

Near-death experiences in cardiac arrest survivors

Christopher C. French*

Anomalistic Psychology Research Unit, Department of Psychology, Goldsmiths College, University of London, New Cross, London SE14 6NW, UK

Abstract: Near-death experiences (NDEs) have become the focus of much interest in the last 30 years or so. Such experiences can occur both when individuals are objectively near to death and also when they simply believe themselves to be. The experience typically involves a number of different components including a feeling of peace and well-being, out-of-body experiences (OBEs), entering a region of darkness, seeing a brilliant light, and entering another realm. NDEs are known to have long-lasting transformational effects upon those who experience them. An overview is presented of the various theoretical approaches that have been adopted in attempts to account for the NDE. Spiritual theories assume that consciousness can become detached from the neural substrate of the brain and that the NDE may provide a glimpse of an afterlife. Psychological theories include the proposal that the NDE is a dissociative defense mechanism that occurs in times of extreme danger or, less plausibly, that the NDE reflects memories of being born. Finally, a wide range of organic theories of the NDE has been put forward including those based upon cerebral hypoxia, anoxia, and hypercarbia; endorphins and other neurotransmitters; and abnormal activity in the temporal lobes. Finally, the results of studies of NDEs in cardiac arrest survivors are reviewed and the implications of these results for our understanding of mind–brain relationships are discussed.

Introduction

Greyson (2000a, pp. 315–316) describes near-death experiences (NDEs) as

profound psychological events with transcendental and mystical elements, typically occurring to individuals close to death or in situations of intense physical or emotional danger. These elements include ineffability, a sense that the experience transcends personal ego, and an experience of union with a divine or higher principle.

He also provides a typical example of an NDE experienced by a 55-year-old man who had been admitted to hospital with an irregular heartbeat.

During diagnostic angiography he suffered a coronary occlusion and had to undergo emergency quadruple bypass surgery. Following this, he reported having had an out-of-body experience (OBE) during which he observed the operating room from above. He was able to accurately describe the behavior of the cardiovascular surgeon during the operation. He also described following a brilliant light through a tunnel to a region of warmth, love, and peace. Here he experienced an apparent encounter with deceased relatives, who telepathically communicated to him that he should return to his body. Upon recovery, he felt transformed, with an intense desire to help others and to talk about his experience.

Modern interest in NDEs owes much to the publication in 1975 of Raymond Moody's best-selling book *Life after Life*, although reports of similar experiences can be found in much earlier texts. Moody (1975, 1977) identified a number of

*Corresponding author. Tel.: +44 020 7919 7882;
Fax: +44 020 7919 7873; E-mail: c.french@gold.ac.uk

Table 1. Common elements recurring in adult NDEs according to Moody (1975, 1977; as summarized by Greyson, 2000, p. 318)

Elements occurring during NDEs:
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”
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”
Elements occurring as aftereffects:
Frustration relating the experience to others
Subtle “broadening and deepening” of life
Elimination of fear of death
Corroboration of events witnessed while “out of the body”

common elements that recur in adult NDEs (see Table 1), although he noted that no element occurs in all NDE reports. He also noted that the order in which the elements occurred varied in the different accounts he had collected. Subsequent researchers, like Ring (1980), adopted a more systematic approach to the study of NDEs. Ring identified a “core experience” on the basis of a structured interview and measurement scale that he administered to 102 people who had been near to death, 48% of whom reported an NDE. This consisted of the following five stages, which tend to occur in the following order:

- (a) *Peace and well-being*: The positive emotional tone of the NDE was reported by 60% of Ring’s (1980) sample. Although the vast majority of NDEs are indeed blissful, more recent research (e.g., Greyson and Bush, 1992) has established that NDEs can occasionally cause terror and distress. Negative NDEs appear to fall into three distinct categories. Firstly, there are those that seem phenomenologically similar to the positive NDE with the exception that the experient

finds the whole process unpleasant. Secondly, there are those involving experiences of visiting hellish regions and encountering the Devil or demonic beings. Finally, there are those in which the NDEr (i.e., the person experiencing the NDE) finds himself or herself in an isolated, featureless, eternal void.

- (b) *Separation from the physical body*: OBEs were reported by 37% of Ring’s (1980) sample. OBEs, which can occur independently of NDEs, involve the feeling that one’s consciousness has become disconnected from one’s physical body. Often the experience involves apparently being able to see one’s physical body from an external vantage point, as was the case in about half of the OBEs (i.e., the person experiencing the OBE) in Ring’s study.
- (c) *Entering a region of darkness*: About a quarter of Ring’s (1980) cases involved entering a transitional region of darkness, either before or after the OBE, which was sometimes referred to as “tunnel-like”.
- (d) *Seeing a brilliant light*: A brilliant light, which did not hurt the eyes, was reported by 16% of Ring’s (1980) subjects. They felt drawn toward this light, which was often perceived to be some kind of spiritual being, such as God or Jesus. A panoramic life review may then take place during which key events in the subject’s life are replayed, sometimes in the company of the spiritual being. The process is felt to be non-judgemental.
- (e) *Through the light, entering another realm*: Around 10% of Ring’s (1980) sample reported entering a spiritual realm, often described as a beautiful garden with heavenly music. Deceased relatives or other spiritual guides are apparently encountered in this realm. Also, some kind of natural border, such as a fence or a river, is often encountered. This seems to symbolically represent the point of no return — and the decision is made, often very reluctantly, to return to the physical body.

Attention has also focused upon the aftereffects of the NDE. In the immediate aftermath of an NDE,

many NDErs feel that the experience was positive and life-enhancing, but some find the experience disturbing and difficult to talk about even when the experience itself was positive (Orne, 1995). How well individuals are able to integrate the experience into their everyday lives often depends crucially upon how their initial reports are received by family, friends, and nursing staff. All too often, this reaction can be to ridicule or dismiss such reports, sometimes leading the NDEr to doubt their own sanity. In the longer term, experiencers typically report that they are less materialistic, more spiritual, less competitive and, not surprisingly, have a decreased fear of death (e.g., Ring, 1980) but even then there may be some negative aftereffects (Bush, 1991; Greyson, 1997). Among the problems most often encountered are frustration at being unable to communicate the significance of the experience to others, fear of ridicule, despair at being returned to the ordinary everyday world having experienced such bliss, and difficulties with ordinary human relationships, having experienced perfect divine love. Friends and family may also have problems dealing with the transformation, and divorce rates are very high following NDEs. Negative, long-term aftereffects following distressing NDEs can be even more disabling, with sufferers understandably showing heightened fear of death, along with flashbacks and other symptoms of post-traumatic stress disorder (Greyson and Bush, 1992).

Although the definition of an NDE provided at the start of this chapter is as good as any other (and considerably better than some), it should be appreciated that no universally accepted definition of the NDE exists. This is an important issue insofar as researchers using different definitions of the NDE are likely to reach different conclusions regarding its nature, causes, and consequences. Given the complex and multifaceted nature of the experience, it should also come as no surprise that there are many other ways of categorizing the phenomenological elements of the NDE in addition to Moody's (1975, 1977) 15-element model (see Table 1) and Ring's (1980) five-stage model referred to above. For example, Noyes (1972) identified three developmental stages of the NDE (resistance, review, and transcendence), while Lundahl (1993) feels that research points to ten

stages (peace, bodily separation, sense of being dead, entering the darkness, seeing the light, entering another world, meeting others, life review, deciding to or being told to return to life, and returning to the body). Noyes and Slymen (1978–1979) classified the common features into three categories (mystical, depersonalization, and hyperalertness) on the basis of factor analysis. Greyson (1985), on the basis of cluster analysis, arrived at four categories related to cognitive, affective, paranormal, and transcendental features.

In order to minimize the potential confusion that could be caused by different researchers adopting different definitions of the NDE, many studies employ standard scales to decide who has and who has not had an NDE and the “depth” of the experience. Although many different scales have been developed, discussion here will be limited to two of the most commonly used. Ring (1980) developed the “weighted core experience index” (often referred to as WCEI), in which the following components are assigned different weights: the subjective sense of being dead, feelings of peace, bodily separation, entering a dark region, encountering a presence or hearing a voice, taking stock of one's life, seeing or being enveloped in light, seeing beautiful colors, entering into the light, and encountering visible spirits. Each feature is scored for presence or absence and the weighted total of those features that are present gives a score between 0 and 29.

Greyson (1983) criticized Ring's scale on the grounds that people could get a fairly high score on the basis of very few typical NDE components. He developed an improved scale commonly referred to as the Greyson NDE scale. To do this, he began by listing 80 features that included all the main items from previous scales. Following an initial pilot study, this list was reduced to 33 items with three-point scaled answers. After further development, the final 16-item scale was produced with questions in four groups (relating to cognitive, affective, paranormal, and transcendental features). This final scale is essentially a modified version of Ring's scale with a maximum score of 32. It has good test–retest reliability and internal consistency. A score of 7 or higher is the criterion for a true NDE.

Greyson (1998), after reviewing all published estimates of the incidence of NDEs, concluded that they probably happen to between 9 and 18% of people who come close to death. The main focus of this chapter will be to consider what can be learned about the nature of NDEs from studying cardiac arrest survivors. This particular population is of special interest in this context for a number of reasons. First, the vast majority of studies of NDE studies are retrospective in nature, with accounts sometimes not being collected until years or even decades after the experience itself. With respect to cardiac arrest survivors, however, it is possible to set up prospective studies that allow for survivors to be interviewed within days of their experience, thus greatly reducing potential problems of memory distortion. Second, such studies potentially allow researchers to correlate objective, physiological and pharmacological measurements with the reported features of the NDE, providing very useful data with respect to testing different theoretical accounts. Third, this population allows for the possibility of objectively testing the veridicality of the OBE component of the NDE, as described below. Finally, it can be argued that the mental state of cardiac arrest victims provides the closest model we have to that of a dying brain (Parnia et al., 2001).

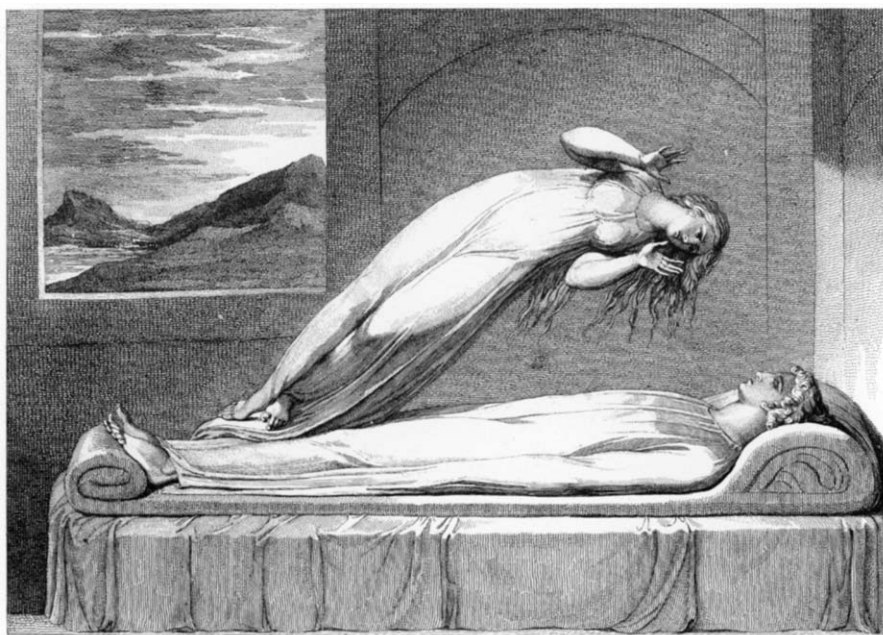
The next section will present an overview of the different theoretical approaches that have been adopted in attempts to explain the NDE. This will be followed by a consideration of studies of NDEs in cardiac arrest patients and the implications such studies may have for the different theoretical approaches. For reviews of various other aspects of the NDE, the reader is referred to Ring (1980, 1982), Sabom (1982), Morse (1990, 1992), Blackmore (1993, 1996a), Fenwick and Fenwick (1995), Bailey and Yates (1996), Greyson (2000a), Roe (2001), and Irwin (2003, Chapters 11 and 12, pp. 163–196).

Theoretical approaches to NDEs

Roe (2001) divides the different theoretical approaches into three broad categories, although it should be realized that such categorization is

purely for convenience of presentation. In reality, the theories and models of the NDE are not distinct and independent, but instead show considerable overlap. The first broad category that Roe refers to is spiritual theories (also sometimes known as transcendental theories). The most popular interpretation of the NDE is that it is exactly what it appears to be to the person having the experience. It is taken as strong evidence that the (allegedly immaterial) mind (or soul) can become separated from the physical body (see artistic depiction in Fig. 1). It is further assumed that the NDE provides a glimpse of a spiritual realm to which souls migrate after death. The allegedly paranormal nature of NDEs would be supported if it could be shown that information gained during the OBE component of an NDE was veridical and could not have been obtained in any conventional way. Some prominent researchers (e.g., Sabom, 1982) in this area have put forward cases that they feel provide strong support for such a position, but critics (e.g., Blackmore, 1993; Woerlee, 2003) remain unconvinced that all non-paranormal explanations for such information acquisition have been ruled out. Blackmore (1996b, p. 480) lists several such explanations including “information available at the time, prior knowledge, fantasy or dreams, lucky guesses, and information from the remaining senses. Then there is selective memory for correct details, incorporation of details learned between the end of the NDE and giving an account of it, and the tendency to “tell a good story”. The degree to which these factors might provide an adequate explanation for such cases is discussed in more detail below.

The second broad category encompasses psychological theories. Some of these offer reasonable explanations for some components of the experience but fail to provide an adequate explanation of all aspects. An example would be Noyes and Klett’s (1976, 1977) suggestion that the NDE is a form of depersonalization which acts as a defense against the threat of death in situations of extreme danger, by allowing a sense of detachment and engagement in pleasurable fantasies. Tellegen and Atkinson’s (1974) concept of psychological absorption, which may be defined as the propensity to focus attention on imaginative or selected



The Soul hovering over the Body reluctantly parting with Life.

Fig. 1. It has long been believed that soul leaves the body at the moment of death, as illustrated above. Does the NDE offer support for such claims? (The soul leaves the body at the moment of death, William Blake, engraved by Schiavonetti, 1808; illustrating Blair's poem *The Grave*; reproduced with permission from the Mary Evans Picture Library).

sensory experiences to the exclusion of stimuli in the external environment, is relevant here as is [Wilson and Barber's \(1983\)](#) concept of fantasy proneness. The depersonalization model receives some support from [Irwin's \(1985\)](#) study which shows that OBEs show higher levels of absorption ability, and [Council and Greyson's \(1985\)](#) observation of both higher absorption and fantasy proneness scores amongst NDEs. The model accounts reasonably well for the OBE component of the NDE, but not for the fact that most NDEs involve a sense of "hyper-reality" and do not feel dream-like at all, as is typical of other forms of depersonalization.

[Irwin \(1993\)](#) pointed out that NDEs differ from depersonalization in a number of ways, e.g., that what is altered is not one's sense of identity but the association of this identity with bodily sensations. He suggested that the NDE is a dissociative state in which there is a dissociation of self-identity from bodily sensations and emotions. This is

supported by [Greyson's \(2000b\)](#) observation that NDEs report more dissociative symptoms than a control group, consistent with a non-pathological dissociative response to stress. It is possible that this tendency developed originally as a coping mechanism in response to childhood trauma ([Ring, 1980; Irwin, 1993](#)).

Another psychological theory that has been proposed is that the NDE reflects memories of being born, with the tunnel representing the birth canal, the light at the end of the tunnel representing the lights in the delivery room, and the being of light representing the midwife, obstetrician, or father ([Grof and Halifax, 1977; Sagan, 1979](#)). [Becker \(1982\)](#) has presented a thorough refutation of this theory. As he points out, the experience of being born is only very superficially similar to the NDE. The birth canal would not appear to the fetus as a tunnel with a light at the end, down which the fetus would gently float. Instead, it would be dark and extremely constrained, and furthermore

babies do not travel down the birth canal facing forward. There is also a great deal of evidence to show that young infants are simply incapable of laying down accurate autobiographical memories during the first couple of years of life. Blackmore (1983) argued that if the NDE truly reflected memories of birth, the nature of the birth ought to influence the type of NDE reported. She found, however, that the tunnel experience is just as common in those delivered by Caesarean section as in those delivered naturally.

The final broad category is organic theories. A number of theories have been proposed that attempt to account for components of the NDE in terms of brain function. It is worth noting that most components of the NDE are known to also occur in non-NDE contexts, many of which have the potential to allow for greater experimental control than would usually be the case in naturally occurring NDEs. Study of these components in the non-NDE context obviously provides strong direct evidence either for or against particular organic theories.

A number of theorists have considered the possible role of abnormal levels of blood gases in the NDE. Cerebral anoxia is the final common pathway to brain death and it is therefore instructive to consider the degree to which the symptoms of hypoxia and anoxia reflect those of NDEs. Whinnery (1997) pointed out that there are indeed many similarities between NDEs and the so-called G-LOC syndrome (i.e., acceleration (+Gz)-induced loss of consciousness). G-LOC episodes can occur in fighter pilots engaged in certain types of maneuver because the extreme acceleration involved can result in a loss of adequate blood supply to the brain. Based on observations of almost 1000 episodes of G-LOC, Whinnery noted that such episodes often involved "tunnel vision and bright lights, floating sensations, automatic movement, autoscapy, OBEs, not wanting to be disturbed, paralysis, vivid dreamlets of beautiful places, pleasurable sensations, psychological alterations of euphoria and dissociation, inclusion of friends and family, inclusion of prior memories and thoughts, the experience being very memorable (when it can be remembered), confabulation, and a strong urge to understand the experience."

(Whinnery, 1997, p. 245). Life review, mystical insights, and long-lasting transformational after-effects are not reported to be associated with G-LOC episodes, but this may simply reflect the fact that such episodes rarely involve any expectation of actually dying.

One common objection to the idea that anoxia may be a factor in some NDEs is the claim that anoxia is characterized by confused thinking, whereas the NDE is characterized by extreme clarity of thought. In fact, as Blackmore (1996a) points out, the effects of anoxia vary enormously depending upon the type of anoxia, its speed on onset, and the time until oxygen is restored. It should also be borne in mind that confused thinking is a state that is often attributed by an outside observer to an individual on the basis of their behavior. As Liere and Stickney (1963, p. 300) point out, "Hypoxia quickly affects the higher centers, causing a blunting of the finer sensibilities and a loss of sense of judgment and of self-criticism. The subject feels, however, that his mind is not only quite clear, but unusually keen." In the case of NDE reports, we should perhaps be wary of accepting the retrospective claims of great clarity of thought.

Hypercarbia is often associated with anoxia and can itself produce NDE-like symptoms including bright lights, OBEs, relived past memories, and mystical experiences (Meduna, 1950). Sabom (1982) reported an NDE in a 60-year-old man who had suffered a heart attack and cardiac arrest. Measured blood gases in this patient showed that levels in the periphery were relatively normal. Furthermore, it is widely recognized that NDEs can occur in people who are obviously not suffering from anoxia and/or hypercarbia. Blackmore (1996a), when arguing in favor of a possible role for such factors in the NDE, explicitly states that there may be many triggers for an NDE with anoxia being just one of them.

Other theorists have considered the possible role of neurotransmitters in generating the NDE. Early suggestions that NDEs are hallucinatory experiences caused by externally administered drugs used in resuscitation attempts can be rejected on empirical grounds. Not only are NDEs reported by patients in circumstances where we can be sure

that no drugs have been administered, but research has shown that administration of such drugs leads to fewer and more muted NDEs (e.g., Ring, 1980).

Others have suggested models based upon naturally occurring neurotransmitters. Carr (1982) argued that endorphin release could account for many aspects of the NDE, a suggestion that was incorporated into the more comprehensive neurobiological model put forward by Saavedra-Aguilar and Gómez-Jeria (1989). Endorphins are released in times of stress and lead to a reduction in pain perception and a pleasant, even blissful, emotional state. Consistent with the idea that endorphin release may be responsible for the positive emotional tone of most NDEs are the occasional reports of pleasant NDEs changing into unpleasant “Hellish” NDEs upon administration of endorphin-blocking drugs such as naloxone (Judson and Wiltshaw, 1983). Morse et al. (1989) have argued that serotonin has a more important role to play in generating NDEs than endorphins, at least with respect to mystical hallucinations and OBEs.

Jansen (1989, 1997, 2001) pointed out that endorphins are not powerful hallucinogens, but that many aspects of the NDE, such as seeing lights and moving through tunnels, can be induced by the dissociative anesthetic ketamine. Jansen developed a model of NDEs on the basis of this observation. He started from the fact that some conditions that lead to NDEs (e.g., hypoxia) involve a sudden increase in the concentration of the excitatory neurotransmitter glutamate, which destroys neurons by overactivating NMDA receptors. Ketamine can bind to NMDA receptors, blocking this neurotoxicity and producing NDE-like symptoms. Jansen hypothesized that under those conditions that produce a flood of glutamate, as yet unidentified neuroprotective “endopsychosins”, similar to ketamine, are released to prevent neuronal damage and that this results in the NDE. However, there are important differences between typical NDEs and typical ketamine experiences. For example, the latter are more likely to be frightening (Strassman, 1997) and to feel unreal (Fenwick, 1997).

The temporal lobe is almost certain to be involved in NDEs, given that both damage to and direct cortical stimulation of this area are known

to produce a number of experiences corresponding to those of the NDE, including OBEs, hallucinations, and memory flashbacks (Penfield, 1955; Blanke et al., 2002, 2004). It is worth noting that both the temporal lobes and the limbic system are sensitive to anoxia, and that release of endorphins lowers the seizure threshold in the temporal lobes and the limbic system (Frenk et al., 1978). Britton and Bootzin (2004) recently produced evidence supporting the idea that altered temporal lobe functioning may be involved in the NDE. They found that individuals who had reported having NDEs had more temporal-lobe epileptiform electroencephalographic activity than a non-NDE control group and that this activity was almost completely lateralized to the left cerebral hemisphere. The control group used in this study consisted of individuals who had not come close to death rather than people who had come close to death but had not experienced an NDE. It is possible, therefore, that the findings are a generalized result of trauma rather than specifically relating to the NDE itself.

Although it seems likely that levels of blood gases, fluctuations in levels of various neurotransmitters, and dysfunction in the temporal lobes and associated structures play some role in the NDE, models which focus mainly on one of these aspects at the expense of the others often seem to be successful in providing plausible accounts of some components of the NDE but not others. This has led to the development of models that attempt to integrate the different types of explanation, most notably by Saavedra-Aguilar and Gómez-Jeria (1989) and Blackmore (e.g., 1993).

Saavedra-Aguilar and Gómez-Jeria's (1989) model invokes temporal-lobe dysfunction, hypoxia, psychological stress, and neurotransmitter changes to explain the NDE. According to this model, brain stress caused by traumatic events leads to the release of endogenous neuropeptides, neurotransmitters, or both, producing such effects as analgesia, euphoria, and detachment. These neurotransmitter effects combine with the effect of decreases in oxygen tension, primarily in limbic structures, to produce epileptiform discharges in the hippocampus and amygdala, leading to complex visual hallucinations and a life review.

Further hallucinations and a sensation of a brilliant light are produced by afterdischarges propagating through the limbic connections to other brain structures. The linguistic system also has a role to play in that the memory of these sensations is reconstructed following recovery to produce a narrative consistent with the individual's cultural beliefs and expectations.

As Greyson (2000a) points out, in common with other models based upon physical trauma and hypoxia, this model cannot account for NDEs experienced in the absence of physical injury even though such cases are known to occur. Greyson is also correct in pointing out that the model is based upon a number of unsupported assumptions and speculations derived from neurochemical investigations of non-humans and that some of its key elements (e.g., "brain stress") are vague. However, he is wrong in criticizing the model (following Rodin, 1989) for allegedly ascribing to abnormal activity in the temporal-lobes key features of the NDE "such as feelings of peace or bliss and sensations of being out of the body" (Greyson, 2002, pp. 235–236) that he claims "have not in fact been reported either in clinical seizures or in electrical stimulation of those brain structures" (Greyson, 2002, p. 235).

Feelings of bliss and even mystical feelings of oneness with the universe are often reported by temporal lobe epileptics just prior to a seizure. Perhaps most famously, Dostoyevsky, himself a temporal-lobe epileptic, provided the following description of this experience in his novel, *The Idiot*: "I have really touched God. He came into me, myself; yes, God exists, I cried. You all, healthy people can't imagine the happiness that we epileptics feel during the second before our attack."

The fact that the temporo-parietal area is associated with OBEs has already been referred to (also see Bunning and Blanke elsewhere in this volume). A recent report by Blanke et al. (2002) described an OBE induced in a 45-year-old woman who had suffered from complex partial seizures for 11 years, probably as a result of right temporal-lobe epilepsy. The OBE was induced by focal electrical stimulation of the right angular gyrus while undergoing evaluation for epilepsy treatment. As pointed out by Tong (2003), these findings are very

similar to those reported by Wilder Penfield over 60 years ago (e.g., Penfield, 1955).

Blackmore (1993, 1996a) argued that different components of the NDE are likely to have different underlying physiological mechanisms, thus producing a model that is to a large extent a synthesis of suggestions from previous theorists along with some novel explanations of particular components. Given the heterogeneous nature of the NDE, this is a reasonable approach. There is no reason to assume that a single comprehensive theory will explain the entire phenomenon. In the limited space available here, full details of Blackmore's theory cannot be presented, but some illustrative examples of her approach will be provided. For example, she argues that the typically positive emotional tone of the NDE may well be due to endorphin release, with the rarer negative NDEs caused by morphine antagonists. Her explanation for the tunnel effect is that it is caused by neuronal disinhibition in the visual cortex, typically (but not necessarily) caused by anoxia. She argues that such cortical disinhibition would cause random firing of the cells in the visual cortex. As there are more cells devoted to the fovea than the peripheral visual field, the subjective experience of this phenomenon is that of a bright circle of light that grows larger as more cells begin to fire, giving the impression of moving down a tunnel towards the light (Fig. 2 shows what some consider as the first artistic representation of this "tunnel to paradise" experience).

Blackmore (1996b) explains the OBE component of the NDE by arguing that our sense of self is a mental construction as indeed is our entire model of reality. The latter is constantly updated on the basis of the ongoing interaction between incoming sensory information (the so-called "bottom-up processing") and our existing knowledge, beliefs, and expectations about the world ("top-down processing"). Our sense of self is one important aspect of our model of reality and, given the predominance of visual information in producing this model, the sense of self is often felt to be just behind the eyes. Under most conditions, our model of reality is strongly influenced by sensory input and, as a consequence, our model of reality corresponds well with the external world. In

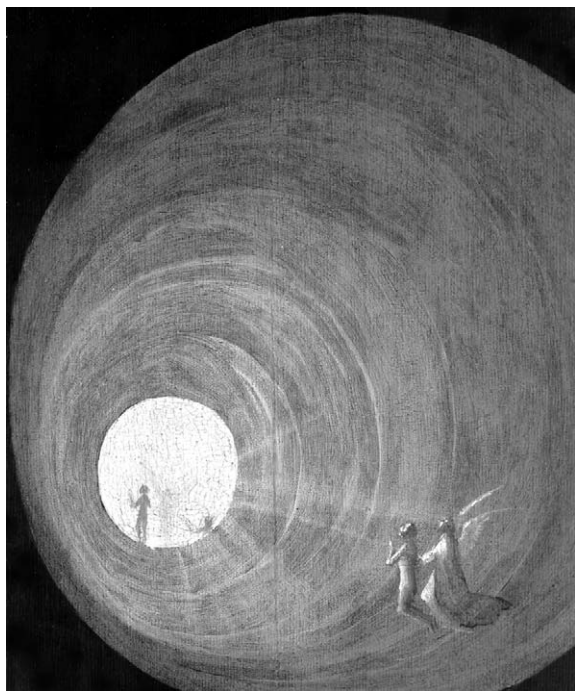


Fig. 2. The first artistic depiction of a NDE? “Paradise and the Ascent to the Empyrean” by Hieronymus Bosch appears to show angels, guiding spirits down a tunnel toward a bright light (detail from panel of the four afterlife paintings, 1500s).

some circumstances, however, especially when the sensory input is degraded in some way (e.g., through the ingestion of drugs, through meditation, or through anoxia), we can, without realizing it, adopt a model of reality that is based upon top-down influences. Thus the world of the OBE is, according to Blackmore, based upon memory, imagination, and expectation. During the NDE, the model of reality that is operative during the OBE will also incorporate any remaining sensory input and any unusual sensations caused by abnormal activity in the brain. Blackmore (1993) essentially argues that there is a common core experience to the NDE that is physiologically determined, but top-down influences can come into play in terms of influencing the detail of what is experienced and how it is interpreted. For example, the religious figures that are met during the NDE almost always correspond to the religion of the person having the experience, with Christians tending to see Jesus and Hindus seeing the

messengers of Yamraj coming to collect them (Osis and Haraldsson, 1977).

Studies of NDEs in cardiac arrest patients

Cassem and Hackett (1978) wrote that at that time the incidence of NDEs in cardiac arrest survivors was unknown, but estimated it to be about 2%. Martens (1994) cites two small-scale studies of consecutive survivors of cardiac arrest (Druss and Kornfeld, 1967; Dobson et al., 1971) in support of the conclusion that NDEs are unusual in such patients. He also offers as support Negovsky’s (1993) assertion that only 0.3–0.5% of resuscitated people talk about visions they had during clinical death (i.e., cardiac arrest). He goes on, however, to echo previous calls (e.g., Greyson and Stephenson, 1980) for “a prospective study on patients who are at risk for sudden cardiac death, such as a cohort of coronary care unit patients” (Martens, 1994, p. 173) in order to “eliminate sampling biases against a background of emotionally driven views, myths and anecdotes” (Martens, 1994, p. 173). We are now in a position where four such studies have been reported. As already stated, such prospective studies provide data that are much less likely to be contaminated by memory bias that might affect previous retrospective studies in which variable lengths of time elapse, typically from a few months to several years, between the NDE and the collection of interview data. Furthermore, prospective studies maximize the opportunity to collect data on objective physiological measurements in order to address issues of etiology.

Parnia et al. (2001) reported a pilot prospective study designed to assess the frequency of NDEs in cardiac arrest survivors and to determine the features of such NDEs. Participants in the study were all of the survivors of cardiac arrest over a 1-year period on the medical, emergency, and coronary care units of a British hospital. Patients were asked if they had any memories occurring during unconsciousness. The Greyson NDE scale (Greyson, 1983; Lange et al., 2004) was used to assess interview data, with a score of 7 or more constituting the criterion for a true NDE. Data concerning a range

of objective physiological measures were also collected, including arterial and peripheral blood gas levels (along with sodium and potassium levels), records of any drugs administered, and records of any abnormality of cardiac rhythm during the arrest. Over the year, 63 survivors were interviewed within a week of their cardiac arrest. Seven (11.1%) reported memories of their period of unconsciousness, of whom four (6.3% of the total sample) had had NDEs according to the criterion employed. All found the experience to be pleasant.

Due to the small number of patients reporting NDEs, it was not possible to draw any clear conclusions regarding possible causative physiological factors, although it was noted that partial pressure of oxygen was higher in the NDE group. This may simply reflect sampling bias given the low number of data points in the NDE group, as acknowledged by the investigators. They also tentatively suggest that this observation may serve to somewhat undermine the idea that cerebral anoxia is an important causative factor in the NDE, given that the NDE group showed higher levels of oxygen during resuscitation. This objection depends upon (a) blood oxygen levels accurately reflecting cerebral oxygen levels and (b) the NDE occurring during the resuscitation phase. Given that both assumptions are open to question and the difference noted is not statistically significant anyway, [Parnia et al. \(2001\)](#) are quite correct to caution against drawing any significant conclusion from this finding.

One notable feature of this study was the attempt by [Parnia et al. \(2001\)](#) to obtain evidence relating to the possible veridicality of the OBE. Boards were suspended from the ceilings on the wards involved in such a way that figures on the surface facing the ceiling were only visible from a vantage point near the ceiling. It was hoped that any individual reporting an OBE involving experienced movement to such a vantage point would be able to report accurately the hidden target figures. Such evidence would constitute a major challenge to those supporting a non-paranormal explanation of the NDE. Unfortunately, and somewhat atypically, none of the survivors in this sample experienced an OBE.

A large-scale prospective study was carried out in the Netherlands by [Van Lommel et al. \(2001\)](#).

This involved 344 consecutive cardiac arrest survivors across 10 Dutch hospitals, all interviewed within a few days of resuscitation. The study found that 62 patients (18%) reported an NDE, of whom 41 (12%) reported a “core experience”. NDE was defined in this study as “the reported memory of all impressions during a special state of consciousness, including specific elements such as OBE, pleasant feelings, and seeing a tunnel, a light, deceased relatives, or a life review” (p. 2040). Patients assigned to the “core experience” group were those scoring 6 or more on [Ring’s \(1980\)](#) WCEI. No patients reported distressing NDEs. The 62 patients reporting NDEs were compared with the non-NDE survivors with respect to a number of demographic, medical, pharmacological, and psychological indices.

Such factors as duration of cardiac arrest or unconsciousness, medication, fear of death before cardiac arrest, and the duration of the interval between the NDE and the interview were not related to the occurrence of an NDE. However, people younger than 60 were more likely to report an NDE than older people, as were those suffering their first myocardial infarction. Deeper experiences were reported by patients surviving cardiopulmonary resuscitation (CPR) outside hospital, and were more likely to be reported by women and those reporting being afraid before CPR. More of the patients who had had an NDE, especially a deep one, died within 30 days of CPR. Memory problems following lengthy CPR appeared to make it less likely that an NDE would be reported but it was unclear how memory had actually been assessed.

This study also included a longitudinal aspect by following up sub-groups after 2 years and then again after 8 years in order to assess any life-transforming effects of the NDE. At the 2-year follow-up stage, 37 of the 62 patients who originally reported an NDE were available and willing to be interviewed, and 37 surviving control participants were also interviewed. Of the former group, it now appeared that 6 had not in fact had an NDE at all, whereas 4 of the control group had, resulting in 35 patients who had had an NDE and 39 who had not. Eight years after the initial interview, available survivors from the first follow-up

were interviewed for a second time, with 23 patients in the NDE group and 15 in the control group. Broadly speaking, results confirmed previous studies of this issue, indicating that NDEs produce long-lasting effects in terms of, for example, reduced fear of death, heightened intuition, social awareness, and so on.

Schwaninger et al. (2002) evaluated all patients who suffered a cardiac arrest between April 1991 and February 1994 at Barnes-Jewish Hospital in St. Louis (with the exception of those in the surgical intensive care unit) in order to assess the frequency of NDEs in cardiac arrest patients, to characterize the experiences, and to assess their impact on psychosocial and spiritual attitudes. Patients were interviewed and assessed using Greyson's (1983) NDE scale and an experience rating form. No attempt was made to relate characteristics of the reported NDEs to objective physiological data. Of 174 cardiac arrests over this period, 119 (68%) died. Of the remaining 55, 30 patients (17%) were interviewed and the remainder were excluded either because they had neurological damage or were intubated through to the point of discharge. Of the 30 patients in the study sample, 19 (63%) had never experienced an NDE, 7 (23%) experienced an NDE during the cardiac arrest, and 4 (13%) did not have an NDE during the index cardiac arrest but had experienced one on a previous life-threatening occasion. Given the fact that the stated objectives of this study all specifically relate to cardiac arrest, it is unfortunate that over a third of the final NDE group had almost certainly experienced their NDEs in different circumstances. Patients were also sent a follow-up questionnaire 6 months after the initial interview. This was returned by 8 of the 11 NDE patients and 10 of the 19 non-NDE patients. Results confirmed previous findings concerning the nature of NDEs and of long-lasting transformational effects of the NDE with regard to personal understanding of life and self, social attitudes, and changes in social customs and religious/spiritual beliefs.

Greyson (2003) carried out a prospective study of all patients admitted to the cardiac intensive care unit or the cardiology step-down unit at the University of Virginia Hospital over a 30-month period, with the exception of those who were too

ill, psychotic, or cognitively impaired to be interviewed. Of the consecutive sample of 1595 patient admissions, 116 (7%) had a primary diagnosis of cardiac arrest. NDEs, as assessed by the Greyson (1983) NDE scale, were reported by 10% of cardiac arrest patients compared to only 1% of other cardiac patients. Compared to non-NDE patients, those reporting NDEs did not differ in terms of "sociodemographic variables, social support, quality of life, acceptance of their illness, cognitive function (as assessed using a standard instrument, the Mini-Mental State Exam; Folstein et al., 1975), capacity for physical activities, degree of cardiac dysfunction, objective proximity to death, or coronary prognosis" (Greyson, 2003, p. 269). Those reporting NDEs were younger, more likely to have lost consciousness, and to report higher levels of approach-oriented death acceptance. They were also more likely to report prior so-called "paranormal" experiences (e.g., déjà vu, altered states of consciousness, and related activities such as meditation) but not "psychic" experiences, such as extrasensory perception (note the rather idiosyncratic usage of the word "paranormal"). This latter observation is consistent with the idea of an "NDE-prone personality" as proposed by Ring (1992). Although prior religion and religiosity is not related to tendency to experience NDEs, a prior tendency to cope with trauma through dissociating may be, although Blackmore (1993) argues that there is simply too little evidence to draw firm conclusions on this issue.

The four prospective studies described above have reported a range of incidence rates for survivors of cardiac arrest: 6.3% (Parnia et al., 2001), 12% (Van Lommel et al., 2001), 23% (Schwaninger et al., 2002), and 10% (Greyson, 2003). Given that the two larger-scale studies are in fairly close agreement, it would appear that the best estimate for incidence of NDEs among cardiac arrest survivors is around 10–12%, considerably higher than earlier estimates. It is unclear why such a discrepancy should have arisen, but the prospective studies are methodologically superior to the earlier retrospective studies and thus should be accorded more evidential weight.

Parnia and Fenwick (2002) have reviewed evidence relating to cerebral physiology during and

after cardiac arrest. As they point out, cardiac arrest is the closest model we have to the dying process itself and may thus provide insight into the experiences likely to accompany the dying process irrespective of cause. The brain receives 15% of cardiac output under normal conditions, and 40–50% of total cerebral blood flow is required to supply enough glucose and oxygen to maintain cellular integrity with 50–60% needed to maintain electrophysiological activity (Buunk et al., 2000).

Both human and animal studies have provided extensive data on cerebral physiology during and after cardiac arrest (Parnia and Fenwick, 2002). Immediately following arrest, blood pressure drops sharply, and even properly performed chest compressions and the administration of epinephrine would typically not be enough to raise diastolic and mean blood pressure to the level needed for adequate coronary and cerebral perfusion. EEGs recorded during cardiac arrest show an initial slowing that, within 10–20 s, progresses to an isoelectric (flat) line. The EEG then remains flat during the cardiac arrest until cardiac output resumes in cases of early defibrillation but may not return for many hours if cardiac arrest is prolonged. Animal studies in which activity is recorded from deep brain structures by in-dwelling electrodes show that absence of cortical activity correlates with absence or reduction of activity in deep structures. Even after the restoration of adequate blood pressure and gross cerebral blood flow rate, local cerebral blood perfusion can remain severely impaired due to local increases in vasoconstriction. Thus normal EEG may not begin to recover for a long period despite the maintenance of adequate blood pressure during the recovery phase (Buunk et al., 2000).

Several NDE investigators have argued that the findings from the prospective studies reviewed above pose a major challenge to current scientific thinking regarding the relationship between mind and brain, and in particular the assumptions that (a) higher cognitive functions can only occur when cerebral functioning is relatively unimpaired and (b) that consciousness is entirely dependent upon the underlying neuronal substrate and cannot become separated from that substrate. In the words of Parnia and Fenwick (2002, p. 8), “The

occurrence of lucid, well-structured thought processes together with reasoning, attention and memory recall of specific events during a cardiac arrest (NDE) raise a number of interesting and perplexing questions regarding how such experiences could arise. These experiences appear to be occurring at a time when cerebral function can be described at best as severely impaired, and at worst absent.” Greyson (2003, p. 275) concurs:

The paradoxical occurrence of heightened, lucid awareness and logical thought processes during a period of impaired cerebral perfusion raises particularly perplexing questions for our current understanding of consciousness and its relation to brain function. [...] [A] clear sensorium and complex perceptual processes during a period of apparent clinical death challenge the concept that consciousness is localized exclusively in the brain.

Similarly, Van Lommel and colleagues (2001, p. 2044) ask, “How could a clear consciousness outside one’s body be experienced at the moment that the brain no longer functions during a period of clinical death with flat EEG?” With respect to the latter point, however, it should be borne in mind that electroencephalography is not a perfectly reliable indicator of brain death, as it is only able to detect activity in one half of the area of the cerebral cortex. Activity in the other half of the cerebral cortex and in the deeper structures cannot be observed (Paolin et al., 1995; Bardy, 2002).

It is clear that the argument that recent findings present a major challenge to modern neuroscience hinges upon the claim that the NDE is actually experienced “during a period of clinical death with flat EEG” as claimed, with the implication that no cortical activity is taking place during this period. Parnia and Fenwick (2002) essentially argue, on the basis of the physiological data reviewed above, that the NDE cannot occur as the patient is becoming unconscious as this happens too quickly. They further argue that it cannot happen during recovery from cardiac arrest as this phase would be characterized by confused thinking, whereas the experience is usually described as involving great

clarity of thought. Other commentators have argued, however, that the possibility remains that the NDE may indeed have occurred as patients rapidly entered the period of flat EEG or as they more gradually recovered from that state (e.g., French, 2001). With regard to the possibility that the experience may have occurred as the patient rapidly entered unconsciousness, it should be borne in mind that altered states of consciousness often have an effect on time perception. This is indeed illustrated very well by the life review component of the NDE itself during which it is claimed that the whole of an individual's life is replayed in a fraction of a second. Who can say, therefore, that the few seconds of remaining consciousness as an individual enters the state of clinical death is insufficient for the experiences that form the basis of the NDE? With respect to the claim that an individual could not have an NDE as they slowly emerge back into consciousness because their thinking will be confused, it has already been pointed out (in discussing the effects of anoxia) that the subjective claim of great clarity of thought may well be an illusion. Finally, and most importantly, it should be borne in mind that we are always dealing with reports of experiences rather than with the experiences themselves. Memory is a reconstructive process. It is highly likely the final narrative will be much more coherent after the individual has reflected upon it before telling it to others, given the inherently ineffable nature of the experience itself.

Parnia and Fenwick (2002) also claim that anecdotal evidence of veridical perception during the OBE phase of the NDE supports the argument that such perception sometimes occurs during periods of clinical death. Unfortunately, many such anecdotes are essentially uncorroborated hearsay. As Blackmore (1993) points out, when serious attempts at corroboration are attempted, the evidence often turns out to be nowhere near as impressive as it initially appeared. Furthermore, as stated earlier, there are several non-paranormal factors that might account for those instances when people do sometimes provide accurate accounts of events that took place during the NDE.

One of the cases often presented as being a strong challenge to those theorists arguing in

favor of non-paranormal accounts of the NDE is that of Pam Reynolds as presented by cardiologist Michael Sabom (1998). In 1991, 35-year-old Reynolds was operated upon by Dr. Robert Spetzler in order to remove a potentially fatal giant basilar artery aneurysm. Standard neurological operating techniques could not be used because of the size and location of the aneurysm and instead a more complex procedure known as hypothermic cardiac arrest was employed. This involved lowering body temperature to 60 °F (i.e., 16 °C), stopping heartbeat and breathing, flattening of brainwaves, and the draining of blood from the head. The aneurysm was then carefully removed, and the patient's body warmed up, normal heartbeat and circulation restored, and head and other wounds were closed. Reynolds was then allowed to awaken slowly in the recovery room. When she was once again able to speak, she told of a NDE that had apparently occurred while she was unconscious under general anesthetic and low-temperature cardiac arrest.

Reynolds reported that she awoke during the early stages of the operation to the sound of the small pneumatic saw that was being used to open her skull. She then felt as if she was being pulled out through the top of her head and, during the subsequent OBE, she was able to watch the proceedings from above the neurosurgeon's shoulder. Her account accords very well with those of the medical staff present at the time, including her description of the pneumatic saw and the fact that the cardiac surgeon expressed surprise that the blood vessels in her right groin were too small to handle the large flow of blood needed to feed the cardiopulmonary bypass machine. She reported that after her heart was stopped and the blood drained from her body, she passed through a black vortex and into a realm of light where she met with deceased relatives. These relatives looked after her, provided her with nourishment, and eventually helped her to return to her physical body. She was able to report the music that was being played in the operating theatre at the point of her return.

This case is often presented as one that simply defies all conventional explanations (e.g., Greyson, 2000). Woerlee (2005a, b), an anesthesiologist with many years of clinical experience, has considered

this case in detail and remains unconvinced of the need for a paranormal explanation. He points out that it is perfectly possible for patients to regain consciousness during operations because the concentration of sleep-inducing and maintaining drugs may vary. Even though such patients cannot move and feel no pain because of the effects of other administered drugs, they may be perfectly aware of what is going on around them. If their eyes are open, they can actually see what is going on in the operating theatre, but even with eyes closed (Reynolds' eyes were taped shut) they are likely to be able to internally visualize proceedings fairly accurately on the basis of other sensory inputs. It should be noted that the OBE phase of Reynolds' NDE took place during the early phase of the operation, before the cardiac bypass apparatus had even been connected to her body.

Greyson (2000), among others, rejects the idea that Reynolds may have been able to hear during the operation because she had small molded speakers inserted in her ears that he claims would block out any other auditory stimulation. These speakers are used to emit 100-db clicks so that auditory evoked potentials (AEPs) recorded from the brainstem can be used to monitor levels of consciousness throughout the operation. However, anyone who has ever worn earphones to listen to music will readily acknowledge that they do not totally block out other sounds from the environment. Sound is transmitted into the auditory pathways not only via the ear itself but also by bone conduction.

Woerlee (2005b) also draws attention to the fact that Reynolds could only give a report of her experience some time after she recovered from the anesthetic as she was still intubated when she regained consciousness. This would provide some opportunity for her to associate and elaborate upon the sensations she had experienced during the operation with her existing knowledge and expectations. The fact that she described the small pneumatic saw used in the operation also does not impress Woerlee. As he points out, the saw sounds like and, to some extent, looks like the pneumatic drills used by dentists. The sound heard by Reynolds when she regained consciousness during the early phase of the operation was unlikely to be

interpreted as being a large chain saw or industrial angle cutter even in the unlikely event that the patient might have expected such inappropriate instruments to be used. As Sabom (1998, p. 189) himself acknowledges, "For some, evidence arising from cases such as Pam's will continue to suggest some type of out-of-body experience occurring when death is imminent. For others, the inexactness which arises in the evaluation of these cases will be reason enough to dismiss them as dreams, hallucinations, or fantasies."

Many commentators are particularly impressed by accounts from blind people that during NDEs they are able to see even though, in some cases, they may have been blind from birth (Ring and Cooper, 1999). Initial readings of such accounts often give the impression that the experience involves seeing events and surroundings in the same way that sighted people do, but closer reflection upon these cases suggests otherwise. As Ring (2001, p. 69) writes,

As this kind of testimony builds, it seems more and more difficult to claim that the blind simply see what they report. Rather, it is beginning to appear it is more a matter of their knowing, through a still poorly understood mode of generalized awareness, based on a variety of sensory impressions, especially tactile ones, what is happening around them.

Ring argues that casual readers may often gain the impression that such NDEs in the blind involved literally seeing events and surroundings but that this impression is based upon having to describe these experiences, no matter how they were originally coded, in linguistic form. Our language is based largely upon the experiences of the sighted and is therefore a "language of vision". Ring believes that the form of knowing reported by the blind during their NDEs, which he refers to as "mindsight", is beyond conventional scientific explanation and is in fact the same form of transcendent knowing that is reported by the sighted during NDEs. But we are then faced once more with the question of whether or not those cases involving apparent veridical perception could be explained by the non-paranormal factors discussed

above. The consequence of this line of argument is that NDEs in the blind are certainly worthy of study but do not merit any special status in terms of evidential support for spiritual explanations of the phenomenon.

There can be little doubt, however, that the OBE component of the NDE still provides the best opportunity to seriously challenge conventional views of the relationship between consciousness and the brain. Although somewhat unconventional (to say the least), attempts to test the veridicality of OBEs using hidden targets (e.g., Parnia et al., 2001) should be welcomed. Should any such test ever produce convincing evidence that the OBE truly allows one to view the world without using the known visual channels, this would indeed be a major challenge to conventional science. To date, no such evidence has been forthcoming.

It is also worth noting in this context that OBEs can be studied in non-NDE contexts (e.g., Blackmore, 1996b; Blanke et al., 2002, 2004). As there appears to be little reason to believe that NDE-based and other OBEs differ in terms of their underlying psychological and physiological causes, it would obviously make sense to pursue research into the veridicality of OBEs of the non-NDE type. However, past attempts to do exactly that have failed to produce convincing evidence for any paranormal aspect to the OBE (Blackmore, 1996b).

French (2001) raised the possibility that at least some reports of NDEs might be based upon false memories, of the mind trying retrospectively to “fill the gap” after a period of disrupted cortical activity followed by cortical inactivity. This suggestion was based upon the observation that, in Van Lommel et al. (2001) study, around 10% of the control sample, i.e., individuals who had not reported NDEs immediately following their cardiac arrests, were reporting that in fact they had had an NDE at the 2-year follow-up stage. It is now known that simply imagining an event that never actually happened can lead to the development of false memories for that event (e.g., Loftus, 2001; McNally, 2003). It is worth noting that susceptibility to false memories is known to be correlated with tendency to dissociate (e.g., Heaps and Nash, 1999; Hyman and Billings, 1999), which in turn correlates with

tendency to report NDEs (Greyson, 2000b; see French, 2003, for a detailed review of the possible relationship between susceptibility to false memories and tendency to report ostensibly paranormal experiences).

However, it should also be borne in mind that there is another possible explanation for the fact that many of van Lommel et al.’s patients reported having had an NDE during the follow-up interviews despite having failed to do so when first interviewed: it may simply be that, although they were always aware of having had an NDE, they feared being ridiculed or diagnosed as mentally ill if they reported their experience when first interviewed (Greyson, 1988, 2003). Perhaps by the time of the second interview they had had the opportunity to research the phenomenon and had realized how common it is among near-death survivors and that it is not associated in any way with mental illness. They may thus have been more willing to talk about their NDE on this occasion. If this is the case, it is an important practical consideration that needs to be addressed urgently in future research if the research community is to gain an accurate picture of incidence rates.

There is no doubt that the research reviewed above raises far more questions than it answers. While none of the studies produced evidence in support of any of the organic theories of NDEs, it should be noted that two of the four prospective studies (Schwaninger et al., 2002; Greyson, 2003) did not attempt to collect data relevant to such theories and another (Parnia et al., 2001) involved a sample that was too small for any valid conclusions on such issues to be drawn. Future research should focus on devising ways to distinguish between the two main hypotheses relating to when the NDE is occurring. If it really is occurring when some claim that it is, during a period of flat EEG with no cortical activity, then modern neuroscience would require serious revision. This would also be the case if the OBE, either within the NDE or not, could be shown to be veridical. However, both of these claims currently remain open to dispute. Challenges facing those proposing purely organic theories include not only producing direct evidence in support of their accounts, but also satisfactorily accounting for those NDEs that are

known to occur in the complete absence of physical threat, such as those that occur when individuals are not actually close to death but only think they are. Further research into this enigmatic phenomenon is likely to cast light upon some fundamental issues relating to the nature of consciousness.

References

- Bailey, L.W. and Yates, J. (Eds.). (1996) *The Near Death Experience: A Reader*. Routledge, New York and London.
- Bardy, A.H. (2002) Near-death experiences [letter]. *Lancet*, 359: 2116.
- Becker, C.B. (1982) The failure of Saganomics: Why birth models cannot explain near-death phenomena. *Anabiosis J. Near Death Stud.*, 2: 102–109.
- Blackmore, S.J. (1983) Birth and the OBE: an unhelpful analogy. *J. Am. Soc. Psychical Res.*, 77: 229–238.
- Blackmore, S.J. (1993) *Dying to Live: Science and the Near-Death Experience*. Grafton, London.
- Blackmore, S.J. (1996a) Near-death experiences. In: Stein G. (Ed.), *The Encyclopedia of the Paranormal*. Prometheus Books, Amherst, NY, pp. 425–441.
- Blackmore, S.J. (1996b) Out-of-body experiences. In: Stein G. (Ed.), *The Encyclopedia of the Paranormal*. Prometheus Books, Amherst, NY, pp. 471–483.
- Blanke, O., Landis, T., Spinelli, L. and Seeck, M. (2004) Out-of-body experience and autoscapy of neurological origin. *Brain*, 127: 243–258.
- Blanke, O., Ortigue, S., Landis, T. and Seeck, M. (2002) Stimulating illusory own-body perceptions. *Nature*, 419: 269–270.
- Britton, W.B. and Bootzin, R.R. (2004) Near-death experiences and the temporal lobe. *Psychol. Sci.*, 15: 254–258.
- Bush, N.E. (1991) Is ten years a life review? *J. Near Death Stud.*, 10: 5–9.
- Buunk, G., van der Hoeven, J.G. and Meinders, A.E. (2000) Cerebral blood flow after cardiac arrest. *Neth. J. Med.*, 57: 106–112.
- Carr, D.B. (1982) Pathophysiology of stress-induced limbic lobe dysfunction: A hypothesis relevant to near-death experiences. *Anabiosis J. Near Death Stud.*, 2: 75–89.
- Cassem, N.H. and Hackett, T.P. (1978) The setting of intensive care. In: Hackett T.P. and Cassem N.H. (Eds.), *Massachusetts General Hospital Handbook of General Hospital Psychiatry*. Mosby, St. Louis, pp. 319–341.
- Council, J.R. and Greyson, B. (1985). Near-death experiences and the fantasy-prone personality: Preliminary findings. Paper presented at the 93rd Annual Convention of the American Psychological Association, Los Angeles, August 1985.
- Dobson, M., Tattersfield, A.E., Adler, M.W. and McNicholl, M.W. (1971) Attitudes and long-term adjustment of patients surviving cardiac arrest. *Br. Med. J.*, 111: 207–212.
- Druss, R.G. and Kornfeld, D.S. (1967) The survivors of cardiac arrest: A psychiatric study. *J. Am. Med. Assoc.*, 201: 291–296.
- Fenwick, P. (1997) Is the near-death experience only N-methyl-D-aspartate blocking? *J. Near Death Stud.*, 16: 43–53.
- Fenwick, P. and Fenwick, E. (1995) *The Truth in the Light: An Investigation of over 300 Near-Death Experiences*. Headline, London.
- Folstein, M.F., Folstein, S.E. and McHugh, P.R. (1975) “Minimal state”: A practical method for grading the cognitive state of patients for the clinician. *J. Psychiatr. Res.*, 12: 189–198.
- French, C.C. (2001) Dying to know the truth: visions of a dying brain, or false memories? *Lancet*, 358: 2010–2011.
- French, C.C. (2003) Fantastic memories: The relevance of research into eyewitness testimony and false memories for reports of anomalous experiences. *J. Conscious. Stud.*, 10: 153–174.
- Frenk, H., McCarty, B.C. and Liebeskind, J.C. (1978) Different brain areas mediate the analgesic and epileptic properties of enkephalin. *Science*, 200: 335–337.
- Greyson, B. (1983) The near-death experience scale: Construction, reliability, and validity. *J. Nerv. Ment. Dis.*, 171: 369–375.
- Greyson, B. (1985) A typology of near-death experiences. *Am. J. Psychiat.*, 142: 967–969.
- Greyson, B. (1997) The near-death experience as a focus of clinical attention. *J. Nerv. Ment. Dis.*, 185: 327–334.
- Greyson, B. (1998) The incidence of near-death experiences. *Med. Psychiat.*, 1: 92–99.
- Greyson, B. (2000a) Near-death experiences. In: Cardeña E., Lynn S.J. and Krippner S. (Eds.), *Varieties of Anomalous Experiences: Examining the Scientific Evidence*. American Psychological Association, Washington DC, pp. 315–352.
- Greyson, B. (2000b) Dissociation in people who have near-death experiences: out of their bodies or out of their minds? *Lancet*, 355: 460–463.
- Greyson, B. (2003) Incidence and correlates of near-death experiences in a cardiac care unit. *Gen. Hosp. Psychiat.*, 25: 269–276.
- Greyson, B. and Bush, N.E. (1992) Distressing near-death experiences. *Psychiatry*, 55: 95–110.
- Greyson, B. and Stephenson, I. (1980) The phenomenology of near-death experiences. *Am. J. Psychiat.*, 137: 1193–1196.
- Grof, S. and Halifax, J. (1977) *The Human Encounter with Death*. Dutton, New York.
- Heaps, C. and Nash, M. (1999) Individual differences in imagination inflation. *Psychon. Bull. Rev.*, 6: 313–318.
- Hyman Jr., I.E. and Billings, F.J. (1999) Individual differences and the creation of false childhood memories. *Memory*, 6: 1–20.
- Irwin, H.J. (1985) *Flight of Mind: A Psychological Study of the Out-of-Body Experience*. Scarecrow Press, Metuchen, NJ.
- Irwin, H.J. (1993) The near-death experience as a dissociative phenomenon: An empirical assessment. *J. Near Death Stud.*, 12: 95–103.
- Irwin, H.J. (2003) *An Introduction to Parapsychology*. (4th ed.). McFarland and Company, Jefferson, NC, and London.
- Jansen, K.L.R. (1989) Near-death experience and the NMDA receptor. *Br. Med. J.*, 298: 1708–1709.
- Jansen, K.L.R. (1997) The ketamine model of the near-death experience: A central role for the N-methyl-D-aspartate receptor. *J. Near Death Stud.*, 16: 79–95.

- Jansen, K.L.R. (2001) *Ketamine: Dreams and Realities*. Multidisciplinary Association for Psychedelic Studies (MAPS), Sarasota, FL.
- Judson, I.R. and Wiltshaw, E. (1983) A near-death experience. *Lancet*, 8349: 561–562.
- Lange, R., Greyson, B. and Houran, J. (2004) A Rasch scaling validation of a 'core' near-death experience. *Br. J. Psychol.*, 95: 149–177.
- Liere, E.J. and Stickney, J.C. (1963) *Hypoxia*. University of Chicago Press, Chicago.
- Loftus, E.F. (2001) Imagining the past. *Psychologist*, 14: 584–587.
- Lundahl, C.R. (1993) The near-death experience: A theoretical summarization. *J. Near Death Stud.*, 12: 105–118.
- Martens, P.R. (1994) Near-death-experiences in out-of-hospital cardiac arrest survivors. Meaningful phenomena or just fantasy of death? *Resuscitation*, 27: 171–175.
- McNally, R.J. (2003) *Remembering Trauma*. Harvard University Press, Cambridge, MA.
- Meduna, L.J. (1950) *Carbon Dioxide Therapy*. Charles C. Thomas, Springfield, IL.
- Moody, R.A. (1975) *Life After Life*. Bantam Books, New York.
- Moody, R.A. (1977) *Reflections on Life After Life*. Mocking Bird Books, St. Simon's Island, GA.
- Morse, M. (1990) *Closer to the Light*. Souvenir, London.
- Morse, M. (1992) *Transformed by the Light: The Powerful Effect of Near-Death Experiences on People's Lives*. Ballantine, New York.
- Morse, M.L., Venecia, D. and Milstein, J. (1989) Near-death experiences: A neurophysiological explanatory model. *J. Near Death Stud.*, 8: 45–53.
- Negovsky, V.A. (1993) Death, dying and revival: ethical aspects. *Resuscitation*, 25: 99–107.
- Noyes, R. (1972) The experience of dying. *Psychiatry*, 35: 174–184.
- Noyes, R. and Klett, R. (1976) Depersonalisation in the face of life-threatening danger: an interpretation. *Omega*, 7: 103–114.
- Noyes, R. and Klett, R. (1977) Depersonalisation in the face of life-threatening danger. *Compr. Psychiat.*, 18: 375–384.
- Noyes, R. and Slymen, D. (1978–1979) The subjective response to life-threatening danger. *Omega*, 9: 313–321.
- Orne, R.M. (1995) The meaning of survival: The early aftermath of a near-death experience. *Res. Nurs. Health.*, 18: 239–247.
- Osis, K. and Haraldsson, E. (1977) *At the Hour of Death*. Avon, New York.
- Paolin, A., Manuali, A., Di Paola, F., Boccaletto, F., Caputo, P., Zanata, R., Bardin, G.P. and Simini, G. (1995) Reliability in diagnosis of brain death *Intens Care Med*, 21: 657–662.
- Parnia, S. and Fenwick, P. (2002) Near death experiences in cardiac arrest: visions of a dying brain or visions of a new science of consciousness. *Resuscitation*, 52: 5–11.
- Parnia, S., Waller, D.G., Yeates, R. and Fenwick, P. (2001) A qualitative and quantitative study of the incidence features and aetiology of near death experiences in cardiac arrest survivors. *Resuscitation*, 48: 149–156.
- Penfield, W. (1955) The role of the temporal cortex in certain psychological phenomena. *J. Ment. Sci.*, 101: 451–465.
- Ring, K. (1980) *Life After Death: A Scientific Investigation of the Near-Death Experience*. Coward, McCann, and Geoghegan, New York.
- Ring, K. (1992) *The Omega Project*. William Morrow, New York.
- Ring, K. (2001) *Mindsight: Eyeless vision in the blind*. In: Lorimer D. (Ed.), *Thinking Beyond the Brain: A Wider Science of Consciousness*. Floris, Edinburgh, pp. 59–70.
- Ring, K. and Cooper, S. (1999) *Mindsight: Near-Death and Out-of-Body Experiences in the Blind*. William James Center for Consciousness Studies, Palo Alto, CA.
- Rodin, E. (1989) Comments on "a neurobiological model for near-death experiences. *J. Near Death Stud.*, 7: 255–259.
- Roe, C.A. (2001) Near-death experiences. In: Roberts R. and Groome D. (Eds.), *Parapsychology: The Science of Unusual Experience*. Arnold, London, pp. 141–155.
- Saavedra-Aguilar, J.C. and Gómez-Jeria, J.S. (1989) A neurobiological model for near-death experiences. *J. Near Death Stud.*, 7: 205–222.
- Sabom, M.B. (1982) *Recollections of Death: A Medical Investigation*. Corgi, London.
- Sabom, M.B. (1998) *Light and Death: One Doctor's Fascinating Account of Near-Death Experiences*. Zondervan, Grand Rapids, Michigan.
- Sagan, C. (1979) *Broca's Brain: Reflections on the Romance of Science*. Random House, New York.
- Schwaninger, J., Eisenberg, P.R., Schectman, K.B. and Weiss, A.N. (2002) A prospective analysis of near-death experiences in cardiac arrest patients. *J. Near Death Stud.*, 20: 215–232.
- Strassman, R. (1997) Endogenous ketamine-like compounds and the NDE: If so, so what? *J. Near Death Stud.*, 16: 27–41.
- Tellegen, A. and Atkinson, G. (1974) Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *J. Abnorm. Psychol.*, 83: 268–277.
- Tong, F. (2003) Out-of-body experiences: From Penfield to present. *Trend. Cogn. Sci.*, 7: 104–106.
- Van Lommel, P., van Wees, R., Meyers, V. and Elfferich, I. (2001) Near-death experience in survivors of cardiac arrest: a prospective study in the Netherlands. *Lancet*, 358: 2039–2045.
- Whinnery, J.E. (1997) Psychophysiological correlates of unconsciousness and near-death experiences. *J. Near Death Stud.*, 15: 231–258.
- Wilson, S.C. and Barber, T.X. (1983) The fantasy-prone personality: Implications for understanding imagery hypnosis and parapsychological phenomena. In: Sheikh A.A. (Ed.), *Imagery: Current Theory, Research, and Application*. Wiley, New York, pp. 340–390.
- Woerlee, G.M. (2003) *Mortal Minds: A Biology of the Soul and the Dying Experience*. De Tijdstroom, Utrecht.
- Woerlee, G.M. (2005a) An anaesthesiologist examines the Pam Reynolds story. Part 1. Background considerations. *Skeptic (British version)*, 18.1 (in press).
- Woerlee, G.M. (2005b) An anaesthesiologist examines the Pam Reynolds story. Part 2. An explanation. *Skeptic (British version)*, 18.2 (in press).