BIOLOGICAL ASPECTS OF NEAR-DEATH EXPERIENCES

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Near-death experiences (NDEs) are profound psychological events with transcendental or mystical elements typically occurring to individuals close to death or in situations of intense physical or emotional danger. Such experiences, once regarded as meaningless hallucinations, have become the subject of serious study by medical and other researchers in recent years. Near-death experiences are important to physicians not only because they may occur to patients while under our care, but because they often lead to profound aftereffects that may affect health and response to medical treatments, and because they may help us understand the interaction between mind and body, particularly as that interface is affected by the dying process.

Once thought to be rare, the NDE is estimated to occur to a third of people who come close to death, or about 5 percent of the American population [1–3]. Although the term "near-death experience" and its acronym were not coined until 1975, accounts of similar events can be found in the folklore and writings of European, Middle Eastern, African, Indian, East Asian, Pacific, and Native American cultures. The phenomenon was first described as a clinical syndrome in 1892, when Heim published a collection of cases of mountain climbers who had fallen in the Alps (as he himself had done), soldiers wounded in war, workers who had fallen from scaffolds, and individuals who had nearly died in accidents and near-drownings; this article was translated into English 80 years later [4, 5].

The term "near-death experience" was coined by Moody to denote "any conscious perceptual experience which takes place during . . . an event in which a person could very easily die or be killed (and may even be so close as to be believed or pronounced clinically dead) but nonetheless survives, and continues physical life" [6]. More recently, Moody has redefined near-death experiences as "profound spiritual events that happen, uninvited, to

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some individuals at the point of death" [7]. *The Dictionary of Modern Medicine* has offered a more specific definition of the near-death experience:

> A phenomenon of unclear nature that may occur in patients who have been clinically dead and then resuscitated; the patients report a continuity of subjective experience, remembering visitors and other hospital events despite virtually complete suppression of cortical activity; near-death experiences are considered curiosities with no valid explanation in the context of an acceptable biomedical paradigm; the trivial synonym, Lazarus complex, refers to the biblical Lazarus who was raised from the dead by Jesus of Nazareth [8].

Predisposing Factors

Near-death experiences are reported by individuals who had been pronounced clinically dead but then resuscitated, by individuals who actually died but were able to describe their experiences in their final moments ("deathbed visions"), and by individuals who, in the course of accidents or illnesses, feared that they were near death.

Researchers have identified very few personal traits or variables that can predict who will have an NDE, or what kind of NDE a person may have. Retrospective studies of near-death experiencers have shown them collectively to be psychologically healthy individuals, who do not differ from control groups in age, gender, race, religion, religiosity, or mental health [2, 9–12]. Locke and Shontz found NDErs to be indistinguishable from control subjects in intelligence, neuroticism, extroversion, trait and state anxiety, and relevant Rorschach measures [13]. However, some studies have suggested that NDErs tend to be good hypnotic subjects, remember their dreams more often, and are adept at using mental imagery, and tend to acknowledge significant childhood trauma and resultant dissociative tendencies [11, 14, 15]. It is not clear, however, whether these personal traits and recall of prior experiences are the results of having had an NDE, or whether people who already have those characteristics are more prone to have NDEs when they come close to death. Children's NDEs are similar to those of adults, except that they tend not to include a life review or meetings with deceased friends and relatives, two differences that might be expected due to children's brief experience with life [16, 17].

While initial studies suggested that how one came close to death, or how close one actually came to death, did not influence the occurrence or type of NDE, more recent research has indicated that physiological details of the close brush with death may play a minor role. It appears, for example, that NDEs dominated by altered cognitive processes, such as distortion of the sense of time, accelerated thoughts, and a life review, are more common in near-death events that are sudden and unexpected than in those that may have been anticipated [18]. NDEs associated with cardiac arrest

resemble out-of-body experiences; those without cardiac arrest are more similar to depersonalization, in which one feels oneself or one's body to be unreal; and experiences occurring to intoxicated persons tend to be bizarre and confused, like hallucinations [19]. Furthermore, while all NDE elements can be reported by individuals who merely perceive themselves to be near death, certain features, such as an encounter with a brilliant light, enhanced cognitive function, and positive emotions, are more common among individuals whose closeness to death can be corroborated by medical records [20]. Closeness to death may be an even more significant factor among children: in one study, while NDEs were recounted by up to half of those children who survived critical illnesses, they were not recounted by children who suffered serious illnesses that were not potentially fatal [17].

Comparisons of NDE accounts from different cultures suggest that prior beliefs have some influence on the kind of experience a person will report following a close brush with death. For example, while features such as encountering other beings and other realms are cross-cultural elements, the life review and tunnel sensation are primarily reported in NDEs from Christian and Buddhist cultures, but rare among native populations in North America, Australia, and the Pacific islands [21]. While these cultural influences have led some scholars to interpret NDEs as nothing more than emotional reactions to the threat of imminent death [22–25], they may reflect not so much cross-cultural variations in the experience itself but rather cross-cultural discrepancies in experiencers' ability to process and express events that are largely ineffable.

Phenomenology

In coining the term "near-death experience," Moody identified 15 separate elements that seemed to recur in NDE reports: ineffability, hearing oneself pronounced dead, feelings of peace and quiet, hearing unusual noises, seeing a dark tunnel, being "out of the body," meeting "spiritual beings," a very bright light experienced as a "being of light," a panoramic life review, sensing a border or limit, coming back "into the body," frustrating attempts to tell others about the NDE, subtle "broadening and deepening" of one's subsequent life, elimination of fear of death, and corroboration of events witnessed while "out of the body" [26]. Moody noted that no two accounts were precisely the same, that no one experience in his collection included more than 12 of these 15 elements, that no one element appeared in every narrative, and that the order in which elements appeared varied from one experience to another. Two years later, having collected a considerably larger sample, Moody added to his initial list of features the somewhat less common elements of a realm in which all knowledge existed, cities of light, a realm of bewildered spirits, and "supernatural rescues"; again he cautioned against taking his description as prescription, warning

that his list was intended as a rough theoretical model rather than a fixed definition [6].

COMPONENT PARTS OF NDE

Several investigators have attempted to classify the common features of NDEs into discrete phenomenological categories. Noyes and Slymen, following a factor analysis of features reported by near-death experiencers, classified them into (a) mystical elements, such as a feeling of great understanding, vivid images, and revival of memories; (b) depersonalization elements, such as loss of emotion, separation from the body, and feeling strange or unreal; and (c) hyper-alertness elements, such as vivid and rapid thoughts and sharper vision and hearing [27]. On the bases of a cluster analysis of reported elements, I have subsequently classified them into (a) cognitive features of time distortion, thought acceleration, a life review, and revelation; (b) affective features of peace, joy, cosmic unity, and an encounter with light; (c) paranormal features of vivid senses, apparent extrasensory perception and precognitive visions, and "out-of-body experiences," and (d) transcendental features of otherworldly encounters with mystical beings, visible spirits, and an uncrossable border [18].

TEMPORAL PATTERNING OF NDE

Other classifications of the NDE have assumed that the experience unfolds in a consistent temporal pattern. Noyes described the developmental stages of the NDE as (a) resistance, terminated by surrender and tranquility; (b) review, including "out-of-body" and panoramic memory experiences; and (c) transcendence, involving a nontemporal dimension of existence [29]. Ring classified the unfolding stages of the NDE into (a) peace and well-being; (b) separation from the physical body; (c) entering a transitional region of darkness; (d) seeing a brilliant light; and (e) entering, through the light, another realm of existence [12]. Though he acknowledged that these stages do not always unfold in that strict sequence, he and other researchers have used this model to measure the "depth" of an NDE, such that, for example, an experience with the light might be considered "deeper" than one of separation from the body. Ring later described a progression of what he called the "core NDE," a particularly "deep" experience; speed and acceleration as one approaches a light that, despite it brilliance, does not hurt the eyes; pure love, total acceptance, forgiveness, and a sense of homecoming in the presence of the light; instantaneous, nonverbal communication with the light, which imparts knowledge, helping the experiencer through a life review to identify what really matters in life; transcendental music, paradisiacal environments, and cities of light; and a yearning to remain with the light forever [1].

TYPES OF NDE

Still other classifications of NDEs have assumed that there are discrete phenomenological *types* of experience. Sabom classified NDEs into (a) autoscopic experiences involving self-visualization from a position of height; (b) transcendental experiences involving apparent passage into a foreign realm or dimension; and (c) combined experiences with both autoscopic and transcendental features [2]. Twemlow, Gabbard, and Coyne, on the basis of a multivariate cluster analysis of phenomenological features, suggested a classification of experiences into those associated with preexisting conditions of (a) low stress; (b) emotional stress; (c) intoxicant; (d) cardiac arrest; or (e) anesthetic [19]. I have classified NDEs into those dominated by my previously identified phenomenological components as (a) cognitive; (b) affective; and (c) transcendental types [18]; and I have classified the rarer distressing type of NDE into (a) experiences phenomenologically like the blissful type, but interpreted as terrifying; (b) experiences of nonexistence or eternal void; and (c) experiences with blatant hellish imagery [30]. Despite the richness of the data examined in these various classifications, to date none of them has been tested in terms of its clinical usefulness or validity in predicting aftereffects.

Aftereffects of NDE

Regardless of their cause, these transcendent NDEs can permanently and dramatically alter the individual experiencer's attitudes, beliefs, values, and behavior. Most of the scholarly and popular literature on NDEs has focused on the beneficial aftereffects, but for a significant minority of experiencers, these profound changes lead to prolonged adjustment problems and emotional distress.

POSITIVE AFTEREFFECTS

The aftereffects most often reported following NDEs include increases in spirituality, concern for others, and appreciation of life, and decreases in fear of death, materialism, and competitiveness [2, 31, 32]. Near-death experiencers tend to see themselves as integral parts of a benevolent and purposeful universe in which personal gain, particularly at others' expense, is no longer relevant. In studies comparing NDErs' attitudes before and after their experiences, Noyes found that they reported a reduced fear of death, a sense of relative invulnerability, a feeling of special importance or destiny, and a strengthened belief in postmortem existence [33]. Ring found that NDErs experienced a greater appreciation for life, a renewed sense of purpose, greater confidence and flexibility in coping with life's vicissitudes, increased value of love and service and decreased concern with

personal status and material possessions, greater compassion for others, a heightened sense of spiritual purpose, and a greatly reduced fear of death [1, 12]. Likewise, Flynn found that NDErs reported a greatly increased concern for others, lessened fear of death, and increased belief in an afterlife, increased religious interest and feeling, and lessened desire for material success and approval of others [34]. Bauer, using an instrument based on Frankl's logotherapy, found experiencers to report significant positive changes in the purpose and meaning of life and in death acceptance [35].

In studies comparing the attitudes of NDErs with those of control groups, including persons who had come close to death but not had NDEs, I found that experiencers placed significantly lower value on social status, professional and material success, and fame, and that they found death less threatening [36, 37]. Although a less fearful attitude toward death has been associated with an increase in suicidal thoughts, I have found that near-death experiencers paradoxically express stronger objections to suicide than do control samples, primarily on the basis of increased transpersonal or transcendental beliefs [38, 39]. These profound changes in attitudes and in behavior have been corroborated in long-term studies of NDErs and in interviews with their significant others [1].

NEGATIVE AFTEREFFECTS

NDEs are usually regarded as positive experiences, and when they do lead to distress, most experiencers gradually adjust on their own, without any help. However, that adjustment often requires them to adopt new values, attitudes, and interests. Family and friends may then find it difficult to understand the experiencer's new beliefs and behavior. Influenced by the popular publicity about the positive effects of NDEs, they may place the experiencer on a pedestal and expect unrealistic changes, such as superhuman patience and forgiveness or miraculous healing and prophetic powers; and they may then become bitter and reject the NDEr who does not live up to these unrealistic expectations.

Although near-death experiencers sometimes feel distress if the NDE conflicts with their previously held beliefs and attitudes, the emphasis in the popular media on the positive benefits of NDEs may inhibit those who are having problems from seeking help. Sometimes people who have had a totally unexpected NDE may doubt their sanity, yet they are often afraid of rejection or ridicule if they discuss this fear with friends or professionals. Too often, NDErs do receive negative reactions from professionals when they describe their experiences, which discourages them even further from seeking help in understanding the experience [40, 41].

Emotional problems following NDEs include anger and depression at having been "returned," perhaps unwillingly. NDErs may have problems fitting the experience into their traditional religious beliefs, or into their

traditional values and lifestyles. Because the experience seems so central to their sense of self, and seems to set them apart from other people around them, NDErs may come to take on that role as their identity. NDErs may feel a sense of distance or separation from people who have not had similar experiences, and may fear being ridiculed or rejected by others—sometimes, of course, with good reason. Difficulty reconciling the new attitudes and beliefs with the expectations of family and friends can interfere with maintaining old roles and lifestyles which no longer have the same meaning. NDErs may find it impossible to communicate to others the meaning and impact of the NDE on their lives. Frequently, having experienced a sense of unconditional love in the NDE, the experiencer has difficulty accepting the conditions and limitations of human relationships [42–44]. Above and beyond these problems, which all NDErs may face to one degree or another, people who have had frightening NDEs have additional concerns about why they had that kind of experience, and they may be troubled by terrifying flashbacks of the experience itself. Similarly, additional problems may follow NDEs arising out of a suicide attempt or in young children.

Several researchers have noted that the value incongruities between NDErs and their families lead to a relatively high divorce rate among NDErs [45]. While many divorces among the general population occur because of arguments over not having *enough* money, NDErs' marriages may break down because they no longer share their spouses' interest in material possessions [31]. The "social death" that occurs when the familiar personality of an NDEr dies can be as disruptive to a family as the physical death of that person [46]. Bush concluded that the price of an NDE "may include long-term depression, broken relationships, disrupted career, feelings of severe alienation, an inability to function in the world, long years of struggling with the keen sense of altered reality" [45]. She quoted a divorce rate as high as 75 percent, and noted that although the most disabling aftereffects seem to affect a minority of experiencers, for them the impact is severe, and effective interventions hard to find.

Psychological Explanatory Hypotheses

DEPERSONALIZATION

Although clinical descriptions of NDEs can be found in medical journals in the 19th century, attempts to understand them psychologically were rare until Pfister's psychoanalytic interpretation of them in 1930 [47]. Pfister's interpretation of NDEs as a defense against the threat of death has been elaborated by Noyes and Kletti, who conceived of the NDE as a type of depersonalization, or feeling of strangeness or unreality [25, 48, 49]. Pfister proposed that persons faced with potentially inescapable danger attempt to exclude this unpleasant reality from perception and replace it with plea-

surable fantasies that protect the individual from being paralyzed by emotional shock. To the extent that a state of depersonalization mimics a state of death, this mechanism may also serve as a sacrifice of a part of the self in order to avoid actual death.

However, as Noyes and his colleagues have indicated, the depersonalization model can accommodate only some of the phenomena common to NDEs. Noyes and Kletti found that survivors of life-threatening danger do report depersonalization, derealization or a feeling of detachment from the environment, time distortion, lack of emotion, and a sense of detachment from their own bodies [49]; but as noted above, Noyes and Slymen also identified a "hyperalertness" factor diametrically opposed to depersonalization, and a "mystical consciousness" factor not addressed by the depersonalization model [27]. Gabbard and Twemlow noted that NDEs differ from depersonalization on a number of parameters [9]. They pointed out that depersonalization usually does not include a sense of being "out of the body", is experienced as "dreamlike"; is typically unpleasant; is characterized affectively by anxiety, panic, and emptiness; is experienced as pathological and strange; typically occurs in persons between 15 and 30 years of age, and rarely over 40; and occurs twice as often to women as to men. NDEs, by contrast, often include a sense of being "out of the body"; are not experienced as "dreamlike"; are typically pleasant; are characterized affectively by joy, ecstasy, and feelings of calm, peace, and quiet; are experienced as religious, spiritual, and noetic; have no characteristic age group; and have an even gender distribution.

DISSOCIATION AND ABSORPTION

Irwin argued against viewing the NDE as a type of depersonalization, in that the NDEr's sense of identity is not altered, but is in fact unusually lucid; what *is* altered is its association with bodily sensation [50]. Thus he argued that the NDE is not an example of depersonalization but rather of dissociation, an unconscious defense mechanism through which emotions are separated and detached from ideas or situations, so that experiencing some emotional impact can be deferred or delayed. However, Irwin found no significant difference between near-death experiencers and a control sample on dissociative coping style, although he did find a significantly higher rate of childhood trauma among the NDErs. He speculated that NDErs may have developed a tendency to dissociate in response to very stressful unforeseen events, but *not* a general dissociative defense style used to cope with everyday stressors.

Ring suggested that dissociation might account for what he called NDErs' "sensitivity to alternate realities" [15]. As reasons for suspecting dissociation to be part of NDErs' psychological profile, he cited evidence from his research that NDErs are more likely than others to have suffered childhood

abuse and trauma. Ring found dissociative defenses of NDErs to be significantly higher than those of a control sample, and argued, as did Irwin, that NDErs may have dissociative *tendencies* even though they do not manifest dissociative *disorders*. He proposed a developmental theory of sensitivity to extraordinary experiences such as NDEs, in which childhood abuse or trauma stimulates the development of a dissociative response style as a means of psychological defense. As dissociating allows the child to "tune out" threatening aspects of the physical and social environment by splitting him- or herself off from the sources of those threats, it also allows the child to "tune into" alternate realities where, by virtue of the dissociated state, he or she can feel safe regardless of what is happening to the body. By "alternate realities," Ring meant dimensions or realms of existence distinct from, but objectively as real as, the world of ordinary waking consciousness.

Ring argued, however, that attunement to alternate realities is not a result of dissociation itself, which only *allows* it, but of psychological absorption, the propensity to focus one's attention on imaginative or selected sensory experiences to the exclusion of other events in the external environment [51]. According to this model, one must transcend the sensory world (dissociation) *and* attend to internal states (absorption) to register and recall alternate realities. Ring argued that individuals who, from a history of childhood abuse and trauma, have developed dissociative tendencies and a capacity to become deeply absorbed in "alternate realities" would be well accustomed to such unusual states of consciousness by virtue of this kind of psychological conditioning, and would be more likely than others in a near-death state—because of their history of familiarity with these "alternate realities"—to "flip" into that mode of consciousness and thereby to "see" what other persons may not perceive.

Empirical data regarding absorption among NDErs have been suggestive but not compelling. Irwin documented that "out-of-body experiences" are in fact related to absorption abilities, and I have found greater tendencies toward absorption among NDErs than among control groups, as well as weak positive correlations between "depth" of NDEs and absorption [11, 14].

OTHER PSYCHOLOGICAL HYPOTHESES

Several other psychological hypotheses have been proposed to explain NDEs and their consistent features [52]. One plausible explanation suggests that NDEs are products of the imagination, constructed from our personal and cultural expectations, to protect us from facing the threat of death. However, while plausible, this hypothesis is not supported by the empirical data. While there are some cross-cultural variations in content of NDEs, individuals often report experiences that conflict with their specific religious and personal expectations of death [1, 53]. Furthermore, people

who had never heard or read of NDEs describe the same kinds of experiences as do people who are quite familiar with the phenomenon, and the knowledge individuals had about NDEs previously does not seem to influence the details of their own experiences [2, 10, 12, 54]. Another problem for the expectancy model of NDEs is that children too young to have received substantial cultural and religious conditioning about death report the same kinds of NDEs as do adults. Several researchers have now published collections of childhood near-death experiences, including some reported to have occurred before the child could have acquired any language skills (but described by the child years later) [9, 17, 45, 55, 56].

The view of NDEs as recollections of the birth experience, popularized by Sagan, has been plausibly refuted by a preponderance of evidence that newborns lack the visual acuity, the spatial stability of their visual images, the mental alertness, and the cortical coding capacity to register memories of the birth experience, as well as by the lack of meaningful correspondence between the birth experience and important features of NDEs [57, 58]. Grof avoided those objections, as well as the reductionistic implications of a literal birth-memory model, by conceptualizing NDEs as products of a Jungian archetype of a birth experience rather than as memories of actual birth events [59]. Grosso further described what he called "the archetype of death and enlightenment," a psychic template of rebirth experience that he saw reflected in NDEs, as well as in dreams, mythology, ancient mystery rites, and psychedelic experiences [60]. While that framework does place NDEs within a larger context, its proponents have not described how it leads either to testable hypotheses or to therapeutic interventions.

Physiological Explanatory Hypotheses

HYPOXIA

A common assumption has been that anoxia or hypoxia, as a common final pathway to brain death, must be implicated in NDEs. However, the only published report in which an investigator has been able to measure blood levels of oxygen and carbon dioxide during NDEs found no effects of anoxia or hypercapnia [2]. Whinnery developed a hypoxia model of NDEs based on the brief periods of unconsciousness induced by rapid acceleration in fighter pilots, which reduces blood flow to the head [61]. Whinnery argued that many features of NDEs are consistent with these hypoxic unconsciousness episodes, the major characteristics of which are incapacitation, myoclonic convulsions, memory alterations, and visual effects.

The major features acceleration-induced loss of consciousness shares with NDEs are tunnel vision and bright lights, floating sensations, automatic movement, autoscopy, out-of-body experiences, not wanting to be

disturbed, paralysis, vivid dreams of beautiful places, frequently including family members and close friends, pleasurable sensations, euphoria, and some pleasurable memories. No life review or panoramic memory has been reported. It would be surprising if some symptoms of loss of consciousness were not associated with NDEs. However, Whinnery cautioned that his model does not explain all near-death phenomena, and suggested that it might be used to differentiate those components of the phenomena that occur as a result of unconsciousness from those that are beyond the scope of the hypoxic experience and are unique to the NDE.

OTHER PHYSIOLOGICAL HYPOTHESES

Since NDErs report events that others around them cannot see or experience, it is plausible to hypothesize that NDEs are elaborate hallucinations produced either by medications given to dying patients or by metabolic disturbances or brain malfunctions as a person approaches death. However, many NDEs are recounted by individuals who had no metabolic or organic malfunctions that might have caused hallucinations. Furthermore, organic brain malfunctions generally produce clouded thinking, irritability, fear, belligerence, and idiosyncratic visions, quite unlike the exceptionally clear thinking, peacefulness, calmness, and predictable content that typify the near-death experience. Visions in patients with delirium are generally of living persons, while those of patients with a clear sensorium as they approached death are invariably of deceased persons [62]. Surveys have documented that patients who are febrile, anoxic, or given drugs when near death report fewer NDEs and less elaborate experiences than do patients who remain drug-free and are neither febrile nor anoxic [2, 12, 62]. Such findings may suggest that drug- or metabolically-induced delirium, rather than causing NDEs, in fact inhibits them from occurring; or they may suggest merely that patients who are delirious tend not to recall their near-death experiences upon recovery.

Several neurobiological models have been proposed to explain the NDE, invoking the role of endorphins or various neurotransmitters, and neuroanatomical models have linked NDEs to specific sites in the brain. Near-death experiences have been attributed to endorphins and other endogenous opioid peptides, to serotonin, to glutamate or endopsychosins acting on NMDA-phencyclidine receptors, and to interaction between muscarinic, NMDA, ACTH, and enkephalin systems [63–68]; and they have been hypothetically localized to the limbic lobe, primarily the hippocampus and a locus along the Sylvian fissure on the right temporal lobe, and to Reissner's fiber in the central canal of the spinal cord [63–65, 69, 70]. At this point, such models are suggestive but untestable.

Persinger proposed that mystic experiences like NDEs represent intru-

sion of the right hemispheric equivalent of the sense of self into left hemispheric awareness [68]. He claimed that major components of NDEs—including out-of-body experiences, floating sensations, feeling pulled toward a light, hearing strange music, and profound meaningful experiences—can be provoked experimentally by inducing electrical currents in the temporal region by applying exogenous spike-and-wave magnetic field sources, though he also noted that the most common experiences reported by his subjects were dizziness and tingling, which are not characteristic near-death phenomena [68, 71]. He noted, furthermore, that these induced experiences are fragmented and variable, unlike the integrated and temporally focused sensations of NDEs; and that subjects in his experimental protocol are able to converse with the experimenter and to report their sensations as they occur—that is, that unlike NDErs, they remain subjectively in the mundane reality and do not experience a subjective shift to a supramundane world during the experience.

Jansen proposed that NDEs are produced by blockade of N-methyl-D-aspartate (NMDA) receptors in the brain [66]. He argued that some conditions that precipitate NDEs, such as hypoxia, release a flood of the excitatory neurotransmitter glutamate, which kills neurons by overactivating NMDA receptors. This neurotoxicity can be blocked if the NMDA receptors are bound by the dissociative anesthetic ketamine, whose psychoactive properties can induce an NDE–like alteration of consciousness. Jansen speculated that, in individuals not under the influence of ketamine, unidentified neuroprotective "endopsychosins" bind to the NMDA receptors to prevent this neurotoxicity, and that these endopsychosins also alter consciousness just as ketamine does. He argued that ketamine can induce experiences of tunnels, lights, and sensations of telepathic communication with what appear to be mystical entities, and proposed that his NMDA receptor model could be a final common pathway for near-death phenomena precipitated by depersonalization, regression in the service of the ego, reactivation of birth memories, sensory deprivation, temporal lobe epilepsy, endorphin release, and hypoxia.

While Jansen's "ketamine model" of NDEs is appealing, it hinges on speculation about the existence of endopsychosins as yet unidentified. Unlike NDEs, ketamine experiences are frequently fearful and rarely regarded by experiencers as "real" [72, 73]. Furthermore, the clarity during NDEs and clear memory for them afterwards are inconsistent with a model based on compromised cerebral function, and NDEs may occur in the absence of upset cerebral physiology. Jourdan proposed a similar model implicating blockade of hippocampal NMDA receptors by endopsychosins, adding that alteration of the hippocampal theta rhythm during meditative states could produce similar physiological events leading to NDEs [69]. He hypothesized that NMDA receptor blockade in the hippocampus prevents "long-

term potentiation," a long-lasting enhancement of hippocampal synaptic efficacy secondary to repeated neural input, which would close access to sensory information, a common stimulus to mystical experience.

To the extent that these psychological and physiological hypotheses succeed in explaining NDEs, many do so by focusing selectively on certain features of the experience and by declaring other features they do not explain to be peripheral to the phenomenon; no theory has yet been proposed that can account satisfactorily for all the common elements of NDEs. There is no logical reason, however, to demand that one comprehensive theory explain the entire phenomenon. It may well be that the "out-of-body" component of NDEs, for example, is best understood as a dissociative defense, while the sense of peace and well-being is a function of endorphins, and the life review related to NMDA receptor blockade.

Such a multifaceted neurobiological model of NDEs was proposed by Saavedra-Aguilar and Gómez-Jeria, invoking temporal lobe dysfunction, hypoxia, psychological stress, and neurotransmitter changes, as modulated by the individual's memory and language systems [64]. They proposed that following a traumatic event, brain stress leads to release of endogenous neuropeptides and/or neurotransmitters, producing analgesia, euphoria, and detachment, while oxygen tension decreases in the brain, primarily in limbic structures. Those two effects combine to excite epileptiform discharges in the hippocampus and amygdala, producing complex visual hallucinations and a life review. Afterdischarges propagating through the limbic connections to other brain structures produce further hallucinations and a sensation of a brilliant light. Following recovery, the linguistic system reconstructs out of these sensations an experience consistent with the individual's cultural beliefs.

Like other physiological models of NDEs, this one assumes physical trauma and hypoxia, and thus does not accommodate those NDEs that occur in the absence of physiological injury. Furthermore, it ascribes to temporal lobe malfunction key features of NDEs that have not in fact been reported either in clinical seizures or in electrical stimulation of those brain structures, such as feelings of peace or bliss and sensations of being out of the body [74]. Saavedra-Aguilar and Gómez-Jeria's model is based on numerous unsupported assumptions and speculations derived from neurochemical research with nonhuman animals, and its key elements such as "brain stress" and unspecified neurotransmitters and neuroanatomical sites are vague and indefinable. That is not to say that their model is incorrect, but that its neurophysiology is too ambiguous for empirical support; it is a plausible model, but not a testable one.

Blackmore proposed a comparably multifaceted model of NDEs in which various components of the experience were explained by different psychological or physiological mechanisms [75]. She attributed noises heard by NDErs either to stimulation of the cochlea by cerebral anoxia or to the

temporal lobe; the tunnel and the light to neuronal disinhibition in the visual cortex, again activated by anoxia; feelings of peace and well-being to release of endorphins; and frightening experiences conversely to morphine antagonists. Blackmore ascribed the sense of being out of the body to the brain's retrospective reconstruction of a plausible reality after the normal body image is broken down by lack of sensory input, and the life review to temporal-limbic seizures induced by endorphins and to hippocampal stimulation by certain neurotransmitters. However, while many of Blackmore's proposed neurophysiological mechanisms are plausible, none has been demonstrated to occur in a near-death state, and some, such as those based on cerebral anoxia, have been contradicted by empirical data. Her model is entirely ad hoc, not addressing, for example, why endorphins might play a leading role in some experiences, while morphine antagonists might dominate others.

Alternative Explanatory Hypotheses

The explanatory hypothesis endorsed most commonly by near-death experiencers themselves is that during the NDE some part of them separated from their physical bodies and experienced a glimpse of the afterlife. Indeed, the widespread popular interest in NDEs seems largely due to their implication that death is a transition rather than an end [80, 81]. Most biomedical investigators have regarded the question of whether consciousness may survive the death of the body as being beyond the realm of biological research [82]. Nevertheless, it must be recognized that our physiological models for the NDE, even when they have some supporting data, leave us in a philosophically ambiguous situation.

Correlating a brain state with an experience does not necessarily imply that brain states cause the experience; the brain state may simply reflect or allow access to the experience. In fact, this latter possibility has been defended by some researchers who have championed neurophysiological studies of NDEs. Persinger wrote that transient changes in the brain during an NDE might allow perception of paranormal information [71]; Jansen described his postulated NMDA receptor changes as creating "a door to a place we cannot normally get to; it is definitely not evidence that such a place does not exist" [67]; and Jourdan wrote that, despite his proposal of a neurochemical model of NDEs, the evidence for paranormal aspects of the NDE "rules out any hypothesis that these experiences are hallucinations or purely neurological phenomena" [69]. As Strassman expressed this dilemma, "understanding how the television set works does not yield any information regarding from where the images and sounds arise" [72].

These contrasting views of brain states as the origin of NDEs or as the mediator of NDEs have been illustrated by two perceptual analogies. One

model relies on Jackson's perceptual release theory of hallucinations: if awareness persists while sensory input is reduced, images originating in the brain are perceived as if they originated from the senses [76]. In Siegel's elaboration of this analogy, a person looks out a window at a garden. In the daylight, the person sees the garden and not the interior of the room. As dusk approaches, however, the images of objects in the illuminated room are dimly reflected in the window, and the observer can focus either on the garden outside or on the reflection of the room's interior. As night falls, the interior of the illuminated room is vividly reflected in the window and appears to be outside [77]. The alternative model is based on James' concept of different forms of consciousness: as sensory input is reduced, another reality, usually masked by sensory input, is revealed [78]. As Ring described this counter-analogy, a person looking up at the sky in the daylight sees only the bright sun; only at night, when sunlight is absent, can the observer see the stars and other heavenly bodies [79].

Future Directions in Near-Death Research

Research into the etiology of NDEs remains handicapped by the difficulty of obtaining direct evidence bearing on the plausible hypotheses, in part due to the unpredictable occurrence of the experience. Psychological hypotheses can be tested indirectly by examining personality traits and cognitive styles of experiencers; but no matter how detailed, such psychological profiles do not reveal what defenses may have operated at the time of the experience. The neurophysiological hypotheses that have been proposed so far are untestable in terms of our current methodological sophistication. While correlating NDEs with physical structures or chemicals in the brain would not necessarily tell us what causes NDEs, it would potentially open up new tools and techniques for investigating the mechanisms and aftereffects of these experience. While it is debatable whether direct evidence of postmortem survival is even logically possible, investigation of NDErs' mental functioning during ostensible unconsciousness can provide indirect evidence of the interaction between, and possible independence of, mind and body.

The most promising aspect of NDEs for future research may be their role in personal transformation, as this is certainly the most easily measured and arguably the most important feature of the experience. Many of the studies conducted so far have been limited by the nature of their subject populations, often limited to self-selected, voluntarily submitted accounts; the lack of a suitable control or comparison group; and the lack of a structured interview protocol and standardized, objective scales. Studies of NDE aftereffects should measure empirical outcomes that can be measured objectively or corroborated independently by other witnesses.

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METAMORPHIC DILEMMA

You need great restraint
when you discover
your beautiful plants
in your butterfly garden
being leaf stripped by
boorish cutworms, hornworms
and caterpillars.
Yes,
much restraint
Indeed!

THOMAS PETER BENNETT