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Neural correlates of memories of near-death and mystical experiences: Preliminary research

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Abstract

This study compares the critical neural correlates of two altered states of consciousness: near-death experience (NDE) and spiritual contemplative experience (SCE), a.k.a. mystical experience. For Centuries NDE and SCE have been reported by all faiths, including Abrahamic religious contemplatives: Christian mystics, Muslim Sufis, and Jewish Kabbalists. Their anecdotal reports show that both NDE and SCE have similar attributes: cognitive timelessness, affective peace, transcendent oneness, and paranormal out-of-body. Our Greyson Scale evaluation of these attributes shows a correlation between NDE and SCE. Contemporary first-person SCE leading to relived NDE provided the insight and incentive for this unique scientific study comparing the memories of NDE and SCE in separate subjects. We recorded and processed brain activity by quantitative electroencephalography tomography (QEEGt) methodology. There was a clear correlation of brain activation in delta, alpha, and gamma bands. We also found frontal lobe activation for both NDE and SCE subjects. However, there was a statistically greater activation for the SCE subjects. QEEGt allows a reformulation of QEEG techniques in a 3D anatomic framework using anatomical information provided by MRI to constrain EEG inverse solutions to the sites where primary currents might be generated. These constraints contribute to overcoming the nonuniqueness of the inverse solutions. This study has relevance to neuroscientists studying consciousness.

Keywords: Near death experiences; mystical experiences; Spiritual contemplative experience (SCE); Greyson Scale; Quantitative electroencephalography tomography (QEEGt); Magnetic resonance imaging (MRI)

1 Introduction

Over the centuries, the wisdom literature in most faith traditions has reported SCEs and NDEs, with these altered states of consciousness having similar attributes. For most of these traditions, both are at the cusp of theories about the transcendence to the next life, which has never been comparatively studied in this way by neuroscience. Medicine has debated defining the moment of death by cardiorespiratory or neurological criteria. People have reported an occasional reliving of an NDE during prayer as a SCE.[1-6]

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Several reports indicated the contemplative state is associated with marked hemodynamic and neuroelectric changes in brain regions involved in positive emotions, visual mental imagery, attention, or spiritual experiences. The temporoparietal junction is the possible anatomic substrate for out-of-body experience (OBE). Hence several authors have reported repetitively induced OBE by subcortical stimulation near the left temporoparietal junction during awake craniotomy. Diffusion tensor imaging tractography implicated the posterior thalamic radiation as a possible substrate for autoscopic phenomena.[6-10]

The brain is assumed to be hypoactive during cardiac arrest. However, the neurophysiological state of the brain immediately following cardiac arrest has not been systematically investigated for NDE. Gamma oscillations during cardiac arrest are global and highly coherent; moreover, this frequency band exhibits a striking increase in anterior-posterior-directed connectivity and tight phase-coupling to both theta and alpha waves. High-frequency neurophysiological activity in the near-death state exceeded levels found during the conscious waking state. These data demonstrate that the mammalian brain can, albeit paradoxically, generate neural correlates of heightened conscious processing at near death.[11-13]

Neuroscientists also tried to estimate the location of the underlying brain EEG generators. This is the basis of quantitative EEG tomography (QEEGt), based on a biophysical model called low-resolution electromagnetic tomography (LORETA). This method solves the inverse problem of converting measurements into information about an observed physical object or system. This revolutionary technique can be understood as an EEG-based neuro-imagining technique, which allows for computing a three-dimensional distribution of 2394 voxels of 7x7x7 mm of the generating electric neuronal activity in the grey matter. A great advantage of this technique is that it is not restricted to a certain number of electrodes or electrode locations; therefore, it self-adapts to almost every electrode setup and EEG-measuring device.[14-20]

Scalp activity shows oscillations at a variety of frequencies. This rhythmic activity is divided into frequency bands; the most commonly known bands are delta, theta, alpha, beta, and gamma. EEG frequency bands have been noted to have certain biological significance and can be associated with different brain functioning states. There are still uncertainties about where various frequencies are generated, but there is strong knowledge about the activated areas within the brain generating certain spectral activity along the scalp. QEEGt analysis of limited frequency bands can be used to determine which brain regions are activated during different states or mental tasks; this helps determine if the brain is operating in an electrically optimal way. Therefore, QEEGt keeps the temporal resolution of EEG and incorporates the necessary anatomic or space resolution provided by MRI.[21-38]

Using QEEGt, this study compares the critical neural correlates of subjects remembering two separate altered states of consciousness, near-death experience (NDE) and spiritual contemplative experience (SCE), a.k.a. mystical experience.

Objective

Compare the neural correlates of subjects in the process of remembering a prior NDE or SCE.

2 Material and method

2.1 Protocol

We chose a protocol to assess by quantitative electroencephalography tomography (QEEGt)[21-26, 28] the memories of two groups who previously had a NDE and separately a SCE. It is important to note QEEGt has a high temporal resolution compared with other neuroimaging techniques.

2.2 Sample Groups

Two groups were studied, each having five subjects from 19 to 65 years of age, both male and female, paired in age and gender. The NDE group was selected from cases who had suffered a cardiac arrest (C-AR) inside the ICU. The SCE group was selected from subjects who described having SCE during their practice of Centering Prayer (CP), an interdenominational Christian form of prayer. A table of the subjects and Greyson Scale results are shown in Figure 1.

All subjects, both NDE and SCE, had neurological examinations, and the Greyson Scale (GS) was applied.[45.] The GS is explained in more detail in the Appendix. The resulting GS scores are shown in Figure 1. The Greyson scale was used to measure a valid NDE and SCE objectively. The subjects who did not describe an NDE or SCE using the Greyson scale were excluded from the study.

SUBJECT (Number)	REMEMBERING (Experience)	AGE (Years)	TIME SINCE (Years)	MEDICAL CAUSE (Description)	PREEXISTING (Conditions)	MEDICATIONS (Name)	GREYSON (Scale)
1	SCE	46	3.0	None	Hypertension	Enalapril	12
2	SCE	61	7.0	None	Diabetes Mellitus	Metformin	15
3	SCE	49	4.0	None	None	None	11
4	SCE	63	8.0	None	Hypertension	Enalapril	16
5	SCE	47	5.0	None	None	None	9
6	NDE	63	1.8	Cardiac arrest	Heart infarct, hypertension, diabetes mellitus	Nitrosorbide, Enalapril, Clopidogrel	12
7	NDE	55	3.8	Bleeding during surgery	Stomach ulcer	Omeprazole	9
8	NDE	48	0.7	Head trauma and coma	None	None	11
9	NDE	61	0.5	Cardiac arrest	Heart infarct, hypertension	Valsartan Chlorothiazide	9
10	NDE	58	0.9	Bleeding during surgery	Pharyngeal benign nodule	None	10

Figure 1 Subjects & Greyson Scale Results

2.3 Experimental Design

Every subject was studied with both quantitative EEG (QEEG) and QEEGt in two experimental conditions:

- Basal record during 7 minutes for both NDE and SCE subjects
- Remembering experiences during 7 minutes for both NDE and SCE subjects

Each subject was given the following brief initial instructions for seven minutes prior to the scan:

- RESTFUL – Close eyes, relax muscles, breathe slowly
- TIMELINESS – Return mentally to the location and time of your experience
- FEELING – Feel the space and time sensually before it started
- IMAGINE – Imagine you are beginning to relive the experience
- DESIRE – Rest in the memory of the experience without regard for time
- REST – Allow a time of silence for the EEG record

2.4 QEEGT Assessment [25, 26]

Subjects were studied inside the ICU in our laboratory with controlled temperature from 24 to 26^0 Celsius, noise attenuation, and dimmed lights. The EEG was recorded from 19 standard locations over the scalp according to the 10-20 system: Fp1, Fp2, F3, F4, F7, F8, T3, T4, C3, C4, P3, P4, T5, T6, O1, O2, Fz, Cz, and Pz. After carefully cleaning the skin, discoidal EEG tin electrodes were fixed using a conductor paste and connected to the input box of the digital Electroencephalographic system Medicid-05 (Neuronic, SA). Monopolar leads were recorded using linked ears as a reference. Technical parameters for EEG were: gain 20,000; pass-band filters 0.1 - 70 Hz; "notch" filter at 60 Hz; noise level of 2 μV (root mean squared); sampling frequency 200 Hz; and electrode-skin impedance never higher than 5 KΩ. A bipolar chest electrocardiogram (ECG) lead was recorded with 0.5 to 30 Hz EEG filters for monitoring purposes.

Two experts visually inspected the recorded EEG and discharged the noised segments with movements or other biological artifacts to select windows for QEEG calculation. EEG segments of no less than 65 seconds from the non-contaminated records were selected for each experimental section. For offline ulterior processing, the records were later exported to an ASCII file using the facilities of the MEDICID-05 system, which contained a matrix of the original EEG values corresponding to the segments selected by the specialists. For further quantitative analysis, three ASCII files were selected for every test and from each subject.

2.4.1 QEEGT Processing

The data were processed using QEEGt, a technique that combines brain anatomical information by MRI with EEG electrical activity, allowing the estimations of EEG sources within the brain.[9-11]

The EEG was recorded using nineteen monopolar derivations of the International 10-20 System (FP1, FP2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6, Fz, Cz, Pz) with linked earlobes as a reference. Eye movement artifacts were monitored by use of the electrooculogram (EOG). The data acquisition was performed using a MEDICID-05 System (Neuronic SA). After visual editing to remove artifacts, 48 artifact-free 2.5-second-long samples were selected for each experimental condition and were transformed using the FFT to the frequency domain. This yielded a power spectrum from 0.78 to 70 Hz with a sampling frequency of 0.39 Hz (178 frequencies), with a 60 Hz notch filter. The Low-Resolution Tomography (LORETA) method was used for estimating EEG source generation.

2.5 Statistical Analysis

Normal distribution for absolute and relative QEEG power spectral density (PSD) values and functional magnetic resonance imaging (fMRI) parameters were achieved through log-normal transformations and tested with the Shapiro-Wilk's W test. Based on the general linear model assumption, the statistical method used for comparing basal and NDE vs. SCE remembering was the multifactor ANOVA test for repeated measures.

Results were tabulated, and graphics were created to achieve a better analysis and presentation of this study. The StatSoft, Inc. (2007). STATISTICA (data analysis software system), version 8.0. (www.statsoft.com) was used for all the analytical processes.

2.6 Ethical Issues

Written informed consent was obtained from each subject with a form approved by the Institute of Neurology and Neurosurgery IRB.

3 Results

In Figure 2, QEEGt was calculated for NDE and SCE subjects for the gamma frequency band. All NDE and SCE subjects' QEEGt showed parieto-occipital activation extending to temporal regions, but it was statistically greater in SCE subjects.

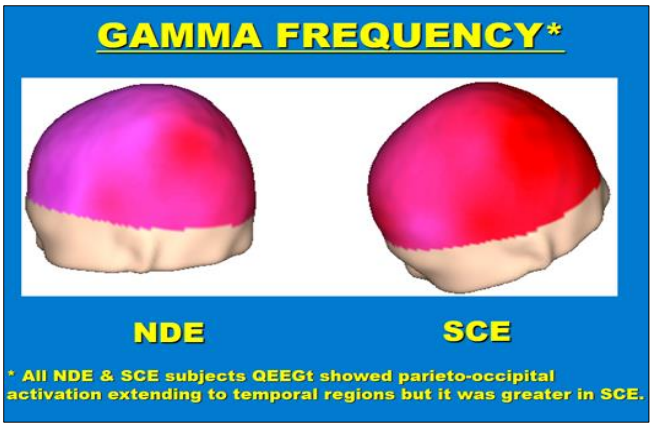

Figure 2 QEEGt calculated for NDE & SCE subjects for gamma frequency

In Figure 3, QEEGt was calculated for NDE and SCE subjects for the alpha frequency band. The 3D reconstructed QEEGt showed increased activation for both NDE and SCE subjects but was statistically greater for SCE subjects.

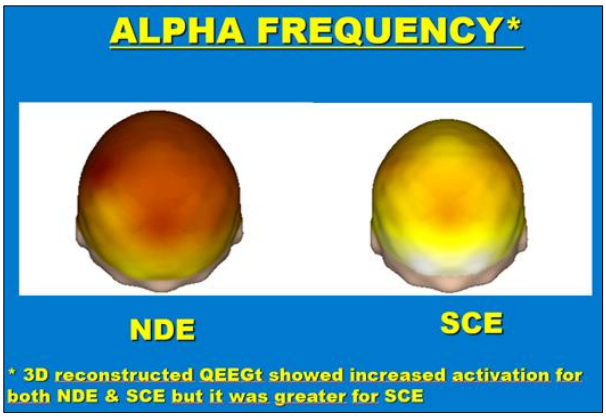

Figure 3 3D-QEEGt reconstructed for NDE & SCE subjects for alpha frequency

In figure 4, QEEGt was calculated for NDE and SCE subjects for the delta band. There was increased activation for NDE and SCE subjects in both right (R) and left (L) temporal lobes, while greater in the right hemisphere was statistically greater for SCE subjects.

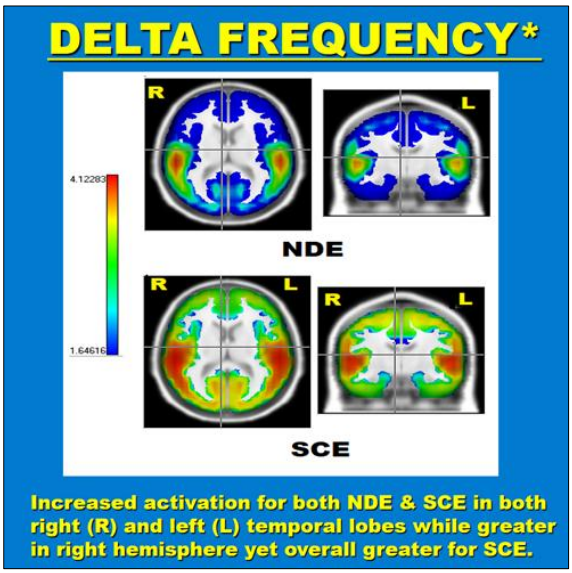

Figure 4 QEEGt calculated for NDE & SCE subjects over MRI slices

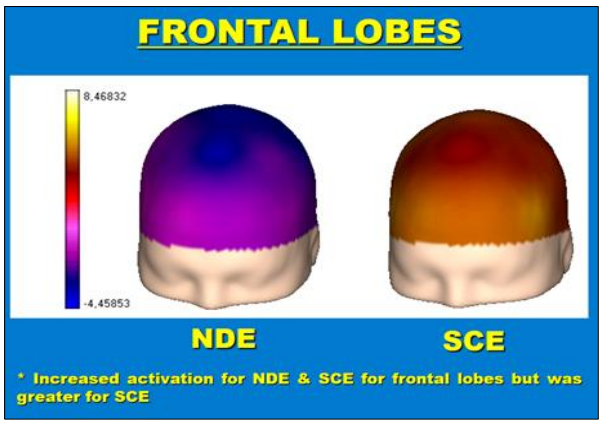

Figure 5 QEEGt calculated for NDE & SCE subjects for frontal lobe activation

In figure 5, QEEGt was calculated for NDE and SCE subjects for frontal lobe activation. There was increased activation for NDE and SCE subjects in both frontal lobes, yet overall was statistically greater for SCE subjects.

4 Discussion

4.1 Near-Death Experience (NDE)

A NDE is a personal experience associated with death or impending death. Such experiences may encompass a variety of sensations, including detachment from the body, feelings of levitation, total serenity, security, warmth, the experience of absolute dissolution, and the presence of a light. NDEs are a recognized part of some transcendent and religious beliefs in an afterlife. Alternatively, some neuroscience research suggests an NDE is a subjective phenomenon resulting from "disturbed bodily multisensory integration that occurs during a life-threatening event.[1-3, 5, 39]

In 2001 Pim van Lommel, a cardiologist from the Netherlands, and his team, conducted a study on NDEs, including 344 cardiac arrest patients who had been successfully resuscitated in 10 Dutch hospitals. Patients not reporting NDEs were used as controls for patients who did. Psychological (e.g., fear before cardiac arrest), demographic (e.g., age, sex), medical (e.g., more than one cardiopulmonary resuscitation (CPR)), and pharmacological data were compared between the two groups. The work also included a longitudinal study in which the two groups, those who had had an NDE and those who had not, were compared at 2 and 8 years of age for life changes. One patient had an out-of-body experience where he reported being able to watch and recall events during his cardiac arrest. His claims were confirmed by hospital personnel. This did not appear consistent with hallucinatory or illusory experiences, as the recollections were compatible with real and verifiable rather than imagined events.[40-42]

4.2 Spiritual or Transcendent Theories

French summarizes this model by saying, "*The most popular interpretation is that the NDE is exactly what it appears to be to the person having the experience*." The NDE would then be represented as evidence of the supposedly immaterial existence of a soul or mind, which would leave the body upon death. The subject having the NDE would then provide information about an immaterial world where the soul would journey upon ending its physical existence on earth.[43, 44]

According to Greyson, some phenomena of NDEs cannot be easily explained with our current knowledge of human physiology and psychology. For instance, when they were unconscious, patients could accurately describe events and report being able to view their bodies "from an out-of-body spatial perspective." In two different studies of patients who had survived a cardiac arrest, those who had reported leaving their bodies could accurately describe their resuscitation procedures, or unexpected events, whereas others described incorrect equipment and procedures.[45-53]

Sam Parnia also refers to two cardiac arrest studies and one deep, hypothermic, circulatory-arrest study, in which patients reported visual and/or auditory awareness occurring when their brain function had ceased. Actual and real events corroborated these reports.[10, 54-57]

Also, according to Greyson, the central features of NDEs are universal and have not been influenced by time. These have been observed throughout history and across different cultures. This is important since the Greyson scale, discussed later, is generally accepted as having application across broad circumstances. This notwithstanding, cultural influences have probably played an occasional role in some NDEs' reported descriptions.[48, 59, 60] Common traits that have been reported by individuals reporting an NDE are:

- A sense/awareness of being dead.[1, 11, 39, 61-69]
- A sense of peace, well-being, and painlessness. Positive emotions and a sense of removal from the world.
- An out-of-body experience. A perception of one's body from the outside, sometimes observing medical professionals performing resuscitation efforts.
- A "tunnel experience" or entering darkness. A sense of moving up a staircase or through a passageway.
- A rapid movement toward and/or sudden immersion in a powerful light, or "Being of Light," which communicates with the person.
- An intense feeling of unconditional love and acceptance.
- Encountering "Beings of Light," "Beings dressed in white, or similar." Also, the possibility of being reunited with deceased loved ones.
- Receiving a life review, commonly referred to as "seeing one's life flash before one's eyes."
- Approaching a border or a decision by oneself or others to return to one's body is often accompanied by a reluctance to return.

- Suddenly, finding oneself back inside one's body.
- Connection to the cultural individual's beliefs that seems to correlate with the experienced phenomena during a NDE, and particularly the later interpretation thereof.

4.3 Observed Stages

NDEs are divided into a five-stage continuum:[70, 71]

- Peace
- Body separation
- Entering darkness
- Seeing the light
- Entering the light

4.4 Common Elements

Bruce Greyson argues that the general features of the experience include impressions of being outside one's physical body, visions of deceased relatives and religious figures, and the transcendence of egotic and spatiotemporal boundaries. Many common elements have been reported, although the person's interpretation of these events often corresponds with the cultural, philosophical, or religious beliefs of the person experiencing it. For example, in the USA, where 46% of the population believes in guardian angels, figures will often be identified as angels, deceased loved ones, or unidentified, while Hindus often identify them as messengers of the god of death. Greyson also stated that 60% experienced stage 1 feelings of peace and contentment, but only 10% experienced stage 5, "entering the light".[60, 72, 73]

4.5 Clinical Circumstances

Clinical circumstances associated with an NDE include cardiac arrest in myocardial infarction; clinical death; shock in postpartum; loss of blood or perioperative complications; septic or anaphylactic shock; electrocution; coma resulting from traumatic brain damage; intracerebral hemorrhage or cerebral infarction; attempted suicide; near-drowning or asphyxia; apnea; and serious depression.[40-42, 68, 74, 75] Contrary to common belief, Kralovec argues that an attempted suicide can lead to a more unpleasant NDE than an unintended near-death situation.[76]

4.6 Experiential Variants

Some NDEs have elements bearing little resemblance to the "typical" NDE. According to a 1982 Gallup poll, anywhere from one percent to twenty percent of subjects may have distressing experiences and feel terrified or uneasy as various parts of the NDE occur. They visit or view dark and depressing areas or are accosted by what seem to be hostile or oppositional forces or presences.[3, 77-79]

Persons having bad experiences were not marked by more religiosity or suicidal background. According to one study, there is little association between NDEs and prior psychiatric treatment, prior suicidal behavior, or a family history of suicidal behavior. There was also little association between NDEs and religiosity or prior brushes with death. This means that the occurrence of an NDE is not influenced by psychopathology, religious denomination, religiosity, experiencers' prior expectations of a pleasant dying process, or continued postmortem existence.[3, 72, 80, 81] Greyson also found the long-term recall of the incidents of NDEs were stable and did not change due to embellishment over time.[82]

Nancy Bush, former Executive Director of the International Association for Near-Death Studies, holds that people with a religious background report, not all negative NDEs. Suicide attempters, who, according to Greyson, should be expected to have a higher rate of psychopathology, did not show much difference from non-suicides in the frequency of NDEs.[9, 83-85]

4.7 Spiritual Contemplative Experience (SCE)

Psychologist William James first clinically described mystical experiences.[86] He identified four qualities: *ineffability, which* cannot be described in words; *noetic,* deep insight into truth; *transiency,* having short occurrence but long-lasting effects; and *passivity,* not sought but passively received. People of all faith traditions have reported such experiences throughout the centuries. They can occur under many unpredictable circumstances but anecdotally can occur when practicing concentrative meditation, known as contemplation, such as Christian-based Centering Prayer (CP). This term was coined by Trappist Monk Fr. Thomas Merton[87] and later provided with a methodology by Trappist Monk Fr. Thomas Keating.[88]

However, as documented by St. John Cassian in the 4th Century, the origin of Christian contemplative prayer dates back to the desert fathers and mothers, the first Christian monks and nuns in Egypt.[89]

The more broadly accepted interfaith term for *mystical* is the synonymous term *contemplative.* Because contemplative experiences are not restricted to just self-proclaimed religious but also the more generic, self-proclaimed spiritual practitioners, we have coined the term Spiritual Contemplative Experience (SCE) for the purpose of this research.[87] We have chosen not to use the broader term, Spiritually Transformative Experience (STE), because it can refer to many altered states of consciousness, including NDE and SCE.

The inspiration for this research came from anecdotal observations. When teaching CP, students would occasionally relive their previous NDE during their CP. It became clear that the four attributes ascribed by Moody to an NDE also applied to an SCE. They are *paranormal,* out-of-body; *cognitive,* timelessness; *affective,* peacefulness; and *transcendent,* divine. This was the case even when CP practitioners never had a previous NDE.

This research comparing NDEs and SCEs was undertaken because about 87% of the US population believes in an afterlife, and both an NDE and an SCE are believed to be at the transition to that life. Identifying subjects in the other 13% of the population, who have had a NDE or SCE and may practice some form of meditation other than CP, is statistically more difficult and not the subject of this research proposal.

4.8 Limitations of Study

This study has a number of limitations, foremost the relatively small number of subjects. The subjective memorization of NDEs and SCEs may not adequately reflect past experience. Even though the QEEGt findings demonstrated a correlation between brain activity and NDEs and SCEs remembering, it was an average, not an EEG record versus time. The base case of not being asked to remember anything may not be as valid as being asked to remember something uneventful, such as peeling a banana. We plan to run future protocols to address these limitations.

5 Summary

There was a clear correlation of brain activation in delta, alpha, and gamma bands for both NDE and SCE groups, although there was a greater activation for the SCE group.

Some people who survived a life-threatening crisis report an extraordinary NDE. NDEs occur with increasing frequency because of improved survival rates resulting from modern resuscitation techniques. The content of NDEs and their effects on patients seem similar worldwide, across all cultures and times. The subjective nature and absence of a frame of reference for NDEs lead to individual, cultural and religious factors determining the vocabulary used to describe and interpret the experience. NDEs are reported in many circumstances: cardiac arrest in myocardial infarction, shock, electrocution, coma resulting from traumatic brain damage, intracerebral hemorrhage or cerebral infarction, near-drowning or asphyxia, and apnea. Experiences similar to NDEs occur during the terminal phase of illness and are called deathbed vision.[1-3, 90]

Although these results cannot simply be correlated with human experiments, it suggests that the brain's remaining activity might explain the NDE.

Clinical observations suggest REM state intrusion contributes to NDE. Support for the hypothesis follows five lines of evidence:

- REM intrusion during wakefulness is a frequent normal occurrence.
- REM intrusion underlies other clinical conditions.
- NDE elements can be explained by REM intrusion.
- Cardiorespiratory afferents evoke REM intrusion.
- Persons with an NDE may have an arousal system predisposing to REM intrusion.[91-98]

As mentioned earlier, we have found from anecdotal observations that occasionally, when teaching CP to students, they would relive their previous NDE experience during their CP. It became clear that the four attributes previously described[70, 99] to NDEs, applied to SCEs. These are *paranormal,* out-of-body; *cognitive,* timelessness; *affective,* peacefulness; and *transcendent,* divine. This was the case even when CP practitioners never had a previous NDE. Our neural correlate research seems to confirm this anecdotal observation.

The fact that there is increased activation in the QEEGs of SCE subjects may be explainable since, compared to the records of the NDE subjects, they remember an incident not connected with an impaired state of consciousness near death. Some researchers observe a surge of brain activity just moments before death. This raises the fascinating possibility that they have identified the neural basis for NDEs.

However, that research on death-related brain activity was in rats, not humans. Obviously, it is easier to study animals' death process than humans. According to the cardiorespiratory view of death, the exact moment is the last regular heartbeat. EEG was recorded during the normal waking phase, anesthesia, and after cardiac arrest, i.e., the so-called clinical death, from the right and left frontal (RF/LF), parietal (RP/LP), and occipital (RO/LO) cortex.[12,100]

These results might explain the brain activation we found in our subjects while remembering NDEs. To explain a greater activation while remembering SCEs, we can consider neuropsychological effects during Centering Prayer. Some authors have demonstrated superior performance on the test of sustained attention compared to controls; long-term meditators were superior to short-term meditators.[13, 18, 101-104] The increment of attention performance during a SCE, might explain a grander brain activation than an NDE. Several authors have reported increments in EEG alpha and gamma bands during meditation.[12, 13, 105]

6 Conclusion

NDE and SCE are at the cusp of theories about the transcendence theories to the next life, which has never been comparatively studied in this way by neuroscience. Therefore, we compare subjects remembering a NDE vs. SCE using quantitative EEG tomography (QEEGt), which allows the electrical source localization in the anatomic background provided by MRI. There was a clear correlation of brain activation in delta, alpha, and gamma bands for both NDE and SCE groups, although there was a greater activation for the SCE group. According to the Authors, this is the first publication on this topic.

Compliance with ethical standards

Acknowledgments

The authors thank Fr. Gilberto Walker, who provided access to the hard-to-identify subjects who had a SCE.

Disclosure of conflict of interest

The Authors report no conflicts of interest.

Statement of ethical approval

The IRB approved this research of the Institute of Neurology and Neurosurgery, Havana, Cuba.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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APPENDIX

IMPORTANT RESEARCH ARTICLES

GREYSON NDE SCALE

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QUANTIFYING THE PHENOMENON

Professor & Psychiatrist **Bruce Greyson** developed this scale to measure the depth of an individual's near-death experience. The following is a copy of the scale as presented in an article entitled **"Altered States"** by Lee Graves in the Summer 2007 edition of the University of Virginia Magazine.

1. Did time seem to speed up or slow down?
0 = No
1 = Time seemed to go faster or slower than usual
2 = Everything seemed to be happening at once; or time stopped or lost all meaning

2. Were your thoughts speeded up?
0 = No
1 = Faster than usual
2 = Incredibly fast

3. Did scenes from your past come back to you?
0 = No
1 = I remembered many past events
2 = My past flashed before me, out of my control

4. Did you suddenly seem to understand everything?
0 = No
1 = Everything about myself or others
2 = Everything about the universe

5. Did you have a feeling of peace or pleasantness?
0 = No
1 = Relief or calmness
2 = Incredible peace or pleasantness

6. Did you have a feeling of joy?
0 = No
1 = Happiness
2 = Incredible joy

7. Did you feel a sense of harmony or unity with the universe?
0 = No
1 = I felt no longer in conflict with nature
2 = I felt united or one with the world

8. Did you see, or feel surrounded by, a brilliant light?
0 = No
1 = An unusually bright light
2 = A light clearly of mystical or other-worldly origin

9. Were your senses more vivid than usual?
0 = No
1 = More vivid than usual
2 = Incredibly more vivid

10. Did you seem to be aware of things going on elsewhere, as if by extrasensory perception (ESP)?
0 = No
1 = Yes, but the facts have not been checked out
2 = Yes, and the facts have been checked out

11. Did scenes from the future come to you?
0 = No
1 = Scenes from my personal future
2 = Scenes from the world's future

12. Did you feel separated from your body?
0 = No
1 = I lost awareness of my body
2 = I clearly left my body and existed outside it

13. Did you seem to enter some other, unearthly world?
0 = No
1 = Some unfamiliar and strange place
2 = A clearly mystical or unearthly realm

14. Did you seem to encounter a mystical being or presence, or hear an unidentifiable voice?

Authors Short Biography

Calixto Machado, MD, Ph.D., is a Full Professor and Researcher in neurology and clinical neurophysiology and currently works at the Institute of Neurology and Neurosurgery, Havana, Cuba. In 1992, he was the first Cuban neurologist who was a member of the American Academy of Neurology (AAN), nominated as a Corresponding Fellow. He is President of the Cuban Society of Clinical Neurophysiology and the President of the Organizing Committee of eight International Symposia on Brain Death and Disorders of Consciousness held in Havana since the early '90s. Dr. Machado is recognized as a world expert in brain death, coma, disorders of consciousness, neuroimaging, clinical neurophysiology, stroke, and recently on the way, SARS-CoV-2 attacks the nervous system. He has bestowed by many national and international Awards. In 2005 Dr. Machado received the AAN Lawrence McHenry Award. He was the main neurological expert in the Jahi McMath case, one of the most controversial suspected brain-dead patients, fully covered by the US and international press.