on the subject of human immortality. Consistent with requests made when it was originally endowed, lecturers can be professors, clergymen, or laypeople but should not be limited to any one group. Notable thinkers and scientists including William Osler, Alfred North Whitehead, Elisabeth Kübler-Ross, and Stephen Jay Gould are among the long list of distinguished speakers associated with the Ingersoll Lectures series. While the specific topics vary according to expertise, many lecturers have offered insights on the survival of human consciousness following bodily death.

In 1897, the famous "Father of American psychology" William James – who was also a notable physician, philosopher, and psychical researcher with a profound interest in the paranormal[133] – delivered the second annual Ingersoll lecture entitled "Human Immortality: Two Supposed Objections to the Doctrine". In his lecture, the transcript of which was published in 1898, James outlined what I submit is the definitive case for the survival of human consciousness[134]. The main arguments put forward in the lecture are as relevant today as they were then; however, over a century of neuroscientific research has provided the benefit of empirical support, which makes his argument significantly more compelling. As I am convinced William James' formulation of the problem of survival is critical to appreciating the proposed solution, I will summarize his lecture and its implications here. Once the concept is characterized, the remaining sections of the essay will be comprised of a systematic description of the empirical support for James' hypothesis.

William James structured his groundbreaking lecture as a reply to two reasonable objections to the doctrine of human immortality. The first objection to which he replied is the same we concerned ourselves with in the previous section: If the brain is the seat of consciousness, how can it survive brain death and decay? After re-stating the objection, James began with a throat-clearing about the dependence of memory, thought, and consciousness on the brain[134]:

> *The first of these difficulties is relative to the absolute dependence of our spiritual life, as we know it here, upon the brain. . . . How can the function possibly persist after its organ has undergone decay? . . . Every one knows that arrests of brain development occasion imbecility, that blows on the head abolish memory or consciousness, and the brain-stimulants and poisons change the quality of our ideas. . . . various special forms of thinking are functions of special portions of the brain. When we are thinking of things seen, it is our occipital convolutions that are active; when of things heard, it is a certain portion of our temporal lobes; when of things to be spoken, it is one of our frontal convolutions. . . . For the purposes of my argument, now, I wish to adopt this general doctrine as if it were established absolutely, with no possibility of restriction. . . .Thought is a function of the brain.* (pp. 7-10)

Having firmly adopted the position that thought – including consciousness – is a function of the brain, James accepted the challenge of reconciling its survival with death. To that end, he explained why most of his contemporaries believed immortality, or the survival of consciousness after bodily death, was impossible and why their reasoning was flawed[134]:

> *The supposed impossibility of its continuing comes from too superficial a look at the admitted fact of functional dependence. The moment we inquire more closely into the notion of functional dependence, and ask ourselves, for example, how many kinds of functional dependence there may be, we immediately perceive that there is one kind at least that does not exclude a life hereafter at all. The fatal conclusion of the physiologist flows from his assuming offhand another kind of functional dependence and treating it as the only imaginable kind.* (pp. 12)

Next, James described three types of functional dependences: productive, permissive, and transmissive. He argued that objections to human immortality – the survival of consciousness after death – are based upon the widely-held assumption that brain functions including consciousness are consequences of productive function[134]. That is, the function is "inwardly created" or caused by endogenous neurobiological events – as is the current dogma in the modern field of neuroscience. He elaborates:

> *When the physiologist who thinks that his science cuts off all hope of immortality pronounces the phrase, ``Thought is a function of the brain,'' he thinks of the matter just as he thinks when he says, ``Steam is a function of the tea-kettle,'' ``Light is a function of the electric circuit,'' ``Power is a function of the moving waterfall.'' In these latter cases the several material objects have the function of inwardly creating or engendering their effects, and their function must be called productive function. Just so, he thinks, it must be with the brain. Engendering consciousness in its interior, much as it engenders cholesterin and creatin and carbonic acid, its relation to our soul's life must also be called productive function. Of course, if such production be the function, then when the organ perishes, since the production can no longer continue, the soul must surely die. Such a conclusion as this is indeed inevitable from that particular conception of the facts.* (pp. 12-13)

Having rejected the conclusion that consciousness necessarily arises from a productive functional dependence of the brain, James then described permissive or "releasing" function, which is derivative of Newton's first law of motion, where function is inevitable unless obstructed by a barrier. To clarify the point, he cited the example of a crossbow, where the release of the string returns the bow to its original shape, thus firing the arrow[134]. However, we will be primarily concerned with James' third type of functional dependence: transmission. In James' view, transmissive function is like a filter or sieve that, by dint of its own structure, organizes the shape and character of existing but separate forces into parcels, units, or subdivisions of the whole. Stating his thesis, William James considered the possibility that consciousness is dependent upon a transmissive property of the brain rather than a productive one[134]. In his own words:

> *In the case of a colored glass, a prism, or a refracting lens, we have transmissive function. The energy of light, no matter how produced, is by the glass sifted and limited in color, and by the lens or prism determined to a certain path and shape. Similarly, the keys of an organ have only a transmissive function. They open successively the various pipes and let the wind in the*

*air-chest escape in various ways. The voices of the various pipes are constituted by the columns of air trembling as they emerge. But the air is not engendered in the organ. The organ proper, as distinguished from its air-chest, is only an apparatus for letting portions of it loose upon the world in these peculiarly limited shapes. My thesis is now this: that, when we think of the law that thought is a function of the brain, we are not required to think of productive function only; we are entitled also to consider . . . transmissive function.* (pp. 14-15)

Staying with the metaphor of transmitted light, James then asked his audience to consider the possibility that "the millions of finite streams of consciousness known to us as our private selves" (p. 15-16) are part of one infinite *Thought* that, like white light through a prism, is shattered into an infinite spectrum of waves[134]. Considering the possibility that brains selectively obstruct the transmission of consciousness, and that this process explains the unique features of human individuality, James described how his proposed mechanism might track changing mental states, death, and the survival of consciousness after brain decay[134]:

*According to the state in which the brain finds itself, the barrier of its obstructiveness may also be supposed to rise or fall. It sinks so low, when the brain is in full activity, that a comparative flood of spiritual energy pours over. At other times, only such occasional waves of thought as heavy sleep permits get by. And when finally a brain stops acting altogether, or decays, that special stream of consciousness which it subverted will vanish entirely from this natural world. But the sphere of being that supplied the consciousness would still be intact; and in that more real world with which, even whilst here, it was continuous, the consciousness might, in ways unknown to us, continue still*. (pp. 17-18)

William James conceded that no known mechanism at the time of his lecture could explain transmissive functional dependence in brains[134]; however, he enjoined his audience to consider that a productive mechanism had also not yet been demonstrated – a fact that remains true today despite an embarrassment of riches with regard to correlational data (e.g., neural correlates of consciousness). James then concluded that the productive theory was only regarded as more likely than the transmissive theory because it was more popular – a point that also remains true today. Finally, he described some perceived advantages of the transmission theory[134]:

*Consciousness in this process does not have to be generated de novo in a vast number of places. It exists already, behind the scenes, coeval with the world. The transmission-theory not only avoids in this way multiplying miracles, but it puts itself in touch with general idealistic philosophy better than the production-theory does. . . . It puts itself also in touch with [Gustav Fechner's] conception of a `threshold' . . . Before consciousness can come, a certain degree of activity in the movement must be reached. . . . but the height of the threshold varies under different circumstances: it may rise or fall. When it falls, as in states of great lucidity, we grow conscious of things of which we should be unconscious at other times; when it rises, as in drowsiness, consciousness sinks in amount. . . . [and] conforms to our notion of a permanent obstruction to the transmission of consciousness, which obstruction may, in our brains, grow alternately greater or less.* (pp. 23-24)

James then dedicated some attention to the important point that transmissive brains could account for phenomena that are conceptually marginalized by the assumption of productive functional dependence. Specifically, he listed several psi phenomena that are made mechanistically plausible by the adoption of a theory of transmission[134]:

> *The transmission-theory also puts itself in touch with a whole class of experiences that are with difficulty explained by the production-theory . . . [such] as religious conversions, providential leadings in answer to prayer, instantaneous healings, premonitions, apparitions at time of death, clairvoyant visions or impressions, and the whole range of mediumistic capacities, to say nothing of still more exceptional and incomprehensible things. . . . On the transmission-theory, they don't have to be `produced,'--they exist ready-made in the transcendental world, and all that is needed is an abnormal lowering of the brain-threshold to let them through. . . . All such experiences, quite paradoxical and meaningless on the production-theory, fall very naturally into place on the other theory. We need only suppose the continuity of our consciousness with a mother sea, to allow for exceptional waves occasionally pouring over the dam.* (pp. 24-27)

William James ended his lecture by addressing the second of the two objections to the doctrine of immortality: If immortality is true, and consciousness continues after death, the number of immortal beings would be unimaginably large. He quickly dismisses the objection as a failure of imagination before summarizing his view, which is potentially inclusive to all living organisms across time and space[134]:

> *For my own part, then, so far as logic goes, I am willing that every leaf that ever grew in this world's forests and rustled in the breeze should become immortal. It is purely a question: are the leaves so, or not? Abstract quantity, and the abstract needlessness in our eyes of so much reduplication of things so much alike, have no connection with the subject. For bigness and number and generic similarity are only manners of our finite way of thinking*. (pp. 43-44).

One important point that James did not discuss was the intercompatibility of functional dependences. Based upon his descriptions, productive and transmissive functional dependences should be able to co-exist and interact within the same system. Indeed, just as James cites examples of objects or devices that express one form of functional dependence – the prism, the pipe organ, and the tea kettle – it is immediately apparent that there are equal numbers of such devices that can be said to have multiple functional dependences. Clock radios, for example, are dependent upon both electric circuits (James cites internal circuitry as productive) and the reception of transmitted information by way of their antennae. A clock radio does not create music *de novo* – it is a conduit for information that, when coupled to a speaker, can transduce electromagnetic waves into mechanical vibrations that are perceived as organized patterns of sound. If the clock radio were to fall and shatter or be unplugged from its power source, the electromagnetic equivalent of the music as radio waves would "survive". Repairing the device or re-establishing its power source would seem to resuscitate the music that had never really been lost. Therefore, it is also possible that brains, with their numerous and complex internal structures, are functionally multi-dependent, expressing both productive and transmissive properties. *Just as the information content of music is preserved in the case of a broken radio, it is* *conceivable that the information content of experience is preserved upon the death of the brain*. In this way, the highly predictive contemporary models of neurobiology do not need to be abandoned to reconcile consciousness with transmission and survival but may instead require a modest amendment.

James' functional dependences may also be less distinct than described. After all, while he points to "steam as a function of the tea kettle" (p. 13), "light as a function of the electric circuit" (p. 13), and "power as a function of the waterfall" (p. 13) as examples of productive functional dependences[134], it is unclear why the causes of these processes cannot equally be attributed to external events. Is the electricity running through the light bulb's circuit not a function of the power generator, which is a function of the waterfall, which is, in turn, a function of gravity? While it is useful to consider the proximate cause as the starting point of any process, further examination will always lead to the discovery of an ultimate cause outside of the system itself[135]. Therefore, the concept of productive dependence is likely an artifact of our perception rather than an actual property of systems and this illusion has defined our intuitions about how brains function. In fact, all functions of the body are subject to this misapprehension. Muscles do not create heat – heat is a biproduct of twitching cells[136], which is itself a product of chemical reactions driven by reactants or their precursors that were at some point ingested as food. The iron in our blood that facilitates oxygen transport throughout the body was synthesized in the core of a star[137], not the body. Albeit a minor digression, it should always be remembered that the ultimate causes of all bodily events are not found within the body at all.

While William James' transmission hypothesis is appealing as a solution to the problem of survival, he did not offer a potential mechanism. Without a physical mechanism by which transmission can occur, the hypothesis cannot survive scientific scrutiny. It seems to me that there are at least two possible mechanisms by which transmission could occur in principle. The first and less likely possibility is that there exists a consciousness-specific signal or particle that interacts with the brain, imbuing it with a capacity for experience and awareness. The famous neurophysiologist John C. Eccles – who shared the 1963 Nobel Prize in Physiology and Medicine with Andrew Huxley and Alan Lloyd Hodgkin for their characterization of the neuronal action potential – proposed the existence of one such particle called the "psychon" that he claimed could solve the classic mind-brain problem[138]. The idea involved a subatomic psychon interacting with a dendron, which is a receptive appendage of a neuron. Eccles posited that psychons would act on dendrons to imbue them with conscious experience and a reverse interaction would transfer perception and memory from the neuron to the particle. Psychons would also be able to interact with each other, creating a "psychon world" separate from the brain[138]. While his model is interesting, is consistent with William James' transmission hypothesis, and is appealing as a solution to the survival problem, Eccles' psychon has never been measured.

The discovery of Eccles' consciousness-specific particle would fundamentally disrupt our understanding of physics and elevate mental processes to the status of something like a fundamental force[139]. However, a more likely mechanism would involve a generic physical force that has already been identified and is well-known to interact with the brain. The candidate force should be pervasive over time and space with the capacity to transmit information over long distances. The electromagnetic force satisfies all of these criteria. Electromagnetic fields define the action potential, allow brain cells to communicate wirelessly, are used as biomarkers of brain disease, and even as clinically effective neuropsychiatric treatments when patterned appropriately. Experimental applications of electromagnetic fields to the brain can cause out-of-body experiences and the sensed presence including visitations and apparitions with reports of communion with a creator or God[60]. In the next section, I will discuss the most significant scientific evidence in support of the joint hypotheses that 1) the transmissive functional dependence of the brain is fundamentally electromagnetic and that 2) this satisfies the criteria for the survival of human consciousness following bodily death.

**Section 3: Psychical energy and the electromagnetic brain**

The empirical basis for the transmission theory of consciousness begins with a historically significant near-death experience in 1893. A few years before William James delivered his seminal lecture, a young Hans Berger was engaged in voluntary military service as a German cavalryman[140,141]. While performing training exercises along a narrow road on the edge of a steep ravine in Wurzburg, Berger fell from his horse and was nearly crushed by the rolling wheels of artillery. In that moment, Berger claimed to have contemplated the certainty of his own death[140,141]. Simultaneously, nearly 200 miles away in Cologne, his sister was suddenly struck by a feeling of impending danger and urged their father to immediately send a telegram to ensure his son was safe. Recounting the experience in detail, Berger[140,141] later wrote:

> *I escaped, having suffered no more than a fright. This accident happened in the morning hours of a beautiful spring day. In the evening of the same day, I received a telegram from my father who enquired about my well-being. It was the first and only time in my life that I received such a query. My oldest sister, to whom I had always been particularly close, had occasioned this telegraphic enquiry, because she had suddenly told my parents that she knew with certainty that I had suffered an accident. . . . This is a case of spontaneous telepathy in which at a time of mortal danger, and as I contemplated certain death, I transmitted my thoughts, while my sister, who was particularly close to me, acted as the receiver.* (pp. 2-3)

Hans Berger was so profoundly changed by this event that he dedicated the rest of his professional life to the pursuit of the "psychical energy"[142] that transmitted his near-death experience to his sister on that fateful day – a force that he hypothesized could connect mental and physical events. Plagued by technical challenges and working alone, his search suffered years of setbacks but eventually led to the invention of electroencephalography (EEG) – a technology that detects and records voltage fluctuations over the surface of the scalp as a means of measuring brain activity[107]. Incidentally, EEG is still used today including as a tool to measure clinical brain death[98,99]. From his original recordings, Berger observed that the brain's electrical rhythms changed as a function of whether the subject's eyes were open or closed[143]. It was also clear that attentional shifts and anxiety could affect the electrical oscillations[144]. Brain waves, it would seem, reflected states of consciousness, and in Berger's view, supported his hypothesis of psychical energy. According to Berger[140], psychical energy was distinct but ultimately conserved, not created – arising as a transformed version of other kinds of generic physical energy:

> *This psychical energy . . . fundamentally distinguishes itself from all other kinds of energies, but can interact with, or rather arise from, and retransform into these. One can rightly argue against this assumption that it maintains the old Dualism of material and*

*psychical processes, only in a somewhat concealed form. This can be admitted easily and does the view no harm.* (p. 24)

We now know that the "psychical energy" that Hans Berger measured with his EEG device was, in fact, the dynamic and complex electromagnetic field of the brain[145]. However, several decades would pass before the full impact of Berger's discovery could be appreciated beyond the obvious and immediate benefit of a tool to measure brain signals. That the brain was fundamentally an electromagnetic organ – which is to say, a collection of tissues that readily emit, respond to, and interact with electromagnetic fields[146] – was not yet apparent and the possibility of transmissive brain function was overlooked for many years. Nevertheless, equipped with a new and powerful tool, neuroscientists spent the next century systematically investigating the mechanisms underlying EEG[107,144], characterizing the neural correlates of consciousness[147], and revealing a wealth of information about the brain's structure-function relationships[148]. The results of their experiments were consistently interpreted with the assumption a productive functional dependence. In other words, while the scientific community embraced the technological output, the theory that led to its discovery, its implicit assumptions, and the general implications of transmission were discarded as part of an intriguing but ultimately coincidental anecdote – a synchronicity devoid of meaning or truth.

Before I delineate the many reasons why the brain *must* be regarded as an electromagnetic organ that can functionally survive death, I will first provide a necessary but non-exhaustive definition and description of electromagnetism. There are four fundamental forces that establish the physical parameters of our Universe: the weak force, the strong force, gravity, and electromagnetism[149]. If they were to suddenly change in amplitude or character, the laws that physicists use to describe Nature would need to be completely re-written. In fact, it is uncertain whether life could even exist given alternative cosmic circumstances. The electromagnetic force is responsible for the attraction between protons and electrons, holding atoms together, and establishing the chemical bonds and intermolecular forces that are required for life[150]. Protons express a positive charge, electrons express an equal but negative charge, and the two particles tend to exist in a state of balance or equilibrium when they form atoms[149,151]. When a neutral atom loses an electron, thereby disturbing the balance and expressing a relative excess of protons, it becomes positively charged – also called a positive ion[152]. Similarly, when a neutral atom loses a proton, it becomes a negative ion[152]. When electrons flow through space, they generate electromagnetic fields (EMFs), which are distributed arrays of point charges in space-time that organize along invisible flux lines[153] that are readily visualized in two dimensions with iron filings and bar magnets. When opposite charges are separated by a distance, they generate a property called polarity – which is the physical basis for both the bar magnet and the electrical properties of the cell membrane discussed in a previous section[154]. The quantum or irreducible unit of the EMF is the photon[155], which is the particle-wave we call light. Indeed, white light, radio waves, and all other forms of electromagnetic radiation are essentially the same photonic "stuff"[156]. What gives them qualitatively different properties are their energy levels, which are proportional to the frequencies of their oscillations[156].

There are two related components to electromagnetic fields: the electric field, which is determined by the charge of the object or particle, and the magnetic field, which is determined by the motion of the charged object or particle[149,151]. For example, the ions that align themselves across the cell's membrane express intrinsic electric fields. When those ions move across the membrane from the outside to the inside of the cell through a channel, their moving charges generate magnetic fields. Suffice it to say that electromagnetism is a pervasive and integral force in the Universe – a necessary but by no means a special property of living organisms or the brain. However, the scientific fields of bioelectricity and bioelectromagnetics have reliably demonstrated that cells and tissues are uniquely structured to receive and channel electromagnetic energy to signal or do work[157,158]. This has been known since the time of Luigi Galvani (1737 - 1798), who demonstrated that static electricity could be used to activate the muscles of dead frogs, suggesting our bodies functioned by endogenous analogues or "animal electricity"[159]. More than a means to move muscles, electromagnetism is intimately linked to brain function and, as I will soon become evident, is likely the fundament of consciousness.

Returning to the task of demonstrating that the brain is an electromagnetic organ, recall that neurons, of which we have tens of billions, are highly polar cells that individually discharge electromagnetic pulses of energy called action potentials dozens of times per second. Therefore, it would be unsurprising to detect electromagnetic emissions from brain tissues at different scales of measurement. Indeed, EEGs detect brain activity by measuring voltage fluctuations across the surface of the scalp that are caused by the dynamic electric fields of thousands of cortical neurons firing in synchrony[107,145]. These complex electromagnetic brain patterns are not random. Rather, they are organized according to predictable patterns that have been described as electrical "microstates"[160]. The duration, shape, and stability of microstates are predictive of age[161], cognition[162,163], and disease[164,165]. Current investigations are linking the brain's multi-regional electromagnetic states or "electomes", with diagnostic applications in neuropsychiatry[166,167]. Magnetoencephalography (MEG), which is a newer technology that measures the brain's weak magnetic fields using highly sensitive detectors, clearly demonstrates that the brain actively emits EMFs that are detectable outside the skull and information-rich[168]. Like EEG, MEG is used as a diagnostic instrument because the specific properties of the brain's magnetic field emissions reflect the synchronous neuronal activity of tens of thousands of cells[169]. Interestingly, MEG has also been applied to study neurocognitive processes in developing fetuses[170] and was recently used to identify the neural correlates of the earliest stages of human cognitive development[171]. One exciting possibility is that MEG may one day be used to identify the precise transition from non-conscious matter to conscious matter in the brains of developing humans.

In addition to its electric and magnetic field emissions, the human brain has been repeatedly shown to emit visible, infrared, and ultraviolet light[172,173]. Distinct from bioluminescence, light emitted by biological organisms or "biophotons" are caused by chemical reactions within cells associated with energy production[174] and are functionally linked to microtubules – the skeleton-like structures that give cells shape and their capacity to move[175-177]. While photons are emitted by other tissues[178,179] and species[180] (**Figure 2A**), some authors have hinted at the possible existence of optical signaling channels within the human brain[181] that operate like fiber optic cables by transmitting photons for cell-to-cell communication. As has been predicted[182], it would be unsurprising if neurons did perform signaling using photons as information carriers since brain exposures to artificial sources of light are known to modify neural oscillations[183,184] as well as facilitate the release of neurotransmitters like glutamate and dopamine[185]. Infrared light, for example, can stop neurons from conducting current[186], meaning a superimposed optical brain network may exist independent of synaptic networks. Given recent the recent discoveries that much more information can be encoded in light than previously assumed[187,188], the possibility of light-based brain function is an increasingly interesting frontier in neuroscience research. In addition to basic amplitude and frequency modulation, information can be encoded within the direction and spacing of rotating photons[187]. Therefore, it is possible that brain biophoton emissions carry tremendous amounts of information when emitted.

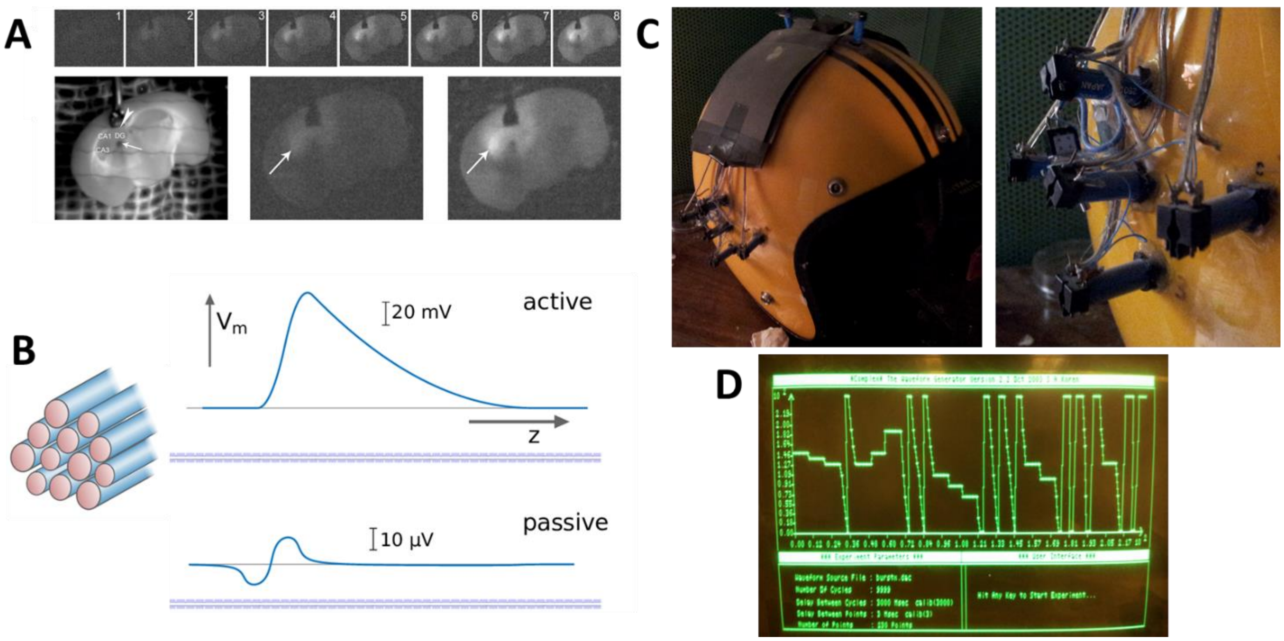


**Figure 2. The brain is fundamentally an electromagnetic organ.** A) Biophotons are generated from mouse brains (the hippocampus is indicated by the white arrow) when stimulated by the most common excitatory neurotransmitter in the central nervous system: glutamate (adapted from doi.org/10.1371/journal.pone.0085643). B) Signals can be passively transmitted across nerves when they are bundled; an action potential in one axon can "wirelessly" generate a passive potential using electric fields (adapted from doi.org/10.1371/journal.pcbi.1007858). C) The God Helmet can be used to stimulate the temporal lobes of human participants, producing experiences of a sensed presence, visitations, or encounters with a deity (original image). D) "Burst X" is a signal pattern used to electromagnetically activate the temporal lobes of humans delivered by the God Helmet and related devices (original image). Creative Commons Attribution (CC BY) license applies to A and B.

Despite the darkened environment of the skull, the cerebral cortex, hypothalamus, and striatum express photoreceptors that are particularly sensitive to blue and ultraviolet light[189-191]. The pineal organ, which is a well-known circadian regulator[192] and René Descartes' hypothesized seat of the soul[193], also contains photoreceptors[194]. Unlike the photoreceptors of our retinas, which allow us to detect photons with wavelengths corresponding to visible light, these deep-brain photoreceptors, which also detect visible light, are not linked to vision at all. Their widespread existence throughout the brain suggests these recondite photoreceptors are functionally relevant; however, investigations to address their roles are ongoing. While light can penetrate the skull[195,196], it is unclear whether these deep-brain photoreceptors primarily detect light from within or outside the brain under normal circumstances. Together, these findings indicate that human brains are equipped with the capacity to emit and detect electromagnetic radiation in the form of visible or near-visible photons.

Though it should be clear by now that the brain emits and is receptive to electromagnetic radiation, the extent to which electromagnetic signaling is integral to brain activity has not yet been fully elucidated. As discussed in a previous section, synaptic transmission involves an electromagnetic discharge called the action potential that triggers the release of neurotransmitters. This is often referred to as electrochemical signaling, and therefore, is only partially electromagnetic. However, there are at least two additional neuronal signaling modalities that are both purely electromagnetic. The first is electrotonic signaling, which involves direct connections between cells called gap junctions[197]. With electronic signaling, the membranes of two or more cells form electrical bridges between their inner compartments and become functionally integrated. The third and most recently identified signaling modality is called "ephaptic coupling" and is the definitive neural signaling modality that demonstrates a direct brain dependence upon EMFs as a source of useful signaling information. While synaptic transmission and electrotonic signaling involve interfaces that are directly connective or "wired", ephaptic coupling is truly "wireless"; it occurs when cells detect and respond to electric fields emitted by adjacent cells[198] (**Figure 2B**). Because ephaptic coupling is non-directional, any neuron that fires an action potential can stimulate surrounding cells including itself by the reciprocal flow of electric field activations. Therefore, ephaptic couplings supply the brain with many more wireless connections than wired connections, including looped circuits that are necessary for a process called reentry: a bidirectional exchange of information that may be a requirement for consciousness[199]. As with other modalities, ephaptic coupling can be excitatory or inhibitory, with known functional roles within olfactory regions, the cerebellum[45], and the memory-encoding hippocampus, where slow and periodic activity self-propagates across the tissue like waves, constructively interfering with a veritable ocean of electric fields[200]. Fundamentally, a neuron stimulated by its neighbor via ephaptic coupling cannot be said to have produced its own activity. Rather, *all neurons are connected to each other by a Jamesian transmission of electromagnetic radiation*.

The discovery of ephaptic coupling demonstrated that the microscopic environment of the brain is teeming with electromagnetic information, and in recent years researchers have turned to this exciting new modality as a means of furthering models of brain dynamics that are compatible with consciousness. Among them, Anastassiou and Koch presented a compelling review that endogenous electric fields at the cellular and network levels may provide vital feedback mechanisms facilitated by ephaptic couplings that are intrinsic to cognitive processes[44]. Some scientists have suggested that ephaptic coupling may extend a capacity for consciousness to single cells[201] as well as other animals and plants[202]. Still others have implicated the often-neglected glial cells as contributors to ephaptic coupling by calcium-current-induced magnetic fields[203], which would indicate that nearly all brain cells contribute to the organ's macro-scale EMF patterns. This runs contrary to modern assumptions about how the brain works but opens up new and exciting possibilities, particularly for transmissive function. There is likely much to learn about ephaptic coupling but one thing is clear: it demonstrates that EMFs within the brain are not mere biproducts or meaningless noise – they contribute to signaling dynamics by transmission and, ultimately, form mental states. What if all the longstanding doctrines and dogmas that position neurotransmitters and other chemical intermediates as the chief determinants of brain functions such as consciousness are more epiphenomenal than causal? As we lift the veil that once obscured the brain's transmissive functional dependence, its fundamental electromagnetic nature becomes clear.

While brain-based emissions of electromagnetic radiation are abundant, the functional relevance of EMF-brain interactions on consciousness can only be fully appreciated with an examination of the effects of experimentally applied and artificially generated EMFs on brain function. The most common experiences associated with applied EMF-brain exposures are the reports of "phosphenes" or perceived flashes of white light in the visual fields among patients subjected to magnetic resonance imaging (MRI)[204]. The magnets that generate the high-intensity, time-varying magnetic fields of the MRI activate nerve bundles within and along the visual pathway by Faraday's law of induction, driving the flow of electric current and ultimately producing simple visual hallucinations. Other established biological effects of MRI exposure are metallic taste, dizziness, nausea, and headaches[205], which suggest activations of the insular and temporal cortices[206,207]. The same principles have been applied to engineer clinical devices and techniques, such as transcranial magnetic stimulation (TMS), to treat neurological disorders[48]. TMS is a technique by which high-intensity EMFs are applied over the surface of the scalp, stimulating brain tissue in efforts to treat depression[208,209], anxiety[210], post-traumatic stress[211], as well as to facilitate recovery from traumatic brain injuries[212]. TMS can also be used to reliably activate the primary motor cortex, which allows experimenters to control the movements of their subjects[213]. In one notable experiment, scientists induced participants to move their left or right hands by secretly stimulating right or left motor areas respectively[52]. Remarkably, when participants – who were not aware if, when, or where they were stimulated – were asked to provide a rationale for why they moved their right or left hand they frequently reported that it was their choice – that they "wanted" and "intended" to move[52]. Indeed, the experiment showed that applied EMFs associated with TMS can be used to control behavior and generate illusions of free will.

Whereas MRI scanners and TMS devices typically emit high-intensity EMFs (> 1 Tesla), decades of research have demonstrated that much weaker intensity fields can also affect conscious experience. As evidenced by my former mentor Dr. Michael Persinger's pioneering work with complex, low-intensity (microTesla) EMFs, some of the most personally meaningful and life-changing human experiences can be reproduced in the laboratory by appropriate stimulations of the brain[61,214,215]. With his co-inventor, Stanley Koren, Persinger created a helmet embedded with EMF-generating solenoids that could stimulate the temporal lobes of experimental subjects with field intensities within range of the brain's own EMFs and environmental sources (**Figure 2C**)[216]. Instead of simple EMF patterns such as sine or square waves normally associated with TMS, Persinger converted EEG recordings from patients in meditative and trance-like states who reported "experiencing God" into complex, digitized patterns that could be applied through the helmet as EMFs (**Figure 2D**)[216]. In other words, he isolated the electromagnetic brain patterns of some people in an altered state of consciousness, transformed them into signals, and applied them to separate brains as information-rich signals. If, as Persinger hypothesized, EMF patterns carried information relevant to conscious experience, the applied patterns would be expected to produce genuine cognitive effects including transmitted subjective experiences. Indeed, hundreds of participants over several decades have reported out-of-body experiences and the feeling of a "sensed presence" when exposed to the helmet[216,61] and some even claimed to have encountered a higher power or deity, inevitably inspiring the device's more popular name: the "God Helmet"[217]. These studies, and those listed throughout this section, clearly demonstrate that the brain is an electromagnetic organ. But what about consciousness? That too, it would seem, is fundamentally electromagnetic as it can be extracted from one brain and re-applied to another as an information-rich EMF pattern with experience-inducing consequences.

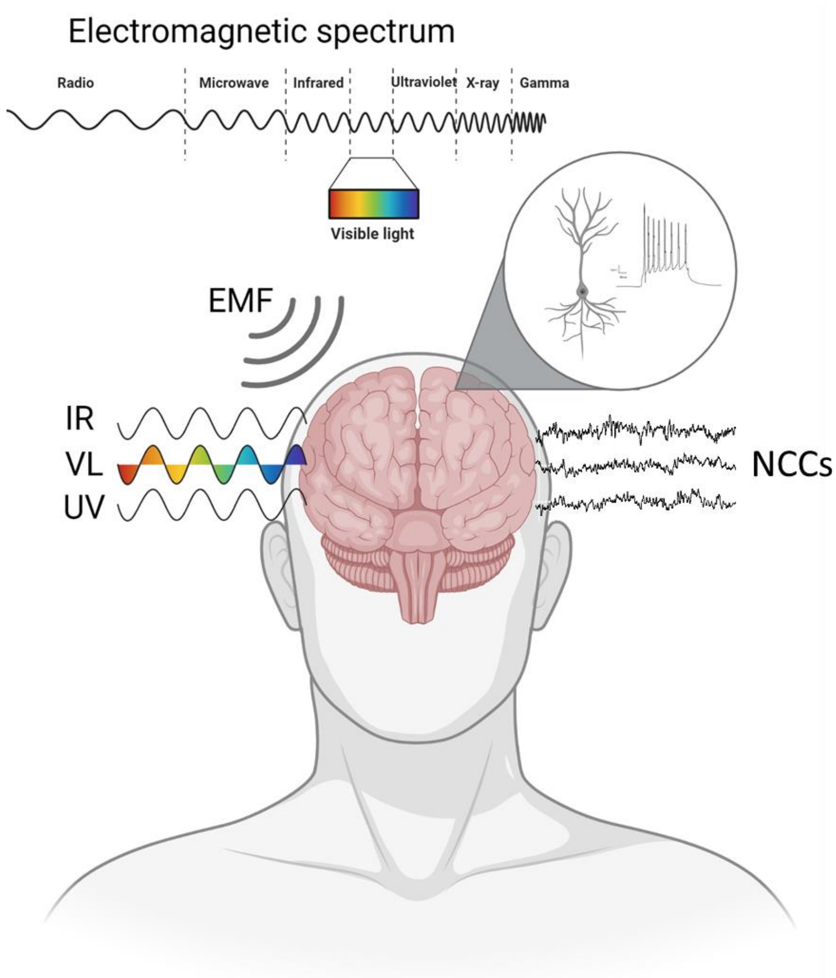


**Figure 3. An electromagnetic, transmissive model of consciousness that survives brain death.** Infrared (IR), ultraviolet (UV), and visual light (VL), as well as electromagnetic fields (EMF) interact with brains to transmit consciousness that can be inferred by measuring the neural correlates of consciousness (NCCs). The electromagnetic energies that transmit consciousness are physically independent of the brain and EM-based signals are readily emitted by the brain (no pictured). Because EM-based inputs and outputs are independent extensions of brain information, consciousness likely survives brain death. Created with BioRender.com.

Having described the mechanisms underlying the electromagnetic transmission of information within the living brain, the following question becomes relevant: How does death impact the brain's ability to interact with electromagnetic energy? As previously discussed, when the brain dies and decays, the cellular membranes that sustained its electromagnetic functions lose their structural integrity and their ability to generate action potentials. Without these features, it is generally assumed that the productive functional dependence of the brain is no longer possible. Given enough time, a decaying brain will decompose and then disintegrate entirely[218] – leaving no trace of function, including consciousness, behind. To prevent decay and decomposition, brains can be placed in preservatives like formaldehyde that maintain both their gross and fine structures – a process called chemical fixation[219]. While there are many ways to "fix" brain tissues[220], the net result is the same: cells are forced into complete stasis.

That is, the positions of cells are held constant and all of their activities that are dependent upon the passage of time stand still. In effect, the brain becomes a three-dimensional "snapshot" of itself that is structurally stable but functionally inert. Or, rather, functionally inert from the perspective of productive functional dependence. Just as a tuning fork holds a definite shape that is receptive to transmissions of a specific frequency of vibrating air, perhaps the fixed structures of the brain are similarly receptive to transmissions of electromagnetic oscillations. While the preservation of brains is by no means a recent development, the technique presents contemporary scientists with a unique opportunity to test the transmission theory of consciousness directly by experimentation. Analogous to the practical significance of genetic knockout models[221], the chemical fixation process eliminates the possibility of productive function. But what about transmissive function? If brains can, even in death, filter EMFs such that they become – as William James put it – "*sifted and limited*" to express electromagnetic signatures of consciousness (**Figure 3**), then survival can be empirically tested. I, therefore, designed several experiments to test the transmission hypothesis using post-mortem human brain tissues and the results compelled me to re-evaluate all of my assumptions about brain death.

## Section 4: Testing transmission with a brain in a vat

When I joined Dr. Michael A. Persinger's laboratory in 2012, I spent a few years developing several ideas and techniques, including EEG, before coming upon William James' hypothesis of transmissive brain function. Dr. Persinger was a clinical neuropsychologist, scientist, and the head of an interdisciplinary neuroscience laboratory – the Neuroscience Research Group (NRG) – where creativity and the desire to challenge assumptions were the price of admission. Beyond the "God Helmet", Persinger and his rotating team of NRG members were responsible for some extraordinary discoveries in both mainstream and marginalized scientific circles over the last 40 years. Indeed, his work on the biological effects of low-intensity EMF exposures[222,224], epilepsy[225,226], traumatic brain injury[227,228], and consciousness[229] are well-noted. However, Persinger also explored the empirical bases of psi phenomena including remote viewing[37,230], poltergeist and haunt events[231-233], alien abduction[234] and mystical experiences[97], as well as mind-matter interactions[235,236]. As I was involved in the NRG's previous investigations concerning the effects of the Earth's magnetic field on cognition and behaviour, I was inspired to ask the question of whether electromagnetic forces and their interactions with the brain could satisfy the conditions of James' hypothesis of transmission. Upon further examination of the problem, it became clear that testing the hypothesis would require a complete re-framing of our traditional approach to neuroscience research. To make any progress at all, we needed to conceptualize consciousness as a physical entity located at least partially outside of the brain. Only then did it become reasonable to consider the possibility of measuring correlates of consciousness as a function of EMF-brain interactions. Just as dissecting radios in search of music would fail to grapple with the underlying mechanism, so too would a study of transmissive consciousness that treated the brain as its generator.

Over the next 3 years, Persinger and I designed and executed dozens of experiments with chemically fixed, post-mortem human brains (**Figure 4A-E**), searching for extracerebral signs of consciousness. We hypothesized that brains could passively receive and process electromagnetic information. Because reception would be dependent upon the antenna-like, material structures of the brains rather than their active neurophysiology, life would not be a requisite condition for transmissive function.

We predicted that by measuring human brains that were chemically fixed shortly after clinical death, it would be possible to detect signals that could be filtered by the brain to express consciousness. Because any brain activity associated with action potentials would be eliminated by fixation, we hypothesized that what dynamics remained would constitute evidence for transmission, and therefore, the survival of at least one type of brain function following death. Our model of brain function would accommodate both active (productive) and passive (transmissive) functional dependencies. The following are some of the types of questions we asked when designing our experiments in search of EMF-brain transmissions: How do the properties of applied electromagnetic fields change when they interact with post-mortem human brain tissues? Can putative transmissive functions be shielded by EMF-blocking materials? Do the frequencies of EMFs shift upon interacting with brain tissues to align with known neural correlates of consciousness? Are EMF-brain interactions similar in living and post-mortem brains? Do brain regions "filter" electromagnetic radiation differently? As far as we were aware, these questions had never been asked before and the potential rewards were worth the time and effort.

In 2017, I published my doctoral dissertation entitled "Structures and Functions of the Post-Mortem Brain: An Experimental Evaluation of the Residual Properties of Fixed Neural Tissues", which is a collection of 7 peer-reviewed scientific journal articles that constitute the first empirical assessments of William James' transmissive hypothesis[31]. In this section, I will describe some of our main results and their implications relative to the survival of human consciousness following bodily death. In each of the studies, we used post-mortem human brain tissues (originally donated for research and teaching purposes) and a common measurement technique based upon EEG. Needle electrodes were embedded into the cerebral cortices of fixed, post-mortem human brains to record low-amplitude microvolt fluctuations[237] (**Figure 4D**). Whereas all conductive substrates, brain or not, can express electrical noise as slight voltage fluctuations, organized patterns among the noise reflective of living-like brain signatures would not emerge in all substrates. This would be analogous to detecting highly organized voices as whispers among a much louder cacophony of environmental sounds. We hypothesized that the preserved structure of the brain could operate like a biological antenna, receiving electromagnetic transmissions as subtle but detectable induced currents that would be uniquely filtered by the probed tissue region. We found promising results. Despite significant levels of electrical noise associated with the measurement of voltage fluctuations within post-mortem tissues, reliable oscillatory patterns were apparent[237,238]. That is, the electrical "fingerprint" of each cortical region was unique, not uniform. Gross electrical geometries could be discerned across the brain and certain regions amplified natural or artificially applied EMFs and direct current more than others[239]. Therefore, whatever we were measuring was not random, and the material properties of the brain were modulating the electrical noise in ways that other materials would not. Here, *I will discuss the specifics of our major findings that demonstrate transmissive brain function, and therefore the survival of consciousness, is possible beyond a reasonable doubt*.

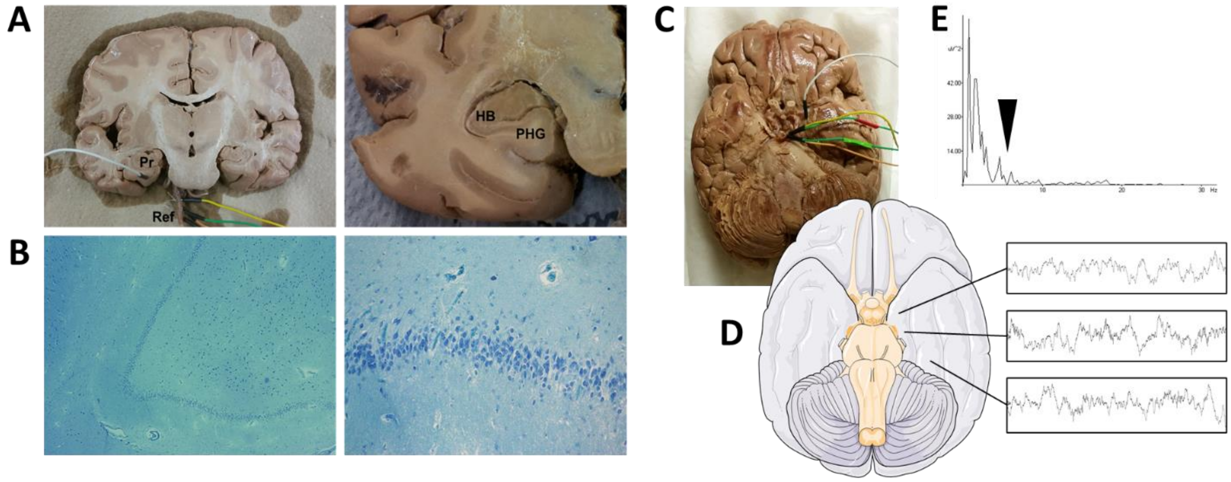


**Figure 4. Post-mortem human brain tissues filter transmissions of ambient EMF and express patterned voltage fluctuations.** A) In coronal brain sections, the parahippocampal gyrus (PHG, right image) was measured (Pr indicates the probe, left image) to assess its capacity to filter ambient EMFs; the basilar artery served as non-brain-based electrical reference (Ref, left image). B) The fine structure of the tissues remained intact; however, cells were unable to generate endogenous or "productive" activity (original images). C) Full, intact post-mortem human brains were also measured. D) Simultaneous measurement across multiple regions revealed unique tissue-dependent filtration properties as evidenced by region-dependent electromagnetic signal "fingerprints" (three representative signal traces are shown). E) Most oscillatory variability across regions occured within the theta (4 Hz – 7 Hz) and alpha (7 Hz – 14 Hz) bands (indicated by the black arrow). The vertical axis represents amplitude ($\mu V^2/Hz$) and the horizontal axis represents frequency (Hz). This technique (A, D) was used to assess the transmissive theory of consciousness on which the survival of consciousness after death depends. All images are original except for D, which was adapted from Servier Medical Art by Servier; Creative Commons Attribution 3.0 Unported License.

Our initial discovery was derived from comparisons of living and post-mortem human brain measurements[239]. First, we measured the brain activity of living human subjects using EEG while they wore EMF-shielding caps over their heads. We wanted to know if brain activity would change as a function of environmental EMFs – which are about 50 million times less intense than those associated with MRI scanners – and if we could inhibit the effects with shielding. The experiment had two measurement phases: 1) with the shield, and 2) without the shield. Therefore, each individual was subjected to EEG measurements with and without the EMF-shielding cap (i.e., within-subject design); however, the order was counterbalanced such that some participants wore it during the first phase and others wore it during the second phase. Just as a full-body Faraday cage made of copper can significantly attenuate the strength of EMFs, we reasoned that a similarly grounded, copper-lined cap covering the skull could partially block impinging EMFs on the brain. We experimentally demonstrated that when living subjects wore a copper-insulated covering over their heads, the amplitudes of their brainwaves were markedly suppressed relative to when they were not wearing it; however, these suppressions were non-uniform[239].

Specifically, low frequency (theta, 4 – 7 Hz) brain activity became less synchronous over the right temporal lobes of participants when they wore the EMF-shielding cap relative to when they did not[239] (**Figure 5**). We source-localized the EEG signals, which were originally obtained over the surface of the scalp, to the parahippocampal region (indicated by red arrows) using a technique called standardized low-resolution electromagnetic tomography (sLORETA). That is, the actual source of the EEG differences at the surface were due to changes in the deeper parahippocampal region near the base of the inner surface of the skull (**Figure 5**). It should be noted that the material structure of the parahippocampal region is unique because it is the architectural transition point between the 6-layered "neocortex" and the 3-layered "archicortex"[240]. It is also the place in the brain where experience and memory functionally converge as the structure of the neocortex shape-shifts into the hippocampus[240,241]. Our results demonstrated that shielding the brain from environmental EMFs affected the temporal lobes asymmetrically, which suggested that the brain may be non-uniformly susceptible to EMF-based transmission[239]. If similar asymmetries could be found in post-mortem tissues, then we could confirm a passive EMF-brain interaction that is expressed in both living and post-mortem brains. To that end, we measured the electrical noise within left and right parahippocampal regions of 3 separate post-mortem human brain specimens[239]. Notably, we observed more theta-band oscillations in the right parahippocampal regions relative to the left. The effect was also specific to the "grey matter" or cell-containing regions and not the adjacent "white matter" or fiber-containing regions, which indicated the complex microstructure of the tissue was a relevant receptive factor. In summary, we found that EMF-brain interactions are detectable in living and post-mortem brains, can be attenuated by EMF-shielding, affect brain regions asymmetrically with a deep temporal lobe focus, and affect some brain oscillation frequencies (i.e., theta) but not others[239].

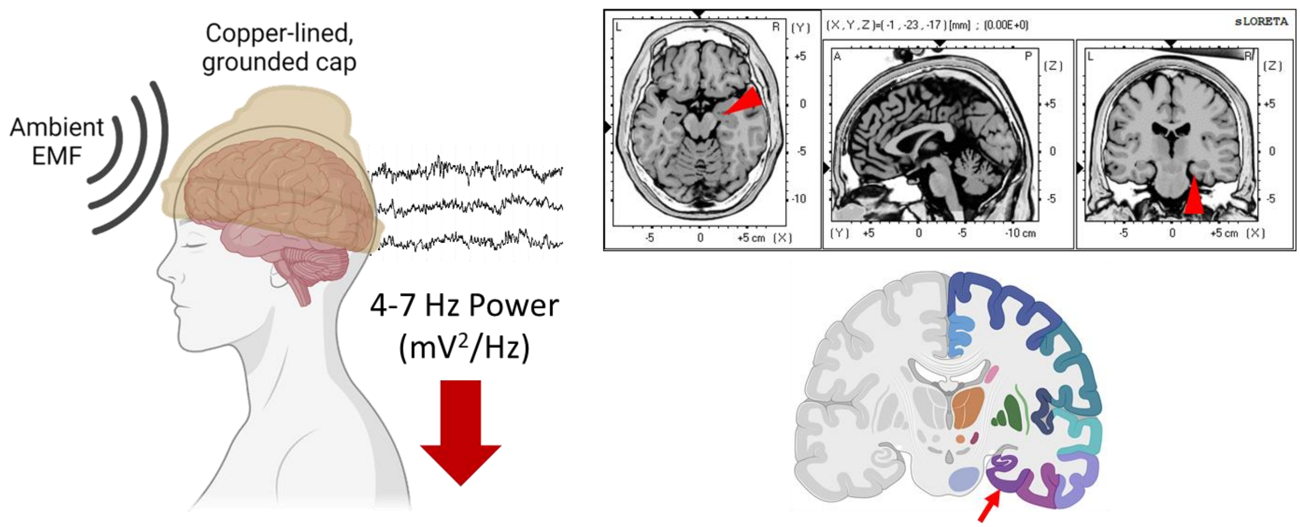


**Figure 5. Shielding the brain from environmental EMFs changes theta-band synchronous brain activity.** EEG data revealed decreased synchronous theta oscillations (4 – 7 Hz power or $mV^2/Hz$) during transcerebral copper shielding relative to no shielding. Standardized low-resolution electromagnetic tomography (sLORETA) confirmed the effect was due to the right, parahippocampal gyrus (red arrows). The parahippocampal region is particularly sensitive to EMFs, in living and post-

mortem human brains. As the EMF-sensitive parahippocampal cortex is the interface between the experience-generating neocortex and the memory-encoding-and-retrieving hippocampus, it represents a strong candidate for the gateway to transmissive function. Created with BioRender.com.

The next major findings in support of transmissive function involved the direct and systematic application of alternating current and time-varying EMFs to fixed, post-mortem human brain tissues[237,242]. We wanted to know how human brain tissues, chemically preserved in such a way as to retain fine-scale structures, could filter direct and induced electrical currents. That is, as the electric current passed through brain tissue, how would the cellular architecture change the signal? If the filtration properties of the post-mortem tissues could amplify certain artificially generated signal frequencies over others within relevant brain regions, the possibility of natural transmissive function with environmental signals would become more likely. For example, the possibility of the brain amplifying an extracerebral EMF signal and it subsequently interacting with the endogenous electric fields of ephaptic couplings was an exciting prospect. In the first study, electric current was injected directly into brain tissue with different waveforms and frequency modulations[237]. Simultaneously, voltage outputs were recorded from adjacent tissues. The results indicated that signals with "spike" waveforms tended to increase the amount of low frequency (theta) voltage oscillations in the right hemisphere of post-mortem brains relative to "square" and "sine" waves[237]. This effect was highly specific to the parahippocampal cortex. The neighboring area of the hippocampus showed a similar responsiveness to spike currents in the right hemisphere relative to the left; however, high frequency (gamma) oscillations – which is a common neural correlate of consciousness (NCC) – were enhanced instead[237].

In a follow-up study, we wondered how induced currents from applied EMFs might affect post-mortem brain oscillations[242]. However, we first explored how perturbations of the Earth's natural magnetic field affected daily recordings of voltage oscillations within the post-mortem tissues. Specifically, we wondered if days with increased "geomagnetic activity" or "storms", which are caused by solar perturbations of the Earth's magnetic field, would affect post-mortem voltage fluctuations within the parahippocampal regions. Even if the electrical recordings from the post-mortem tissues were mostly noise, storm-dependent frequency shifts within particular parts of the fixed human brain would clearly indicate a material-like receptive feature. To our astonishment, the right parahippocampal cortex displayed more low-to-mid frequency (theta-alpha) oscillations on days of greater geomagnetic activity (storms) relative to quieter days[242] (**Figure 6A**). The left parahippocampal tissues were not similarly affected. Using artificially generated EMFs (**Figure 6B**), we exposed full post-mortem human brains to different signals within a large coil while simultaneously measuring voltage fluctuations across multiple tissue sites. Consistently, theta (4Hz – 7.5Hz) and alpha (7.5Hz – 14Hz) frequency oscillations within right hemispheric structures – particularly frontal and temporal areas – were affected by the applied EMFs[242] (**Figure 6C**). In several related studies, we reported that post-mortem oscillations could be induced to change by chemical stimulation and that they even emitted stimulation-dependent photons[238]. We also demonstrated that post-mortem rat brain oscillations could be used to predict whether or not they had experienced seizure activity while alive[243] – which revealed that damaged brain tissues changed the way oscillations were expressed, like bending a tuning fork and changing its capacity to resonate with particular frequencies of vibrating air.

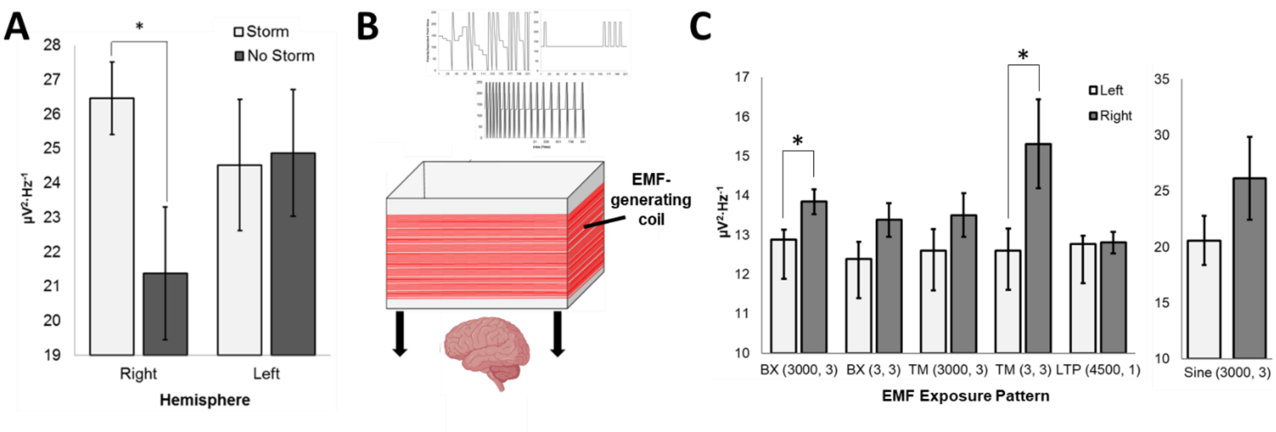


**Figure 6. The right hemispheres of post-mortem human brain tissues selectively amplify natural and artificial EMFs.** A) Geomagnetic storm conditions (light bars) produced more alpha (7.5 Hz – 14 Hz) power within the right parahippocampal region relative to geomagnetically quiet conditions (dark bars); a similar effect was not observed in the left parahippocampal region. B) Fully intact post-mortem human brains were exposed to artificial EMF patterns using a large coil. C) Complex EMF signals were selectively amplified by the right hemisphere but not the left; simple sine waves did not produce any effects. Statistically significant differences between conditions at the $p<0.05$ threshold are indicated (*) in A and C. All images by were adapted from doi.org/10.4172/0974-8369.1000392; Creative Commons Attribution License applies.

Together, our results indicated that post-mortem brains were selectively responsive to natural and artificial electromagnetic signals, that the effects were primarily localized to the temporal lobes, that certain waveforms amplified activity more than others, and that theta and alpha frequency oscillations were primarily affected. We agreed that the empirical evidence suggested brains possessed a "passive" functional capacity distinct from its "active" neurophysiological processes. And we reasoned that this passive feature of the brain was consistent with the idea that some residual functional capacities may persist shortly after brain death and the cessation of endogenous activity but before the microstructural features of the organ could decompose[31]. Further, there was a strong case to be made on the basis of the experimental data that the parahippocampal cortex represented a particularly sensitive area akin to an EMF-receptive sub-organ of the brain.

*This empirical project, which does not rely upon subjective experiences or the intrinsic fallibility and unverifiability of eye-witness testimony, remains the only objective experimental assessment of William James' hypothesis and constitutes one of the best pieces of evidence for the continuation of consciousness after permanent bodily death*. Of course, without a tool to measure the content of experience directly, it is impossible to assess conscious percepts in post-mortem or living brains. Nevertheless, the identification of neural correlates of consciousness embedded within the voltage fluctuations of post-mortem brain tissues is one step toward an objective assessment of the survival hypothesis.

We will proceed with the substantiated assumption that brains can passively receive electromagnetic signals – particularly within the temporal lobes where theta rhythms are prominent[244-246]. It should be noted that cortical gray matter exhibits a material-like resonant frequency of 7 Hz given intrinsic permeability and permittivity properties of the tissues[247]. Indeed, Nunez provided the original quantitative solution for the fundamental resonant frequency of the entire cerebrum, which was within the same range based upon spatial brain parameters[248]. Therefore, the theta band may be intimately linked to the material structure of the brain itself. Of course, it is undoubtedly true that EMFs can interact with active neurophysiology[249,250] and there are known productive mechanisms of theta pace-making[251,252]. However, even the brain's major theta-rhythm-producing cells are located within the temporal lobes' hippocampal bodies[253], parahippocampal cortices[254,255], and neighboring entorhinal cortices[256,257] – the same regions that appeared to be particularly sensitive to passive EMF amplification in post-mortem tissues. Because our results were observed in chemically fixed brain specimens, they could not have generated action potentials or any known endogenous signals. The precise mechanisms underlying transmissive brain functions and the full implications of their effects on consciousness are not yet known and additional research efforts will be needed to elucidate them. In the concluding paragraphs of my doctoral dissertation[31], I wrote the following statement on the prospect of future works that might build upon our groundbreaking advances toward a scientific study of passive brain functions and the prospect of immortality:

> *It is predicted that this type of research, which is likely avoided for many dozens of reasons, will become increasingly unavoidable. . . . Faced with the looming prospect of human immortality . . . it is incumbent upon us as a species to challenge the taboos which cast the longest shadows and to transcend our more undesirable primate impulses. A new enlightenment, marked by a genuine study of death, religious experiences, and all "untouchable" things should be pursued without prejudice. . . . Though some will rest on their accolades or dismiss challenges of scientific dogma as denialism, the battle of ideas marches forward unimpeded and without regard for the individual desires of scientists.* (p. 275)

In the next section, I will describe the likely environmental sources of electromagnetic brain transmissions, the evidence for natural EMF-brain interactions in living humans, and the potential to store the electromagnetic information of memories and experiences outside of the brain. We will explore the possibility that consciousness, thought, and memory are all around us – in life and in death.

**Section 5: Into the void or the Akashic record?**

If consciousness persists after we die, where might it be found? Recall that the transmissive model of consciousness is consistent with survival precisely because, even when the brain is alive, the source of consciousness exists independent of it. Therefore, the question should be re-formulated: Where can consciousness be represented other than the brain? Where is consciousness stored? The issue of where a person's consciousness goes when they die has always been of interest to the human species as evidenced by our complex rituals associated with death as well as the rich cultural narratives that accompany them. Whether the beliefs were originally constructed to address grief[258], increase group cohesion[259], or identify the veridical position of a person in space-time after their body decomposes[260], the proposed solutions have typically shared thematic elements. In our modern era, the idea of "returning to the void" is becoming an increasingly popular belief, where in death, consciousness exists in the same space it existed before life: nowhere at all[261]. This view is logical if one assumes, as most do today, a productive dependence of brain function. Because if consciousness is generated by the brain, and it did not exist before the brain developed, then it will not exist after it decomposes. In other words, productive models of consciousness will leave you stranded at the gates of Heaven – or Hell.

Other well-subscribed beliefs about a "life after life" are consistent with the transmissive dependence of brain function. For example, a mechanism for "reincarnation" might involve the return of consciousness to a reborn version of oneself or the transfer of consciousness into a new body[111]. Concepts of "ascension" and "descension" place consciousness in non-living realms, where rewards and punishments may be issued[262]. There are also notions of a "persistent" consciousness that may linger among the living as an independent apparition[263] or exist in unity with the consciousness of others[111]. It is, however, difficult to discern which model, if any, reflects reality. Many have reported experiencing glimpses of an afterlife, apparently confirming or disconfirming one or more of these popular beliefs[119,264]. Because afterlife beliefs are common and often conflicting, confirming any one of them will depend upon which eye-witness reports are prioritized. However, for reasons that I have outlined in a previous section, I do not think near-death and other experiences commonly cited in survival research should be regarded as the best available scientific evidence as they cannot be independently verified or replicated. Even if near-death experiences are informed by genuine glimpses of an afterlife, the burden of repeatability – for which exceptions should not be granted in science – may be too extreme by dint of the transient nature of the phenomenon. Again, this is not to say the experiences are fabrications or even confabulations. As a method, science admits a weakness when it attempts to grapple with the private contents of experience[265,266]. Rather than rejecting experiences outright, I claim that we cannot base an empirical case for the survival of consciousness following death on these types of experiences alone due to an intrinsic limitation of the scientific method[267]. Nevertheless, themes of survival consistent across cultural narratives and eye-witness testimonies have inspired the formation of hypotheses toward more scientific approaches that are grounded in objective measurement.

In the late 1800s, the notable philosopher and mystic H.P. Blavatsky borrowed from Vedantic and Buddhistic thought to formulate her own narrative concerning, among other things, the location of consciousness outside the body[268]. Indeed, her theosophy of Akasha[269] – a term derived from the Sanskrit word for "space" or "sky"[270] – places all intent, consciousness, memory, thought, and will in a pervasive and ethereal plane. Indeed, the Akashic record was also thought to be the place from which radiates "the First Logos"[271], where logos refers, in context, to sound or speech. Blavatsky's idea is essentially a reformed version of the Hindu concept of Akasha as the eternal and imperceptible substrate of the Universe – a sound or musical vibration from which all else emerges[272]. Artistic representations of it are found in classical Indian music as the meditative drone of a single repeating note played by instruments like the tanpura or shruti box over which all other notes are played. Interestingly, one of the most ancient Indian stringed instruments – the veena – began as a harp-like device called Akasa, which consisted of strings tied to the tops of trees that vibrated with the wind – thus channeling what was assumed to be the musical substrate of the Universe[273]. Inspired by Blavatsky's original interpretation of Akasha as an external but accessible record of all minds, the philosopher Ervin László identified analogous concepts in quantum mechanics that he claimed could accommodate evolutionary and cosmological processes as well as consciousness in the "Akashic Field" or "A-Field"[274]. A recent paper even discussed the possibility of extracting information from the Akashic records for military intelligence purposes[275]. These ideas parallel William James' view of consciousness as being transmitted from one "infinite Thought" (p.15), existing "behind the scenes, coeval in the world" (p.23), which he reasoned avoided "multiplying [the] miracle" (p.23) of *de novo* consciousness production within billions of brains across the planet and over time[134]. But is there a scientific basis for the storage of memory and consciousness in space? Or perhaps, given the electromagnetic nature of the brain, one might ask: Is it possible to store memory and consciousness in an electromagnetic field? The survival of consciousness after death requires a space within which it can exist independent of the brain. Here, I will demonstrate that the evidence indicates it is stored all around us in our shared electromagnetic environment.

In a previous section, I demonstrated that the brain is fundamentally an electromagnetic organ. While I did discuss the effects of artificial EMFs on brain function, I did not touch on the effects of their natural or environmental equivalents. This section is reserved for a detailed exploration of natural EMFs, their effects on human cognition and behaviour, and the possibility that they can store and transmit information to and from brains – thus permitting its survival beyond brain death. The primary reason why environmental EMFs demand our special attention is the following: If brain function is at least partially dependent on the reception of transmitted EMF signals, there must be at least one source in Nature that functions as the transmitter or zeitgeber. Whether transmissive brain function was selected or an incidental adaptation, the environmental source of the cue should be physical and therefore subject to measurement. The most conspicuous and pervasive source of natural EMFs across the planet is the Earth itself[276,277]. Its geomagnetic field, which extends through the planet and out in all directions well-beyond the atmosphere, is generated by rotating molten iron within its core[276]. The strength of the Earth's magnetic field is approximately 50 μT, which is about the same intensity as a hair dryer and other household appliances[278]. Its electric field is equivalent to about 100 volts per meter and is maintained by thunderstorms that constantly deposit negative charge on the planet[279]. The Sun's extended magnetic field – the interplanetary magnetic field – interacts with Earth's in several ways[280]. When it carries plasma toward the Earth's magnetic field, the net result is an aurora – a light show caused by charged particles moving along flux lines that ultimately excite particles in our atmosphere[280]. Another category of interaction is called the geomagnetic storm, which is caused by a compression and energization of the geomagnetic field by a colliding coronal mass ejection from the Sun[281,282]. Incidentally, the frequency of coronal mass ejections is cyclical and tracks solar activity over periods of 11 and 22 years as indicated by sunspot numbers[283]. The net result of the collision is an increase in geomagnetic field strength coupled with increased geomagnetic current[284]. A sufficiently intense storm has the capacity to wipe out satellites and other electronic devices[285] but there are also marked biological effects.

There is overwhelming evidence that biological organisms detect and respond to Earth's magnetic field and its storms[286-288]. The highly-cited works of Joseph L. Kirschvink demonstrate that magnetoreception – the ability to detect and respond to magnetic fields – is not uncommon among biological organisms[289]. Indeed, bats[290], honeybees[291], pigeons[292], species of bacteria[293], and fish[294], as well as humans[43] and many other animals display capacities to orient and navigate using the geomagnetic field as a reference point. Kirschvink has proposed biogenic magnetite as the primary receptor and transducing element for magnetoreception[295]. These biologically precipitated particles of iron oxide can even be "magnetized". That is, the polar structure of the material can be re-aligned to become a permanent magnet. Magnetite is also ferrimagnetic – which is to say it displays a property called magnetic hysteresis[296]. This unique property allows the magnetic behaviour of the material to change as a function of the history of its magnetization, holding a memory of its previous states. Incidentally, iron bars with similar properties can be induced to display conditioned responses that are operationally indistinct from animal forms of learning[297]. Therefore, as a material, magnetite is able to store and re-express electromagnetic information as magnetic "states" or "memories".

Magnetite deposits were initially found to be homogenously distributed throughout the brain[298]. However, experimental magnetizations of these particles by exposures to high-intensity fields from an MRI scanner recently enabled researchers to use a MEG-based localization technique to identify increased concentrations of magnetite within the limbic regions[299]. In particular, there were high concentrations of magnetite found within the hippocampal bodies, deep within the temporal lobes. Incidentally, while the hippocampus is an important organ for memory encoding and retrieval, it is also associated with spatial orientation and navigation[300-302]. If magnetite participates in human magnetoreception, it may be a fundamentally passive process. Unlike heme iron in the oxygen-transporting metalloprotein hemoglobin, magnetite is not clearly coupled to any protein that opens an ion channel or performs some other active function at the level of the cell. Magnetite may instead interact with brain and environmental EMFs at a material level, though the precise mechanism remains unknown.

As reviewed in Persinger's 1974 book "ELF and VLF Electromagnetic Field Effects"[303], as well as Dubrov and Brown's 1978 book "The Geomagnetic Field and Life: Geomagnetobiology"[304], there is considerable evidence that the Earth's magnetic field influences living systems including the human brain. In the early part of the 20th century, it was reported that psychiatric hospital admissions tracked geomagnetic activity[305], which was independently confirmed decades later[306]. The same effect would later be observed in epileptic patients as the frequency of their convulsions – usually within the temporal lobes[307] – correlated with geomagnetic activity[308]. On the bases of these and other observations, it was predicted that EEG rhythms and geomagnetic activity would also likely correlate[309]. Since the 1960s, the effects of geomagnetic activity on synchronous brain activity as inferred by EEG have been independently replicated by several research groups.

In 2007, Babayev and Allahverdiyeva quantitatively demonstrated that right hemispheric theta (4 – 7 Hz) and alpha (8 – 13 Hz) EEG power correlated with geomagnetic activity[310]. The changes were observed within the temporal-limbic regions and typically marked by negative emotional responses, which is unsurprising given the correlation between geomagnetic activity and population-level aggression or war[311]. The right hemispheric theta-alpha effect was quickly replicated by Mulligan, Hunter, and Persinger in 2010 with data from quiet periods of geomagnetic activity[312]. The same authors later established a causal role by experimentally simulating geomagnetic storm conditions[313]. One of the most recent examples of brain-based interactions with simulated geomagnetic field changes was reported by Kirschvink's group. Indeed, with Wang and colleagues, Kirschvink reported a desynchronization of alpha rhythms (8 – 13 Hz) which was associated with the static component of the Earth's magnetic field and was orientation-dependent[43]. In addition to EEG changes and the well-documented suppressions of the hormone melatonin[314], geomagnetic field fluctuations have always been associated with reliable reports of post-mortem apparitions (i.e., ghosts)[315,316], and other intense paranormal experiences[317].

All states of consciousness are apparently affected by geomagnetic activity; however, influences on sleep states are notable. Incidences of vivid[318] and bizarre[319] dreams, as well as sleep paralysis[320] are associated with geomagnetic activity. The duration of rapid eye movement (REM) was also affected by the position of the human head relative to the Earth's magnetic poles, where the latency for East-West orientation was significantly shorter relative to North-South[321]. Recently, a similar experiment demonstrated that low-frequency EEG rhythms – alpha in particular – were significantly affected by sleep orientation[322]. In 1996, Stanley Krippner and Michael Persinger demonstrated that performance on a remote viewing task involving the identification of target pictures by dream content alone was enhanced by reduced geomagnetic activity[230]. Incidentally, prophetic or precognitive dream events are widely reported and have been linked to geomagnetic activity as well[323,324].

There is clearly a connection between the Earth's magnetic field, brain activity, cognition, and behavior. The mechanisms that relate them have not been fully elucidated; however, repeating patterns in the data have revealed a likely unifying candidate. Recall that the literature consistently reported that synchronous neural activity with frequencies ranging from 4 Hz to 14 Hz (theta and alpha rhythms) are affected by natural and artificial EMFs. If the geomagnetic field oscillates with a similar frequency, resonance with the brain may be possible. Resonance is a physical phenomenon associated with waves where the frequency of an applied force can become amplified by a paired frequency or wavelength-matched structure[325]. A tuning fork, for example, will resonate with particular frequencies of vibrating air but not others. Likewise, antennae will only receive particular frequencies of electromagnetic radiation. In both examples, as the frequency of the signal becomes less like the ideal receptive frequency of the system, resonance potential decreases. Fortunately, the oscillations of Earth's magnetic field, which are driven by a resonance phenomenon involving lightning strikes, have been under investigation for nearly a century[326].

There are, on average, approximately 39 to 49 lightning flashes that occur between the Earth's ionosphere and ground surface every second[327]. Lightning strikes interfere with each other, perturbing the geomagnetic field with a predictable oscillation pattern. The Earth-ionosphere cavity is effectively a resonance chamber for lightning that generates a perturbation of the geomagnetic field with a frequency mode of 7.83 Hz, which is called the Schumann resonance for its discoverer W. O. Schumann[326]. With his colleague H.L. König, Schumann measured a peak frequency of approximately 8 Hz with harmonics which have since been confirmed at 14, 20, 26, and 33 Hz[328]. König and colleagues later noted the peculiar overlap of brain EEG rhythms and Earth-ionospheric resonances[329] – an observation that has received significant quantitative support in recent decades[330]. In particular, Kevin Saroka's research has empirically demonstrated the existence of a real-time coherence between Schumann resonance and the frequency spectra of human EEG rhythms[47] (**Figure 7A-C**). That is, the synchronized activity of brain cells and geomagnetic oscillations driven by lightning occur simultaneously – presumably across all 7.9 billion human brains. Whether or not they can be causally disentangled is unknown; however, the possibility that they are fundamentally one unified process is promising for the continuity of consciousness following brain death. Because if brain activity is the transmitted product of Schumann-type signals, survival is likely. Interestingly, Persinger noted several other conspicuous overlapping features between lightning and the brain that point to a scale-invariant relationship[331]. For example, both action potentials from neurons and lightning strikes share pulse patterns, refractory periods, current densities, and energy densities. Together, these studies support the conclusion that the electromagnetic patterns of the Earth and the brain are not only similar across several parameters, but they are also functionally synchronized in time.

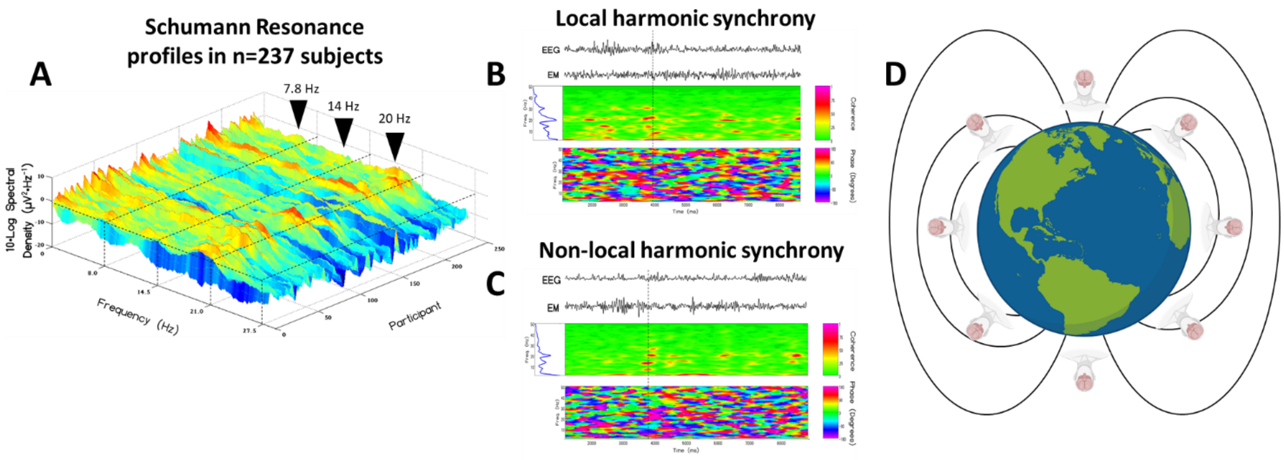


**Figure 7. Human brain activity coheres with geomagnetic activity in real-time to display Schuman Resonance profiles.** A) Superimposing all n=237 EEG records revealed brain activity within the temporal and occipital lobes displayed frequency peaks at 7.8, 14, and 20 Hz – reflecting the mode, 1st, and 2nd harmonics of the Schumann Resonance. B) Whether the geomagnetic activity was measured locally (top) or C) non-locally (bottom) to the participant (i.e., a distant geographical location), their EEG profiles remained synchronous with geomagnetic oscillations in real-time. D) Schumann Resonance of the Earth's magnetic field may unite billions of human brains, transmitting a shared signal that generates consciousness and that survives death. Panels A-C were adapted from doi.org/10.1371/journal.pone.0146595; Creative Commons Attribution (CC BY) license applies. Panel D was Created with BioRender.com.

There are several additional reasons to suspect geomagnetic-brain resonance. As referenced in a previous section, the intrinsic, material-based resonant frequency of brain tissue is approximately 7 Hz or "theta"[247]. Nunez's mathematical modelling of the skull-brain cavity suggested that a dominant resonance frequency of 10 Hz is expected, which is equivalent to the alpha rhythm, or the dominant frequency affected by geomagnetic activity in empirical studies[248]. Neurobiological processes associated with memory consolidation, particularly during sleep, are also associated with prominent theta rhythms[332]. Sleep spindles[333], which are bursts of synchronous neural firing in the order of 11 to 15 Hz, are also well-within range of the first harmonic of the Schumann resonance frequency, which may explain EMF-sleep interactions. In summary, synchronous brain activity, Schumann resonances, and their interactions by way of the geomagnetic field operate within a narrow band of low-frequency oscillations centering on 7 – 8 Hz but extending up to 14 Hz. That they display real-time coherence indicates they are likely related, not coincidental. This connection between the brain and the Earth is interesting, but it does not explain how memory or consciousness can be stored within it.

In his 2013 paper entitled "Billions of Human Brains Immersed Within a Shared Geomagnetic Field: Quantitative Solutions and Implications for Future Adaptations", Michael Persinger provided a theoretical and quantitative basis for the storage of brain-based information in the Earth's magnetic field[56]. Discussing the available energies to store brain activity, Persinger wrote:

> *The potential energy that could be maintained within the geomagnetic field is significant. The product of its dipole moment ($8{\cdot}10^{22}$ $A{\cdot}m^2$) and average intensity ($5{\cdot}10^{-5}$ T or $kg{\cdot}A^{-1}{\cdot}s^{-2}$) is about $4{\cdot}10^{18}$ J. With ~$10^{-20}$ J per action potential associated with each unit charge, an average discharge of ~10 Hz (range of alpha rhythms) and $4{\cdot}10^{10}$ neurons in the cerebral cortices, the life-time (~2 Gsec) electromagnetic energy from the information associated with this activity from each human cerebrum would be about 1 J. Assuming 50 billion human brains in recent history, the total energy associated with cerebral activity (and the subsequent alterations in synaptic activity associated with memory) would have involved ~$10^{11}$ J. Even if there were diminishment in the magnitude of the dipole moment by factors of 100s, there would still be sufficient potential to represent all of this information. This means the earth's magnetic field has sufficient capacity to represent or "store" the information within the energy that has been associated with the action potentials that have been generated by every human brain that has existed on the planet.* (p. 9)

Based upon parameters of magnetic diffusivity, Persinger explained that this holographic-like, transcerebral field could potentially activate every brain on the planet over a period of approximately 10 minutes[56]. He argued that the same period of time associated with the duration of REM cycles could account for a functional exchange of information between the geomagnetic field and the human brain during sleep – a kind of uploading and downloading procedure for brain activity[56] (**Figure 7D**), like a neural form of cloud computing. Persinger viewed Schumann resonance as a conduit for the information transfer, with 7 to 8 Hz as the carrier wave (i.e., the signal that transports the information)[56]:

> *The role of the Schumann-type frequencies (fundamental around 7 to 8 Hz) may be relevant as well. This frequency is in large part determined by the fixed relationship between the velocity of light ($3{\cdot}10^8$ $m{\cdot}s^{-1}$) and the earth's circumference (~$4{\cdot}10^7$ m). The total magnetic flux of the earth's surface ($5.1{\cdot}10^{14}$ $m^2$) for an average global value of $5{\cdot}10^{-5}$ T is $2.6{\cdot}10^{10}$ Webers. The amperage for this field would be the dipole moment ($8{\cdot}10^{22}$ $A{\cdot}m^2$) divided by the surface area, or $1.6{\cdot}10^8$ A. Therefore the inductance, which is Weber per amp, would be $1.6{\cdot}10^2$ Henrys. With this value for inductance, a global capacitance of 2 Farads, and a frequency of 7 - 8 Hz, the solution would be 2 ks or about 30 min. These values are within the range required for consolidation of memory (the representation of experience) from the electrically labile stage to the patterns associated with the synthesis of proteins and the growth of dendritic spines at synapses* (p. 10)

It should be noted that the strongest theta rhythms produced by the brain are generated by cells in the temporal lobes – specifically, the hippocampus and adjacent entorhinal cortex[334]. Because the neurophysiology of memory formation – long-term potentiation (LTP) – is dependent upon theta activity within the hippocampus[335], a reduced resonance potential between the Schumann frequency and the underdeveloped hippocampal circuitry of young children may account for the universal experience of infantile amnesia – our inability to remember the first few years of our lives[336]. However, after the age of 3 or 4 and into adulthood, the brain would meet the structural criteria to resonate with the geomagnetic field and continually exchange packets of electromagnetic information. It follows that the memories of those whose brains have decayed have survived death. Instead of disintegrating with the body, they remain as electromagnetic representations in a planetary Akashic record. It should therefore come as no surprise to you, dear reader, that when I walked by Dr. Persinger's old office after he passed away in 2018, I smiled when I read what he had written years earlier on the magnetic white board affixed to his door: "To Find Dr. Persinger Check the Akashic Record" (**Figure 8**).

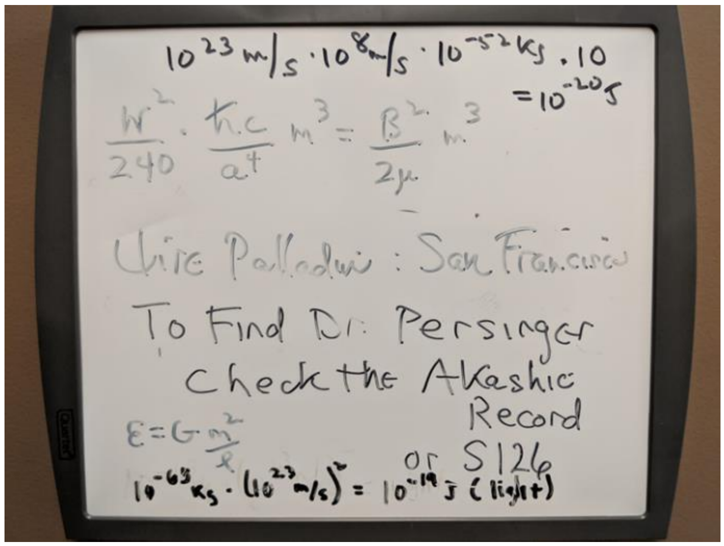


**Figure 8. A message from Dr. Persinger.** The magnetic whiteboard affixed to Dr. Michael A. Persinger's former office at Laurentian University in Sudbury, ON, Canada. Written: "To Find Dr. Persinger Check the Akashic Record" (original image, 2018).

**Section 6: A proposed theory of survival**

Throughout this essay I have presented significant evidence in support of a hypothesis that reconciles the continuity of experience and death. Before offering some important corollaries, implications, and final thoughts, I think that for the purposes of clarity it is necessary that we briefly return to the question at the core of this essay by restating its challenge: *What is the best available evidence for the survival of human consciousness after permanent bodily death?* On the bases of what has been presented thus far, I offer the following answer: *The best available evidence for survival is the significant observational and experimental data that indicate the brain is an organ that receives and emits electromagnetic radiation in ways that are consistent with a transmissive model of brain function that positions consciousness as independent and at least partially separate from the brain itself*. Admittedly, there are several conceptual steps that must be followed to fully appreciate the argument and I suspect its conclusion can only be compelling if all of the evidence can be considered simultaneously. Therefore, it may be necessary to compress the argument down to its most essential postulates, even at the risk of losing information. Here, I will provide an explicit and succinct summary of the evidence I have laid out in previous sections, formalize my proposed theory of survival, suggest a general mechanism, and provide some historical background for models of consciousness that support survival.

Recall that, initially, I approached the question by focusing on how brains function because the survival of consciousness is only threatened by death if brains produce consciousness by force of internal mechanisms alone. I then invoked William James' transmissive model of brain function, which posits that consciousness is a signal or the product of a signal that may interact with the brain but originates in the external environment. Therefore, if consciousness is generated in part or whole by forces outside the head, brain death is not synonymous with the end of consciousness. I argued that the transmissive model is consistent with the electromagnetic nature of the brain and is supported by an established literature of EMF-brain interactions. I demonstrated that cognition, behaviour, and even free will can be manipulated by external EMFs. Next, I summarized the results of my own experiments with fixed, post-mortem human brains. Together, they suggested that a transmissive model could be mediated by the material-like properties of brain tissues that filter induced voltage fluctuations caused by natural and artificial EMF exposures. The right parahippocampal cortex was particularly capable of passively amplifying and filtering electromagnetic signals. Other EMF-brain mechanisms are possible including interactions with biogenic magnetite. Finally, I discussed human magnetoreception, environmental sources of EMFs, real-time Schumann-brain resonances, and the reasons why brain-EMF interactions can account for the continuity of consciousness and the storage of memories outside the brain.

The argument put forward here is that brain death cannot eliminate consciousness because consciousness is not a product of the brain. Rather, consciousness and other brain functions are explained by EMF-brain interactions, and these are not wholly dependent on the activities of living cells. To formalize my theory of survival: *Consciousness survives permanent bodily death because the electromagnetic forces that give rise to experience and thought are not created by brain tissues – they are only received, interpreted, filtered, or transmuted by them*.

The idea that an electromagnetic field emitted by the body may permit the continuation of consciousness after permanent bodily death has been previously articulated. In the 1987 paper entitled "Electromagnetic Radiation and the Afterlife", Janusz Slawinski cited the pioneering biophoton research of Fritz-Albert Popp and others to propose a scientific theory of the afterlife[337]. Slawinski theorized that sharp increases of biophoton emissions from dying organisms[338] – the "death flash" – may represent the separation of an electromagnetic consciousness or life force from the body that carries information about the individual. The following excerpt from his seminal paper[337] echoes several key themes in this essay:

> *An important finding is that all dying cell populations and organisms emit a radiation ten to 1,000 times stronger than their stationary emission during homeostasis. That phenomenon of "degradation" or "necrotic" radiation, picturesquely called "light shout", "light S.O.S", or "death flash", is universal and independent of the cause of death. Its intensity and time course reflect the rate of dying. Of particular significance are reports on electromagnetic radiation from the human brain during the agony (and/or ecstasy) of contemporary near-death experiences, which center on ineffable light. Measurements of the number of photons emitted and the number of dying cells, $N_{dc}$, give the ratio $N_{h\nu}/N_{dc} = 1$. That suggests the involvement of*

> *one center critical both for the life of the cell and for light emission. The phenomenon of the "death flash" constitutes a cornerstone of this hypothesis."* (p. 82)

Persinger and St-Pierre later calculated that the energy of the death flash (5 x $10^{-17}$ Joules) would be within the range of visible detection for dark-adapted eyes, meaning it should be perceivable under very low light conditions[57]. They argued that the existence of the death flash phenomenon accounts for historical reports of perceived blue and white light emissions observed hovering over or emanating from the bodies of dying people[339] and blue-shifted wavelengths of light associated with cellular stress[340]. Therefore, the proposed theory of survival outlined in this essay builds on an existing scientific literature concerning the biophysics of death and dying that should be pursued with vigor.

The proposed theory of survival is dependent upon the validity of transmissive brain function, which is not incompatible with models of productive brain function. The action potential really is generated by local, electrochemical events – and those that run along the corticospinal tract really do generate voluntary motor activations. However, the complexities of higher order functions appear to be reliant on the synchronizing and cohering effects of endogenous and exogenous EMFs. And because many of these effects are mediated by inorganic, sub-cellular, or material-like properties, it is reasonable to treat transmissive and productive modalities as compatible, parallel processes. Therefore, the proposed theory does not require a complete revision of our understanding of the brain but rather, an amendment and consideration of some important implications. Still, there are some possible limitations that will need to be addressed by future research efforts. Most notably, the dependence of consciousness on external EMFs, how qualia are derived from EMF-brain interactions, whether the surviving consciousness is personal or shared, and the degree to which productive mechanisms participate in transmissive function are important issues that will require dedicated investigation.

Over the past century, modern scientists have grossly overemphasized molecules and their pathways as the bases for biological function, which has sadly overshadowed the equally relevant electrodynamic features of cells and organisms. Despite its general dismissal or outright suppression, the scientific evidence in support of the electromagnetic basis of life is longstanding and mounting. Early modern pioneers like the neuroanatomist and electrophysiologist Harrold Saxton Burr, who summarized his work in the 1972 book entitled "Blueprint for Immortality", identified how electric fields changed as a function of ovulation, menstruation, gestation, growth, maturation, and regeneration[341]. He described these fields, which seemed to track the development, physiology, and psychology of an organism the "fields of life" or "L-fields" and even commented on their relationship with death[342]:

> *Electricity seems to bridge the gap between the lifeless world and living matter. . . . [it] is one of the fundamental factors in all living systems just as it is in the non-living world* (p. 2)

Burr's influence on the field of biology can be found in the works of later scientists like Robert O. Becker, who significantly popularized the view that electrodynamics were consequential features of biological organisms rather than incidental biproducts[343] and even suggested they may underlie psi phenomena[344]. Over time, electrical contributions to living systems became increasingly clear and electromagnetic theories of consciousness began to emerge in the literature, where they continue to develop and gain popularity. One review of the literature suggested that many prominent thinkers including Köhler and Libet have touched on elements of EMF-based theories of mind but have been historically misclassified[345]. Among the more explicit theorists is the neuroscientist E. Roy John, who developed his own field theory of consciousness and claimed that spatiotemporal coherence of electromagnetic and quantum-like processes could resonate with brain structures to give rise to binding, synchronous firing and other important features of consciousness including cortico-thalamic reverberations[346,347]. Related is the conscious electromagnetic information (CEMI) field theory proposed by Johnjoe McFadden[348-350]. Arguably, the famous orchestrated objective reduction (Orch OR) model of consciousness offered by Roger Penrose and Stuart Hameroff is fundamentally an electromagnetic theory of consciousness since it relies upon the quantum effects of electrons and their interactions with the material properties of microtubules[351,352], which are well-known to align and interact with EMFs[353]. Indeed, microtubules represent an obvious candidate for the mediation of EMF-brain interactions since they generate dipoles within cells[354], respond to electric fields[355], and interact with biophotons[356]. Incidentally, microtubules also display electric circuit properties of memristors that give rise to hysteresis-like phenomena that can encode information sub-cellularly[357] – providing a mechanism for EMF-based memory within cells. Therefore, it is unsurprising that some have explicitly placed microtubules at the center of electromagnetic field theories of consciousness[358].

A good theory should provide new ways of interpreting existing empirical data and the supposedly established concepts on which they are based. In addition to explaining survival, a working model of transmissive consciousness may provide new insights that challenge existing assumptions about life, death, and everything in between. When a baby babbles as part of normal language acquisition, we currently assume it is essentially practicing behaviour that is selectively reinforced by caregivers as part of normal development[359]. In other words, babies learn language from trial and error. Viewed through the lens of transmissive function, babbling may represent something subtly different. Suppose babbling is the behavioural correlate of downloading linguistic information from a local or distant "source file". This may involve a wireless brain-to-brain connection with caregivers or access to historical linguistic information in the electromagnetic equivalent of the Akashic record. This would be consistent with the disproportionate representation of EMF-sensitive REM cycles[360] in infant sleep. Even if language is learned by conventional means, it may be reinforced and crystalized by EMF-sleep interactions. Similarly, the insidious cognitive decline associated with neurodegenerative disorders and dementia may represent an uncoupling of the brain's structure from the transmitted signal rather than a failure of endogenous neurophysiology. As brains degenerate, they become increasingly "out-of-tune", space and time become increasingly irrelevant, the life-death boundary may become blurred, and individuals may incorrectly identify people in their environments as long deceased spouses or friends. With both babbling and dementia, the neurobiology would be exactly as it is currently understood; however, the causal mechanisms and ultimate explanations would be fundamentally different.

A good theory should also explain more phenomena than its predecessor or its contemporary alternatives. Indeed, a theory of survival that relies on transmissive brain function will necessarily implicate psi phenomena because they too are reliant upon the independence of mind from brain. Consider that popular models of brain function that are based upon the assumption of productive functional dependence do not provide a mechanistic framework for psi and paranormal events. Consequently, psi research has either been ignored or marginalized by modern scientists despite significant interest among people all over the world and throughout history. In the following section, I will describe how the apparently unique abilities of some individuals classically termed telepathy, remote viewing, and psychokinesis are consistent with the survival of consciousness and easily accommodated by a model of transmissive brain function. It will also become evident that these phenomena can be inhibited or modulated by natural and artificial electromagnetic fields, which supports the general arguments that have been put forward in previous sections.

**Section 7: Implications for psi phenomena**

Humans have always shared and preserved stories of unique individuals who could apparently perform extraordinary acts or, by David Hume's definition of miracles, "violations of the laws of Nature"[361]. Contemporary equivalents of those once mythologized as prophets, oracles, soothsayers, and other special beings[362], are often regarded as frauds or charlatans – and many of them likely are[363]. Of course, the convenient argument that unique abilities may be incompatible with measurement or the highly controlled environments of scientific laboratories could be valid; however, it is an untestable hypothesis and therefore not scientific – or rather, a limitation of the scientific method. Regardless, there are also many credible reports of individuals who have reliably demonstrated unique abilities including better-than-chance outcomes that also exceed the average performance of other humans[264,265]. Beginning with the 1886 publication of "Phantasms of the Living"[366] and well into the 20th century, scientists and scholars began to operationally distinguish these unique phenomena from the typical behaviors and mental states under the dominion of the newly formed field of psychology. Thus, parapsychology research was first initiated to investigate infrequent, transient, esoteric, and fringe phenomena that I will refer to as "psi phenomena". Classically, these include mediumship, telepathy, clairvoyance, remote-viewing, different types of extrasensory perception, as well as near-death experiences, post-mortem apparitions, synchronicities, and other oddities[367]. Most are intrinsically subjective but some including psychokinesis and poltergeist phenomena involve objectively measurable mind-matter interactions[369] and are empirically linked to emotional states of arousal and interpersonal conflict[370,371]. The early 20th century was a genuinely exciting time to be scientist with an interest in psi phenomena – this is perhaps best illustrated by Duncan MacDougall's famous experiment published in 1907, where he attempted to weigh the soul as it left the body by placing the beds of dying humans and dogs on an industrial-sized scale[372]. His results indicated that the soul might weigh approximately 21 grams; however, his experiments suffered from low sample size and, without further investigation, his inconsistent results could reasonably be explained by variations in lung capacity and sweating[57,372].

Though it might seem like a digression, I claim that the likelihood that human consciousness survives permanent bodily death increases if the model of consciousness that accommodates it – the transmissive model – can also accommodate psi phenomena. Because, as I will demonstrate, some psi phenomena are measurable but unexplained by productive models of brain function. And if transmission can do what production cannot by successfully unifying psi with mainstream psychology, its strength as a theory will be further supported. Also, because survival is dependent upon transmissive consciousness, demonstrating the validity of certain psi phenomena will, in turn, bolster the plausibility of survival itself. Further, if psi abilities can be suppressed, modulated, or enhanced by electromagnetic energies including EMFs and geomagnetic fluctuations, their convergence with transmission and survival will be even greater by dint of a shared putative mechanism. Therefore, I will now present three cases of individuals who display psi abilities under experimental conditions with similar neural correlates localized to the right temporal lobe, and I will discuss how the individuals involved are affected by natural and artificially-generated EMFs. The details of each case were originally compiled by Persinger in his 2015 book chapter entitled "Neuroscientific Investigation of Anomalous Cognition"[373].

Sean Harribance is a representative example of an individual who displays telepathy – which is also known as "mind reading"[373]. His ability to access the memories, experiences, and medical histories of other people, which is consistent under experimental scrutiny, has been assessed by several independent investigators[374]. Harribance describes his process of "reading" people as a communion with an "angel", experienced as a sensed presence, that is accompanied by the perception of images about the person that appear in his upper-left visual field, which corresponds to the brain's visual receptive areas of the right temporal and occipital lobes[373]. When engaged in a reading, Harribance's brain expresses a distinct pattern of EEG rhythms over the surface of his right hemispheric temporo-parietal region[375], which becomes more prominent as his reports become more accurate[373] (**Figure 9**). Source-localization methods have identified the right parahippocampal cortex as the locus of his unique right hemispheric activations[374], which is the area of the brain's temporal lobe that links the experiential neocortex and the memory-accessing hippocampus[376].

As measured by magnetometers placed alongside his temporal lobes, local geomagnetic field intensity significantly diminishes over his right temporal lobe proportionally to EEG rhythms within the same region and returns to baseline intensity when he mentally disengages from the reading procedure[375] (**Figure 9F**). In other words, there is a conserved relationship between his brain activity and the geomagnetic field intensity on the right side of his head. Remarkably, Harribance's right temporal lobe activity strongly coheres with the activity of his subject's left temporal lobes when he is "reading" them[375] (**Figure 9A-D**) as if their brains are functionally connected. The right side of his brain also emits many more photons when he "reads" his subjects (**Figure 9E**) or imagines white light[375] and displays prominent EEG frequency signatures of Schumann resonances[34]. Finally, experiments have demonstrated that Harribance's sensed presence experience and visions could be systematically induced by stimulating his right temporal lobe using artificially applied EMFs[377]. A parsimonious integration of these findings can only be achieved by adopting a transmissive model of consciousness. Indeed, telepathy may represent a rare capacity to intentionally access the electromagnetic representations of personal information. Experiences of unintentional access or exchanges during altered states and sleep could account for similar phenomena in average individuals. Further, it is conceivable that mediumship is the equivalent of telepathy, however, in the case of the former, the electromagnetic information is associated with a deceased individual instead of a live one. Whether individuals such as Harribance accesses information directly from the brains of their subjects, or indirectly by either intercepting transmissions of consciousness or retrieving stored data from the shared geomagnetic environment is unknown but likely testable.

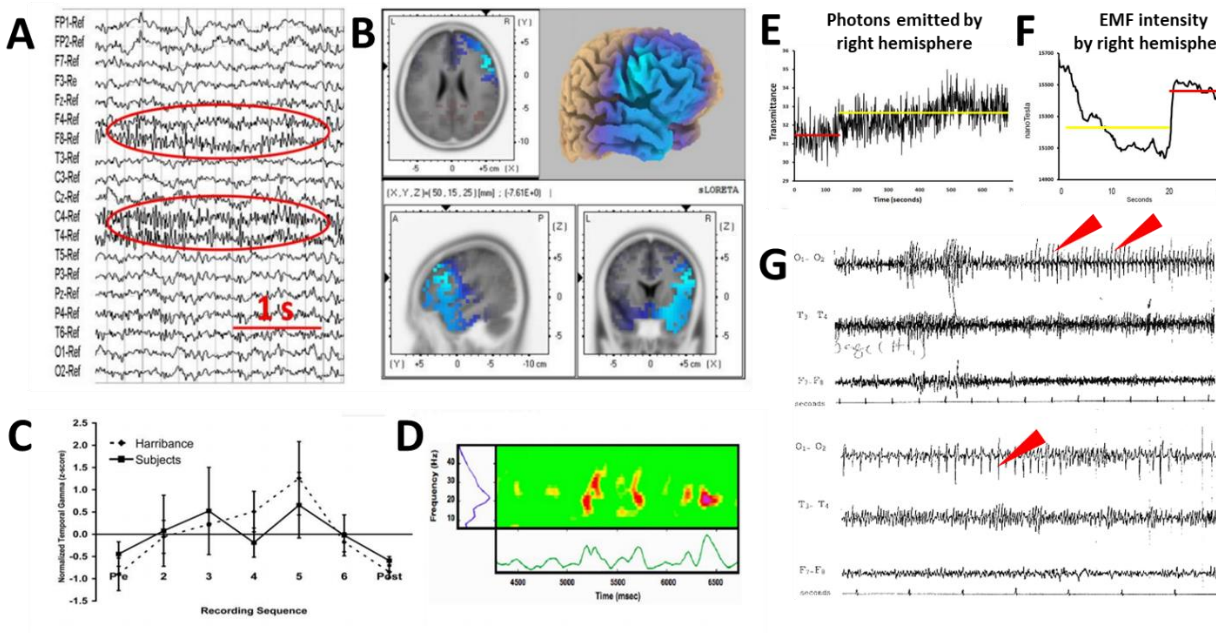


**Figure 9. Unique brain activations associated with telepathy and remote-viewing that are linked to local electromagnetic energies.** A) Sean Harribance's (SH) unique, right hemispheric activation patterns (circled in red) associated with his "reading" states when he engaged in telepathy. B) sLORETA indicated widespread involvement of the right temporo-parietal region and deep parahippocampal cortex. C) SH's high-frequency (gamma) brain activity correlated with his subjects' high-frequency brain activity. D) Their spectral profiles cohered over time, which was unique to him and not observed with other pairs. E) More photons were emitted over SH's right hemisphere when he engaged in telepathy (yellow line) relative to baseline conditions (red line). F) Electromagnetic field intensity (geomagnetic) decreased next to his right temporal lobe when engaged in telepathy (yellow line) relative to rest conditions (red line), indicating a conservation of energy. G) Ingo Swann's occipital lobe (visual cortex) displayed prominent and conspicuous theta spikes (red arrows) when he engaged in remote-viewing; the duration of the spikes correlated positively with the accuracy of his remote-viewing performance. These data (and others presented throughout the essay) indicate that consciousness and memory are at least partially independent of the brain and can likely be transmitted electromagnetically. Panels A through F were adapted with written permission from the publisher[375]. Strip-chart data from panel G is original data courtesy of Dr. Michael A. Persinger, Neuroscience Research Group (NRG), retrieved in 2016.

The most famous and well-documented example of an individual who could engage in "remote viewing" or a capacity to experience people, places, and events at a distance is the late Ingo Swann[373]. Originally investigated by prominent psychical researchers Hal Puthoff and Russel Targ in the 1970s, Ingo Swann's remote viewing procedure was supported by U.S. national defense and intelligence agencies with clear military and strategic applications[378]. When Swann engages in remote viewing, he experiences flashes of visual stimuli and words, as well as recognizable images, the sensation of floating, and out-of-body experiences[373] – all known correlates of temporal lobe activation[379,380]. In one experiment, Swann was asked to remotely view pictures placed in envelopes positioned in a distant room while his EEG rhythms were measured. Just as Puthoff and Targ had originally observed[381], Ingo Swann's readings were highly accurate[381]. When he began to concentrate and engage in his remote viewing procedure, bursts of 7 Hz spikes were observed over his right temporal and occipital lobes that strongly correlated with his accuracy scores[382] (**Figure 9G**). MRI scans later revealed structural abnormalities within the same regions of his right hemisphere[37]. To discern how Swann was receiving information, EMFs were applied to his brain while he was not engaged in remote viewing[373]. Echoing Harribance's experience, Swann reported spontaneous inductions of his remote viewing experiences when exposed to the applied EMFs; however, some EMF patterns could also disrupt his abilities[373,383]. Again, the simplest explanation supports the existence of transmissive brain function and an electromagnetic basis of memory and consciousness. The involvement of the right temporal lobe and the conspicuous 7 Hz signature also suggests a potential link to Schumann resonances and the geomagnetic field.

Finally, the lesser-known Ms. Black (anonymized) represents a rare case of an individual who expresses psychokinesis – an ability to move objects by means of thought alone – with associated poltergeist phenomena including electronic, movement, and sound-based events coupled to her own emotional state[373,384]. The sounds were typically experienced as taps that were linked to real-time fluctuations in geomagnetic activity[384]. Notably, they were typically heard on the left side of her body, and she reported experiencing occasional discharges of light from her left hand[384] – both of which indicate lateralized, right hemispheric brain activations. This is relatively unsurprising given she sustained an impact to the right side of her head during a car accident earlier in adulthood, causing a moderate right hemispheric brain injury[384]. EEG measurements confirmed an anomalous, high-intensity and high-frequency signal over her right temporal lobe that could be attenuated by sitting in a Faraday cage that significantly reduces local geomagnetic field intensity[384] – suggesting an electromagnetic basis to the phenomenon. The signal was source-localized to the right insula – a region of the cortex that is structurally adjacent and medial to as well as continuous with the temporal lobe.

Ms. Black reportedly developed her psychokinetic ability by learning to rotate a pinwheel by force of concentration alone[384]. In one experiment, she was asked to move the pinwheel while her EEG rhythms were monitored. A strong relationship was identified between the amount of 7 Hz activity she expressed over her right temporal lobe and the rotation of the pinwheel[384]. When she was exposed to a simulated geomagnetic EMF in the laboratory, the 7 Hz signal that was diminished by the EMF-shielding cage spontaneously returned with a paired feeling of distress and unease[384]. Like Harribance and Swann, Ms. Black displayed a prominent right hemispheric functional brain anomaly that could be modulated by electromagnetic fields. However, unlike the highly subjective reports of the former cases, Ms. Black displayed an objective mind-matter interaction, which supports the transmissive model of brain function. Assuming scientists will one day conclusively validate the existence of psychokinetic activity, a revision of some historical events may be necessary. For example, recalling the near-death experience that inspired Hans Berger to pursue the measurement of "psychic energy", it is worth considering the possibility that he did not telepathically transmit fear to his sister, but rather that her distress psychokinetically caused the fall that nearly killed him.

Here, I have focused on a small set of cases to demonstrate parallel findings across psi research; however, statistically abnormal performance on tasks related to telepathy[385-387] and remote viewing[388,389] have been reliably reported to varying degrees among randomly sampled, otherwise normal people. Indeed, the use of random event generators (REGs) to demonstrate mind-matter interactions in humans has indicated that some individuals can bias random physical systems by concentration alone[390]. Meta-analyses of hundreds of studies examining the effects of consciousness on REGs[364] and the results of falling dice[391] clearly indicates the existence of a genuine interaction between thought and physical systems outside the head. Consciousness therefore likely extends beyond the brain, supporting a transmissive model over current productive models. Interestingly, EMFs can be used to induce, amplify, and suppress psi task performance among randomly selected individuals[392]. There is also a developed literature on psi phenomena that reinforces the significance of geomagnetic activity and its effects on performance[393,394]. Geomagnetic storms affect extrasensory perception scores indicative of telepathy among average human participants[395] and are linked to poltergeist phenomena[396].

Despite independent verification of some specific cases and phenomena, the mainstream rejection of psi abilities as "spooky" or the always-childish "woo-woo" is reasonable given the productive model of consciousness. That is, if brains generate consciousness by endogenous mechanisms that can only interface with the external environment by way of the peripheral nervous system and its control of our musculoskeletal system, psi is a total non-starter because it lacks a realistic mechanism. However, it should be noted that, historically speaking, phenomena which are unexplained because of an incomplete or inaccurate model of the system always seem spooky until an accurate model is adopted. Once a causal mechanism is identified, the phenomenon becomes mundane and post-hoc analyses are often paired with a dense incredulity associated with sentiments such as "How could we have ever thought otherwise?". Similarly, the survival of consciousness after death is expected to become increasingly mundane as a concept if empirical efforts toward its validation yield compelling results with a defined mechanism. Based upon the three presented cases, psi phenomena are typically associated with anomalous right hemispheric activity with localized activations in the temporal lobe and parahippocampal area in particular. Synchronous brain activity is often reflective of Schumann resonance frequencies with dominant theta rhythms that track psi performance. Finally, actual and simulated geomagnetic fields as well as artificial EMF exposures can modulate psi ability. Together, these findings strongly support the validity of transmissive, electromagnetic models of consciousness. Therefore, the survival of consciousness after bodily death – which is at least partly dependent upon transmissive function – is likely beyond a reasonable doubt.

## Conclusion

In this essay, I have presented the best available evidence for the survival of human consciousness after permanent bodily death. As it stands, the data indicate that survival is possible beyond a reasonable doubt. Predicted over a century ago by William James in his prescient lecture on human immortality, contemporary neuroscience research indicates that brains display transmissive functions – they receive, process, and emit electromagnetic energies that are not dependent upon the activities of living cells. Consciousness is not produced by the brain alone. It is a force that exists independent of any organ as an electromagnetic signal that can interact with the brain by transmission to generate thought and experience. Therefore, when brain cells functionally deactivate, decay, decompose, and disintegrate, an immortal stream of consciousness persists. Just as consciousness survives death, so too do our memories as electromagnetic patterns stored in a physical Akashic record[397]. The dying brain does not drag consciousness into the void – it merely loosens its grip on the transcerebral field that gives rise to it and connects us all. The butterflies of the soul cannot be caged, and without the air beneath their wings, they cannot fly.

I hope what was presented here will inspire philosophers and scientists alike to pursue an increasingly sophisticated study of consciousness as it relates to death and dying. Equipped with advanced measurement tools, modern investigators will likely be successful in elucidating the forces that give rise to consciousness and its relationship with death. However, there are many self-defeating habits that threaten its discovery. Chief among them is a failure of imagination, which shackles the mind to the useful dogmas and doctrines of so-called established disciplines. The life sciences, in particular, have become ironically resistant to change or new ideas that subvert convention. On the other hand, there are some who are too willing to accept any model of consciousness that conveniently satisfies a particular belief system. Extreme positions such as these do not grapple with the data, but rather attempt to contort facts to satisfy theories. Therefore, the practical success of this essay will only be realized if it breaks more bonds than it builds – an open mind is more productive toward the related sciences of consciousness and survival. Above all else, we should dispassionately align ourselves with whatever the empirical evidence suggests is most likely.

**Experimental suggestions and future directions for survival research**

In the spirit of kindling scientific discussion and creative ideas, I will close this essay with a forward-looking exercise by outlining possible future directions for survival research. Specifically, I will offer suggestions to experimentally assess the brain's putative transmissive functions on which the post-mortem survival of consciousness likely depends. What I will discuss are only a few obvious paradigms that follow from the main points of the essay; however, I suspect the most creative ideas will come from readers from all over the world and across all areas of study. Therefore, I will frame each thought with a question that I hope others will refine or attempt to answer.

Among the many possible experimental approaches, the continued investigation of complex EMF-brain interactions and their effects on consciousness represents the lowest-hanging fruit and can be immediately pursued. Therefore, the first question is: *If environmental EMFs are received and filtered by brain tissues to generate consciousness, will selective shielding conditions change experience?* While previous studies have focused on attenuating field strength or intensity, efforts should now focus on blocking frequencies and pulse patterns using high- and low-pass EMF-filtering materials. For example, selectively inhibiting theta- and alpha-band EMF oscillations should attenuate real-time EEG coherence with geomagnetic field fluctuations. Psychometric scales of mood, attention, and arousal states as well as personality inventories should also be administered and correlated with brain measurements. Quantitative analyses of linguistic themes and emotional content of self-reported experiences should be analyzed across large groups of participants exposed to the same EMF-blocking conditions. Dying patients may also be measured using combinations of shielding, magnetometers, EEG devices, and photomultiplier tubes to determine relationships between functional brain death and local electromagnetic energies including biophotons. In particular, I anticipate that measuring the "death flash", its neural correlates, and environmental dynamics will help advance an empirically-based science of survival.

Beyond a study of the individual, the transmissive model predicts that consciousness can effectively be shared between all brains. In recent decades, there have been several independent efforts to demonstrate real-time brain signal coherence between paired human subjects who are physically isolated from each other. One of the most simple and elegant experiments[398] of brain-brain "excess correlation" was performed by Leanna J. Standish's team and published in 2006. A pair of human subjects, designated as "stimulated" or "non-stimulated", were separated by 30 feet and a wall of medical-grade EMF shielding material (**Figure 10A**). The stimulated individual always sat in front of a video screen that presented them with visual stimuli in sequential ON-OFF patterns while the non-stimulated individual, wearing sensory-isolating goggles, was always placed in an fMRI scanner. Remarkably, the visual cortex of the non-stimulated person became reliably activated when the other person was being stimulated and deactivated when the stimulation stopped[398]. In other words, even though the non-stimulated person was not experiencing visual stimulation, their cortex was being activated as if it was. This was one of the first robust demonstrations of brain-to-brain communication without the use of an intermediate technology. Since her seminal discovery, others have replicated the effects with weaker intensity magnetic fields. As a graduate student in Michael Persinger's laboratory, I published a similar experiment wherein subjects separated by approximately 6,000 km were exposed to synchronized rotating magnetic fields with changing angular velocities[399] (**Figure 10B-D**). Interestingly, when we measured the EEG rhythms of our paired subjects and later source-localized the brain activity, theta band (4 - 8 Hz) signals originating within the parahippocampal cortex displayed significant superimposition across pairs of brains as if they were functionally connected (**Figure 10D**). Therefore, the second question is the following: *Are all brains fundamentally connected by shared forces, electromagnetic or otherwise, which permit the exchange of brain-based information associated with memory and consciousness? And can they be enhanced or attenuated by certain technologies?*

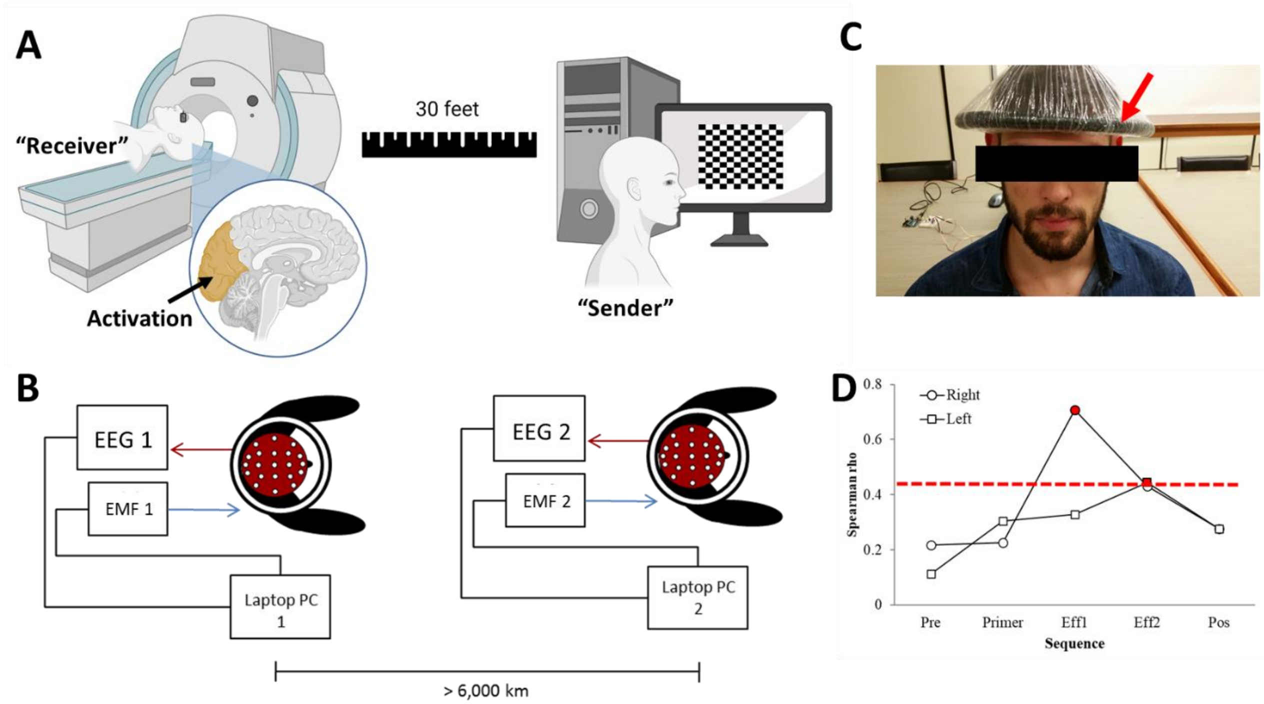


**Figure 10. Brain-to-brain information transmission experiments with and without applied EMFs.** A) A schematic representation of the Standish experiment wherein visual stimulation (flashing black-and-white checkerboard on screen) of a "sender" 30 feet away from a "receiver" elicited synchronous activation of the receiver's occipital lobe as inferred by fMRI[398]. B) A schematic representation of our own brain-to-brain information transmission experiment over 6,000 km (transatlantic) involving pairs of synchronized, counter-clockwise rotating electromagnetic field exposures[399]. C) An example of a participant wearing the "halo" coil (indicated by the red arrow; coil designed by Dr. Ryan Burke). D) Correlations of theta (4 Hz – 7 Hz) power between the right (circles) and left (squares) parahippocampal gyri of paired participants separated by over 6,000 km as a function of each sequence of the of the experiment; a strong correlation is indicated in the right hemisphere when the "effector" field is initiated (red circle); the red line indicates the threshold for statistical significance. These experiments are preliminary demonstrations of functional connectivity between brains that may explain psi phenomena and potentially validate the independence of consciousness from the brain. The survival of consciousness after death would be one significant implication of an independent consciousness that can be shared between human brains. Panel A was created with BioRender.com, C is an original image, and D is my own original data.

Pursuing fundamental mechanisms of survival and transmissive consciousness may require a completely different approach grounded in biological engineering. In our 2021 review article entitled "Toward Studying Cognition in a Dish", my colleagues and I discussed using neural tissue engineering techniques to assess cognitive capacities including consciousness in lab-grown brains[59]. One implication of this approach would be a novel means of testing independence of consciousness from substrates including brain matter:

*Instead of probing the preassembled brains of animals, investigators are now free to design and build artificial circuits and pathways that differ from their naturally selected counterparts and to push systems to their extremes in search of first principles that underlie brain function. Indeed, artificial neural tissues are not limited by inborn developmental morphology or structural–functional templates found in nature. As it is conceivable that some or all higher-order cognitive functions may be substrate independent, the rationale and means to test the independence hypothesis are now beginning to converge.* (p. 295)

We argued that incremental innovations would eventually lead to the creation of bioengineered brains that would be indistinguishable from their natural templates and that these lab-grown tissues would necessarily display features of consciousness[59]:

*To fully replicate the structure of the brain such that the artificially generated tissue is at every level of analysis – from the proteins that make up the cells and the precise composition of the extracellular matrix linking neurons and glia – indistinguishable from its natural template would be, by definition, to create a tissue that can experience. To suppose otherwise would be to admit that consciousness does not emerge from brain matter. . . . Just as comparative anatomy highlighted the remarkable overlap between species which were thought to be phylogenetically unrelated, we submit that a comparative study of cognition across a large set of iterative artificial neural tissues is of equal importance as we attempt to understand the biological origins of phenomena such as thought, intelligence, and even consciousness.* (p. 301)

With near-limitless customization potential, lab-grown tissues may represent the perfect tools to test passive neural properties and the transmissive theory of consciousness[59]. Thus, the third and final question is: *Are transmissive brain functions independent of productive functions or do they interact?* One way to parse productive and transmissive brain functions is to build modular brains in the laboratory and to systematically add and subtract tissue elements to examine their relative impact on passive EMF signal filtration and amplification as well as how these properties influence action potentials and network properties. Neural tissue engineering techniques may also be used to identify the receptive structures and transduction mechanisms that underly both passive and active magnetoreception. Lab-grown brains with titrated concentrations of embedded magnetite could be exposed to alternative EMF conditions while measuring neural activity. EMFs could then be applied to examine the role of magnetite on brain activity and its resonance potential. As technological innovations accelerate, it is worth considering the possibility that memory and consciousness could one day be transmitted to artificial or bioengineered brains – a voluntary rebirth for those who resist drifting away from their bodies. A procedure to transfer experience from one brain or to another would circumvent the need for medical breakthroughs associated with cancer and senescence because the diseased body could always be substituted for another without sacrificing the ”individual”. In that case, repairing the body would always be less desirable than replacing it. Similarly, a sufficiently precise 3D printer may one day be able to re-create the fine-structure of a deceased person's former brain. If the transmissive theory of consciousness is valid, the 3D printed brain would be precisely "tuned" to capture the signals which once defined the individual's consciousness. While it may only be a distant reality, consciousness may be “brought back” from its brain-independent state by re-creating the brains of the deceased using advanced technologies.

The future of survival research will depend on our willingness to entertain creative and previously unexplored ideas as well the availability of funding opportunities to legitimize the subject matter, attract talent, stimulate discovery, and elevate the topic for public engagement. In addition to what I have presented, alternative solutions to the problem of survival should be explored in the interest of generating competing scientific theories and a robust dialectic that drives innovation. For example, consider the possibility that there are many paths to immortality. Indeed, the simulation argument[400] is quite compelling: If humans, equipped with super powerful computers, will one day be able to generate simulations with conscious humans that are indistinguishable from reality, they may also be able to run many simultaneous simulations – perhaps several orders of magnitude more than the one surface reality. It is then much more likely than not that our consciousness is simulated. While it is likely that consciousness survives death independent of any technological assistance, the opportunity to choose an afterlife would be the ultimate expression of human freedom.

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