Chapter 14
Near-Death Experiences: Actual Considerations

Vanessa Charland-Verville, Charlotte Martial, Helena Cassol, and Steven Laureys

Abstract The notion that death represents a passing to an afterlife, where we are reunited with loved ones and live eternally in a utopian paradise, is common in the anecdotal reports of people who have encountered a "near-death experience" (NDE). These experiences are usually portrayed as being extremely pleasant including features such as a feeling of peacefulness, the vision of a dark tunnel leading to a brilliant light, the sensation of leaving the body, or the experience of a life review. NDEs are increasingly being reported as a clearly identifiable physiological and psychological reality of clinical and scientific significance. The definition and causes of the phenomenon as well as the identification of NDE experiencers are still matters of debate. The phenomenon has been thoroughly portrayed by the media, but the science of NDEs is rather recent and still lacking of rigorous experimental data and reproducible controlled experiments. It seems that the most appropriate theories to explain the phenomenon tend to integrate both psychological and neurobiological mechanisms. The paradoxical dissociation between the richness and intensity of the memory, probably occurring during a moment of brain dysfunction, offers a unique opportunity to better understand the neural correlates of consciousness. In this chapter, we will attempt to describe NDEs and the methods to identify them. We will also briefly discuss the NDE experiencers' characteristics. We will then address the main current explicative models and the science of NDEs.

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Description of the Phenomenon

After recovering from a coma caused by brain injury, patients can sometimes report vivid perceptions and memories that have occurred during their period on seemingly unconsciousness. Some of these memories have been popularized under the expression "near-death experiences" (NDEs) [1]. NDEs can be defined as a set of mental events including highly emotional, self-related, mystical, and spiritual aspects occurring in an altered state of consciousness classically occurring in the context of a life-threatening condition (e.g., cardiac arrest, trauma, perioperative complications, intracerebral hemorrhage, septic or anaphylactic shock, near-drowning or asphyxia, electrocution, attempted suicide) [1–3]. The NDE core features most commonly include ranked by frequency feelings of peacefulness/well-being, out-of-body experience (OBE), seeing a bright light, an altered time perception, and entering some other, unearthly environment [4]. Despite their circumstances of occurrence, NDEs are generally experienced as extremely pleasant and can induce life-changing consequences on the experiencers' set of values and attitudes toward death [3]. However, in addition to the ill-described relation between the NDEs and the precipitating factors, the reliability of NDE accounts remains controversial.

Without being designated as such, NDEs were already addressed in Plato's Republic [5] and represented in paintings by Hieronymus Bosch during the fifteenth century (Fig. 14.1). The expression was unofficially first formulated in the nineteenth century when Albert von St. Gallen Heim, a Swiss geologist and alpinist, collected "near-death" testimonies from his fellow climbers and himself after climbing accidents in the Alps [8]. He described these experiences as being similar in their content including an expanded time perception, the review of past episodes of one's life, auditory perceptions containing music and various sounds, visions of idyllic landscapes, and the absence of pain at the moment of impact. Following Heim's work, the equivalent French term *Expérience de Mort Imminente* was proposed by the French psychologist and epistemologist Victor Egger. Some decades later, Moody [1] popularized the expression "near-death experience—NDE" through his best seller *Life After Life* in which he defined NDEs as "any conscious perceptual experience occurring in individuals pronounced clinically dead or who came very close to physical death." Moody drew a list of the most frequently recounted features by a recruited sample of 150 individuals coma survivors in intensive care who had been hospitalized after a near-fatal incident of various etiologies (Moody's features are described in Table 14.1). Later, NDEs have been defined as a "profound psychological event including transcendental and mystical elements, typically occurring to individuals close to death or in situations of intense physical or emotional danger" [2]. More such broad definitions of NDEs have been proposed like "transcendental experiences precipitated by a confrontation with death" [9] or "responses to life-threatening crisis characterized by a combination of dissociation from the physical body, euphoria, and transcendental or mystical elements" [10] and not all agree on the investigated phenomenology associated with a "typical" NDE rendering their scientific study difficult.

Fig. 14.1 Reproduction of Hieronymus Bosch's work "Ascent of the Blessed" (painted around 1490 in the Netherlands). Palazzo Ducale, Venice. "The image evokes a symbolic imagery, religious or esoteric, where after the end of earthly life, souls saved, helped by angels, throw off the last remains, and reborn in a different plane, rising almost without the support of its heavenly guides, following by a corridor (or tunnel) where an intense light emerges from the darkness and illuminates their path of ascension" [6]. Unfortunately, too little is known about the life of the painter to provide a satisfactory explanation of this work on the basis of his biographical background [7]. File taken from the Wikimedia Commons (http://en.wikipedia.org/wiki/File:Ascent_of_the_Blessed.jpg#globalusage)

Table 14.1 Common elements recurring in adult NDEs and their aftereffects [1]

Elements occurring during NDEs	Elements occurring as aftereffects
Ineffability	Frustration relating the experience to others
Hearing oneself pronounced dead	Subtle "broadening and deepening" of life
Feelings of peace and quiet	Elimination of fear of death
Hearing unusual noises	Corroboration of events witnessed while "out of the body"
Seeing a dark tunnel	
Being "out of the body"	
Meeting "spiritual beings"	
Experiencing a bright light as a "being of light"	
Panoramic life review	
Experiencing a realm in which all knowledge exists	
Experiencing cities of light	
Experiencing a realm of bewildered spirits	
Experiencing a "supernatural rescue"	
Sensing a border or limit	
Coming back "into the body"	

Identifying NDEs

According to a Gallup Poll, it was estimated that about 5% of the American population have had such an experience (or at least experienced some NDE features) in the context of a life-threatening situation [11]. More recently, surveys conducted in Australia [12] and Germany [13] have yield a prevalence of 4–15%. However, these values might not reflect the absolute frequency since many NDE experiencers can be uncomfortable of sharing their experience or might have forgotten about those memories [14]. Moreover, it is not clear how NDE experiencers are identified. To facilitate NDE identification, Ring [15] and Greyson [16] developed tools to use in clinical and research settings. Ring's "Weighted Core Experience Index (WCEI)" [15] was developed based on a previous narrative collection of 102 individuals who have been "close to death" from various contexts. The index aims at quantifying the depth of a NDE according to ten arbitrarily weighted items with a maximum score of 23 [15] (Table 14.2). According to Ring, if the individuals' scores are less than 6, they are not considered to have had "enough" of an experience to be qualified as a "core experiencer." Respondents scoring between 6 and 9 are considered as "moderate experiencers," and finally, those who score more than 10 will be qualified as "deep experiencers" [15]. Based on the narratives collected, he also proposed a

Table 14.2 Ring's Weighted Core Experience Index [15]

Components	Weight
Subjective sense of being dead	1
Feeling of peace, painlessness, pleasantness, etc.	2
Sense of bodily separation	2
Sense of entering a dark region	2
Encountering a presence/hearing a voice	3
Taking stock of one's life	3
Seeing, or being enveloped in, light	2
Seeing beautiful colors	1
Entering into the light	4
Encountering visible "spirits"	3

five-stage temporality sequence to describe NDEs: peace and contentment, detachment from physical body, entering a transitional region of darkness, seeing a brilliant light, and entering through the light into another realm of existence [15]. However, the actual sequence of NDE features remains an unexplored area.

Although useful in quantifying the depth of an experience, Ring's WCEI was neither based on statistical analyses nor tested for coherence or reliability. Ring's scale limitations were addressed with Greyson's construction of the "near-death experience scale—NDE scale" [16]. He began by selecting 80 features from the existing NDE literature and subsequently reduced these to a final validated [17] 16-item multiple-choice tool used to quantify the intensity of the NDE (i.e., total score ranging from 0 to 32) and to assess core content components of 16 NDE features (Table 14.3). For each item, the scores are arranged on an ordinal scale ranging from 0 to 2 (i.e., 0 = "not present," 1 = "mildly or ambiguously present," and 2 = "definitively present"; 16–17). The latter scale is also, according to its author, clinically useful in differentiating between individuals that have experienced NDEs and in excluding organic brain syndromes and nonspecific stress responses [16]. The scale is subdivided into four psychologically meaningful clusters: cognitive, affective, paranormal, and transcendental experiences. According to the scale, an individual with a NDE scale score of 7 or higher on the maximum of 32 qualifies as a NDE experiencer [16]. The Greyson NDE scale is the most widely used tool to standardize the identification of NDErs in research literature [18]. According to a recent retrospective collection of data obtained from 354 individuals with self-reported NDEs over a 7-year period using the NDE scale, the top three most reported features were (1) a feeling of peace or pleasantness (92%), (2) a feeling of detachment from the body (77%), and (3) seeing or feeling surrounded by a brilliant light (74%) [19].

Table 14.3 Greyson's NDE scale (1983)

Questions/features	Response
Cognitive	
1: Did time seem to speed up or slow down?	0 = No
	1 = Time seemed to go faster or slower than usual
	2 = Everything seemed to be happening at once; or time stopped or lost all meaning
2: Were your thoughts speeded up?	0 = No
	1 = Faster than usual
	2 = Incredibly faster
3: Did scenes from your past come back to you?	0 = No
	1 = I remembered many past events
	2 = My past flashed before me, out of my control
4: Did you suddenly seem to understand everything?	0 = No
	1 = Everything about myself or others
	2 = Everything about the universe
Affective	
*5: Did you have a feeling of peace or pleasantness?	0 = No
	1 = Relief or calmness
	2 = Incredible peace or pleasantness
6: Did you have a feeling of joy?	0 = No
	1 = Happiness
	2 = Incredible joy
7: Did you feel a sense of harmony or unity with the universe?	0 = No
	1 = I felt no longer in conflict with nature
	2 = I felt united or one with the world
*8: Did you see, or feel surrounded by, a brilliant light?	0 = No
	1 = An unusually bright light
	2 = A light clearly of mystical or other-worldly origin
Paranormal	
9: Were your senses more vivid than usual?	0 = No
	1 = More vivid than usual
	2 = Incredibly more vivid
10: Did you seem to be aware of things going on elsewhere, as if by extra sensorial perception/ telepathy?	0 = No
	1 = Yes, but the facts have not been checked out
	2 = Yes, and the facts have been checked out
11: Did scenes from the future come to you?	0 = No
	1 = Scenes from my personal future
	2 = Scenes from the world's future

Table 14.3 (continued)

Questions/features	Response
*12: Did you feel separated from your body?	0 = No
	1 = I lost awareness of my body
	2 = I clearly left my body and existed outside it
Transcendental	
13: Did you seem to enter some other, unearthly world?	0 = No
	1 = Some unfamiliar and strange place
	2 = A clearly mystical or unearthly realm
14: Did you seem to encounter a mystical being or presence or hear an unidentifiable voice?	0 = No
	1 = I heard a voice I could not identify
	2 = I encountered a definite being or a voice clearly of mystical or unearthly origin
15: Did you see deceased or religious spirits?	0 = No
	1 = I sensed their presence
	2 = I actually saw them
16: Did you come to a border or point of no return?	0 = No
	1 = I came to a definite conscious decision to "return" to life
	2 = I came to a barrier that I was not permitted to cross or was "sent back" against my will

*Top three most reported features of our recent study are marked with an asterisk (Charland-Verville et al. [4])

NDEs Not "Near Death"

Unlike these "classical" NDEs associated with impeding death or coma, "NDE-like" experiences have also been reported in situations where there was no genuine threat to the individuals' life. Only a few studies have assessed "NDE-like" phenomena in non-life-threatening situations [20–23]. Such accounts have also been reported in epileptic patients [24], syncope [25], intense grief and anxiety [26], Cotard's syndrome [27], and during meditative state [28]. These NDE-like experiences can be very strong and lead to profound life transformations just like "classical" NDEs. In a recent case study, the subject reported common NDE features in the context of grief after a divorce (e.g., the vision of a supernatural light, peacefulness, deep joy, and empathic fusion with the whole world) in the absence of critical cerebral or psychological disorders [20]. The subject reported no history of psychiatric disorders, use of psychotropic drugs, or substance abuse. It remains unclear whether some NDE features are exclusive to life-threatening or non-life-threatening situations and if they differ in intensity. It seems that NDE-like experiences are reported more frequently than usually assumed. Recent retrospective data highlighted that 21% of the self-reported NDEs occurred during a non-life-threatening context

(e.g., during sleep, after a concussion) [19] and that according to the Greyson NDE scale, no difference could be found in terms of intensity and reported content when comparing "classical NDEs" vs. NDE-like experiences [4]. Gabbard and Twemlow [22] have proposed that the expectancy of an incoming death or the strong belief of one's death would suffice to trigger NDEs.

Negative NDEs

Although NDEs are usually reported as being extremely pleasant, distressing or hellish experiences can also occur. Previous estimations suggest an incidence of 1–2% [4, 11, 29–31]. To document the frequency of frightening NDEs can be challenging because individuals might be reluctant to report them due to its post-traumatic stress component [32, 33]. Bush et al. [32] identified three types of frightening NDEs. First, the "inverse experience" has a similar content as a pleasant NDE (e.g., light, presences, knowledge, landscapes) but is perceived as an alien reality out of control and is extremely stressful. The second type involves perceptions of emptiness, the individual feels left alone, and nonexistent. The third type is the prototypical "hellish" encounter, with threatening entities, and various accouterments of the traditional hell, marked by perceptions of impending judgment and torment [32]. Whether the experience was perceived as being pleasant or frightening, some individuals have reported psychological distress related to the difficulty in integrating the experience and its consequences into their lives [34].

NDE Experiencers Characteristics

Previous work has aimed to investigate NDE experiencers' characteristics. So far, there is still no longitudinal study conducted, and the characteristics are assessed after the individual lived the experience. Therefore, in those who report a NDE, researchers aimed at (retrospectively) measuring personal characteristics that might be related to the NDE features reported and (prospectively) assessing the characteristics that might differentiate the individuals who report a NDE from those who don't [35]. According to age, studies performed among patients with cardiac arrest have shown that NDEs seem to be reported more frequently before the age of 60 [3, 14]. This tendency could be explained by the possibility of a greater vulnerability of older patients' brain to cerebral ischemia and more susceptible to amnesia. The same study highlighted the fact that having had a previous NDE could facilitate the reoccurrence of such an experience, as individuals can report multiple NDEs [3]. Using Ring's WCEI, van Lommel et al. [3] observed deeper NDEs in women, but no other studies reported such a difference in gender. This gender observation might

be partly explained by the fact that women might be less afraid to report a NDE [1] or that women have been found to score generally higher on anomalous-perception questionnaires than male subjects [36]. More demographic variables such as ethnicity, social class, religiosity, educational level, and factors like prior psychiatric disorders or psychiatric characteristics, suicidal behavior, or family history of suicidal have not been shown to influence the frequency of reported NDEs [3, 15, 37–40]. Most of the NDE literature comes from Western cultures, but according to the published data, taking into account religiosity and cultural background, these variables seem to have an influence on the NDEs' content and the features' interpretation [38, 41] (see Table 14.4 for an overview of non-Western NDE features). While Western experiencers might describe the presence perceived in their NDE as guardian angels, Hindus might see them as messengers of the god of death [42, 43]. Some authors have argued that NDEs would be culturally determined phenomena reflecting cultural and social influences [41]. In fact, it appears that some NDE features may not be universal like the tunnel vision [43]. The tunnel feature has been identified as a "cultural contaminant not necessarily integral to NDEs" [44]. In fact, when investigating NDE testimonials before and after Moody's best seller release in 1975, the only feature has been absent before 1975 was the tunnel vision. The authors explained that by suggesting that the societal models might have influenced this feature [44]. Even though the sociocultural background might influence the reported content and interpretation, the overall reports show sufficient common content and meaning to be considered a universal human experience of great interest for modern neuroscience [41, 45].

Table 14.4 Descriptive overview of five NDE features according to retrospective cases reported anecdotally around in non-Western countries (adapted from Greyson et al. 2000a)

Countries/continents	*N* of published cases	NDE features				
		Tunnel	OBE	Life review	Encounters with beings	Other world
China	180	±	+	+	+	+
India	109	−	+	+	+	+
Thailand	10	±	+	+	+	+
Tibet	16	−	+	+	+	+
Hawaii	1	±	+	−	+	+
Guam	4	−	+	−	+	+
New Zealand	1	±	+	−	+	+
South America	14	−	+	−	+	+
Australia	1	−	−	−	+	+
Africa	15	±	−	−	+	+

Note that similar features seem to be experienced worldwide
Most of the represented data are still anecdotal since NDEs were not identified through a standardized manner and the full narratives are not available. *OBE* out-of-body experience. China [99]; India [100]; Thailand [101]; Tibet [102]; Hawaii [103]; Guam [104]; New Zealand [105]; South America [106]; Australia [107]; Africa [108]. Symbols "+" and "−" used by the different authors to report the presence (+) or absence (−) of the feature

Research on NDEs

So far, the majority of published work on NDEs is retrospective and sporadic. NDEs are challenging to study as their occurrence is unpredictable, and they are generally not reported at their moment of occurrence, but days, months, or even only years later. The work of Moody [1] opened the way for scientific research on NDEs starting with the establishment in 1981 of the International Association for Near-Death Studies (IANDS) in the USA. The majority of the NDE studies aimed at identifying the presence of NDEs among various populations. Empirical studies on NDEs can be differentiated between retrospective and prospective designs (for a review of the main retrospective and prospective studies, see Table 14.5).

Retrospective research involves a convenient sample of individuals with so-called self-reported NDEs that have responded to the researchers' strategies of recruitment to share their NDE account. This research design dominates the field of NDE research and has been conducted among various populations: after a coma of different etiologies [4, 23, 46], cardiac arrest [14], suicide attempts [47], and uremic coma before dialysis therapy [48]. The main advantages of retrospective studies are that NDEs in various populations and from different contexts can be studied and that larger samples of experiences can be included. On the other hand, retrospective samples are always biased and include only NDEs of self-reporters, whom might share different accounts from individuals more reluctant to share their experience. Moreover, retrospectives NDEs are sometimes shared many years after they originally took place leading to a possible exaggeration the experience's content and intensity [49].

The prospective design usually follows a population of patients that are susceptible of experiencing a NDE in the context of a life-threatening medical condition. That way, researchers have access to complete medical information before and during the supposed occurrence of the NDE. In addition, NDE accounts are collected just a few days after the recovery. The prospective design reveals itself to be more rigorous than the retrospective one. However, prospective studies are expensive, heavy to set up, and only permit to recruit a narrower sample [35]. The prospective design have mostly been conducted among resuscitated patients after a cardiac arrest [3, 14, 39, 50–52] and (albeit more rarely) in patients with severe traumatic brain injury [53]. According to the NDE scale, 2–13% of the resuscitated patients after a cardiac arrest report accounts that are compatible with a NDE when asked an open question regarding any memories that could have occurred during the period surrounding their cardiac arrest and period of unconsciousness [51, 52]. Cardiac arrest survivors with NDEs cannot be distinguished by administered medications, metabolic states, psychology, sociodemographic factors, resuscitative interventions, or the duration of cardiac arrest or unconsciousness [3, 52, 54].

The choice of the study design can certainly have an impact on the collected data. It has been observed that fewer cases of NDEs are recounted by individuals interviewed prospectively than when the interviews are retrospectively conducted among self-reported NDE experiencers [49]. On the other hand, Greyson [109] argues that

Table 14.5 Overview of main NDE publications since Moody's popularization of the phenomenon

References	Type of material Title of book/ journal	Peer reviewed Medline/ PubMed	Study design Time since NDE	*N* Characteristics of the sample and inclusion criteria	NDEs (%)	Scale used to identify NDE minimum score	Reported features
Moody [1]	Book *Life After Life*	No	Retrospective NM	150 Individuals who reported an "unusual experience" after a coma of different etiologies	150	None	Please refer to Table 1 in the introduction section
Ring [15]	Book *Life at Death: A Scientific Investigation of the Near-Death Experience*	No	Retrospective NM	102 Self-reported NDEs of individuals claiming to have been "close to death"	49 (48)	The author introduces his scale—the WCEI and his five stages	Please refer to Table 2 in the introduction section
Sabom [31]	Book *Recollections of Death: A Medical Investigation*	No	Retrospective NM	111 Self-reported NDEs of individuals claiming to have been "close to death" with a majority of cardiac arrest survivors	47 (42)	None	NM

(continued)

Table 14.5 (continued)

References	Type of material Title of book/ journal	Peer reviewed Medline/ PubMed	Study design Time since NDE	*N* Characteristics of the sample and inclusion criteria	NDEs (%)	Scale used to identify NDE minimum score	Reported features
Gabbard and Twemlow [21]	Journal article *Omega: Journal of Death and Dying*	Yes Yes	Retrospective NM	339 Individuals with self-reported OBEs after life-threatening and non-life-threatening situations	34 (5)	None	NM
Ring and Franklin [110]	Journal article *Omega: Journal of Death and Dying*	Yes No	Retrospective NM	36 Suicide survivors of various etiologies	17 (47)	WCEI	NM
Sabom [31]	Book *Recollections of Death: A Medical Investigation*	No	Retrospective NM	116 Self-reported NDEs of individuals claiming to have been "close to death"	33 (28)	None	NM

Gallup and Proctor [11]	Book *Adventures in Immortality: A Look Beyond the Threshold of Death*	No	Retrospective NM	1500 Individuals from the general adult American population claiming to have been "close to death"	60 (4)	None	NM
Greyson [16]	Journal article *The Journal of Nervous and Mental Disease*	Yes Yes	Retrospective 18 ± 16 years	74 Self-reported NDEs of individuals claiming to have been "close to death"	62 (84)	The author introduces his scale—the Greyson NDE scale	Please refer to Table 3 in the introduction section
Greyson [47]	Journal article *Journal of Near-Death Studies*	Yes No	Retrospective ~17 days	61 Suicide survivors of various etiologies ranging from minor to potentially lethal attempts Subjects need a score of ≥6 to be included	16 (26)	WCEI 6/30	NM

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Table 14.5 (continued)

References	Type of material Title of book/ journal	Peer reviewed Medline/ PubMed	Study design Time since NDE	*N* Characteristics of the sample and inclusion criteria	NDEs (%)	Scale used to identify NDE minimum score	Reported features
Greyson [46]	Journal article *Journal of Near-Death Studies*	Yes No	Retrospective ~18 years	183 Self-reported NDEs of individuals claiming to have been "close to death" Subjects need a score of ≥7 to be included	183	Greyson NDE scale 7/32	The most reported features were the feeling of peacefulness (92%) as well as OBEs (86%). The least reported features were the life review (25%) and precognitive visions (14%)
Schoenbeck and Hocutt [111]	Journal article *Journal of Near-Death Studies*	Yes No	Prospective 5–52 days	11 Patients who have undergone cardiopulmonary resuscitation Subjects need a score of ≥7 to be included	1 (1)	Greyson NDE scale 7/32	The NDE was considered to be "transcendental" (encounter with a religious spirit; entering an unearthly world and coming to a boarder)

Zhi-ying and Jian-xun [112]	Journal article *Journal of Near-Death Studies*	Yes No	Retrospective 11 years	81 Survivors of the severe earthquake in Tangshan, China, in 1976 Subjects need a score of ≥7 to be included	32 (40)	Greyson NDE scale 7/32	Features' frequencies are measured among the whole sample ($N = 81$). The most reported features of experiencers and non-experiencers were the feeling of peacefulness (52%) as well as thought acceleration and life review (51%). The least reported features were the feeling of joy (10%) and precognitive visions (14%)
Orne [113]	Journal article *Research in Nursing and Health*	Yes No	Prospective 3–21 days	44 Cardiac arrest survivors Subjects need a score of ≥7 to be included	9 (20)	Greyson NDE scale 7/32	NM
Pacciolla [114]	Journal article *Journal of Near-Death Studies*	Yes No	Retrospective 3 months–10 years	64 Self-reported NDEs of individuals claiming to have been "close to death" Subjects need a score of ≥7 to be included	24 (38)	Greyson NDE scale 7/32	The most reported features were the feeling of peacefulness and the meeting with deceased or religious spirits (>75%), while the least reported features were the time distortion and the extrasensory perception (29%)

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Table 14.5 (continued)

References	Type of material Title of book/ journal	Peer reviewed Medline/ PubMed	Study design Time since NDE	*N* Characteristics of the sample and inclusion criteria	NDEs (%)	Scale used to identify NDE minimum score	Reported features
Knoblauch et al. [13]	Journal article *Journal of Near-Death Studies*	Yes No	Retrospective NM	2044 Individuals from the general adult German population Subjects need to report any Moody's features to be included	82 (4)	None	Open-ended questions lead to these main features (no ranking of frequency mentioned): transcendent reality, great feelings, contrast between light and dark, out-of-body experiences, panoramic memory or life review experiences, descriptions of landscapes
van Lommel et al. [3]	Journal article *The Lancet*	Yes Yes	Prospective 74% of the sample was interviewed 5 days after	344 Cardiac arrest survivors Subjects need to report any memory of the event to be included	62 (18%) with a minimum score of 141 (9%) with a minimum score of 6/30	WCEI scale 1/30	Positive emotions and the awareness of being dead were the most reported feature (56% and 50%), while the life review and the final boarder/point of no return were the least reported ones (13% and 8%)
Parnia et al. [52]	Journal article *Resuscitation*	Yes Yes	Prospective NM	63 Cardiac arrest survivors Subjects need a score of ≥7 to be included	4 (6)	Greyson NDE scale 7/32	All four patients in the NDE group sensed a final boarder/point of no return (100%), and three out of the four also experienced seeing a bright light and feelings of peace, pleasantness, and joy (75%)

Schwaninger et al. [39]	Journal article *Journal of Near-Death Studies*	Yes No	Prospective ~2–3 days after	30 Cardiac arrest survivors and coma survivors of various etiologies Subjects need a score of ≥7 to be included	7 (23)	Greyson NDE scale 7/32	The most reported features were the feeling of peacefulness (100%) and OBEs (90%), while the least reported ones were time distortion, thought acceleration, life review (9%), and extrasensory perception (0%)
Greyson [14]	Journal article *General Hospital Psychiatry*	Yes Yes	Prospective "Patients were approached as soon after admission as their condition had stabilized"	1595 Cardiac arrest survivors Subjects need a score of ≥7 to be included	27 (2)	Greyson NDE scale 7/32	The most reported feature was the feeling of peacefulness (85%), while the least reported one was precognitive visions (7%)
Greyson [37]	Journal article *Psychiatric Services*	Yes Yes	Retrospective NM	832 Psychiatric patients claiming to have been "close to death" Subjects need a score of ≥7 to be included	61 (7)	Greyson NDE scale 7/32	NM

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Table 14.5 (continued)

References	Type of material Title of book/ journal	Peer reviewed Medline/ PubMed	Study design Time since NDE	*N* Characteristics of the sample and inclusion criteria	NDEs (%)	Scale used to identify NDE minimum score	Reported features
Nelson et al. [10]	Journal article *Neurology*	Yes Yes	Retrospective NM	446 Self-reported NDEs of individuals claiming to have been "close to death" Subjects need a score of ≥7 to be included	55 (12)	Greyson NDE scale 7/32	NM
Lai et al. [48]	Journal article *American Journal of Kidney Diseases*	Yes Yes	Retrospective 7 ± 13 years	710 Dialysis patients who have had a previous close brush with death Some patients had more than one NDE/event Subjects need a score of ≥7 to be included	45 with 51 events (6)	Greyson NDE scale 7/32 WCEI 1/30	The most reported feature were the feeling of peacefulness (75%) and OBEs (73%), while the least reported features were the awareness of being dead, precognitive visions, and tunnel vision (<10%). The frequencies are based on the number of NDEs ($n = 51$)

Klemenc-Ketis et al. [51]	Journal article *Critical Care*	Yes Yes	Prospective NM	52 Out-of-hospital cardiac arrest survivors Subjects need a score of ≥7 to be included	11 (21)	Greyson NDE scale 7/32	NM
Corazza and Schifano [115]	Journal article *Substance Use & Misuse*	Yes Yes	Retrospective 1 month in 30% of the sample	125 Previous ketamine misusers recollecting a ketamine-related NDE Subjects need a score of ≥7 to be included	50 (40)	Greyson NDE scale 7/32	The most reported features were an altered time perception (90%) and OBE (88%), while the least reported ones were the meeting with deceased or religious spirits (14%) and the final boarder/point of no return (8%)
Hou et al. [53]	Journal article *Annals of Indian Academy of Neurology*	Yes Yes	Prospective >14 days after recovering consciousness	86 Post-traumatic coma Subjects need a score of ≥7 to be included	3 (4)	Greyson NDE scale 7/32	Semi-structured oral interviews lead to these main features: unique light visions, intense feelings of astonishment, pleasure and fear, sense of helplessness, "supernatural but logical experience," and changes in opinions about death

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Table 14.5 (continued)

References	Type of material Title of book/ journal	Peer reviewed Medline/ PubMed	Study design Time since NDE	*N* Characteristics of the sample and inclusion criteria	NDEs (%)	Scale used to identify NDE minimum score	Reported features
Charland-Verville et al. [4]	Journal article *Frontiers in Human Neuroscience*	Yes Yes	Retrospective 25 ± 17 years	190 Self-reported NDEs of coma survivors of various etiologies n = 140 and n = 50 after non-life-threatening situations Subjects need a score of ≥7 to be included	190	Greyson NDE scale 7/32	The most reported features for all groups were the feeling of peacefulness (89–93%) and OBEs (74–80%), while the least reported ones were the life review (18–37%) and precognition (17–20%)
Charland-Verville et al. [90]	Journal article *Consciousness and Cognition*	Yes Yes	Retrospective 19 ± 9 years	22 Patients with LIS and after a coma Subjects need a score of ≥7 to be included	8 (37)	Greyson NDE scale 7/32	The most reported features were: an altered time perception (75%), life review (75%), and OBEs (75%)

NDE near-death experience, *OBE* out-of-body experience, *NM* "not mentioned"; "close to death" and "various etiologies" situations can include: cardiac arrest, shock in postpartum, hemorrhage, perioperative complications, septic or anaphylactic shock, electrocution, coma resulting from traumatic brain damage, intracerebral hemorrhage or cerebral infarction, attempted suicide, near-drowning or asphyxia, and apnea

reports of NDEs are not modified over time, even 20 years after the original account. To the best of our knowledge, these results were not replicated, and no study has yet formally paid attention to the cognitive and phenomenological nature of such memories. In addition to the ill-described relation between the NDE and the precipitating factor, the reliability of NDE accounts remains controversial [55, 56].

Explicative Models for NDEs

Transcendental, psychological, and neurobiological theories have been proposed to account for the global phenomenon and more specifically for its core features.

Transcendental Theories

The scientific study of consciousness indicates that there is an intimate relationship between the mind and brain [57]. Interestingly, surveys conducted among highly educated medical professionals and scientists have revealed that "dualistic" attitudes toward the mind–brain relationship remain [58]. These are expressed through beliefs that the mind/soul is separable from the body or by the conviction that some spiritual part of us can survive after death [59]. Advocates of transcendental theories argue that postulating the NDEs represents a different state of consciousness (transcendence), in which the self, cognition, and emotions would function independently from the brain, but would retain the possibility of non-sensory perception, e.g., [60, 61]. To date, these theories lead the field of NDE research. Quantum physics models of nonlocal consciousness have also been used to support the premise of the continuation of mental function when the brain is apparently inactive or impaired or when an individual is "near death" [62, 63]. For these authors and others, the NDE phenomenon—especially the OBE core feature during which experiencers report having viewed their bodies from a different point in space and are able to describe accurately what was going on around them while they were considered unconscious—poses a serious challenge to current scientific understandings of the brain, mind, and consciousness [15, 31, 52]. However, protocols that have been set up to test for that hypothesis are still failing to confirm the veracity of such OBEs. For instance, a recent multicentric feasibility study had set up resuscitation and operating rooms with shelves containing targets (i.e., a combination of nationalistic and religious symbols, people, animals, and major newspaper headlines) that would be possible to see only from an elevated perspective usually described by the experiencers [116]. However, from the 2% of the patients' sample with explicit recall of "seeing" and "hearing" actual events related to their resuscitation, none of them could report seeing the targets. Like we will discuss in the next sections, neuroscientifically, it seems more probable that NDE features are the result of specific interactions between psychological and neurological mechanisms precipitated by the context of occurrence and an altered state of consciousness [18, 64].

Psychological Theories

The "awareness of being death" or very close to dying has been proposed to be an important factor for triggering NDEs. In fact, as suggested by Owens et al. [23], "it would seem that among individuals who were not near death their experiences could be precipitated by their belief that they were." The "expectation hypothesis" postulates that NDEs take their origin from an altered state of consciousness triggered by a life-threatening condition that could result in death without medical care. The NDE phenomenology would reflect the individual's system of beliefs and expectations of dying and a possible afterlife [23, 65, 66]. According to the "depersonalization and dissociation hypothesis," when facing a life-threatening situation, an individual would disconnect from the external world and engage in internally oriented fantasies as a projective defense mechanisms to make the new reality more intelligible and less distressing [67, 68]. Individuals with "fantasy-proneness personality" are described as having the propensity to focus their attention on imaginative or selected sensory experiences and to exclude other events from the external environment [69]. Finally, the NDE phenomenology has been proposed to be at least in part imagined mixing information available during the context of occurrence, the experiencers' prior knowledge, sociocultural background, fantasies or dreams, lucky guesses, and information from the remaining senses [70]. In fact, the brain is constantly trying to make sense of the information it receives. In order to preserve a coherent interpretation of highly stressful events associated with episodes of altered consciousness, NDEs could be built as a result of the individual's attempt to interpret its confusing experience [71] and the experiencers' the tendency to tell a good story. However, a recent study using the memory characteristic questionnaire [72] showed that when comparing the phenomenological content of NDE memories with imagined and real-life events memories, the NDEs are richer than both types of memories in terms of sensorial, emotional, contextual, and self-related characteristics [73]. Another hypothesis raises the possibility that at least some NDEs may be the result of false memories, with the mind trying to retrospectively "fill in the gap" after a period of unconsciousness [55].

Neurobiological Theories

These theories follow empirical findings on the brain mechanisms that are associated behaviorally and neuronally with NDEs. Recently, a study recorded electrophysiological state of rats' brain following cardiac arrest [74]. The brain is assumed to be hypoactive during cardiac arrest. However, results obtained by the researchers showed a transient and global surge of synchronized gamma oscillations, displaying high levels of interregional coherence and feedback connectivity. These results have led to the highly mediatized and criticized hypothesis that heightened conscious processing measured in rats after a cardiac arrest could serve as an explicative

model for the rich and realistic experiences associated with NDEs reported in the same context. Lempert et al. [25] while studying motor phenomena of vasovagal syncope incidentally observed that the faints were accompanied by memories. Sixty percent of the fainters reported vivid NDE-like features (e.g., feeling of peace, OBE, entering another world, life reviews). Syncopes were induced via the combination of hyperventilation and Valsalva maneuver (i.e., a forced expiration against the closed larynx) in healthy young adults [25, 75]. Harmless syncopes have since been proposed to be a good model to study NDEs [76]. Another theory has postulated that the transient impaired cerebral oxygen levels caused by a syncope (and more dramatically as in the context of a cardiac arrest) lead to a disruption of the physiological balance between conscious and unconscious states causing the ascending arousal system to blend rapid eye movement (REM) sleep attributed partly to the action of the locus coeruleus–noradrenergic system [10, 76]. The REM state can intrude into wakefulness as visual hallucinations, and during crisis, the atonia of REM intrusion could reinforce a person's sense of being dead and convey the impression of death to others. In line with that hypothesis, a cohort of NDE experiencers have been found to be more sensitive to REM sleep intrusions and sleep paralysis associated with hypnagogic and hypnopompic experiences [10]. It has also been suggested that NDEs would result from a massive release of endorphins in a condition of impeding death—at least for the positive feelings since the endorphins do not have hallucinatory properties [77]. Other authors have suggested that NDEs can be reported as hallucinatory experiences similar to what can be experienced with some drugs. Jansen et al. [78] have proposed the ketamine model for studying NDEs. This dissociative anesthetic and recreational drug has a blockade action on the glutamate N-methyl-D-aspartate (NMDA) receptors [79]. Likewise, conditions which can precipitate NDEs (e.g., decreased brain oxygen, blood flow, blood sugar) could increase the levels of glutamate release in the context of excitotoxic brain damage, stimulating the release of a ketamine-like neurotoxin [80, 81]. The phenomenology of a recreational ketamine experience have highlighted many similar features with NDEs: peace and tranquility, the conviction that one is dead, trips through dark tunnels into light, OBEs, seeing spirits, telepathic communion with God, and mystical states [82, 83].

The clinical core features of NDEs should provide an indication of their neurophysiologic basis. Altered blood gas levels (i.e., ischemia, hypoxia) has been suggested to induce NDE-like features. The mechanisms involved have been proposed to occur as a cascade of events, beginning by a neuronal disinhibition in early visual cortex spreading to other cortical areas [70, 84–86]. Blackmore [87] proposed that the tunnel vision and the perception of bright lights could be linked to the loss of bilateral peripheral visual field and retinal ischemia. Based on previous neuroimaging data, it seems clinically plausible that resuscitated patients with NDEs may suffer from transient ischemic and/or hypoxic lesions or interferences with bilateral occipital cortex and the optic radiation [23, 88, 89]. However, these speculations have to be regarded with caution; as to date, no neurological, neuropsychological, and neuroimaging data exist to corroborate these hypotheses empirically. As stated by Blackmore [70], the brain's altered oxygen levels are probably one of several related

mechanisms that lead to NDEs as it does not account for NDEs occurring in the absence of damage attributable to this mechanism.

In line with neurobiological theories, recent work aimed at assessing whether the etiology of the brain damage could influence the reported content and intensity [4]. The study could reveal that according to the Greyson NDE scale, the reported intensity and content of the NDE did not seem to vary across etiology groups. Another finding from this study, and in parallel from previous work [49], highlights that the study design (i.e., retrospective vs. prospective studies) seems to influence the reports of NDE, and in this case the content of what was reported (i.e., an altered time perception, the feeling of harmony and unity, the sudden understanding of everything, the heightened senses were more frequently reported retrospectively, while encounters with deceased or religious spirits were more frequently reported prospectively). In further work, authors assessed whether the brain lesion site would influence the reported Greyson NDE scale's features of a NDE. For this purpose, NDEs after a coma of patients with a locked-in syndrome (i.e., infratentorial brain stem lesions) and patients with supratentorial cortical lesions were compared. The results showed that the infratentorial lesions cohort reported less positive emotions and had a tendency to report more life review—in contradiction with the "classical" supratentorial cohort [90].

Studies with neurological patients have led to more hypotheses and findings about the neural correlates of NDE core features. For instance, it has been shown that the stimulation of the right temporoparietal junction area, including the anterior part of the angular gyrus and the posterior temporal gyrus, can produce OBEs caused by a deficient multisensory integration at the temporoparietal junction area. Focal electrical stimulation protocols in patients with epilepsy, migraine, or tinnitus have also been shown to induce repeated OBEs described from a visuospatial perspective localized outside the physical body and illusory transformations of the patient's limbs [91, 92]. Using a positron emission tomography (PET) scan, these authors also showed that the OBE was related to increased activity in the right superior temporal and precuneal cortices [92]. The out-of-body illusions may be the result of a complex illusory replication of one's body based on ambiguous input from proprioceptive, tactile, visual, and vestibular information and their integration at the disrupted temporoparietal junction area [93]. To some extent, these body illusions have also been reported in healthy individuals during microgravity conditions (inversion illusion during space mission or the low gravity phase of parabolic flights) [94], in the context of sleep paralysis [95] and virtual reality [96]. Behavioral findings have also included the left temporoparietal junction in a possible neural correlate of NDE features for the "feeling of a presence." Electrical stimulation of this brain area in a patient who was undergoing presurgical evaluation for epilepsy treatment provoked the strange sensation that somebody was nearby when no one was actually present [97]. In parallel to those findings, epileptiform activity was observed in the left temporal lobe in a population of NDE experiencers as compared to an age-matched population of individuals without NDEs [98].

In conclusion, there is currently no consensual or satisfying scientific explanation for NDEs. Although the phenomenon attracts a lot of attention from the media

worldwide, still just a handful of empirical studies are available. To date, transcendental interpretations have led the discussion of these empirical findings. These have largely omitted discussing of any psychological and neurobiological bases for these experiences and instead appear to prefer paranormal explanations over and above scientific enlightenment. The claims that NDEs are evidence for life after death may have contributed to the reluctance of designing rigorous empirical protocols to study such a "pseudoscience" phenomenon. In fact, the latest neurosciences evidence from consciousness research leads to the speculation that these experiences would rather emerge from a modified or altered brain functioning in an altered or modified state of consciousness resulting from various circumstances. We also hypothesize that all NDE features could be generated from specific neural correlates arranged in a biopsychosocial integrated phenomenon.

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