Supplementary File S2: Part Two:

Understanding Consciousness in Relation to Death and the Recalled Experience of Death

The Emergence of the Recalled Experience of Death in Adults:

Although reports of profound transcendent experiences close to death by cardiopulmonary criteria are not new, it was not until 15 years after the discovery of CPR in 1960 that widespread knowledge of their existence entered the public domain.[1] In 1975, Raymond Moody, an American psychiatrist with a background in philosophy, collected and published the experiences of 150 people who had been involved in a seemingly life-threatening (near-death) event.[1] These experiences included a consistent set of features with transcendent qualities. Although various phrases were used to describe such experiences at the time, Moody labeled them *near-death experiences* (NDE),[1] a term that became widespread due to its use by the media and the popularity of Moody's book. Subsequently, other terms have also been used, including spiritually transformative experience. However, none were ever accurately defined. Moody concluded that people who were "near-death" described 15 themes. Of these, 11 were related to the experience itself: 1) ineffability, 2) hearing the news (being pronounced dead), 3) feelings of peace and quiet, 4) unusual noises, 5) going through a dark tunnel, 6) meeting others, 7) encountering a being of light, 8) experiencing a life review, 9) sensing a border or limit, 10) perception of being separated from the body and observing events from a point above (which he described using the term *out-of-body experience* [OBE]), and 11) returning to the body.[1] He also described four themes related to events *after* the experience: 12) telling others, 13) effects on lives, 14) new views on death, and 15) corroboration (of the experience)[1] [Table S1, online only].

Table S1: The Classical/Original NDE Themes Described in Relation to Proximity to Death

Features	Exemplar Quotes
Ineffability:	• "There are just no words to express what I am trying to say." • "They just don't make adjectives and superlatives to describe this." • "There is a real problem for me as I'm trying to tell you this, because all the words I know are three-dimensional… That is as close as I can get to it, but it is not really adequate. I can't really give you a complete picture."
Hearing The News: Hearing doctors or others pronounce them dead	• [Doctor explains]. "I told the other doctor … 'Let's try one more time'. Later… [the patient] said she didn't remember [anything] except that she did hear me say, 'Let's try one more time and then we'll give up'." • "I heard a woman who was there say, 'Is he dead?' and someone else said, 'Yeah, he's dead'."
Feeling Peace and Quiet	• "I began to experience peace [and] comfort." • [Patient described feeling] "a great attitude of relief. There was no pain, and I've never felt so relaxed. I was at ease it was all good." • "I just had a nice, great feeling of solitude and peace."
The Noise: Various auditory sensations	• "I began to hear music of some sort." • "I would hear what seemed to be bells tingling, a long way off, as if drifting through the wind." • "A loud ringing. It could be described as a buzzing."
The Dark Tunnel: Sensation of being pulled very rapidly through a space	• "I went through this [vacuum]. You could compare it to a tunnel." • "I felt as if I were moving in a vacuum." • "I found myself in a tunnel."

Out of The Body: Looking down upon one's own physical body from a point outside of it, as though one is "a spectator"	• "I started rising upward … floating right below the ceiling … As I saw them below beating on my chest … I thought, "Why are they going to so much trouble? I'm just fine now." • "I could see my own body all tangled up in the car amongst all the people who had gathered around, but …, I had no feelings for it whatsoever." • "I left my body. I had a floating sensation as I felt myself get out of my body, and I looked back and I could see myself on the bed below and there was no fear. It was quiet- very peaceful and serene."
Meeting Others: Becoming aware of the presence of other spiritual beings in their vicinity	• "[My friend who had passed] was there but he didn't have a physical body." • "While I was dead … I had the feeling that there were people around me, and I could feel their presence… though I could never see anyone." • "I recognized my grandmother and a girl I had known when I was in school… it seems that I mainly saw their faces and felt their presence."
The Being of Light: Encountering a very bright light with a very definite personality	• "I could see this light. It was a very, very brilliant light … I was trying to get to that light." • "I didn't see a person in this light, and yet it has a special identity, it definitely does. It is a light of perfect understanding and perfect love." • I just can't describe [the light]. It seemed that it covered everything … it kind of asked me if I was ready to die… the light was what was talking to me."
The Review: Being presented a review of one's life. Some people characterize this as an educational effort	• "My whole entire life was there …. It was … more in the form of thought ... I thought … about things that I had done wrong. After I [saw] the mean little things I did … I wished I could go back and undo them." • "… there were certain things that I had done in my life that I regretted … This flashback was in the form of mental pictures, I would say, but there were much more vivid than normal ones."
The Border or Limit: Approaching what might be called a border of a limit of some kind	• "I looked ahead of me … I saw a fence [and] I started moving towards [it] … I saw a man on the other side of [the fence] ... I wanted to reach him, but I felt myself being drawn back, irresistibly." • "On the distant … I could see all my loved ones who had died … they seemed to be beckoning me to come on over and all the while I was saying '… I'm not ready to go'."
Coming Back	• "[I was sent back], I believe that it was because I had those two small children to raise." • "I was concerned about my children, about who would take care of them. So, I was not ready to go." • "I wondered whether I should stay there, but as I did I remembered my family … I knew that I had a duty to my family. So I decided to try to come back."
Telling Others: Thinking that others would think they were mentally unstable if they were to relate their experiences.	• "I tried to tell my nurses what had happened when I woke up, but they told me not to talk about it, that I was just imagining things." • "[I tried to tell my mother]. But, I was just a little boy and she didn't pay any attention to me. So I never told it to anybody else." • "I tried to tell my minister, but he told me I had been hallucinating."
Effects on Lives: Positive transformation /sense of purpose	• "After my experience, I started wondering whether I had been doing the things I had done because they were good, or because they were good for me ... I try to do things that have more meaning." • "Since [my experience], it has been on my mind constantly what I have done with my life, and what I will do with my life."
New Views of Death: No longer being afraid of death/sense of purpose.	• "Now, I am not afraid to die. … The reason why I'm not afraid … is that I know where I'm going." • "Since the experience, I don't fear death. Those feelings vanished." • "I suppose this experience molded something in my life … and I am not afraid to die."
Corroboration: Others confirm the experience	• "I told [my doctor] the whole story…He was really shocked to know that I knew everything that had happened." • "When I woke up after the accident … I told my father who had dragged me out of the building, and even what color clothes that person had on, and how they got me out… and my father said "well yes, these things were true."

Table S1 represents a summary of experiences reported in relation to life threatening circumstances and labelled NDE by Raymond Moody in 1975. The themes and quotes in this table were collected, reviewed and summarized from the original publication.[1]

In the years that followed Moody's original descriptions, particularly in the absence of a definition of being "near death," the use of the term NDE drifted away from its origin and started to be used much more broadly to refer to many other experiences, which at times had little or nothing in common with Moody's original themes, death, or even one another.[2, 3] In 2000, Bruce Greyson and colleagues tried to provide a definition that encompassed the different situations in which the term was being used.[4] He defined these situations as "profound psychological events with transcendental and mystical elements, typically occurring to individuals close to death or in situations of intense physical or emotional danger. These elements include ineffability, as well as a sense that the experience transcends personal ego, and an experience of union with a divine or higher principle."[4] As with Moody's original observations, this proposed definition included the need for a transcendent component with ineffability and long-term positive transformative changes. However, despite the fact that being "near-death" was *the* major unifying aspect of Moody's original cases and is encapsulated in the term NDE,[1] his definition deviated from its origin by excluding the need for any relationship with death, critical illness, or life-threatening conditions.[3–11]

Due to the continued absence of stringent criteria, today many human experiences in relation to a heterogeneous and diverse group of medical and non-medical conditions with differing underlying pathophysiological states with no relation to physical illness, death, or each other, are mislabeled as "NDE."[3–11] These include, but are not limited to, experiences that occur in relation to syncope,[9] disorders of REM sleep,[6] meditation,[7] and the use of recreational drugs, such as N,N-Dimethyltryptamine (DMT)[10] and ketamine.[12] However, the recalled experiences after these varied events are quite dissimilar to the original experience that was described by Moody in 1975 [summarized in Table S2 and S3, online only]. To encapsulate these diverse and unrelated groups of experiences, some have proposed a new term—"NDE-like" experiences.[13] To complicate things further, events that could be conceived as placing someone physically close to death in a literal sense (such as an accident, illness, or cardiac arrest), but without any actual cognitive experiences or recollections, are also being mislabeled NDE.[14] For the purposes of this document, considering the heterogeneity of experiences mislabeled as "near-death," and to provide some precision, we will specifically refer to the recalled experiences of death that are largely consistent with Moody's original accounts as "classical" NDE. Those experiences that retain the same overall phenomenology and arc of the classical experiences described by Moody in 1975 in people who have been in a coma after life-threatening illnesses and cardiac arrest [summarized in Figure 1, online only], but may also include additional subthemes that have been discovered in the years since, are being referred to as recalled experiences of death (RED). Furthermore, with respect to other experiences labeled using the umbrella term NDE, we will refer to these separately—that is, using specific descriptions and terms that uniquely relate to each of these different experiences. For the purposes of comparison with the classical or authentic NDE, these other experiences will be referred to using the umbrella term of "mislabeled near-death experiences."

Table S2: Experiences Labelled as "NDE" During Events Unrelated to Death or Life-Threatening Illness

Author	Experience Type	Summary of Study	Summary of Reported Themes and Description of the Phenomenological Features of the Experiences Being Labelled as "NDE"
Lempert et al., 1994 [9]	Syncope	Syncope was induced in 42 healthy adults for up to 22s by hyperventilation and Valsalva maneuver to study possible similarities between syncopal experiences and so-called near-death experiences	The authors reported six themes. However, no actual qualitative descriptions were provided to enable a more detailed analysis of the phenomenology and themes and to examine for any similarity with the classic NDE. **Colors and lights** (these could intensify to a glaring brightness) **Landscape** (no further details provided) **Familiar People** (sometimes people with no discernible faces, but no specific examples were provided) **"OBE"** (no themes or examples provided to understand the nature of the experiences labeled as "OBE" and whether there were actual similarities between the reported experiences and authentic OBE descriptions, or whether they were more consistent with autoscopic, or other illusory experiences). **Sounds** (Ranging from noises to screaming- or unintelligible human voices. However, no specific examples provided) **Emotions** (Pleasant, detached, peaceful. However, no specific examples provided to enable more detailed analysis of the phenomenology of the described themes)
Kondziella et al., 2019 [82]	REM Sleep Intrusion	The occurrence of NDE and REM sleep intrusion features were examined in 1034 subjects in order to test the hypothesis that people who report NDE have a greater frequency of REM sleep intrusion. However, the authors incorporated a diverse mixture of unrelated experiences including conventional dreams in the group labelled "NDE".	The Greyson NDE Scale was used to determine the presence of a so-called NDE*. Selected quotes from the participants classified as having a so called reported "NDE" were: • "I often see characters in my hallway or feel someone else's presence before going to sleep." • "I nearly drowned when I was around 8 years old. I felt total peace. Twenty years later I can still remember how I felt. It was an amazing feeling." • "Sometimes I wake at night, and I can't move. I see strange things, like spirits or demons at my door, and after a while, I see them coming beside me. I can't move or talk, and they sit on my chest. It scares the hell out of me! I think that it is a dream, count to 3 and close my eyes. Sometimes this helps." • "…my eyesight and visual became incredibly abstract. For around an hour I had no sense of self or my surroundings…" • "…I was aware of being outside my body. My partner saw me at the window, calling for help..." • "I was 10-11. Suddenly, huge waves started pulling me further and further from the shore. As I was fighting, my life started flashing before me in my head."
Van Gordon et al., 2018 [110]	Meditation	Buddhist meditators were asked to meditate and the researchers recorded their experiences during meditation but then labelled their reported meditative experiences as meditation induced NDE (MI-NDE)	The Greyson NDE Scale was used to determine the presence of a so-called NDE*. A limited number of qualitative descriptions were provided regarding the reported phenomenology and themes experienced during meditation, which were then simply labelled as "NDE" as follows: **Identification with Elements:** Reduced degree of connection to their physical body and unbinding of 5 body elements (earth, water, fire, wind, space). **Diverse Experiences:** feeling of drowning, being stuck/unable to move, being too hot or too cold, feeling breathlessness and weightlessness, being without a body **Altered Perception of Time and Space:** Ceasing to be aware of time and space

			Encounters with Realms: Undesirable realms, realms of torture, worlds where beings "hang from ropes", "Hungry ghost realm", Realm comprising of humans and animals, realm where inhabitants were partially or fully composed of light (heaven), Godly realm, Asura Realm **Encounters with beings:** Recently deceased beings, demonic beings, meeting their own known living or deceased spiritual teacher. **Emptiness:** Referring to the content of experience as being the nature of "emptiness", "voidness", and "non-self" **Awareness of Physical Worldly Body:** Remaining aware of the body **Awareness of Non-Corporeal Form:** Retaining full meditative awareness and control and experiencing the choice of whether or not they assumed a bodily form **Volitional Control:** Voluntarily inducing and terminating the experience and retaining control over which so called “non-worldly” realm and or “being” they “visited” and retaining control of the duration of the encounter **Meaningful Insights:** Gaining access to insights that helped to augment their meditative awareness which allowed them to discover “treasures” and “gifts of wisdom” that were “placed in their mind” by their “spiritual teacher”
Beauregard et al., 2009 [7]	Meditation	Brain activity was measured and compared in two different experiment conditions: meditation condition group, where subjects were asked to visualize and connect with the "being of light" encountered during their NDE and the control condition, participants were instructed to mentally visualize the light emitted by a lamp.	The Greyson NDE Scale was used to measure the depth of a so-called NDE*. No actual qualitative descriptions were provided to enable a more detailed analysis of the phenomenology and themes and to examine for any similarity with classical NDE in relation to meditation. Participants reported having intense alterations of the state of consciousness, as well as peace and bliss. They also reported experiencing a feeling of connection with the subject of their meditation (being of light or the light from a lamp) that they were thinking about during both experiments.
Timmerman et al, 2018 [10]	DMT	DMT or placebo were administered to 13 participants whose experiences were then compared to a group of people with reported NDE.	The Greyson NDE Scale was used to determine the presence of a so-called NDE*. Authors concluded that DMT could induce features of the classical NDE. However, no actual qualitative descriptions were provided to enable a more detailed analysis of the phenomenology and themes described during DMT and to examine for any similarity between classical NDE and DMT related experiences.

Martial et al, 2019 [12]	Ketamine	The authors compared the narrative texts of self-reported NDE and DMT-induced experience in order to identify semantic similarities between the narratives. This was done based upon an underlying assumption that should two subjects explain experiences with similar core words, it could be that they reflect a similar experience.	The Greyson NDE Scale was used to determine the presence of a so-called NDE*. No actual qualitative descriptions were provided to enable a more detailed analysis of the phenomenology and themes described during DMT and so called NDE states to examine for any similarity between classical NDE and DMT related experiences. The authors identified five themes, which led them to conclude similarities exist between the two. These themes and the words described by participants that led to this conclusion are: **1) perception** (face, vision, saw), **2) emotion** (fear), **3) consciousness and cognition** (reality, moment, universe, understand, consciousness, memory, explain, learn), **4) self and others** (own, arm, self, person, human, everyone, others), **5) setting** (door, floor, inside, outside)

Table S2 represents data derived from publications that have reported on recalled experiences from syncope, meditation, hypnagogic, hypnopompic, and psychedelic induced states that were labelled as "NDE". In this table, the reported descriptions were collected and summarized for illustrative purposes.

* The Greyson NDE Scale, was used in a non-context specific manner in these studies. However, this scale has not been validated for use in diverse circumstances, such as hypnagogic and hypnopompic or other non-life threatening states. It is not specific or sensitive enough to distinguish a classical or authentic NDE from other diverse human experiences when used in a non-context specific manner.

Table S3: Experiences Recalled in Relation to the Use of N,N-Dimethyltryptamine (DMT) and Ketamine

S3.A. Subjective Description and Selected Quotes from Experiences Related to Use of DMT	
•**Intensive Body Misperceptions and Deformations** Deformation of body parts Sensations as if one's arm did not belong to oneself	• **Loss of Awareness and Control of Physical Experience and Body** "I no longer had a body" "My body dissolved; I was pure consciousness" "I thought I had died"
•**Enlarged/Shrunken body Parts**	•**Melting** Sensation of body melting away
•**Body Twitching** Leg Twitch	•**Losing Control of the body** Perceiving the action of face muscles as being "made" by somebody else
•**Difficulty Sensing the Boundaries of the Body**	•**Whispering** Whispering voices
•**Various Noises** Music Telephone rings	• **Crepitus** Crinkling noise Crunching noise
•**Cartoon Sounds** Comical [such as boing, sproing sounds heard in cartoons]	•**Low-pitched Sounds** Chattering sounds
•**High-Pitched Sounds** Auditory effects were described as usually high-pitched Whining Whirring	•**Tree** A tree of life and knowledge
•**Ballroom** Vision of a ballroom with crystal chandeliers	•**Insects** Vision of a huge fly eye bouncing in front of the face
•**Animals** Vision of a fantastic bird	•**Stairways** Vision of a stairway
•**Duct** Vision of a duct	•**Disc** Vision of a golden disc
•**Tunnel** Vision of a tunnel	•**Spirals** Vision of DNA double helices
•**Diaphragm** Vision of a pulsating diaphragm	•**Computer Board and Screen** Vision of the inside of a computer's boards

	Vision of moving persons and body parts on the computer screen
•Geometric Patterns Complex geometric patterns on the walls Kaleidoscopic geometric patterns: "beautiful, colorful pink cobwebs; an elongation of light", "tremendously intricate tiny geometric colors, like being 1 inch from a color TV."	**•Colors** Neon Colors
•Egotistical "I was God"	**•Paranoid Ideation** A higher power conducting the experiment in which the patient was administered DMT (the actions of the researchers were part of the plan of this higher power).
•Seeing "Other Beings" "Elves" "Alien beings" "Higher Intelligence" "Little round creature with one big eye and one small eye"	**•Emotions and Sensations** Giggles and Bliss Sense of Vibration Feeling uncomfortable with the emotional alterations Emotionally unresponsive Feeling that emotions are not being "real" but made by the drug
•Zippo Lighter Thinking about a missing Zippo Lighter	**•Focus** Losing focus and coming back to focus
•Information Overload	**•Being in the Middle of a Galaxy**
•Entering a Dimension through a Chrysanthemum	**•Truer than Anything Else**

Selected Illustrative Quotes Related to the Use of DMT:

Body Twitching (Leg twitch)

•"There's that feeling of the dip in the road, swinging on a swing, your stomach sinks. The flushes run through you, your legs twitch."

Losing Control of the Body

•"I looked up and saw how mechanical and essentially soul-less you were. Your movements were not your own, they were no longer smooth and coordinated."

Egotistical (I was God)

•"I was essentially told that I was God."

Seeing "Other Beings" (Elves)

•"One of the elves made it impossible for me to move. There was no issue of control; they were totally in control. They wanted me to look here and there. That was all I could do."

•"The "elves" were prankish and ornery in their nature. There were four of them by the highway, they totally commanded the scene- it was their territory. They were about my height and held up placards."

Seeing "Other Beings" (Other intelligent figures)

•"[Other intelligent figures] were aware of me, but not particularly concerned. It was like what a parent would feel looking into a playpen at his 1-year-old laying there."

•"He was teaching me the rules/regulations of the NFL (National Football League)."

Emotions and Sensations (Bliss and giggles)

•"I had an overwhelming feeling of bliss and giggles while on the come up, and during the peak, it was so intense that humor was almost obsolete."

Emotions and Sensations (Emotionally unresponsive)

•"I tried to get myself worked up over what I was seeing, but I just wasn't able to respond emotionally."

Emotions and Sensations (Vibration)

•"I was worried that the vibration would blow my head up. The colors and vibrations were so intense, I thought I would pop. I didn't think I would stay in my skin."

Information Overload
•"There is so much information coming at you at once that it is very hard to comprehend and make sense of at the time."

Zippo Lighter (Thinking about a missing Zippo Lighter)
•"I thought about a missing zippo lighter for some reason and [the being they encountered] flashed to me where it was and after I came back, I went to that spot deep inside a couch and grabbed it perfectly, it was unreal."

Focus (Losing focus and coming back to focus)
•"Things are coming into focus. I'm feeling human again. I had no idea what was going on."
•"My mind was definitely at a different place, but it was commenting on the state as it was going on along."

Being in the middle of a galaxy
•"I was in the middle of the galaxy and there was no one to help me. For a second, I needed help. It just happened so fast."

Entering a Dimension through a Chrysanthemum
•"I was greeted with a chrysanthemum in vivid lime-ish green and deep red, which then opened up into another plane, or dimension of existence, or some type of parallel conscious living part of the universe."

Truer than Anything Else
•"It felt truer than anything else I'd ever experienced."

S3.B. Subjective Description and Selected Quotes from Experiences Related to Use of Ketamine:	
•Intensive Body Misperceptions and Deformations Deformation of body part Sensations as if one's arm did not belong to oneself	**•Catatonic-like Behavior** Unnatural postures Holding the mouse for several seconds Keeping hands in mid-air
•Enlarged or Shrunken Body Parts Midget hands Very big legs	**•Losing Control of the Body** Losing control of body movements Impossible to stand up Limbs being stuck to the chair
•Difficulty Sensing the Boundaries of the Body	**•Elongated Body Parts** Elongated pipe cleaner legs and arms Spindly E.T.-like fingers
•Insect-Alien Morphing insect alien head	**•Time** Time had stopped Everything takes a long time
•Prominent bodily and/or vestibular sensations Body moving rapidly in space like a motor vehicle Being in a moving elevator	**•Melting** Feelings as if whole body was melting away
•Breathing Becoming fixated on breathing	**•Egotistical** "I was Isis the goddess" "I felt God-like" "I was actually God"
•Autoscopy but Not Out of Body Seeing and talking to multiple of themselves	**•Shapes** Vision of round shapes
•Television Screen Vision of a 1980's television screen with snow	**•Fish Scale** Vision of a fish scale
•2D Image Appearing like a 2D image	**•Sandpaper** Being made of sandpaper
•Kaleidoscope	**•Paranoid Ideation** Subjects reported that they had performed the computer tests like an automaton "running automatically" without personal will.
•Colors	**•Seeing "Other Intelligences"**

Neon Colors	Ketamine Creature that was a spaceship (referred to as "Kreature") "Aliens"
•**Emotions and Sensations** Experience being more or less unpleasant Isolated from others Feeling more or less remote Emotionally blunted	•**Being in a Dimension where Nothing and Nobody Existed** Subjects had felt as if they were transported to a different "dimension" where nothing and nobody existed apart from themselves and the test [while actually they had been engaged in the computer tests]
•**Speaking Gibberish**	•**Delay between Thoughts and Verbalizing Thoughts**

Selected Illustrative Quotes Related to the Use of Ketamine:

Intensive Body Misperception and Deformations (Deformation of body part)
•"Each limb seems separate, detached from each other."

Elongated Body Parts (Elongated pipe cleaner legs and arms , Spindly E.T.-like fingers)
•"My body image was distorted beyond recognition—fantastically elongated pipe cleaner legs and arms, spindly E.T.-like fingers, and morphing alien-insect head in the mirror…"
•"My hands look small, but the fingers are really long."

Enlarged or Shrunken Body Parts (midget hands, Very big legs)
•"My hand looks like a midget hand … like a funhouse mirror effect."
•"I feel like I'm shrunken inside."
•"My legs look very big and funny shaped, like another person's."

Losing Control of the Body (Losing control of body movements)
•"Not in control of my body, can't move."
•"I don't feel in control of my muscles any more - like a zombie is a very good description of it. There is something making me just stay here. Something in my head is telling me I can't move."
•"The will is there but difficult to get my legs to do what I want them to do."
•"I feel myself slipping away. I can no longer remember my name. I search my memories for clues to my identity. I do not know where I am."

Losing Control of the Body (Impossible to stand up)
•"Feel like it would be impossible to stand up, body feels like a ten ton weight… noticeable delay between thinking about moving and it happening."

Losing Control of the Body (Limbs being stuck to the chair)
•"My limbs feel like they've got a magnet and they're stuck to the arm of the chair like lead weights."

Breathing (Becoming fixated on breathing)
•"I become oddly fixated on my breathing. I watch my chest rise and fall, but in my dissociated state I cannot understand what I am seeing."

Speaking Gibberish
•"… it was as though you were speaking gibberish."

Delay between Thoughts and Verbalizing Thoughts
•"There's a delay between the thought and your mouth."

Television Screen and Kaleidoscope (1980's television screen)
•"My mind bounces from a 1980s television screen, black and white with snow, to a kaleidoscope of colors."

Fish Scale
•"My visual world was made up of glistening fish scales."

Autoscopy but Not Out of Body (Multiple of themselves)
•"I talked to my selves as a group. I would say: 'O.K. guys, how do we feel about this?' Once I actually saw myself split up into 3 different people, not in my mind either. I mean that I actually saw one of me to the right, and one of me on the left."

•"I was sitting on the floor – but I was also sitting on the ceiling and on the walls, looking down and up and sideways at everything. Multiple perspectives – then suddenly more and more – I was sitting, standing, walking, flying, falling and totally still."
•"K can split you into several personalities—different selves in one room—without anything to unify all the subroutines into a single whole. You realize that the real miracle is that there is ever a unifying self."

Shapes (Rounded shapes)
•"Everything looks rounded."

Colors (Neon Colors)
• This is real light. I'm not talking about the God-light either, the one at the end of the tunnel and all that white light of the void stuff…This light in the body doesn't have that sense of meaning. It's more as if neon signs and lasers are actually inside you.
•"It's as though green emerald is like in and around me …"

Sandpaper (Being made of sandpaper)
•"I am feeling like I am made of sandpaper."

2D Image (Appearing like a 2D image)
•"You appear like a 2D image."

Seeing "Other Intelligences"
•"It felt like there were more people in the room than two, presence of four people. I could see shapes of people moving but I couldn't keep track and they were all talking. I could hear people talking but I couldn't tell who was doing the talking - so it could have been something inside my head, I don't know. But I was definitely hearing things that I couldn't just place to any specific person or thing."
•"[There was] a large space with strange textures and geometrical shapes. Two of these shapes were eventually perceived as intelligent beings."

Seeing "Other Intelligences" (Kreature)
•"I became aware of a 'ketamine creature' (Kreature) who was simultaneously some kind of spaceship, and it told me that the person I usually was in everyday life was also something like a four-dimensional 'badge' that was worn by some larger multi-dimensional entity."

Egotistical (I was God-like)
•"I felt God-like. I would love myself; it was great."

Egotistical (I was actually God)
•"I was actually God. I distinctly felt the universe watching for my signal to see if it should cycle through itself once again, as it had an infinite number of times, or should it simply conclude."

Egotistical (I was Isis the goddess)
•"I was Isis herself, the virgin mother-goddess brooding lovingly over this world that I had created and was enfolding with arms like wings."

Time (Everything takes a long time)
•"Everything takes a long time, for example moving my foot."

Time (Time had stopped)
•"[Time] had stopped, feels like I've been here for hours."

Table S3 represents data derived from various publications that have reported on the features of DMT (Table S3A) and Ketamine induced-experiences (Table S3B). [111-119] Qualitative descriptions in relation to DMT and Ketamine induced experiences were collected and further summarized into themes in tables S3A and S3B, respectively. We have also included specific illustrative quotes for the recalled experiences after the use of DMT and Ketamine in each table to provide greater context and appreciation of these drug induced experiences.

Perception of External Visual Awareness and Lucidity in Relation to Death (so called Out of Body Experience)

People who have come close to death describe a perception that the self—one's consciousness—separates from the body, yet maintains lucidity and the ability to process visual and auditory information that relates to actual ongoing events, which have at times been verified and corroborated.[1,15,16] This reflects a lucid state of visual and sometimes auditory awareness of one's own body and its surroundings, which is paradoxically perceived through an external view of oneself. We consider that a more appropriate and accurate term to describe this experience is External Visual Awareness (EVA). Moody referred to these episodes using the older term OBE, in the context of being "near" to death.[1] It is clear that this phenomenon can occur under multiple circumstances, one of which is a life-threatening illness or being in proximity to death.[15–26] Over the last 45 years, despite growing use of this term, a definition regarding what constitutes an EVA has never been advanced. For this reason, much like the term "NDE," wide discrepancies exist in the ways this term has been used to refer to a heterogeneous group of experiences that are often quite different from the original descriptions, and were all under an overall umbrella term of "OBE." These include autoscopy and visual and perceptual illusions created through virtual reality goggles,[27,28] as well as a broad range of bodily illusions created through brain stimulation.[29,30]

During autoscopy, people describe seeing a physical double—a replica of themselves—who is often at a distance and acting independently and separately. For example, the replica/double of the individual is seen standing across the hall and cooking, reading, or doing other activities.[31,32] This is phenomenologically different from the classical description of an OBE, as during autoscopy people do not describe that their self—their consciousness—is separating from the body or is being able to perceive events from a point outside of the body. They simply describe seeing a double of themselves, some distance away, who they recognize as being unreal and imaginary, yet is conducting various activities independently and in a manner that is unrelated to what the individual is actually doing.[33]

Another category of experiences, which lack any of the phenomenological features of an OBE but have been labeled OBE, are optical illusions created through virtual reality goggles.[27,28] Here, participants are asked to wear goggles that obscure their vision of the outside world and, as a result, can only see what they are shown through a screen. They are then video recorded from behind using a camera and the image of their own back is transmitted through the goggles. Consequently, over time, the individuals become accustomed to seeing themselves from behind and start to perceive this initially novel perspective as their reality; they can even become startled when the camera is attacked with an object (i.e., believing they are being attacked from behind).[27,28]

Almost 20 years ago, Blanke et al. further proposed that OBE are complex somatosensory illusions.[29] This theory was based on a case report published in 2002 of a 43-year-old woman who was receiving stimulation for epilepsy.[29] When her right angular gyrus was stimulated, she reported a feeling of "sinking into the bed" followed by "falling from a height" and then seeing her legs and lower trunk from above.[29] Specifically, she stated: "I only see my legs and lower trunk" and then reported seeing her legs "becoming shorter," followed by a perception that "her legs appeared to be moving quickly towards her face"—something that had felt real enough to make her take evasive action.[29] The investigators stated that when the woman was asked to look at her outstretched arms during electrical stimulation of the cortex, she "felt as though her left arm was shortened" and "that her left lower arm and hand were moving towards her face." Furthermore, "when her eyes were shut, she felt that her upper body was moving towards her

legs…" Based on these descriptions of illusory alterations in the length of her limbs, which were phenomenologically completely different to the classical OBE descriptions, and because no definition of an OBE existed, her experience was labeled as an 'OBE.'[29] Following this case report, other case reports were published claiming that an 'OBE' may be reproduced through stimulation of the brain.[18,21,22,24] However, on closer examination, these studies are largely referring to a similar type of illusory experience that Blanke et al. had described, or a sensation of floating, rather than an experience that was phenomenologically consistent with the classical OBE descriptions. Other investigators have also claimed a link with vestibular disorders.[23] Overall, these reports have not provided a detailed narrative of an experience that reflects the original or classical OBE.

Today, the use of the label 'OBE' to describe multiple phenomenologically different experiences has continued, and appropriately specific terminology is needed to distinguish among these experiences in the future. Furthermore, it is challenging to compare all the different case reports and studies that purport to be reporting on so-called "OBE," because 1) there is no specific definition of an OBE, 2) in most instances, the researchers have not provided detailed phenomenological descriptions of the experiences that are being labeled OBE, and 3) researchers have not offered criteria by which an experience was deemed to be an OBE. To illustrate the breadth of experiences with different phenomenology that have been labeled 'OBEs' yet are inconsistent with the original concept of an OBE, we have summarized the reported features from selected studies in Table S4 [Online only]. Although only limited studies of experiences with the classical description of an OBE exist, an ongoing pilot qualitative study underway with survivors of life-threatening illnesses has identified multiple characteristic themes, which are consistent with the original/classical description of an OBE. These are also presented for the first time for illustrative purposes in Table S5 [Online only]. A comparison of these cases with many other reported so-called OBE in Table S4 [Online only] illustrates some of the fundamental differences.

Table S4: Diverse Experiences Labelled as "Out of Body Experiences"

Author	Summary of Study	Quote/ Description of Features
Blanke et al., 2005 [30]	Several examples of illusory experiences have been cited in this article suggesting that illusory reduplication/ illusory self-relocation may be related to multisensory disintegration at temporo-parietal junction	[The patient] awakens from sleep and has the immediate impression as if she were seeing herself from behind herself. She described that I felt [as if I were] "standing at the foot of my bed and looking down at myself." Yet . . . the patient also expressed the impression to "see" from her physical [or bodily] visuo-spatial perspective, which looked at the wall immediately in front of her. Asked at which of these two positions she thinks herself to be, she answered, "I am at both positions at the same time." She did not have the feeling of being out of her body.
Blanke et al., 2002 [29]	Focal electrical stimulation of the brain's right angular gyrus in one patient who was undergoing evaluation for epilepsy treatment	**Report of the patient:** •She was "sinking into the bed". •She was "falling from a height". •Her legs "becoming shorter". •Her legs appeared to be moving quickly towards her face, and she took evasive action •Feeling as though her left arm was shortened while the right arm was unaffected •Feeling that her left lower arm and hand were moving towards her face •Feeling that her upper body was moving towards her legs when her eyes were shut.

Ehrsson, 2007 [28]	Optical illusion created using camera	This paper lacks any descriptions of phenomenological features to suggest a classical OBE.
Kaijia, 2018 [21]	Case report of a 17 year old female with epilepsy who had an illusory experience during intracranial electrode stimulation	**Report of the patient:** •The patient was completely conscious during the stimulation procedure •She saw herself elevating to the left upper side 2m high under ceiling without any vestibular sensations like floating, flying, rotation or vertigo •She felt the "virtual body" was real herself and she saw her own body entirely lying in bed being electrode stimulated by the doctor and nurses walking around.
Fang et al, 2014 [26]	Case report of a 15 year old male with epilepsy who experienced observing his body from the ceiling	**Patient was conscious and could describe what had happened to him:** • Told his mother he had been projected out of his physical body to an elevated position under the ceiling • He was staring at his own body
Eelke M. Bos et al, 2016 [24]	Case report of a patient who experienced floating during an awake craniotomy for resection of low-grade glioma	**Report of the patient:** • Feeling as if she was floating just below the ceiling and saw her own body lying on the operating table •A day after the surgery patient reported that she could verbally reproduce the events and sensations that occurred to her during her procedure
Dirk De Ridder, et al, 2007 [120]	Case report of a 63-year old with illusory experience during stimulation of temporoparietal junction on the right side	Patient reported feeling of disembodiment without an alteration in the patient's level of consciousness. However, paper lacks descriptions of phenomenological features to suggest a classical OBE.
R Bhaskaran, 1990 [121]	Case report of a sixty year old man with history of bifrontal throbbing headache who had an altered experience of autoscopy	**Report of the patient:** •Patient started seeing his own image in front of him-more towards left •He could identify the face and upper part of the body •Patient stated seeing the double once while brushing his teeth and once while sitting on his bed where the image turned around and walked away
Bugger et al, 1993 [122]	Case report of a 21 year old man with seizures who had an experience	**Report of the patient:** •Feeling dizzy •Patient reported turning around to see himself lying in bed •He tried to wake the body in the bed by shouting at it, shaking it and jumping on his alter ego in the bed •His bodily awareness switched from the one standing upright to the one still lying in bed. When patient was in the lying in bed mode he felt quite awake but completely paralyzed and scared by the figure of himself bending over and beating him
Dewhurst and Pearson, 1995 [123]	3 case reports of people who reported experiences during their illness: - First report is from a 46-year-old male who was hospitalized and was later diagnosed with hemorrhage - Second report is from a patient who was hospitalized due to stroke and experienced visual hallucinations	**Report of the 1st patient:** •Seeing his "double" which appeared as if seen in a mirror •Double was dressed exactly as patient was •Accompanied him everywhere; at meal-times it stood behind his chair and did not reappear till he had finished eating •At night his double would undress and lie down on the table or couch in the next room • The double never said anything but repeated his actions and had a sad expression •On a different occasion when patient was hospitalized, the patient reported seeing the image dressed in pajamas in the middle of the ward getting into an empty bed

	seven weeks after admission. - Third report is from a patient who was admitted to the hospital complaining about episodes in which patient "saw himself" during grand mal attacks.	**Report of the 2nd patient:** •Patient saw number of white lights but was not certain of the direction in which they moved •Occasionally he saw the figure of a middle-aged man "out of the corner of his eye" •Patient reported seeing image of himself, which was exactly "like looking in a mirror". While seeing image of himself all his movements were reciprocated by the image. **Report of the 3rd patient:** •On one occasion, the patient said: "I was in the doctor's surgery staring into the garden. Then I saw the man about four feet away to my left. It suddenly dawned on me who it was. It was me." •On another occasion, the patient said that he had an experience of being in a wood gathering sticks. He said: "I knew that I was alone, yet suddenly I felt surrounded by hordes of people" •On another occasion, the patient said that he saw "crowds of tiny figures all the colors of the rainbow- all myself."

Table S4 illustrates different experiences labeled as "Out-of-Body" Experiences through a variety of publications. These include diverse illusions, including autoscopic experiences. Qualitative descriptions and features documented in these studies were collected and summarized to further illustrate the difference between these experiences and authentic cases of OBE (summarized in Tables S1, S5, S8).

Table S5: Themes Related to Classical/Authentic "Out of Body Experiences" in the Context of Life Threatening Illness

Feature	Exemplar Quote
Separating from the body	•"I remember leaving my body and rising up to the ceiling of the room." •"I found myself very near the ceiling in the corner of the room. I was so high that I was within inches of the ceiling tiles." •"I left my body at the scene of the accident."
Paradoxical Lucidity	•"The thought was very lucid and came through immediate knowing. It was a different way of thinking from which I had experienced." •"I still was completely lucid and aware of what was going on." •"I was dead and yet here I was, still alive and fully conscious."
Initial Confusion	• "I was intrigued. I tried to find an explanation but I couldn't. I looked around stunned." • "I didn't know why I was there…." • "I was wandering around … found others who were similarly confused as to … what was going on."
Realization of Having Died	• "I was sure I had died." • "I knew obviously my body still lay in bed, but I could not go back into it anymore. 'Is this death?' I contemplated." • "'I am dead,' I thought to myself."
A Sense of Liberation and Weightlessness	•"I felt weightless and free: absolutely free!" •"The thought of letting go was pleasurable, as releasing all the entanglements of this life neared. This body was so dense, cold and heavy. It was good to let this go." •"I looked at my body and knew it wasn't the real me, it was the thing I had been caught inside, and now I was free!"

Visual Awareness: Observing the Body or Events from Above	•"I was looking down at myself from above! At first, I did not even recognize that it was me." •"I looked down and saw my body on the floor with about a dozen people gathered around it. I could even see the color of the clothes these people had on." •"I turned around instinctively and to my great surprise, I saw my body still lying on the bed with the eyes shut. I then understood that I was outside of my body".
A Birds Eye View: I Felt like I Could "See" in All Directions (360 degrees)	•"I had 360-degree vision and could see all around me." •"I recall no limits on perception, no binocular vision, but panoramic/spherical/360 degrees: hard to describe." •"I perceived and saw everything around me, like in 360 degrees."
Becoming Detached from Events Below	•"[I] recognized the body as mine but was no longer interested: I was not that body." •"I didn't identify, in any way, with the body or the people in the room. I was instead, a detached observer." •"I also noticed that I was no longer concerned about my body, [or] how it looked."
"I", Myself Remains	•"My consciousness had separated from my body and I seemed to be next to it [the body]. I was watching like an observer or a bystander." •"I had no body but I was me." •"I thought, 'This must be who I really am' when I [saw] myself in that state found that 'I' was an alive … being without a body (and saw that body on the table)."
Shedding the body like a piece of clothing	•"I was feeling no pity toward the... body, neither was I feeling attachment to it, as though it was a worn and taken off article of clothing." •"I had shed the sense of my body very quickly." •"I was amazed… that body there was just a coat I had been wearing. It felt good to be out of it."
Connected by a "Cord"	•"I distinctly remember marveling at the thin, glowing, silver 'cord' leading ... to the body on the table. It was stretched very thin." •"I did see a silver cord attached to my body which had a luminescence to it." •"It felt like I was attached to a cord."
Hovering or floating in the space	•"I floated without weight ... I was above my body and directly below the ceiling of the intensive therapy room." •"I was floating up towards the ceiling of the operating room and toward the light." •"I continued to float up and a tunnel appeared. There was a beautiful tunnel with a bright light at the end of it."
Moving to a destination	•"At that moment, I had left my body and began to return home." •"I went upward…I began to look towards the direction we were travelling." •"I found myself pulled through the light at an accelerated speed….I knew I was going home."

Table S5 represents a summary of data derived from an ongoing qualitative study exploring visual and auditory awareness (out of body experiences) described in relation to life threatening circumstances. These are consistent with those reported as part of the overall Recalled Experience of Death (RED).

Future studies are needed to better characterize the features and phenomenology of authentic or classical OBEs, as well as other experiences that have been categorized as "OBEs" but are inconsistent with the original descriptions. These include autoscopy, somatosensory illusions, and bodily illusions, as well as illusions created through virtual reality glasses. Such an endeavor would aid with the creation of a unified definition and measurement scale. Systematic mechanistic studies are also needed to determine whether stimulation of a focal point or multiple foci in the brain may trigger the occurrence of an authentic or classical OBE, or whether this approach can only induce the types of bodily illusions that *Blanke et al.* and others were able to create. Nonetheless, the identification of a brain modulator of OBE cannot establish

the reality (or lack of reality) of the experience, just as the identification of brain modulators underlying other human experiences, such as love or religious experiences, cannot determine their reality or otherwise [Section on Hallucinations, Delusions, or Reality]. In particular, the occurrence of the perceived separation of the self—consciousness—from the body, with continued lucidity, visual and auditory consciousness, as well as awareness and recall of actual verifiable events, is inexplicable through current neuroscientific models. Even more peculiar is the ability to maintain visual and auditory consciousness by approximately 2% of individuals undergoing cardiac arrest,[15,16] because during cardiac arrest, the brain—and cortical activity in particular—is typically severely disordered or non-functional.

These descriptions of paradoxical lucidity and consciousness are not illusory, and the phenomenon of an OBE, much like consciousness itself, remains a scientific paradox—inexplicable through our current neurobiological paradigms and models. In particular, more detailed studies into the mechanisms of paradoxical lucidity and consciousness in cardiac arrest are needed. Nonetheless, in order to standardize and stimulate future research, we strongly recommend that investigators refer to experiences that exhibit the phenomenology of an authentic or classical OBE, as EVA or simply OBE, but use more specific and appropriate terms, such as autoscopy or artificially induced visual illusions (AIVI), to refer to the array of other experiences previously mislabeled 'OBE.' The use of the term AIVI is a more appropriate umbrella term for the somatosensory and bodily illusions, as well as virtual reality induced optical illusions that have been mislabeled OBE.

The Epidemiology of the Recalled Experience of Death.

Recalled experiences in relation to death and severe or life-threatening illnesses have been reported globally and across different cultures, including in India and China.[20,34,35] Subsequent studies have indicated that although the central features of the experience appear universal, the interpretation of the experience appears to be influenced by personal, religious, philosophical, and cultural views.[20,34,35] Surveys in the US and Australia suggest 4-9% of the general population may have had an experience that is consistent with recalled experiences in relation to death.[36,37] We recently commissioned an international poll of the general population, which was carried out by Opinion Research Business (ORB) among 6,019 people in the United Kingdom, United States, France, China, Thailand, and Brazil. This poll indicated that in these countries, the prevalence of a recalled experience of death after a life-threatening event is ~11%, while the prevalence of EVA is ~10%. Assuming a global population of roughly 7.8 billion, we estimate there to be around 850 million people at present with a recalled experience of death and 780 million with EVA**.**

Over the past 20 years, multiple prospective cardiac arrest studies have consistently indicated that the incidence of recalled experiences in relation to death is ~10% among cardiac arrest survivors.[15,16,37–41] The estimate of resuscitation attempts after out of hospital cardiac arrest is ~95 per 100,000 people, with a similar estimated number of in-hospital cardiac arrests. Thus, based on the current global population of approximately 7.8 billion, at least 15 million resuscitation attempts are expected per annum. Using a conservative estimate by combining in and out of hospital rate of survival after resuscitation of ~10%, this equates to approximately 1.5 million survivors per year, with an incidence of approximately 150,000 people with explicit recalled experiences of death. However, the true numbers of cardiac arrest survivors

with such experiences are expected to be much higher, when considering the impact of memory loss and explicit recall [Section 3.4]. Considering that CPR is 60 years old, cumulatively many millions of people are likely to have had such explicit recalled experiences, while a much larger population are likely to have had such experiences but subsequently lost explicit recall of them. The overall population of people with recalled experiences of death, when considered more broadly among patients with life-threatening illnesses (without cardiac arrest), is likely to be much higher, due to higher survival rates in this population.

Recognizing the Impact of Memory Loss in Relation to the Recalled Experience of Death.

Explicit recall of memories does not fully reflect the totality of human experiences.[42] In particular, explicit recall is also not expected to provide a true representation of the totality of the recalled experience of death. This is in part because brain insults including ischemia, reperfusion injury, and inflammation—the hallmarks of post-cardiac arrest syndrome and other critical illnesses that lead to loss of consciousness (LOC)—adversely impact memory circuits.[43] In addition, critically injured patients are often given sedative medications, and several of these drugs are known to produce hypnosis: γ–aminobutyric acid type A (GABA-A) receptor agonists (propofol, etomidate, midazolam and diazepam), which further impedes memory circuits.[44] It is now understood that memory recall after cardiac arrest may exist on a spectrum, with some people recalling more features, and others fewer features or nothing, from their experience. This is thought to reflect the impact of memory loss arising from brain insults. In the AWAreness during REsuscitation (AWARE) study of 2,060 cardiac arrests, 101 survived and were able to be interviewed.[16] Almost 40% reported a perception of awareness but without explicit recall, while 9% recalled experiences that were consistent with the classical or authentic NDE. However, the frequency of the recalled themes varied among participants.[16] These findings presumably reflect the impact of a primary brain insult (e.g., reduced brain blood flow) and sedatives on memory circuits, which lead to no recalled memories or fragmented memories with different frequencies. [16] Thus, in the future, more refined methods that incorporate tests of implicit learning may better describe the wider prevalence and depth of these experiences.

Recalled Experiences of Death in Children

Children have also described similar recalled experiences to adults, often using children's terminology and during the course of play, sometimes over many months.[45–49] In some cases, the experiences occurred at ages (e.g., <3 years) in which children would not have been expected to have cultural insights into concepts related to death or an afterlife and thus were unlikely to have imagined their experiences through the influence of cultural and religious traditions. Two illustrative children's experiences are presented in Table S6 [Online only]. Because children's experiences have not been studied in depth, and the data in the literature are largely limited to case reports and series,[45–49] more systematic studies are needed.

Table S6: Children's Classical/Authentic Near-Death Experiences:

Children's Experiences	Summary of Event	Experience Reported by Parents
Case 1	John's heart had stopped…. There was a lot of commotion…they were pressing on his chest and he was lifeless and blue…. They put him in an ambulance and took him to hospital… (description provided by a grandparent).	[After he had been discharged from hospital] one day, during the course of play, he said, "Grandma, when I died, I saw a lady." He was not yet three years old. I asked my daughter if anyone had mentioned anything to John about him dying and she said, No, absolutely not. But over the course of the next few months he continued to talk about his experience. It was all during the course of play and in a child's vocabulary. He said, When I was in the doctor's car the belt came undone and I was looking down from above. He also said, "when you die, it is not the end…a lady came to take me…. There were also many others, who were getting new clothes, but not me, because I wasn't really dead. I was going to come back." Interestingly, John's parents noticed that he kept on drawing the same picture over and over again. As he got older, it got more complex. When asked what the balloon was, he said, "When you die you see a bright lamp and …are connected by a cord."
Case 2	My son Andrew, then three and a half years old, was admitted to hospital with a heart problem…. He had to undergo open heart surgery (description provided by a parent).	About two weeks after the surgery he started asking when he could go back to the beautiful sunny place with all the flowers and animals. I said, We'll go to the park in a few days when you are feeling better. No," he said, "I don't mean the park, I mean the sunny place I went to with the lady." I asked him, "What lady?" and he said, "The lady that floats." I told him I didn't know what he meant and that I must have forgotten where this sunny place was, and he said, "You didn't take me there, the lady came and got me. She held my hand and we floated up…. You were outside when I was having my heart mended…. It was okay, the lady looked after me, the lady loves me, it wasn't scary, it was lovely. Everything was bright and colourful [but] I wanted to come back to see you." I asked him, "When you came back, were you asleep or awake or dreaming?" and he said, "I was awake, but I was up on the ceiling and when I looked down I was lying in a bed with my arms by my sides and doctors were doing something to my chest. Everything was really bright and I floated back down…" About a year after his operation we were watching Children's Hospital (a television program filmed in a hospital) and a child was having heart surgery. Andrew got really excited and said, "I had that machine" (a bypass machine). I said, "I don't think you did." He said, "Yes, I did really." "But," I said, "you were asleep when you had your operation, so you wouldn't have seen any machines." He said, "I know I was asleep, but I could see it when I was looking down." I said, "If you were asleep, how could you be looking down?" He said, "You know, I told you, when I floated up with the lady…." [One day] I showed him a photo of my mum (she had passed away) when she was my age now, and he said, "That's her. That's the lady."

Table S6 illustrates two children's experiences in relation to Recalled Experiences of Death reported by their parents.

Recalled Experience of Death: A Transcendent Dimension and Positive Transformational Changes

Much like profound mystical, spiritual, or religious experiences, one of the major hallmarks of Moody's original descriptions of recalled experiences of death is a transcendent dimension, which appears to lead to long-term positive transformational effects.[1,2,15,50] People often report a greater sense of purpose, less fear of death, a greater sense of altruism, as evidenced by greater empathy and responsibility toward others, increased faith and interest in the meaning of life, and less materialism.[1,2,15,50] This positive effect seems to predominantly reflect the impact of the experience itself rather than coming physically close to death.[15,50] During religious and mystical experiences, people may report profound joy and comfort, as well as moments of insight regarding realities that had been unknown to them, a feeling of oneness, serenity, and a loss of the sense of space and time.[1,2,51–53] These specific aspects of the classical NDE also share the same transformative long-term effects described during many deep religious and mystical experiences, which may account for the paradoxical claim by some that NDE may also occur when people are not in life-threatening circumstances.[11] A more likely explanation is that the terms are being confounded because neither what constitutes a religious experience, nor NDE, has been adequately defined. In essence, what these experiences share are transcendent qualities and research has elucidated the neural correlates of religious experiences, which include connections between almost all of the major brain structures, including the limbic system, the cerebellum, the temporal lobe, the prefrontal cortex, and the medial parietal lobes. [54,55]

Recalled Experience of Death: The Need to Decipher Other Coma-Related Experiences.

During the period of coma, a variety of experiences and memories can form at different times. However, after recovery, when people later attempt to explicitly recall their experiences, the separate memories might merge into "one" singular memory. Thus, people's recollections may actually represent a mixture of phenomenologically distinct memories developed at different times during a coma—many of which are not consistent with the classical or authentic NDE.

This was demonstrated by the AWAreness during REsuscitation (AWARE) study.[16] The 101 of 140 survivors who were able to complete the questionnaires reported memories containing seven major cognitive themes that were incompatible with classical NDE but suggested other types of memories that would be expected to form during periods of coma, such as dreams (e.g., seeing animals or plants), as well as memories that may form during partial recovery of consciousness (emergence from coma) after cardiac arrest (e.g. removal of endotracheal tube).[16] Overall, 9% (*n* = 9) reported experiences compatible with classical NDE, and 2% (*n* = 2) described an awareness of actual events related to the period of cardiac arrest (i.e., paradoxical lucidity with visual and auditory awareness and explicit recall of actual events, compatible with so-called classical OBEs).[16] This study confirmed that people in a coma after cardiac arrest are likely to report multiple phenomenologically different experiences that are separated in time. Consequently, when survivors are asked to recall their experiences, they may exhibit some degree of memory loss[43] or recall of memory fragments that could relate to: 1) a classical or authentic NDE,[1] 2) conventional dreams,[56] 3) memories related to states of delusions and delirium,[57] 4) memories formed during a period of entry into or recovery/emergence from unconsciousness,[16,58] as well as 5) CPR-induced

consciousness (CPRIC).[58,59] The themes that relate to ICU delirium, delusions and dreams are summarized in Table S7 [Online only]**.** It should be noted that unlike the recalled experience of death, or classical or authentic NDE, which only follow a certain limited number of related themes that comprise a specific narrative [Figure 1, online only], these experiences recalled during ICU delirium, delusions, and dreams include a very diverse set of seemingly unrelated themes [Table S7, online only].

Table S7: Themes Related to the Experience of ICU Delirium, Delusion, and Dreams

S7.A.Themes		
•Bodily themes and feelings related to self: Being out of it Falling or sinking Distorted perception of body and bodily sensations Feeling of floating	**•Eating and drinking** Giving the doctor a beer Ice-cream on the ceiling Drinking water Feeling thirsty	**•Sleep and time** Disrupted time perception Shift of day and night Disrupted sleep pattern Fear to fall asleep
•Misperception of places Prison Restaurant Waiting in a queue to go to a burial site On a cloud walking a dog Another country/city Not remembering where they were Car Pipe Farm Hole Wedding	**•Religious themes** Conversations with God Face of Jesus Christ in the wall and ceiling Being in a temple	**•Strong emotional feelings** Anger Fear Frustration Guilt Incomprehension Joy during and after delirium No fear
•Persecuting others Attempting murder	**•Robots** Robots coming out of a cupboard	**•Landscape** Slope
•Being persecuted Being poisoned Attempted murder by staff Buried alive in a glass sided coffin Nurse trying to steal tablets	**•Shapes** Round	**•Void/darkness** Dark nothingness
•Nature Flower River	**•Glass window** Looking through a glass window Vision of glass window all around	**•Alien Creatures** Lady with a wing Other creatures
•Seeing faces Seeing familiar faces in strange and unrealistic surrounding	**•Sounds** Strange noises Clicking noises like horses Rock breaking	**•Others** Rubber Commercial Temperature
•Aloneness Being alone	**•Animals** Horse Dog	
S7.B. Selected Quotes From Themes Described in Relation to ICU Delirium, Delusion, and Dreams		
Bodily themes (Distorted perception of body) •"...as if I had no body, only head – a big huge ball! This nurse poked me in the arm, [. . .] and I began to sense my body . . . I was in great pain . . . I only wanted to go back into my head and hide." •"I felt swollen, huge and very heavy . . . once they moved me and I felt like they were plucking a whole house out . . . My fingers felt enormous and stiff like gas pipes . . ." **Bodily themes (Being out of it)** •"... It just feels so unreal. I was so out of it. [...] Nothing really mattered. Like being out of myself."		

Bodily themes (Sinking)
•"I was sinking and I felt very peaceful – at the same time a part of me was thinking: this is death, I am dying. I was saying good-bye in my own way ..."
•"...I kept sinking deeper and deeper, for hours I just kept sinking into myself."

Bodily themes (Feeling of floating)
•"I was floating through the air surrounded by beautifully bright colored foam blocks...It was so peaceful and pretty...I felt so good with no pain."

Misperception of places (Prison)
•"[It] felt like I was still in a prison hospital."

Misperception of places (walking on clouds)
•"… was walking in clouds—big fluffy cotton wool clouds, with a dog and a rabbit, no noise, just quiet."

Misperception of places (Restaurant)
•"I remember seeing an Indian restaurant, sold Indian stuff. I remembered a woman and man arguing with each other. I remember coming to, seeing a specialist, would you believe it, he was Indian. He had his hands around my throat; he was playing with the lifesaver in my throat."

Misperception of places (Another country/city)
•"During the dreams, I was in other places. In America, because I lived there."
•"A certain moment I thought being in South Africa. Together with a large group of people, it was an experiment we already did ten years ago. There was supervision of a physician; the experiment was in the same place. Moreover, the manager of the hospital was present."

Misperception of places (Car)
•"I can still see me sitting in a car. With that little girl, the daughter of a cousin… that I drove off with her and that I entered somewhere with her not knowing where I was. And yes I called, I called… and somewhere somebody was responding. Then I called my daughters…"

Misperception of places (Pipe)
•"I was at the end of a very narrow pipe and from there I could hear everything...the pipe was I."

Misperception of places (Not remembering where they were)
•"I did not know where I was."
•"It was in the late afternoon and I certainly was somewhat tired after the operation and everything… and I did not know where I was. I thought it became like misty, in some way… the outlines were sort of fuzzy."

Misperception of places (Farm)
•"…mostly the images. The craziest thing is, and as it appears now, this is not possible and cannot be true, the ambulance dropped me in village XX, where I often pass with the train. I was at a farm, and… I clearly see the landscape… The farmer's wife obliged me to pray outdoors, naked, together with the small child of the family."

Misperception of places (Hole)
•"You are thinking all kind of weird stuff. I said, okay here I go and then there was a hole in the ground, a sink. I very often encountered that hole, but I always managed to climb out of it."

Misperception of places (Wedding party)
•"There was a wedding party going on in the room next to mine."

Being persecuted
•"The staff was trying to kill me first in the hospital and ultimately moved me to a basement …. They were extracting my blood by force to sell it and they were doing the same to a friend's daughter. I was in fear of dying. …. I pleaded for my life."
•"I was so afraid, so afraid, and I cried and shouted…. I was certainly very afraid… and every time I got that injection, I thought I got worse, and I was convinced that they were going to kill me. I was very angry with the cleaner, doctor and everybody."

•"I had to get away, at all costs… When the staff disappeared into another room and I was left alone, I thought that now I have the opportunity to get away. How terrifying it was when I realized that I had no strength left. But I got hold of the bandage and wrapped it around the bedside, to get a firm hold of it, and to get out of the bed…."
•"I remember that everything changed to me. Suddenly I was a prisoner on a Nazi camp, and I thought that the nurses were the Nazi camp guards… and I wondered whatever happened since the nurses had become so unkind to me although they were so nice before."

Persecuting others
•"I thought I was in a prison hospital … I thought I'd killed my mother and father-in-law."
•"I was in an elevator but I stood beside the bed… I was abusing the nurse, who was trying to kill me. I was mad and it was scary."

Seeing faces:
•"I was surrounded by elderly tribal people who were held in high esteem...they had some spiritual and symbolic connections...I was very confused but not aggressive. I did not know what went on around me and I had vision of things that happened to me…a perfumed bath...I know that there was so much more but I can't remember."
•"There were a lot of faces. All faces from earlier years, people living around me, neighbors and people from work. At that time, I was still working. All those people were present."

Landscape
•"I was on some large slopes and there were some green and red balls that kept growing bigger and bigger... I felt scared and terrified and did not want to go to sleep out of fear...I even saw the figures when I closed my eyes...I had no feelings of day and night."

Eating and drinking
•"I could hear a river close...I wanted to turn around and drink. I was very thirsty, but at the same time [I thought] keep going, don't stop, walk!"
•"I was watching the waterfall and I drunk water from it."
•"It began with an enormous thirst… it was like fire in my throat, my tongue was stuck up against my palate and then the nightmares began."

Animals:
•"That's the way it was, I was a horse and the horse was lame and was going to be shot. And I thought that the horse would be shot, and I thought that I would be shot. It was probably at that moment that I tried to get out of bed."

Sleep and time
•"There is [no time/passage] of time. Like being on vacation somewhere."
•"Actually you do not know when its day or night, in your dream you can make any time of it. When you want to call it day, then it is daytime…"
•"I was confused; sometimes I woke up in the morning and looked at my clock. Since it was seven o'clock, I presumed it was morning and wanted to get out of bed. But, I did not understand, it had to be light. Then I did not knew anymore if it was day or night…"

•"I asked for the day and the time. But when you looked outside it did not match. In the morning they said sleep well, and in the evening they said good morning or something alike."

Sounds
•"… clicking doors … all noises like trucks and earth works happening around me."

Strong emotional feelings
•"I was so frightened… all the feelings… it was dizzy, it took a long time before I could calm down and control the situation. Now I am dying, I thought."
•"Afraid, yes…afraid and you do not understand why, you start to think how long I had to stay imprisoned."
•"I was afraid, I could not breathe."
•"I was scared, really scared…"
•"I was angry… You blame someone you do not know. They told me to pray naked! Naked!"
•"I was so frightened… all the feelings… it was dizzy, it took a long time before I could calm down and control the situation. Now I am dying, I thought."

•"They said...I would die...I was not afraid. I knew exactly what death was...He was there with me and I was not afraid. From that point on I am not afraid of death. I wish I could tell others – it is really so simple."

Aloneness:
•". . . I am alone in this big huge area, where there is nobody and nothing!...(a) kind of a desert, a vast brown empty thing."
•"I could hear them talking about me – but I was alone, like suspended in space."

Void/Darkness
•"...everything is so dark, no light,...just black. There is nothing, no sound, like under water. I could not do anything, even if I wanted to. I was still..."
•"… it truly has taken away my fear of death, so incredibly! It was such a peaceful feeling, it was just NOTHINGNESS […] it was just a peaceful feeling."

Aliens/other creatures
•"I was dreaming about a lady with wings. Although, it was a beautiful lady, fair-haired. She wanted to take me to another world… There were all kind of creatures…"

Nature (Flower)
•"It was so beautiful…such incredibly beautiful flowers… and I almost feel the loss of it. But later on, in the evening it was much more frightful…."

Nature (River)
•"I needed them to hold my hand. I thought this was the only way to remain on the surface and not get swept along in the river I felt beneath me."

Shapes (Round)
•"It was as if everything went round and round, I was in hospital but still it did not look like a hospital to me."

Rubber
•"There were no walls, as if they were from rubber and they were extending to infinity – everything was there at once, I could see everything."

Commercial
•"I was several times in situations that… oriental situations… Arabic, Asian. Always outdoors and not very luxurious. What I found unpleasant was the commercial passing by. Always the same and it kept on showing up. It was 'made in China… made in China…"

Temperature
• "… I remember having a fan because I was hot …"

Table S7 represents data derived from various publications that have reported on the features of dreams, delirium, and delusion in relation to critical illness and intensive care unit admission[56,61,124-126]. Qualitative descriptions were collected and summarized into themes (Table S7A) and quotes (Table S7B), respectively.

Recalled Experience of Death—so-called Frightening, Distressing and Hellish NDE:

During the years after Moody's descriptions of the classical NDE, some started to label persecutory, frightening or distressing experiences in relation to medical disorders and critical illness as "negative," "distressing," or "hellish" NDE.[3,60] However, typically, these so called 'negative NDE' neither share the same narrative or themes as the classical NDE, nor do they share the same transcendent qualities, ineffability, and long-term transformative effects of the classical NDE. In sum, so called negative NDE appear to be fundamentally and phenomenologically different from the classical NDE.[60] In reality, the majority of these descriptions largely represent a mislabeling of ICU delirium and delusions, which have a rich literature and are well described in relation to toxic metabolic states, withdrawal states and other derangements that can lead to persecutory and frightening experiences, as well as dreams, in hospitalized

and critically ill patients.[61,62] The initial mislabeling of these experiences was not based on specific criteria or a scientific process, and no definition or consensus has ever been established. Notwithstanding, the use of these terms contributed to and enabled the notions of so-called "hellish" experiences related to death in the media and elsewhere.

Accordingly, researchers should be aware that many experiences classically categorized in the medical literature as ICU delirium, delusion, and dreams can be inadvertently and erroneously mislabeled as so-called negative, hellish, or distressing NDE. In many cases, these delusional experiences may represent confused processing and/or misattribution of information relating to actual events that were occurring at a time when the individual was either entering into or awakening (emerging) from a coma. In the AWARE study, some of the broad recalled themes included a sense of violence or a feeling of being persecuted, as well as partial recall of events that relate to ICU clinical care during emergence from coma (e.g., removal of an endotracheal tube).[16] At the time of partial recovery of consciousness and emergence from coma, patients may misattribute the activities of staff to violence and persecution (e.g., when they are being restrained to protect themselves from harm).[62,63]

Ineffability: The "Flatland" Story of Limitations in Language, Brain, and Sensory Organs.

People with transcendent experiences in relation to death consistently describe their experiences as being ineffable.[1,2] One challenge is that in any language the words available to describe internal states are typically limited to a certain number of specific terms (e.g., happiness, sadness, euphoria, light, darkness, and color) with much overlap. Thus, although experiencing a bright light may arise after a diverse series of events, distinguishing between these phenomenologically different experiences—as well as their qualitative effects and impacts on the individual—is very difficult. For example, experiencing a light may occur when looking at a light source, but also due to an ophthalmological disorder, a disorder of the occipital lobe, the impact of drugs, a deep transcendental religious and mystical experience, or in relation to death. While qualitatively and phenomenologically distinct, due to the limits of language, these varied experiences are all labeled as a "light."

The reports of ineffability may also be rooted in the inherent limitations of the human brain and sensory organs with respect to their ability to perceive reality. The limitations of the five sensory organs to gather data regarding external realities are well documented. For example, while the human eye is only capable of detecting electromagnetic waves in a very specific and narrow range (i.e., light waves only), a bee's eye or a snake's eye can detect wavelengths that lie outside the range of the human eye. Dogs have a far more sensitive sense of smell than humans, and so on. Thus, animals may detect certain realities that lie beyond the capabilities of humans. Yet the inability to detect reality does not mean it is not present. The human brain also has processing limitations that, while not initially obvious, become evident when attempting to make sense of information beyond its usual processing capabilities. This limitation may be experienced in its simplest form when viewing visual/optical illusions (such as an Escher drawing) and in a more complex form when attempting to tackle realities that exist beyond the limits of detection of human sensory organs. Anything that exists and emits electromagnetic (EM) radiation beyond the visible light range will not ordinarily be perceived and 'knowable' to humans except with the aid of technology that can detect the specific EM radiation outside this range.

Although some physicists have argued that multiple dimensions exist in the universe,[64] the realities that lie beyond a three-dimensional world are not readily accessible using a three-dimensional brain. Even if such realities (e.g., an n^{th} dimension) could be theoretically perceived, as soon as someone tries to communicate them to others, they will be transfigured into the framework of a three-dimensional reality by virtue of being processed by a three-dimensional brain. This point has been explained further by prominent modern-day physicists, such as Lisa Randall, by reference to the characters of a well-known 19th-century book *Flatland: a Romance of Many Dimensions.* In this book, the lead character struggles to describe a three-dimensional structure—a sphere—using two-dimensional terminology and constructs that exist in a theoretical two-dimensional world called "Flatland." In the end, a three-dimensional sphere passing through this two-dimensional flatland world is necessarily only able to be observed and described as a series of two dimensional circles that start small, but get larger and larger, before becoming progressively smaller and smaller until they disappear (much like how a computed tomography scan illustrates the three-dimensional human body as a series of two dimensional sliced cuts).[64,65]

Whether an authentic case of classical NDE or a deep religious or mystical experience reflects an external reality cannot be known. Many people with these experiences have described a belief that their experiences are real and that they have perceived an alternate reality that they are unable to express adequately, as the qualitative nature of their experiences are changed and "transfigured" due to the limitations of their brain. Consequently, such experiences are typically expressed using terms commonly shared with other human experiences, such as seeing a tunnel or a bright light, irrespective of what may have been experienced. Thus, although it is possible that people with NDE may have witnessed exactly what they describe (e.g., a tunnel or a light), it is also possible that their experiences were entirely different but, when recalled, were transfigured and made to fit into one of a series of available brain states (such as seeing a tunnel), much like how a three-dimensional sphere is transfigured into a series of circles in a two-dimensional world. We cannot say whether such experiences are "real." However, while science today has not been able to prove the reality or meaning of these experiences, it also has not disproved them.

Some Proposed Explanatory Theories for Recalled Experiences of Death and Their Limitations.

For decades, some attempts have been made to categorize the recalled experiences of death as delusional, illusory, or hallucinatory, brought about as a by-product of cerebral dysfunction and altered neural intermediaries in relation to death. This line of thought—and theories associated with it—has two major conceptual limitations. The first limitation is that the identification of a relationship between a given neural intermediary and a human experience (whether in relation to death or otherwise) cannot determine whether the experience is actually real, hallucinatory, delusional, or illusory. This is in part because all human experiences, whether triggered in response to what may be considered a real event, artificially induced, or occurring in response to an imaginary event, are mediated by the same underlying neural intermediaries (neurotransmitters, hormones, and neuropeptides) across multiple brain regions.[66] In the same way that identifying changes in levels of dopamine, oxytocin, or other intermediaries in relation to the study of love[66] cannot determine whether someone's love is real,

hallucinatory, delusional, or illusory, there are no specific neuromodulators that can distinguish between experiences arising in response to a 'real' or 'non-real' event.

The second major conceptual limitation is the well-established fact that any observed association between two variables—including a human experience and its underlying neural intermediaries or otherwise—cannot be assumed to reflect a causative relationship between them. For instance, just because experiences of love are associated with increases in oxytocin, dopamine, and other transmitters, this does not mean that love causes those increases or that those increases cause the feeling of love.

In addition to these two broad conceptual limitations, the proposed intermediary-based theories summarized below can be classified into three categories, each suffering from other broad limitations: (1) speculative theories put forward without any supporting research data (e.g., the hypoxia/anoxia, NMDA, serotonin, and endorphin theories), (2) theories based on very weak association data (e.g., hypercarbia and REM-intrusion theories), and (3) theories that reflect the lack of precise definitions, as well as measurement scales used incorrectly in non-context-specific circumstances. As a result, many different and diverse human experiences have been mislabeled as the same experience.

Nonetheless, a variety of potential neural intermediaries have been proposed to account for the occurrence of recalled experiences in relation to death as either hallucinations, delusions, or illusions in response to a disordered brain. These include hypoxia,[9,67–69] hypercarbia,[70] hormones and neurotransmitters including endorphins[71,72]or serotonin,[73]*N* -methyl-D-aspartic acid (NMDA) receptor activation,[74] or activation of the temporal lobes leading to seizures[75] or limbic lobe activation.[76]

Seizures, Epilepsy, and Religious Symbols

Although a universally accepted definition of what constitutes or defines a 'religious' or 'spiritual experience does not exist, some have proposed that experiences labeled as 'religious' occur in 1.3% of epilepsy and 2.2% of temporal lobe epilepsy (TLE) patients.[77] However, in these studies, the label 'religious' has been applied loosely based on the simple use of a religious symbol or phrase by individuals during seizures, rather than a deeper analysis of what constitutes a religious or spiritual experience, including its phenomenology.[77] Specifically, patients with TLE have been observed to report vivid dream-like states, déjà vu experiences, and repeated automatisms in which they may repeat phrases, such as "God, God, God," as well as depersonalization, and fearful and anxiety-eliciting experiences.[77] Some have used this observation to propose that experiences in relation to death, and religious experiences in general, may occur as a result of aberrant cerebral functioning similar to that seen during TLE.[78] However, without any supporting studies to demonstrate either causation or association, this is at best a speculative assumption. In addition, any conclusions regarding the use of terms and phrases within the context of language should be based on linguistic analytics and the science of language. Furthermore, studies have shown that the phenomenology and characteristics of recalled experiences of death are not consistent with automatisms with or without religious terminology that occur with TLE and are in fact phenomenologically dissimilar to TLE experiences.[79]

Oxygen Deprivation: Hypoxia or Anoxia Induced Experiences

Another oft-discussed theory concerns hypoxia. [67,68] More than 20 years ago, hypoxia was proposed to lead to the illusion of seeing a tunnel.[67,68] Although hypoxia has been extensively researched as part of a wide range of medical disorders, such as asthma, emphysema, and acute respiratory distress syndrome, including COVID-19, no association between so-called NDE and hypoxia has been reported. In fact, the hypoxia theory has received no support from any scientific studies. Furthermore, despite thousands of human studies involving hypoxia, none have reported any observations of patients seeing a tunnel. Instead, hypoxia leads to an acute confusional state (delirium) with clouding of consciousness, as opposed to the structured episodes of paradoxical lucidity, and the thought processes, reasoning, and memories with transcendent features that reflect the classical or authentic NDE.[79] Furthermore, at least one study of cardiac arrest survivors has demonstrated no difference between oxygen levels in patients with NDE and those without,[70] while another study demonstrated a possible inverse relationship.[38]

Acceleration (+Gz)-Induced Loss of Consciousness

In 1997, Whinnery, an engineer, claimed similarities between NDEs and acceleration (+Gz)-induced loss of consciousness (G-LOC), which causes transient episodes of syncope due to cerebral ischemia arising from reduced cerebral blood flow (CBF) in fighter pilots.[69] This phenomenon occurs when extreme acceleration during flight leads to the pooling of blood in the limbs, with a significant reduction in CBF.[69] This report was largely a description of the author's own personal views laced with a limited number of anecdotes and largely did not contain scientific data. Despite this lack of scientific rigor by today's standards, on closer examination, it is worth noting that the experiences Whinnery reported and labeled as "NDE" were quite dissimilar to the classical NDE and were consistent with conventional dreams.[69] For example, one 20-year-old fighter pilot stated that during his unconscious state he had a dream, which he described as follows: "… I can't remember what we were doing, but when I came back [return of consciousness] I thought I shouldn't be here. We were outdoors; it was wild!" Other anecdotes related to dreams during G-LOC included watching a "sunset" or people dreaming that they were "floating in a blue ocean."[69] Whinnery also claimed that some individuals after experiencing G-LOC reported OBE, but provided no detailed descriptions. It is possible that what those individuals described may not have been phenomenologically consistent with the classical OBE descriptions. Unlike the classical NDE descriptions, these G-LOC reports did not include a life review, a transcendent experience, or any long-lasting transformational effects[69]–further evidence that these were likely phenomenologically dissimilar experiences (e.g., conventional dreams labeled as NDE due to lack of definition). Finally, the NMDA receptor, serotonin, and endorphin-based theories are also unsupported by scientific studies to date.[73–76] Nonetheless, it has been proposed that the NDE is caused by aberrant changes in NMDA receptor activation, leading to hallucinations, or that serotonin or endorphins cause a sense of peace and comfort.[73–76]

Another category of theories are those advanced based on weak association data. One small study reported a possible association between NDE and hypercarbia.[72] Much like hypoxia, this condition has also been extensively studied as part of a diverse group of respiratory disorders, without any indication of classical NDE-like experiences occurring in hypercarbic patients. In reality, carbon dioxide levels

measured during CPR are a marker of resuscitation quality[80] and this might impact the recall of memories and so-called NDE. Furthermore, an earlier study of NDE after cardiac arrest found no association with hypercarbia.

Disorders of Sleep and Dreaming

Another proposed theory suggests that REM intrusion—the continuation of features that occur during rapid eye movement (REM) sleep into states of wakefulness (such as transient paralysis) causes the recalled experience of death and manifests as a type of hallucination or delusion.[6] This theory was proposed based on an association found between reports of so-called 'NDE' and symptoms of REM intrusion in a very small study with significant design limitations, including concerns for bias related to the control group.[81] In 2019, Kondziella et al., attempted to replicate this study with 1,034 people through an internet-based crowd-sourcing platform.[82] They concluded that features of REM intrusion were more likely to be reported by people who they had categorized as having had an "NDE."[82] However, this study too had significant design concerns. In particular, the researchers failed to distinguish individuals with experiences that were consistent with a classical NDE from those describing many other experiences that did not meet the criteria for an NDE, including experiences based on the measurement scale that they had used themselves to define an NDE (i.e., Greyson NDE scale score <7) and experiences that were clearly not phenomenologically consistent with an NDE but were nonetheless arbitrarily and unilaterally labeled as "NDE" by the authors (e.g., a variety of distressing experiences, frightening dreams, drug induced experiences, and other experiences in non-life threatening circumstances).[82] One illustrative case that demonstrates the misuse of the term NDE in this study involves the following case of a 28-year-old woman who reported her dreams to the authors. She stated: "Sometimes I wake at night, and I can't move. I see strange things, like spirits or demons at my door, and after a while I see them coming beside me. I can't move or talk, and they sit on my chest. It scares the hell out of me! I think that it is a dream, count to 3 and close my eyes. Sometimes this helps."[82] The authors included this case as an "NDE", likely because of the reference to spirits and demons, despite the fact that the measurement scale they used was used in a non-context specific manner but is not designed for use in relation to dreams and other diverse human experiences [section 3.12]. Not only did this study demonstrate major errors determining so-called NDE cases, but it also revealed problems related to the questions (which were not specific or sensitive) used in the measurement scale/survey used to determine a predilection for REM intrusion. For example, the following question was used to identify REM intrusion: "Have you ever had abrupt muscle weakness in your legs or knee buckling or felt sudden muscle weakness in your face or head drop?"[82] This question is so nonspecific that a "yes" response could characterize an individual with any broad range of orthopedic or neurological disorders at any time in their lives, ranging from knee arthritis and meniscus tears, to multiple sclerosis and muscular palsy. Thus, this study is not able to determine whether a true association exists between REM intrusion (e.g., feeling transiently paralyzed after waking up) and the classical NDE. Notably, REM intrusion is very common in the general population and has been described in association with many conditions, including post-traumatic stress disorder (PTSD).[83] In the same way

that any association between REM intrusion and PTSD cannot be considered to be causative, should such an association ever be identified with classical NDE, it cannot be assumed to be causative.[81,83]

Hallucinogenic Drug Induced Experiences

Currently, a host of phenomenologically diverse experiences, including hallucinogenic drug-induced experiences, are loosely labeled using the umbrella term of 'NDE'.[10] Because people sometimes mention 'religious' and 'spiritual' features or symbols, or use ill-defined terms like "spirits," when reporting dreams[82] or during experiences induced by hallucinogenic drugs, such as DMT, ketamine, and psilocybin, some have proposed that the classic NDE reflects dreams[82] or hallucinatory experiences.[10] They have further proposed that the brain mechanisms behind these experiences are probably similar or even identical. However, closer examination of the data from these studies indicates that in large part these experiences that are being labelled as NDE reflect the use of imprecise definitions and research scales, rather than actual phenomenological similarities.[12, 13,84] Data synthesized from published studies related to the experiences that arise after the use of hallucinogenic drugs are summarized in Table S3 [Online only]. It is important to point out that as with TLE, the lack of a universal definition of what constitutes a religious experience or even a so-called NDE has contributed to the assumption that there may be a similarity between so-called NDE and hallucinogenic experiences. This has been further exacerbated due to the lack of rigorous analyses using linguistic approaches and reliance on the science of language to ascertain the meaning of these experiences. Consequently, when a religious symbol, figure, or phrase (e.g., cross, Jesus, God, or spirit) is simply mentioned during neurological or psychiatric events such as TLE, schizophrenia, dreams, or drug-induced states, it can be superficially categorized by some as a 'religious' experience, without regard to the phenomenology, meaning, and impact of such an experience. Another major contributing factor that enables some to argue that drug-induced states are similar to so-called NDE involves the misuse of research scales that were developed for the specific study of so-called NDE in non-context-specific circumstances, even though these are not designed for, nor are they sensitive or specific enough to distinguish a classical NDE from other experiences.[52,84]

Hallucinations, Delusions, or Reality: Limitations of Neuroscience at Determining Reality.

The reality of human experiences and the meanings ascribed to them are determined socially and not using neurobiological criteria. Specifically, reality is established through social consensus, whereby humans determine and ascribe meaning to phenomena and experiences within any given culture or society, including scientific groups. When a sufficient number of members of a society or social group (including scientific and medical bodies), particularly those with influence, assign reality to a given experience, it becomes socially accepted as being "real." Of course, with regard to the experience of death, only a minority of individuals have come close to death and returned to describe their experiences. Therefore, in some social circles and scientific groups, their experiences may be considered real, while in others they may not.[85] However, as with many other subjective and personal experiences, such as love, which are discerned as being real to the individuals who have experienced them, it is impossible for others to reliably reject or determine the reality of someone else's internal experiences.

Nonetheless, two separate methods have been used to try to address the issue of reality in relation to the recalled experiences of death. The first, a small study of coma survivors, attempted to explore this question based on the principle that memories of imagined events are distinguishable from memories of real events, because memories of imagined events have fewer phenomenological characteristics. In particular, they contain fewer perceptual (i.e., visual, auditory, gustatory, and olfactory sensations), temporal, and spatial details, as well as less emotional information. [86] Thus, to test the hypothesis that NDEs are imagined experiences brought about by abnormal or awry cerebral mechanisms, Thonard et al.[87] analyzed the phenomenological characteristics of real and imagined memories in 21 patients who had recovered from comas. The results showed that NDE memories had more characteristics associated with real memories than with memories of imagined or even actual real events ($p < 0.02$). For example, NDE memories contained more self-referential and emotional information and had better clarity. [87] The investigators concluded that NDE memories are not consistent with imagined memories.

The second study, AWAreness during REsuscitation (AWARE), aimed to test and verify the timing of awareness and consciousness during cardiac arrest. Although only 2% of 101 cardiac arrest survivors who could be interviewed showed explicit recall and awareness compatible with so-called classical OBE, in at least one case, the recalled experience relating to actual events occurring in the resuscitation room was verified as being accurate, correct, and consistent with real events that had occurred some 3-5 minutes after the heart had stopped and when the brain was expected to be either severely disordered or not functioning.[16] This supports a similar observation by Van Lommel et al. in 2001, in which a patient had correctly recalled watching his dentures being removed and could recall where they had been placed during a cardiac arrest.[15] The investigators concluded that, while a larger study is needed, in some cases of cardiac arrest, paradoxical lucidity with visual awareness compatible with so-called classical OBE corresponds to actual events and cannot be considered a hallucinatory, illusory, or delusional experience.[16]

Exploring Potential Underlying Electrocortical Biomarkers at the Time of Death:

One animal and one human study have reported a brief surge of electrical activity within 30 seconds after cardiac standstill.[88,89] Others have also observed depolarization leading to electroencephalographic changes around the time of death in the brain, which has been referred to as “anoxic,” “asphyxial,” or “terminal” depolarization. This phenomenon, which may be initiated from one or multiple foci in the brain before spreading across the whole brain as a self-propagating wave, has led to speculation by some that this surge of electrocortical activity may represent a biomarker related to the occurrence of cognitive activity and/or paradoxical lucidity in relation to death.[88,89] Although the identification and characterization of electrocortical biomarkers in relation to death may have significant implications for diverse fields such as organ transplantation, unfortunately, it will never be known whether any of the human or animal subjects in these studies had any mental experience or lucidity, because no humans survived to recall their experiences. Therefore, to make a claim for an association between two variables when one variable of interest is not known to have been present, is speculation at best. Furthermore, animals are not known to have transcendental experiences and none of the animals survived in these studies either. Rather than being related to any speculative cognitive experiences, the observed spikes

in electrical activity and terminal depolarization represent a biomarker of the pathophysiological changes related to excitotoxicity and the intracellular influx of calcium at around 30 seconds after anoxic brain injury starts.[86]

Evolutionary Theories:

More recently, Kondziella and colleagues have proposed that the universality of recalled experiences in relation to death suggests that they must have a biological and evolutionary origin, which they propose may be related to the phenomenon of *Thanatosis* – or death-feigning.[90]

The Study of Recalled Experiences of Death: Implications for the Study of Consciousness and the Mind-Body Problem.

During cardiac standstill, brain function ceases almost immediately, as there is an immediate drop in CBF to levels less than that required to maintain cellular metabolic activity before CBF ceases completely, within a few seconds.[91,92] The initiation of CPR typically leads to approximately 10-15% of baseline CBF, which cannot meet the metabolic requirements of the brain.[93,94] Overall, these changes in CBF are manifest as a loss of brain function as evidenced clinically by the rapid loss of brain stem reflexes (evidenced as loss of the gag reflex and fixed dilated pupils), as well as loss of consciousness, which remain largely absent despite ongoing CPR.[93,94] Concurrent EEG monitoring has demonstrated the concomitant loss of cortical function.[95–101] The loss of CBF initially manifests as a slowing of the EEG that progresses to an isoelectric (flat) line within 2–20 seconds and usually remains flat in spite of attempts at CPR, typically until after the resumption of the heartbeat.[98] Recent studies have shown that although some patterns of EEG activity may transiently reappear during CPR, the majority of the time no measurable EEG activity is observed.[102] In these cases, the emergence of transient EEG activity may reflect transient episodes of restoration of cardiac activity (restoration of the heartbeat) before cardiac activity is lost again. In cases of prolonged cardiac arrest, EEG activity may not return for many minutes or hours after the heartbeat has been restored (or not at all depending on the extent of the cerebral insult).[100]

Although certain non-cardiac arrest deep coma states may lead to a selective absence of cortical electrical activity in the presence of deeper brain activity,[103] this state is unlikely to occur during cardiac arrest, as this condition is associated with global cerebral hypoperfusion rather than selective cortical hypoperfusion. Furthermore, the loss of cerebral perfusion, leading to a loss of cortical EEG activity during cardiac arrest, typically correlates with loss of activity of deep brain structures as measured by in-dwelling electrodes.[104]

Growing reports of conscious awareness and, in particular, of paradoxical lucidity, with well-structured cognitive processes, including attention and memory recall of specific events at a time when cerebral function is severely impaired or absent during cardiac arrest, raise a number of interesting and perplexing questions. Notably, cerebral localization studies have indicated that cognitive processes are mediated through the concerted activity of multiple cortical regions, and evidence of this activity is used by scientists to determine the presence of consciousness.[105] Based on this assumption, a globally disordered brain, including a nonfunctioning cortex, should not support lucid thought processes, memory recall, and consciousness. Ordinarily, a prerequisite for being able to report an experience – whether a so-called NDE

or otherwise - is that a person would have to have had a well-functioning brain. Without a well-functioning brain, how would it be possible to make an experience that is so rich in details, store it over many years, retrieve it easily, and report on it in an eloquent manner many years later? Even relatively minor reductions in CBF lead to confusional states (acute confusional state/delirium) and impaired attention, followed by LOC, rather than the lucid thought processes, attention, and memory formation that are ordinarily reserved for consciousness in a normally functioning brain with levels of CBF that can support normal levels of brain metabolism.[106] However, the experiences reported are not confusional; furthermore, they are reported from a time when consciousness and memory formation should not be possible in light of the underlying levels of cerebral activity and markedly reduced CBF.[91] Alternatively, these experiences may occur either before the brain shuts down completely or just after recovery from cardiac arrest, when brain function resumes. However, the AWARE study indicated that cognitive experiences and consciousness can occur during the period of cardiac standstill, when brain activity is not expected.[16] This study further indicated that the memories and conscious experiences consistent with a classical NDE or OBE are phenomenologically different from the very rare phenomenon of CPR-induced consciousness (CPRIC), which has an incidence of 0.3% during CPR attempts.[59] During CPRIC, patients demonstrate visible external signs of consciousness.[59,107] The most common sign of CPRIC is combativeness/agitation, groaning, and eye opening/rolling.[59,107] Although more studies are needed, episodes of CPRIC likely represent patients who have regained a heartbeat during CPR, but whose heartbeat remains undetectable when clinicians examine for the presence of a pulse.[108]

Although science has yet to discover the nature of human consciousness, little evidence supports the notion that experiences of paradoxical lucidity with conscious awareness (with visual and auditory perception) in relation to death are hallucinatory, illusory, or delusional and occur in response to metabolic or other derangements, including hypoxia or hypercarbia. Overall, two broad mechanisms have been proposed to account for the emergence of the phenomenon of consciousness. Consciousness is thought to be the product of either a “bottom-up” or a “top-down” phenomenon. That is, consciousness or psyche (self) is a by-product of brain cell activity—an epiphenomenon—arising from the coordinated activities of cerebral regions, or consciousness is a separate entity that, while undiscovered by science today, is not produced by conventional brain cell activities and can itself independently modulate brain activity.[91] Although further studies are needed, the finding that the human mind, consciousness, or psyche (self) may continue to function when brain function is severely disordered or has ceased raises the possibility that the latter mechanism may need to be considered in any future scientific exploration of consciousness.[91,109,]

Recalled Experience of Death: Limitations of Current Measurement Scales and Their Misuse.

In light of the numerous challenges facing the study of recalled experience of death, as well as the heterogeneous nature of experiences being labeled as NDE at this time, it is not surprising that a research scale that can measure these experiences with sufficient sensitivity and specificity has not yet been developed. In 1980, Ring created the “weighted core experience index” (WCEI) by taking specific components of an NDE, such as the sense of being dead, feelings of peace, or separating from the body, and assigning a weight to each.[52] Each feature was scored based on its presence or absence, and the

weighted total of the features that were present were given a score between 0 and 29. Scores between 1 and 5 were classified as a superficial NDE and those over 6 were classified as a core NDE. [52]

Although the WCEI represents a promising attempt to measure NDE, one notable challenge is that the presence of non-specific features alone (e.g., a sense of being peaceful) can lead to an experience being classified as an NDE, even when it could easily have occurred under entirely different circumstances.[52] This would lead to many false positive cases of 'NDE'. In 1983, Greyson developed the most commonly used measurement scale of so-called NDE. The scale contains 16 items that are weighted (0 = absent, 1 = mildly present, 2 = definitely present). Initially, 80 items were identified and narrowed down to 33. These items were tested on 100 people with self-reported NDE (mean age = ~50 years) after surgery, childbirth, pregnancy, accidents, and sudden natural events (but few cardiac arrests or specific illnesses requiring intensive care unit care).[84] A frequency analysis was then used, whereby frequency counts were created for each feature and correlation coefficients computed to quantify the correlation between each item and the other 32 items. Sixteen items that correlated with each other ($r > 0.35$) were ultimately selected. Using this scale, an NDE was defined as an NDE Scale score ≥7. [84]

Today, almost 40 years after these scales were developed, a number of limitations have become apparent. Furthermore, while not obvious at the time of the scales' development, many of the terms and prompts used in Ring and Greyson's scales, adopted in a literal sense from the public, are not sensitive or specific enough to distinguish a classical or authentic NDE from other phenomenologically different human experiences.[52, 84] For example, the questions in Greyson's proposed NDE scale[101] include the following ambiguous terms related to experiencing: "strange bodily sensations," an "unearthly" [place], "mystical" [feelings], "joy," "harmony," "pleasantness," and "spirits." Such terms can refer to a multitude of human experiences. [84] Additionally, the term, "unearthly" [84] is very broad and relates to non-specific experiences that are out of the ordinary, which could range from experiencing a beautiful and idyllic vacation spot to feeling "high" after ingesting psychoactive drugs. As a result, even though this is implied, because a clear definition of being 'near death' did not exist when the scales were developed, neither measurement scale included a question that would ensure the scales would be used in a specific and appropriate population, i.e. those with a life-threatening event. Thus, when these scales are used out of context, as with other scales, many false positives can arise. For example, if a person travels to an idyllic, beautiful, and peaceful vacation spot that seems out of the ordinary, and thinks back on their life, then this simple common experience would be mislabeled an NDE using Greyson's NDE scale, as it includes the following features: a) feelings of peace, b) harmony, c) being in an unearthly place, and d) memories of one's past. Researchers need to be aware of these false positive cases.

Notably, although these scales were intended to measure and quantify the depth of a classical or authentic NDE, they are now used by some to misclassify other experiences (without reference to the context), including dreams and drug-related experiences, as "NDE." More recently, a new measure derived from the original Greyson NDE scale, the Near-Death Experience Content (NDE-C) scale, has been proposed. Although not yet used widely, it retains all the same limitations of the Greyson NDE scale that have been outlined and from which it was derived, including the inability to distinguish between true or authentic cases of NDE and false positive cases of NDE. However, the NDE-C has the added limitation that the authors have included the undefined and unregulated concept of so-called "negative" or "distressing

NDE." The unilateral inclusion of these memories in contrast to all other prior scales is a major confounder and weakness, as these experiences often represent memories related to ICU delirium, delusions, and dreams in response to toxic metabolic states and withdrawal states (e.g., alcohol withdrawal) and are phenomenologically and fundamentally different from a recalled experience of death (and classical/ or authentic NDE). As such, these negative experiences should be studied separately under the correct term of ICU delirium, delusion, and dreams, rather than being mixed in with and mislabeled as "NDE." The development of this scale, like the original NDE scale proposed by Greyson in 1983, also does not require a relation to life-threatening events. Additionally, it relies on frequency analysis, despite the fact that many features of a classic or authentic NDE may not be recalled by individuals. Thus, the development of any research scale that relies on the frequency of explicit recall of specific memories (using factor analysis or otherwise) does not represent an ideal method for accurately assessing experiences related to a period of unconsciousness, in which memory loss is expected by definition. Furthermore, such an approach will lead to the loss of important themes related to the experience of death (due to inadequate recall), and the inclusion of other themes frequently recalled in relation to other human experiences such as dreams.

References:

1. Moody RA. *Life after Life*. Bantam Press; 1975.
2. Fenwick P, Fenwick E. *The Truth in the Light*. Hodder Headline; 1995.
3. French C. Near-death experiences in cardiac arrest survivors. *Prog Brain Res*. 2005;150:351–367.
4. Cardena E, Lynn SJ, Krippner. *Varieties of Anomalous Experiences: Examining the Scientific Evidence*. American Psychological Association
5. Greyson B. Near-death encounters with and without near-death experiences: Comparative NDE Scale profiles. *J Near-Death Stud*. 1990;8:151–16.
6. Nelson KR, Mattingly M, Lee SA, Schmitt FA. Does the arousal system contribute to near-death experiences? *Neurology*. 2006;66:1003–9.
7. Beauregard M, Courtemanche J, Paquette V, V. Brain activity in near-death experiencers during a meditative state. *Resuscitation*. 2009;80:1006–1010.
8. Charland-Verville V, Jourdan J-P, Thonnard M, Ledoux D, Donneau A-F, Questermont E. Near-death experiences in non-life-threatening events and coma of different etiologies. *Front Hum Neurosci*. 2014;8:203.
9. Lempert T. Syncope and near death experience. *Lancet*. 1994;344:829–830.
10. Timmerman C, Roseman L, D W. DMT models the near-death experience. *Front Psychol*. 2018;9:1424.
11. Owen, J.E, Cook, E.W , Stevenson, I. Features of "near death experience" in relation to whether or not patients were near death: Lancet. 1990;336:1175 – 77.

12. Martial C, Cassol H, Charland-Verville V, Pallavicini C, Sanz C, Zamberlan F. Neurochemical models of near-death experiences: a large-scale study based on the semantic similarity of written reports. *Conscious Cogn*. 2019;69:52–69.

13. Martial C, Simon J, Puttaert N, Gosseries O. The Near-Death Experience Content (NDE-C) scale: Development and psychometric validation. *Conscious Cogn*. 2020;86:103049.

14. Eertmans W, Salcido D, Genrugge C. Regional cerebral saturation in post-cardiac arrest patients is doomed...or is it just a near death experience? *Resuscitation*. 2020;154:117–118.

15. Van Lommel P, Wees Van R, Meyers V, Elfferich I. Near-death experience in survivors of cardiac arrest: a prospective study in the Netherlands. *Lancet*. 2001;358:2039–45.

16. Parnia S, Spearpoint K, de Vos G, et al. AWARE-AWAreness during REsuscitation-A prospective study. *Resuscitation*. 2014;85:1799-1805. doi:10.1016/j.resuscitation.2014.09.004

17. Greyson B, Fountain NB, Derr LL, Broshek DK. Out-of-body experiences associated with seizures. *Front Hum Neurosci*. 2014;8(65).

18. Bateman L, Jones C, Jomeen J. A narrative synthesis of women's out-of-body experiences during childbirth. *J Midwifery Womens Heal*. 2017;62:442–451.

19. Cardeña E, Alvarado CS. Anomalous self and identity experiences. In: Cardeña E, Lynn SJ, Krippner S, eds. *Varieties of Anomalous Experience: Examining the Scientific Evidence*. 2nd Edn. American Psychological Association; :175–212.

20. Khoshab H, Seyedbagheri S, Iranmanesh S, PM S. Near-death experience among muslim cardiopulmonary resuscitation survivors. *Iran J Nurs Midwifery Res*. 2020;25:414–418.

21. Yu K, Liu C, Yu T, et al. Out-of-body experience in the anterior insular cortex during the intracranial electrodes stimulation in an epileptic child. *J Clin Neurosci*. 2018;54:122–125.

22. Kantaro H, Shinoura N, Ryoji Y, Midorikawa A. Dissociation of the subjective and objective bodies: Out-of-body experiences following the development of a posterior cingulate lesion. *J Neuropsychol*. 2020;14:183–192.

23. Lopez C, Elziere M. Out-of-body experience in vestibular disorders - A prospective study of 210 patients with dizziness. *Cortex*. 2018;104:193–206.

24. Bos EM, Spoor JKH, Smits M, JW S, Schouten JW, Vincent AJPE. Out-of-Body Experience During Awake Craniotomy. *World Neurosurg*. 2016;92(586):586 9–586 13.

25. Devinsky O, Feldmann E, Burrowes K, Bromfield E. Autoscopic phenomena with seizures. *Arch Neurol*. 1989;46:1080–1088.

26. Fang T, Yan R, Fang F. Spontaneous out-of-body experience in a child with refractory right temporoparietal epilepsy. *J Neurosurg Pediatr*. 2014;14:396–9.

27. Yong E. Out-of-body experience: Master of illusion. *Nature*. 2011;480:168–170.

28. Ehrsson H. The experimental induction of out-of-body-experiences. *Science (80-)*.

2007;317:1048.

29. Blanke O, Ortigue S, Landis T, Seeck M. Stimulating illusory own-body perceptions. *Nature*. 2002;419:269–70.

30. Blanke O, Arzy S. The out-of-body experience: disturbed self-processing at the temporo-parietal junction. *Neuroscientist*. 2005;1:16–24.

31. Dening TR, Berrios GE. Autoscopic Phenomena. *Br J Psychiatry*. 1994;165:808–817.

32. Blanke O. Out of body experiences and their neural basis. *Br Med J*. 2004;329:1414–5.

33. Palmer TD, Schwartz PH, Taupin P, Kaspar B, Stein SA, Gage FH. Progenitor cells from human brain after death. *Nature*. 2001;411:42-43. doi:10.1038/35075141

34. Pascricha S. Stevenson I Near Death Experiences in India. *J Nerv Ment Dis*. 1986;55:542 – 9.

35. Feng Z. Research on near death experiences of survivors in big earthquake of Tangshan 1976 Zhonghua Shen Jing Jing Shen Ke Za Zhi. Published online 1991.

36. Gallup G, Proctor W. *Adventures in Immortality: A Look beyond the Threshold of Death*. McGraw-Hill; 1982.

37. Perera M, Padmasekara G, Belanti J. Prevalence of near-death experiences in Australia. *J Near Death Stud*. 2005;24:109–116.

38. Parnia S, Waller D, 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.

39. Martens PR. Near-death-experiences in out-of-hospital cardiac arrest survivors. Meaningful phenomena or just fantasy of death? *Resuscitation*. 1994;2:171–5.

40. Greyson B. Incidence and Correlates of Near Death Experiences in a Cardiac Care Unit. *Gen Hosp Psychiatry*. 2003;4:269–76.

41. Schwaninger J. A prospective analysis of Near Death Experiences in cardiac arrest patients. *J Near Death Exp*. 2002;20:215–232.

42. Squire LR, Dede AJO. *Conscious and Unconscious Memory Systems*. Vol 7. Cold Spring Harb Perspect Biol; 2015.

43. Lim C, Alexander MP, LaFleche G, Schnyer DM VM, Lim C, Alexander MP, LaFleche G, Schnyer DM, Verfaellie M. The neurological and cognitive sequelae of cardiac arrest. *Neurology*. 2004;63:1774–1778.

44. Son Y. Molecular Mechanisms of general anesthesia. *Korean J Anesth*. 59:3–8.

45. Morse M L. Near death experiences of children. *J Pediatr Oncol Nurs*. 1994;11:139–144.

46. Serdahely WJ. Pediatric Near-death experiences. *J Near Death Stud*. 1990;9:33–39.

47. Herzog, D.B.Herrin JT. Near-death experiences in the very young: Critical Care Medicine.

1985;13:1074 –1075.

48. Morse M, Castillo P, Venecia D, Milstein J, Tyler DC. No Title. *Child near death Exp Am J Dis Child*. 1986;140.

49. Shears D, Elison S, Garralda ME, Nadel S. Near-Death Experiences with Meningococcal Disease. *J*. Published online 2005.

50. Klemenc-Ketis Z. Life Changes in Patients After Out-of-Hospital Cardiac Arrest. *Int J Behav Med*. 2013;20:7–12.

51. Sabom MB. *Recollections of Death: A Medical Investigation*. Harper & Row; 1983. doi:10.2307/3470205

52. Ring K. Life at Death. *Coward Mc Cann*. Published online 1980:12-26.

53. Paper J. *The Mystic Experience: A Descriptive and Comparative Analysis. SUNY Series in Religious Studies*. SUNY Press; 2012.

54. Newberg AB. The neuroscientific study of spiritual practices. *Front Psychol*. 2014;5:1–6.

55. Saver JL, Rabin J. The neural substrates of religious experience. *J Neuropsychiatry Clin Neurosci*. 1997;9:498–510.

56. Roberts B, Chaboyer W. Patients' dreams and unreal experiences following intensive care unit admission. *Nurs Crit Care*. 2004;9:173–80.

57. Arumugam S, El-Menyar A, Al-Hassani A, G. S. Delirium in the Intensive Care Unit. *J Emerg Trauma Shock*. 2017;10:37–46.

58. Schiff N. Recovery of consciousness after brain injury: a mesocircuit hypothesis. *Trends Neurosci*. 2010;33:1–9.

59. Olaussen A, Nehme Z, Shepherd M, PA J. Consciousness induced cardiopulmonary resuscitation: An observational study. *Resuscitation*. 2017;113:44–50.

60. Cassol H, Martial C, Annen J, G M. A systematic analysis of distressing near-death experience accounts. *Memory*. 2019;27:1122–1129.

61. Roberts BL, Rickard CM, Rajbhandari D, Reynolds P. Patients' dreams in ICU: Recall at two years post discharge and comparison to delirium status during ICU admission: A multicentre cohort study. *Intensive Crit Care Nurs*. 2006;22:264–273.

62. Darbyshire JL, Grieg PR, Vollam S, Young DJ, Hinton L. I can remember sort of vivid people ...but to me they were plasticine. *PLoS*. 2016;11:153775.

63. B G. After. *St Martin's Essentials*. Published online 2021.

64. Randall L. *Warped Passages: Unravelling the Mysteries of the Universe's Hidden Dimensions*. Ecco; 2005.

65. Abbott E. *Flatland: A Romance of Many Dimensions*. Dover Pulications; 1992.

66. Zeki S. The neurobiology of love. *FEBS Lett*. 581:2575–2579.

67. Blackmore SJ, Troscianko T. The physiology of the tunnel. *J Near Death Stud*. 1988;8:15–28.

68. Blackmore SJ. Near-Death Experiences. *J R Soc Med*. 1996;89:73–76.

69. Whinnery JE. Psychophysiologic correlates of unconsciousness and near-death experiences J. *Near Death Stud*. 1997;15:231–258.

70. Klemenc-Ketis Z, Grmec S, Kersnik J. The effect of carbon dioxide on near-death experiences in out-of-hospital cardiac arrest survivors: A prospective observational study. *Crit Care*. 2010;14:R56.

71. Carr DB. Endorphins at the approach of death. *Lancet*. 1981;1:390.

72. Sotelo J, Perez R, Guevara, Fernandez A. Changes in brain, plasma and cerebrospinal fluid contents of B-endorphin. Published online 1995.

73. Morse M, Venecia D, Milstein J. Near-death experiences: A Neurophysiologic Explanatory Model Journal of. Published online 1989.

74. Jansen K. Near death experience and the NMDA receptor. *Br Med J*. 1989;298(1708).

75. Appleton ARE. Reflex anoxic seizures. *Br Med J*. 1993;307:214–215.

76. Carr D. Pathophysiology of stress induced limbic lobe dysfunction: a hypothesis for NDEs. *Journal*. Published online 1982.

77. Devinsky O, Lai G. Spirituality and religion in epilepsy. *Epilepsy Behav*. 2008;12:636–643.

78. Britton WB, Bootzin RR. Near-death experiences and the temporal lobe 2004. *Psychol Sci*. 2004;15:254–258.

79. MacLullich AMJ, Ferguson KJ, Miller T, S R. Unravelling the pathophysiology of delirium: a focus on the role of aberrant stress responses. *J Psychosom Res*. 2008;65:229–238.

80. Sheak KR, Wiebe DJ, Leary M, et al. Quantitative relationship between end-tidal carbon dioxide and CPR quality during both in-hospital and out-of-hospital cardiac arrest. *Resuscitation*. 2015;89:149-155. doi:10.1016/j.resuscitation.2015.01.026

81. Greyson B, Long JP. Does the arousal system contribute to near death experience? *Neurology*. 2006;67(2265).

82. Kondziella D, Dreier J, Olsen MH. Prevalence of near-death experiences in people with and without REM sleep intrusion. *PeerJ*. Published online 2019:7 7585.

83. Husain AM, Miller PP, Carwile ST. REM sleep behavior disorder: potential relationships to post-traumatic stress disorder. *J Clin Neurophysiol*. 2001;18:148–157.

84. Greyson B. The near-death experience scale: Construction, reliability, and validity. *J Nerv Ment Dis*. 1983;171:369–375.

85. J.M. H. *Down to Earth Sociology: Introductory Readings 2005*. 13th ed. Free Press; 2005.

86. Uematsu D, Greenberg JH, Reivich M, Kobayashi S, Karp A. In Vivo Fluorometric Measurement of Changes in Cytosolic Free Calcium from the Cat Cortex during Anoxia. *J Cereb Blood Flow Metab*. 1988;8:367–374.

87. Thonnard M, Charland-Verville V, Brédart S, Dehon H, Ledoux D, Laureys S. Characteristics of near-death experiences memories as compared to real and imagined events memories. *PLoS One*. 2013;8:e57620.

88. Chawla LS, Akst S, Junker C, Jacobs B, Seneff MG. Surges of electroencephalogram activity at the time of death: A case series. *J Palliat Med*. 2009;12(12):1095-1100. doi:10.1089/jpm.2009.0159

89. Borjigin J, Lee U, Liu T, et al. Surge of neurophysiological coherence and connectivity in the dying brain. *Proc Natl Acad Sci*. 2013;110:14432–7.

90. Peinkhofer C, Martial C, Cassol H, Laureys S, Kondziella D. The evolutionary origin of near-death experiences: a systematic investigation. *Brain Commun*. 2021;22;3(3).

91. Parnia S, Fenwick P. Near death experiences in cardiac arrest: visions of a dying brain or visions of a new science of consciousness. *Resuscitation*. 2002;52:5–11.

92. Buunk G, Van Der Hoeven JG, Meinders AE. Cerebral blood flow after cardiac arrest. *Neth J Med*. 2000;57:106-112. doi:10.1016/S0300-2977(00)00059-0

93. Eleff SM, Kim H, Shaffner DH, Traystman RJ, Koehler RC. Effect of cerebral blood flow generated during cardiopulmonary resuscitation in dogs on maintenance versus recovery of ATP and pH. *Stroke*. 1993;24:2066–73.

94. Shaffner DH, Eleff SM, Brambrink AM, et al. Effect of arrest time and cerebral perfusion pressure during cardiopulmonary resuscitation on cerebral blood flow, metabolism, adenosine triphosphate recovery, and pH in dogs. *Crit Care Med*. 27:1335–1342.

95. Levin P, Kinnell J. Successful Cardiac Resuscitation Despite Prolonged Silence of EEG. *Arch Intern Med*. 1966;117:557-560. doi:10.1001/archinte.1966.03870100085015

96. Rossen R, Kabat H, Anderson JP. Acute arrest of cerebral circulation in man. *Arch Neurol Psychiatry*. 1943;50:510-528. doi:10.1001/archneurpsyc.1943.02290230022002

97. Kano T, Hashiguchia A, Sadanaga M, Ashimura K, Sakamoto M, Morioka T. Cardiopulmonary-cerebral resuscitation by using cardiopulmonary bypass through the femoral vein and artery in dogs. *Resuscitation*. 1993;25:265-281. doi:10.1016/0300-9572(93)90124-9

98. Angelos M, Safar P, Reich H. A comparison of cardiopulmonary resuscitation with cardiopulmonary bypass after prolonged cardiac arrest in dogs. *Reperfus Press Neurol Recover Resusc*. 21:121–135.

99. Lavy S, Stern S. Electroencephalographic changes following sudden cessation of artificial pacing in patients with heart block. *Confin Neurol*. 1967;29:47-54.

100. Hossman KA, Ophoff GB. Recovery of Monkey Brain After Prolonged Ischemia. I. *Electrophysiol Brain Electrolytes J Cereb Blood Flow Metab*. 1986;6:15–21.

101. Gonzalez ER, Ornato JP, Garnett AR, Levine RL, Young DS, Racht EM. Dose-dependent vasopressor response to epinephrine during CPR in human beings. *Ann Emerg Med*. 1989;18:920-926. doi:10.1016/S0196-0644(89)80453-6

102. Reagan EM, Nguyen R, Ravishankar S, Chabra V, Reagan, EM, Nguyen, RT, Ravishanker, ST, Chabra, V, Fuentes, B, Spiegel, R, Parnia S. Monitoring the Relationship Between Changes in Cerebral Oxygenation and Electroencephalography Patterns During Cardiopulmonary Resuscitation: A Feasibility Study. *Crit Care Med*. 2018;46:757–763.

103. Kroeger D, Florea B, Amzica F. Human brain activity patterns beyond the isoelectric line of extreme deep coma. *PLoS One*. 2013;8:75257.

104. Mayer J, Marx T. The pathogenesis of EEG changes during cerebral anoxia In: Cardiac and vascular diseases handbook of electroencephalography and clinical neurophysiology. Drift JV Der, ed. 1972;14:5–11.

105. Vrselja Z, Daniele SG, J S. Restoration of brain circulation and cellular functions hours post mortem. *Nature*. 2019;568:336–343,.

106. Marshall RS, Lazar RM, Spellman JP. Recovery of brain function during induced cerebral hypoperfusion Brain. 2001;124:1208–1217.

107. Doan TN, Adams L, Schultz B V, Bunting D. Insights into the epidemiology of cardiopulmonary resuscitation-induced consciousness in out-of-hospital cardiac arrest. *Emerg Med Australas*. 2020;32:769–776.

108. Kouwenhoven WB, Jude Jr KG. Closed-chest cardiac massage. *JAMA*. 1960;173:1064–7.

109. Parnia S. Do reports of consciousness during cardiac arrest hold the key to discovering the nature of consciousness? *Med Hypothesis*. 2007;69:933–7.

110. Van Gordon W, Shonin E, Dunn TJ, Sheffield D, Garcia-Campayo J, Griffiths MD. Meditation-Induced Near-Death Experiences: a 3-Year Longitudinal Study. *Mindfulness (N Y)*. 2018;9:1794-1806.

111. Newcombe R. Ketamine Case Study: The Phenomenology of a Ketamine Experience, Addiction Research & Theory. 2008;16: 209-215

112. Simon E. Ketamine: Safe Until It's Not - A Terrifying Trip to the K-Hole. J Emerg Med. 2019;57:587-588.

113. Pomarol-Clotet E, Honey GD, Murray GK, et al. Psychological effects of ketamine in healthy volunteers. Phenomenological study. Br J Psychiatry. 2006;189:173-179.

114. Strassman RJ, Qualls CR, Uhlenhuth EH, Kellner R. Dose-response study of N,N-dimethyltryptamine in humans. II. Subjective effects and preliminary results of a new rating scale. Arch Gen Psychiatry. 1994;51:98-108.

115. Rock A, Cott C. Phenomenology of N,N-Dimethyltryptamine Use: A Thematic analysis. Journal of Scientific Exploration, 2008;22:359-370

116. Janesen K. Ketamine: Dreams and Realities. Multidisciplinary Associatoin for Psychdelic Studies, 2004

117. Davis AK, Clifton JM, Weaver EG, Hurwitz ES, Johnson MW, Griffiths RR. Survey of entity encounter experiences occasioned by inhaled N,N-dimethyltryptamine: Phenomenology, interpretation, and enduring effects. Journal of Psychopharmacology. 2020;34:1008-1020.

118. Newcomer JW, Farber NB, Jevtovic-Todorovic V, et al. Ketamine-induced NMDA receptor hypofunction as a model of memory impairment and psychosis. Neuropsychopharmacology. 1999;20:106-118.

119. Gouzoulis-Mayfrank E, Heekeren K, Neukirch A, et al. Psychological effects of (S)-ketamine and N,N-dimethyltryptamine (DMT): a double-blind, cross-over study in healthy volunteers. *Pharmacopsychiatry*. 2005;38:301-311.

120. De Ridder D, Van Laere K, Dupont P, Menovsky T, Van de Heyning P. Visualizing out-of-body experience in the brain. N Engl J Med. 2007;357:1829-1833.

121. Bhaskaran R, Kumar A, Nayar PC. Autoscopy in hemianopic field. J Neurol Neurosurg Psychiatry. 1990;53:1016-1017.

122. Brugger P, Agosti R, Regard M, Wieser HG, Landis T. Heautoscopy, epilepsy, and suicide. J Neurol Neurosurg Psychiatry. 1994;57:838-839.

123. Dewhurst K, Pearson J. Visual hallucinations of the self in organic disease. J Neurol Neurosurg Psychiatry. 1955;18:53-57.

124. Papathanassoglou ED, Patiraki EI. Transformations of self: a phenomenological investigation into the lived experience of survivors of critical illness. Nurs Crit Care. 2003;8:13-21.

125. Duppils GS, Wikblad K. Patients' experiences of being delirious. J Clin Nurs. 2007;16:810-818.

126. Van Rompaey B, Van Hoof A, van Bogaert P, Timmermans O, Dilles T. The patient's perception of a delirium: A qualitative research in a Belgian intensive care unit. Intensive Crit Care Nurs. 2016;32:66-74.