

Dr. Nelson explores near-death experiences through the lens of science and discovers that near-death fits within the conventional neuroscience framework as securely as the Germ Theory of Disease and Evolution stand in other branches of science.

In our time, near-death experiences (NDE) dominates the discussion of spiritual experience. The drama of going through a tunnel, being enveloped by “the light,” floating above one’s body, and sometimes meeting deceased loved ones or spiritual beings constitutes a narrative thoroughly portrayed by the media. In the early 20th century, American physician, philosopher and psychologist William James makes little mention of NDE in his seminal work, *The Varieties of Religious Experience*. Yet, NDE fulfills his expectation of a spiritual experience whereby “feelings, acts and experiences” touch “whatever they may consider the divine.”¹



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Today’s early 21st century view of these NDE starts by first training our gaze on near-death’s many overlooked scientific truths; some facts deliberately ignored and others simply neglected. So far, inundating the public with near-death topics has most served to reinforce media stereotypes rather than rooting out mistaken ideas.

‘Near-Death’ Is Often a Misnomer

For half of the instances of “near-death” the term is a misnomer because the person does not face imminent death. An excellent but seldom cited study examined the medical records of 58 people who experience near-death.² Twenty-eight of those had a true medical crisis, while the other 30 were not medically endangered at the time. Surprisingly, the results showed almost identical experiences in both groups. Regardless of danger, people went through a tunnel, and had similar thoughts and emotions. Sixty-eight percent of all subjects had an out-of-body experience (OBE) whether they were medically near-death or not. The only physiologically interesting difference between their experiences intriguingly focused on “enhanced light” appearing to those truly endangered. These findings resonate with what else we know about the origins of near-death. Many things can cause near-death including fear alone.^{3,4}

Cardiac arrest stands among the most sensational triggers for near-death, occurring in approximately 10 percent of survivors that recover with sufficient memory to recall the experience in some form.⁵⁻⁷ (See Figure 1.) Although this scenario features prominently in the public mind, it is not likely to top the list of causes for NDE. We have yet to see a well-designed study in the general population, however, in a self-selected series of 55 subjects, syncope edged out cardiac events (10 versus 8).⁸

The role of syncope is crucial in NDE. Syncope alone in the safely controlled environs of the neurophysiology laboratory produces features indistinguishable from NDE.^{9,10} This includes out-of-body experiences about ten percent of the time. Upwards of one-third of people faint within their lifetime, often while feeling endangered, making syncope fertile ground for a spiritual experience. This may also explain why it was said that upwards of 18 million Americans may have had a near-death experience by a 1997 issue of *U.S. News & World Report*.

Out-of-Body Experience

Out-of-body experience (OBE), often a feature of near-death, is also an astoundingly frequent and normal experience separate from NDE. In a survey of over 13,000 individuals in the general population, 5.8 percent reported at least one OBE.¹¹ It is sobering to look upon a large crowd knowing that one in twenty have had an out-of-body experience. And like near-death, many physiologic factors lead to OBE. The common experience of syncope helps us understand the high incidence of OBE, but another physiologic state, a normal one, surely contributes as we shall soon see.

OBE accompanies near-death experience 76 percent of the time.¹² Do OBE experiences always embody the qualities of spiritual experience? No! I have many subjects who regard their out-of-body experiences as a curiosity. One night drifting off to sleep, my psychiatric colleague floated a few feet above her bed and turned to see herself and husband beneath the quilt she crafted as a newlywed. She considered the intoxicating illusion “odd” but not profound. Many who have experienced OBE agree with the philosopher Descartes, not in his division of mind and brain, but when he said: “Whatever I have up till now accepted as most true I have acquired either from the senses or through the senses. But from time to time I have found that the senses deceive, and it is prudent never to trust completely those who have deceived us even once.”¹³ The OBE illusion is one of these sensory deceptions, and arises in the brain’s temporoparietal region. Directly stimulating the temporoparietal cortex with a small

electrical current evokes OBE,^{14,15} arguably by disturbing the integration of visual, proprioceptive and motion senses into the coherent self. In the laboratory or operating room, the neurophysiologist can bring a patient in and out-of-body, back and forth with the flip of a switch. (See Figure 2.)

Figure 1

Cardiac arrest stands among the most sensational triggers for near-death experiences, occurring in approximately 10 percent of survivors that recover with sufficient memory to recall the details in some form.



As important as NDE has now become, another variety of spiritual experience reigns supreme by the fact that it is always and exclusively spiritual, and consequently the most historically influential variety serving as the “root and center” for organized religions of nearly every sort. James identified this experience as the ‘mystical sense of Oneness.’ Some of the many words used to describe the mystical Oneness include: boundless, ceaseless, bottomless, nothingness, fathomless, infinite, empty void, barren, abyss, abysmal, and absolute.

The philosopher W.T. Stace elaborated on the mystical nature brought out by James, noting that the core feeling of Oneness could be expressed in two forms.¹⁶ The extrovertive mystical experience looks outward to the world through the physical senses and finds unity. On the other hand, the introvertive mystical experience turns inward, shuttering out the senses and transcending into a “pure” consciousness.

Both James and Stace believed the core nature of mystical experience was universal to humans. NDE also appears universal but the narratives vary widely between persons and cultures, and are not always viewed in a spiritual perspective. Little thought has tied NDE and mystical Oneness together until recently. A sizable

42 percent of near-death experience subjects feel “united, one with the world.”⁸ Although not as thorough a measure as other tools provide,¹⁷ this finding suggests that mystical Oneness may play an unsuspected role in making NDE spiritual. This is important because much of the neuroscience behind mystical Oneness experience is understood.

Mystical Feelings of Oneness

Mystical feelings of Oneness are expressed through a special quality of serotonin neurochemistry, specifically the serotonin-2a receptors. Much like a molecular scalpel, if serotonin-2a is pharmacologically blocked or parts of the limbic system containing serotonin-2a surgically removed, then the mystical expression is blocked too.

In retrospect the connection between NDE and the mystical Oneness should not come as a shock since fear, the primal emotion of the limbic system and survival, often accompanies mystical experience. Which brings up another point. When exploring brain function during spiritually transforming experience it is not just the fervor over the drama of near-death that blinds some to the importance of the brain. The grandeur of the brain’s accomplishments leads many to overlook the brain’s prime biologic and evolutionary purpose lying at the heart of many spiritual experiences. First, last and foremost the brain needs to keep itself alive through the crisis of near-death.

One extensively studied physiological crisis concerns cerebral blood flow. Crucial to its prime purpose, the brain governs its blood flow each second of life. Brain activity relies upon aerobic metabolism that demands a constant supply of oxygen and glucose at rest, in exercise, and during physiological and emotional stress. Controlling cerebral blood flow depends principally upon the arterial baroreflex that in turn pivots on the yoked opposition of cholinergic and adrenergic neurons in the peripheral and central nervous systems. Fading cerebral blood flow with looming unconsciousness, often the proximate circumstance leading

Figure 2

Directly stimulating the temporoparietal cortex with a small electrical current evokes out-of-body experience. In the laboratory the neurophysiologist can bring a patient in and out-of-body, back and forth with the flip of a switch. In young healthy adults, out-of-body experience accompanies the sleep paralysis of REM intruding into waking consciousness.



to NDE, signals a crisis to the brain that then orchestrates a cascade of survival responses, including the familiar fight-or-flight guiding our ancestors survival for millions of years. In the initial seconds of failing cerebral blood flow and dimming consciousness, there is no reason to expect the brain reacts differently between uncomplicated syncope and cardiac dysrhythmia.

When the brain becomes ischemic, many times the border between consciousness and unconsciousness is indistinct, and between these two borders exists a borderland of consciousness then entered. Consciousness is lost if blood flow drops below a threshold, and consciousness can come and go if cerebral blood flow rises and falls across this threshold, which routinely happens in clinical settings. It remains a scantily appreciated observation that the eyes remain open at syncope’s onset¹⁸ and beyond. So as consciousness waxes and wanes, a person may be far more aware of surrounding events than appreciated by others tending to medical urgencies. And those stricken may later recall the episode in startling detail. Simply because one does not respond while in shock or peri-syncopal does not mean the person is unconscious or dead (for example see the case of Ms. Martin¹⁹). Adding to this caution, evidence suggests that the brain electrical activity may persist even during deep coma and apparent isoelectric electroencephalogram.²⁰

Although a misnomer a good part of the time, in one way the term “near-death experiences” aptly describes these experiences. They are not “return-from-death” experiences. Regrettably, some investigators use the term “clinical death” to “signify a period of unconsciousness caused by insufficient brain blood supply because of inadequate circulation, breathing, or both.”²⁵ By this definition even harmless syncope is “clinical death” and we have already seen how this ambiguity can seriously mislead the unwary. Linking NDE to “clinical death” erroneously implies NDE happen when the brain has died and the neurons lysed, a hallmark of neurologic brain death. Confusing cardiac dysrhythmia and “clinical death” has gone to extremes, leading one author to claim that these experiences are direct scientific evidence for “consciousness beyond life.”²¹

One near-death experience has commanded so much media attention that it deserves some of ours; that of Eben Alexander, III, MD, a neurosurgeon versed in neuroscience principles. [Editor’s note: See *Missouri Medicine* January/February 2015;112:17-21.] In the midst of severe delirium from *E. coli* meningitis he describes a fantastic NDE sojourn. Later believing his brain had completely ceased functioning during his NDE, he titled his book, *Proof of Heaven*.²² However, a simple question seemingly dismisses his contention: When in his delirium did the NDE arise? Since he provides no answer to that question, I believe there is no scientific basis to his assertion that his experience happened with his brain completely shut down.

Dr. Alexander’s delirious memories do demonstrate one thing. The influence of near-death experience can be powerful enough to conflate faith and science even in the mind of a neurosurgeon. They also show Descartes is once again correct, that our senses and the mental images derived from them can fool us about what we think we know.

The claims of Alexander, characterized by the eminent neurologist Oliver Sacks as anti-science, clash²³ with the sage words of a brilliant Canadian neurosurgeon from the mid 20th century. Wilder Penfield dedicated his career to electrically stimulating the brain and his observations unveiled important new insights into the mysteries of mind and brain. He concluded that as scientists “we can only set out the data about the brain, and present the physiological hypotheses that are relevant to what the mind does.” But as a human, he believed that “it is not unreasonable for him to

Table 1
Near-Death Features and Neuroscience Considerations Summarized

<u>Near-Death Feature</u>	<u>Neuroscience Considerations</u>
Tunnel	Retinal ischemia (common with systemic hypotension)
Light	Robust link with visual system (e.g. REM)
Appearing Dead	Atonia while alert
Out-of-Body	Temporoparietal association
Life Review	Activating memory in the face of danger
Bliss	Dopamine reward system
Narrative Quality	Left hemisphere, limbic and other brain regions
Paranormal Impressions	Limbic system
Mystical Oneness	Serotonergic-2a receptors and limbic system

hope (italics added) that after death the mind may waken to another source of energy.”²⁴ Hope springs from faith, and there is room in the brain for faith.

A central tenet of neuroscience holds that all human experience arises from the brain,²⁵ akin to the Germ Theory of Disease and the Theory of Evolution in other branches of science. So far, the narratives of NDE fit securely within the framework of conventional neuroscience. Sometimes I hear that neuroscience fails to explain a part of someone’s recollection of their NDE; after allowing for selective, suggestible, reconstructed and imperfect memory as well as the difficulty of knowing when in the crisis an experience occurred, nothing about NDE, including OBE, offers objective evidence that consciousness can exist without a living brain. Extraordinary claims require extraordinary evidence and here not even the most ordinary objective data supports the bold assertion of human consciousness outside the brain. When more facts become known in “unexplained” cases, a plausible neuroscience explanation has always been found. Belief in consciousness beyond the brain lies in the realm of faith beyond science. Faith has its place separate from science, in part because science has its limits imposed by the requirements of verification and reproducibility. Still, keep in mind that although not every scientific fact has been uncovered about black holes that still does not make black holes a supernatural force.

Alexander’s book and others like *Heaven is Real* fall into a slick and clever literary genre works taking the interpretation of near-death experiences as absolute and literal truth.²⁶ The literalist’s success in the marketplace fails to substitute for evidence challenging the foundation of neuroscience.

Although science looks askance at the literalist take on NDE, they do raise a valid question. Do near-death experiences provide a glimpse of “The undiscover’d country, from whose bourn no traveller returns?” (Hamlet, act 3, scene 1). Of course we have no way of

scientifically verifying if those having a NDE were on road, off road, made it part way, or almost all the way to that undiscover'd country (absolute death). The distance, direction and destination of absolute death will never be proven scientifically.

Certainly if one posits the brain unnecessary for the sublime near-death experience, one can gloss over the arcane details of brain anatomy, chemistry, and physiology necessary to understand the brain's role. At the same time, for good reasons not everyone wants to know how the brain functions in spiritual experience. In an example from a different physiologic venue, I personally give little thought to my pancreatic juices as I dine on an excellent meal. My sister-in-law made clear to me why knowing how the brain works may not matter for a more important reason. Her father sustained a series of heart attacks and during one he left his body and calmly moved toward a warm glowing light. Afterwards he lost his fear of death and gained a new purpose in life, giving witness to the real, positive value of some NDEs. "I don't care what the brain is doing" she said, "I'm just happy with the comfort it gave dad."

But something deeper, something driving the neurologist within has set me on the quest for understanding NDE. Split-brain studies from the 1970s unveiled the left cerebral hemisphere as the curious side, the one dominant for speech and symbolic understanding that also compels us to seek explanations for our experiences. There have been a host of offerings on what takes place in the brain during NDE. Most flounder because of their simplicity by failing to recognize that the diversely rich experience of near-death surely draws upon more than a single physiological or biochemical system, or anatomical structure. (See Table 1.)

Any neuroscience basis for NDE must not only explain NDE features but provide a testable hypothesis and one that explains the relationship with syncope and the multitude of other triggers.

Many other factors must also be taken into account, factors which have received only the slightest attention. Since consciousness is central in many near-death experiences,

explanations must address mechanisms regulating consciousness. In crisis, survival demands an awake and attentive brain to meet the threat head on. This expectation seems so intuitively obvious that it typically escapes scrutiny. However, to survive the brain cannot take for granted being in the right conscious state at the right time. In waking consciousness attention suddenly orients to whatever survival requires. Therefore, consciousness and its altered states are bound to fight-or-flight action coordinated by the brainstem arousal and limbic systems. Essential to an effective survival response is the arousal system's locus coeruleus, the brain's nearly exclusive source of nor-epinephrine. The locus coeruleus is a minuscule cluster of pontine neurons key to regulating consciousness as well as survival behavior. This nucleus sends adrenergic neural projections throughout most of the entire brain.

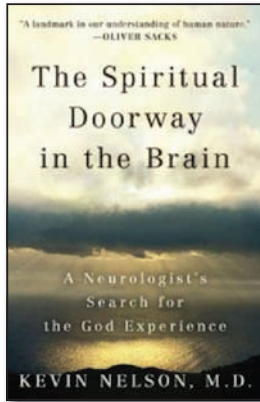
Rapid Eye Movement Consciousness and NDE

The strongest case for the neurophysiologic contribution to NDE can be made for a borderland of consciousness. A borderland when the conscious states of waking and rapid eye movement (REM) blend, forming a hybrid conscious state. REM consciousness is named for the saccadic eye movements that accompany the robust visual system activation characterizing this conscious state. Cortical activation similar to wakefulness and the atonia of non-respiratory muscles also distinguish the REM state. The most complex dreaming takes place during REM sleep in cortical regions far removed from the pontine brainstem switch triggering REM. Importantly, these different elements of REM consciousness commonly fragment, and can individually intrude into the waking state. Most often the REM intrusion occurs in the transitions between REM and waking, happening in up to a quarter of people at least once in their life.⁸ The blending of REM and waking consciousness takes the form of complex visual and auditory hallucinations, dream narratives, as well as

Table 2
Summary of Evidence that REM Consciousness Contributes to Near-Death*

- Those with a near-death experience are strongly predisposed to life-long REM intrusion
- Arousal electroencephalogram recorded after cardiac arrest
- REM switch components linked to survival behavior that includes during systemic hypotension
- Many clinical conditions provoke REM intrusion into waking consciousness
- REM switch is part of the brainstem instrumental to the cardiovascular response to crisis (e.g. syncope/cardiac event)
- Vagal nerve electrical stimulation briskly provokes REM intrusion
- REM consciousness in situational context leads to many near-death features (e.g. out-of-body, paralysis, visual hallucinations, narrative, paralysis)

*A fuller discussion is found elsewhere ^{27,28}



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The Spiritual Doorway in the Brain: A Neurologist's Search for the God Experience

by Kevin Nelson, MD

"Kevin Nelson has made a lifelong study, from a neurological viewpoint, of the remarkable phenomena of near-death and out-of-body experiences. Combining patient accounts and the latest neuroscience, he shows that what was once regarded as a purely spiritual or religious experience is rooted in biologic processes. In no sense does he diminish the remarkableness of these experiences, or the spiritual impact they may have—but he gives us a sense of how evolutionarily based mechanisms in the brain can serve the highest religious functions. This book is an eloquent and compassionate landmark in our understanding of human nature."

—Oliver Sacks, M.D., author of *The Man who Mistook His Wife for a Hat*



the atonia of sleep paralysis or cataplexy. This borderland is unstable, lasting seconds or minutes before reverting to a more stable conscious state.

The REM intrusion hypothesis of near-death was first investigated by discovering that those with a near-death experience have a 2.8 times greater incidence of lifetime REM intrusion than age and gender matched controls.⁸ Near-death subjects possess a pontine REM switch so astoundingly predisposed to REM intrusion that the incidence of sleep paralysis does not differ between near-death and the sleep disorder of narcolepsy. Furthermore, for those who have been near death, REM intrusion happened with the same frequency before as after their near-death experience, telling us that near-death is but a single episode in a lifetime of REM intrusion.

To understand how conscious states interplay during a crisis like near-death, it is necessary to understand how the brainstem regulates consciousness and how the REM switch reacts in crisis to blend waking and REM consciousness bringing about effective survival behaviors. These details are beyond the scope of this review and chronicled more fully elsewhere.^{27, 28} Table 2 summarizes the evidence that REM intrusion contributes to the near-death experience.

Another frequently overlooked fact is the long established relationship between out-of-body and REM consciousness. Narcolepsy is a boundary of consciousness disorder whereby the afflicted suffer from REM frequently intruding into waking consciousness. Narcoleptics are very prone to out-of-body experience,^{27, 29, 30} especially during sleep paralysis. The frequency of out-of-body wanes as the narcolepsy is treated. Out-of-body also appears in lucid dreams³¹ — a special expression of dreaming wherein the dreamer maintains insight while dreaming. In young

healthy adults, OBE accompanies the sleep paralysis of REM intruding into waking consciousness.³² (See Table 2.) The selective temporoparietal activity that normally takes place during REM³³ neatly explains the strong link between REM consciousness and OBE. REM intrusion further explains the gripping feature of out-of-body often central to the NDE narrative and common in syncope. Further evidence of the bond between REM consciousness and NDE comes from the observation that persons with a near-death experience are as likely to have OBE transitioning between waking and REM consciousness as they are to have it during NDE itself.¹² Their OBE often accompanies sleep paralysis.

Is REM intrusion the last word in NDE? Of course not! However, a notion sometimes expressed by those unfamiliar with the physiology of REM consciousness contends that near-death experiences do not engage REM mechanisms because NDE "doesn't feel like a dream." This assertion seems straightforward on the surface. After all, the memory of many near-death experiences feels "realer than real" is at striking odds with the oftentimes outlandish, unreal and faint impressions left by dreams upon awakening. Somehow this contention dismisses a crucial physiologic fact. Actually, we should expect different experiences from the same REM mechanism expressed under the very different conditions of routine sleep and NDE. Context means much to experience. For example, temporoparietal brain stimulation in the laboratory evokes an OBE unlike an OBE while piloting a fighter jet. So, too, the crisis of NDE brings its own context to influence an experience based upon the same brain physiologic mechanisms as REM sleep. One of my subjects, a severe narcoleptic with near daily REM intrusion, commonly has out-of-body experiences and nightly visions that feel every bit as real to him in the

night as they do in the morning. Only through repeated occurrence does the true nature of REM intrusion reveal itself to him. He possesses no motivation, psychological or otherwise, to consider his illusions and hallucinations real. So the notion that NDEs are unrelated to REM because they do not feel like dreams carries little neuroscience weight. As a reminder, the feelings of *deja vu* cause by mesotemporal seizures leave an intensely real but false impression both during the seizure and afterwards.

In spite of the differences between near-death and dream narratives, near-death can be almost identical to lucid dreams, whereby the dreamer retains self-insight. This normal manifestation of dreaming conceivably arises when dorsolateral prefrontal cortical activity, instrumental to logical executive cognition and normally shut down during REM, persists during REM consciousness. Why some experiences seem real and others do not endures as a compelling question that applies to more experiences than just near-death. Persisting dorsolateral prefrontal brain activity while REM blends with wakefulness in a moment when impaired cerebral metabolism struggles to sustain consciousness, may deeply touch someone's impression of reality.

What Can We Conclude About Near-Death Experiences?

Clinicians must welcome near-death accounts with non-judgmental reassurance, providing safe harbor for patients with experiences that often bring overwhelming passions and memories. Medical professionals who tout spiritual shortcuts by forsaking science seriously risk debasing near-death experiences in the minds of many who hold science in esteem. We must not allow unsubstantiated literalists claims playing upon popular sentiments too tarnish the sincere near-death narrative.

In the end, the neuroscience of how the brain participates in near-death experiences does not demean their why or spiritual interpretation; these lie in the province of personal faith. Clinicians have an ethical responsibility to clearly differentiate the domains of science and faith. And with respect to the power of near-death experiences to steadfastly transform personal meaning and spirituality, I urge heeding the advice of James when he drew upon biblical inspiration to counsel on spiritual experience: "by their fruits ye shall know them, not by their roots."¹

References

1. James W. *The Varieties of Religious Experience*: Longmans, Green, and Co., 1902.
2. Owens JE, Cook EW, Stevenson I. Features of "near-death experience" in relation to whether or not patients were near death. *Lancet* 1990;336:1175-1177.
3. Dostoyevsky F, Garnett C. *The Idiot*. New York: Dell, 1959.
4. Frank J. *Dostoevsky, the years of ordeal, 1850-1859*. Princeton, N.J.: Princeton University Press, 1983.
5. van Lommel P, van Wees R, Meyers V, Elfferich I. Near-death experience in survivors of cardiac arrest: a prospective study in the Netherlands. *Lancet* 2001;358:2039-2045.
6. Parnia S, Waller DG, Yeates R, Fenwick P. A qualitative and quantitative study of the incidence, features and aetiology of near death experiences in cardiac arrest survivors. *Resuscitation* 2001;48:149-156.
7. Greyson B. Incidence and correlates of near-death experiences in a cardiac care unit. *Gen Hosp Psychiatry* 2003;25:269-276.
8. Nelson KR, Mattingly M, Lee SA, Schmitt FA. Does the arousal system contribute to near death experience? *Neurology* 2006;66:1003-1009.
9. Lempert T, Bauer M, Schmidt D. Syncope and near-death experience. *Lancet* 1994;344:829-830.
10. Lempert T, Bauer M, Schmidt D. Syncope: a videometric analysis of 56 episodes of transient cerebral hypoxia. *AnnNeurol* 1994;36:233-237.
11. Ohayon MM. Prevalence of hallucinations and their pathological associations in the general population. *Psychiatry Res* 2000;97:153-164.
12. Nelson KR, Mattingly M, Schmitt FA. Out-of-body experience and arousal. *Neurology* 2007;68:794-795.
13. Descartes R, Cottingham J, Williams BAO. *Meditations on first philosophy : with selections from the Objections and replies*, Rev. ed. New York: Cambridge University Press, 1996.
14. Blanke O, Ortigue S, Landis T, Seeck M. Stimulating illusory own-body perceptions. *Nature* 2002;419:269-270.
15. Blanke O, Landis T, Spinelli L, Seeck M. Out-of-body experience and autoscapy of neurological origin. *Brain* 2004;127:243-258.
16. Stace WT. *Mysticism and philosophy*. London: Macmillan, 1960.
17. Hood RW, Ghorbani N, Watson PJ, et al. Dimensions of the Mysticism Scale: Confirming the Three-Factor Structure in the United States and Iran. *Journal for the Scientific Study of Religion* 2001;40:691-705.
18. Lempert T, von Brevem M. The eye movements of syncope. *Neurology* 1996;46:1086-1088.
19. Moody R. *Life after life*. Covington, GA: Mockingbird Books, 1975.
20. Kroeger D, Florea B, Amzica F. Human brain activity patterns beyond the isoelectric line of extreme deep coma. *PLoS ONE* 2013;8:e75257.
21. van Lommel P. *Consciousness beyond life : the science of the near-death experience*, 1st ed. New York: HarperOne, 2010.
22. Alexander E. *Proof of heaven : a neurosurgeon's journey into the afterlife*, First Simon & Schuster hardcover edition. ed2012.
23. Sacks OW. *Seeing God in the Third Millennium*. The Atlantic 2012 12/12/12.
24. Penfield W. *The mystery of the mind : a critical study of consciousness and the human brain*. Princeton, N.J.: Princeton University Press, 1975.
25. Kandel ER. A new intellectual framework for psychiatry. *AmJPsychiatry* 1998;155:457-469.
26. Gottlieb R. *Back from Heaven-The Science*. The New York Review of Books 2014 11/6/2014.
27. Nelson KR. *The Spiritual Doorway in the Brain: A Neurologist's Search for the God Experience*. New York, NY: Penguin Group, 2011.
28. Nelson KR. Near-death experience: arising from the borderlands of consciousness in crisis. *Annals of the New York Academy of Sciences* 2014;1330:111-119.
29. Mahowald MW, Schenck CH. Dissociated states of wakefulness and sleep. *Neurology* 1992;42:44-51.
30. Overeem S, Mignot E, van Dijk JG, Lammers GJ. Narcolepsy: clinical features, new pathophysiologic insights, and future perspectives. *J Clin Neurophysiol* 2001;18:78-105.
31. LaBerge S, Levitan L, Brylowski A, Dement W. "Out-of-body" experiences occurring in REM sleep. *Sleep Res* 1988;17:115.
32. Cheyne JA, Girard TA. The body unbound: vestibular-motor hallucinations and out-of-body experiences. *Cortex; a journal devoted to the study of the nervous system and behavior* 2009;45:201-215.
33. Maquet P, Ruby P, Maudoux A, et al. Human cognition during REM sleep and the activity profile within frontal and parietal cortices: a reappraisal of functional neuroimaging data. *Prog Brain Res* 2005;150:219-227.

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None reported.

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