Pim van Lommel

Non-local Consciousness

A Concept Based on Scientific Research on Near-Death Experiences During Cardiac Arrest

'To study the abnormal is the best way of understanding the normal.'
— William James

Abstract: *In this article a concept of non-local consciousness will be described, based on recent scientific research on near-death experiences (NDEs). Since the publication of several prospective studies on NDEs in survivors of cardiac arrest, with strikingly similar results and conclusions, the phenomenon of the NDE can no longer be scientifically ignored. In the last thirty years several theories have been proposed to explain an NDE. The challenge to find a common explanation for the cause and content of an NDE is complicated by the fact that an NDE can be experienced during various circumstances, such as severe injury of the brain as in cardiac arrest to conditions when the brain seems to function normally. The NDE is an authentic experience which cannot be simply reduced to imagination, fear of death, hallucination, psychosis, the use of drugs, or oxygen deficiency. Patients appear to be permanently changed by an NDE during a cardiac arrest of only some minutes duration. According to these aforementioned studies, the current materialistic view of the relationship between consciousness and the brain as held by most physicians, philosophers, and psychologists is too restricted for a proper understanding of this phenomenon. There are good reasons to assume that our consciousness does not always coincide with the functioning of*

Correspondence:
Pim van Lommel, MD, Department of Cardiology, Rijnstate Hospital, Arnhem, The Netherlands. *Email: pimvanlommel@gmail.com*

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our brain: enhanced or non-local consciousness can sometimes be experienced separately from the body.

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Introduction

A near-death experience (NDE) can be defined as the reported memory of a range of impressions during a special state of consciousness, including a number of special elements such as an out-of-body experience, pleasant feelings, seeing a tunnel, a light, deceased relatives or a life review, or a conscious return into the body. Many circumstances are described during which NDEs are reported, such as cardiac arrest (clinical death), shock after loss of blood (childbirth), traumatic brain injury or stroke, near-drowning (children) or asphyxia, but also in serious diseases not immediately life-threatening, during isolation, depression or meditation, or without any obvious reason. Similar experiences to near-death ones can occur during the terminal phase of illness, and are called deathbed visions, end-of-life experiences, or nearing death awareness. Furthermore, so-called 'fear-death' experiences are mainly reported after situations in which death seemed unavoidable like serious traffic or mountaineering accidents. The NDE is usually transformational, causing enhanced intuitive sensibility, profound changes of life-insight, and the loss of fear of death (van Lommel, 2010). The content of an NDE and the effects on patients seem similar worldwide, across all cultures and all times (*ibid.*, pp. 81–105). However, the subjective nature and absence of a frame of reference for this ineffable experience lead to individual, cultural, and religious factors determining the vocabulary used to describe and interpret this experience.

Near-death experiences occur with increasing frequency because of improved survival rates resulting from modern techniques of resuscitation. According to a recent random poll in the US and in Germany, about 4% of the total population in the western world experienced an NDE (Gallup and Proctor, 1982; Schmied *et al.*,1999). Thus, about 9 million people in the US, about 2 million people in the UK, and about 3 million people in Germany should have had this extraordinary conscious experience. An NDE seems to be a relatively regularly occurring, and to many physicians an inexplicable, phenomenon and hence an often ignored result of survival in a critical medical situation. Physicians hardly ever hear a patient tell about his or her near-death experience. Patients are reluctant to share their experience with others because of the many negative responses they usually get.

As a cardiologist I had the privilege to meet many patients who were willing to share their NDE with me. The first time this happened was in 1969. In the coronary care unit a patient with an acute myocardial infarction had a cardiac arrest. After two electric shocks and a spell of unconsciousness lasting some four minutes, the patient regained consciousness, much to the relief of the nursing staff and attendant doctor. That attendant doctor was me. I had started my cardiology training that year. Following the successful resuscitation everyone was pleased, except the patient. To everyone's surprise he was extremely disappointed. He spoke of a tunnel, of colours, of a light, of a beautiful landscape, and of music. He was extremely emotional. The term near-death experience did not yet exist, nor had I ever heard of people having any recollection of the period of their cardiac arrest. Whilst studying for my degree, I had learnt that such a thing is in fact impossible: being unconscious means not being aware, and that applies to people suffering a cardiac arrest or patients in coma. In the event of a cardiac arrest, patients are unconscious; they have stopped breathing and have no palpable pulse or blood pressure. I was always told that according to current science it should be simply impossible to be conscious or to have memories at such a moment because all brain functions have ceased.

Although I had never forgotten the successfully resuscitated patient from 1969 with his memories of the period of his cardiac arrest, I had never done anything with the experience. This changed in 1986 when I read a book by George Ritchie about his near-death experience with the title *Return from Tomorrow* (Ritchie, 1978). When suffering double pneumonia as a medical student in 1943, Ritchie had experienced a period of clinical death. At the time, antibiotics such as penicillin were not yet widely used. Following a period of very high fever and extreme tightness of the chest, he passed away: he stopped breathing and his pulse had gone. He was pronounced dead by a doctor and covered with a sheet. But a male nurse was so upset by the death of this medical student that he managed to persuade the attendant doctor to administer an adrenalin injection in the chest near the heart — a most unusual procedure in those days. Having been 'dead' for about nine minutes, George Ritchie regained consciousness to the immense surprise of the doctor and nurse. It emerged that during his spell of unconsciousness, the period in which he had been pronounced dead, he had had an extremely deep conscious experience of which he could recollect a great many details. At first he was quite unable and afraid to talk about it. Later he wrote his book about what happened to him in those nine minutes. And, after graduation, he shared his experiences with medical students in psychiatry lectures. One of the students attending these lectures was Raymond Moody, who was so intrigued by this story that he started looking into experiences that may occur during critical medical situations. In 1975 he wrote the book *Life after Life* (Moody, 1975). In this book Moody first used the term near-death experience (NDE).

After reading George Ritchie's book I kept asking myself how someone can possibly experience consciousness during cardiac arrest and indeed whether this is a common occurrence. That is why, in 1986, I started systematically asking all the patients at my out-patient clinic who had ever undergone resuscitation whether they had any recollection of the period of their cardiac arrest. I was more than a little surprised to hear, within the space of two years, 12 reports of such a near-death experience among just over 50 survivors of cardiac arrest. Since that first time in 1969, I had not heard any other such reports. I had not enquired after these experiences either. But all these reports I was hearing now roused my scientific curiosity. After all, according to current medical knowledge it is impossible to experience consciousness when one's heart has stopped beating.

Questions

For me it all started with curiosity. With asking questions; with seeking to explain certain objective findings and subjective experiences. The phenomenon of near-death experience raised a number of fundamental questions. An NDE is a special state of consciousness that occurs during an imminent or actual period of death, or sometimes without any obvious reason. But how and why does an NDE occur? How does the content of an NDE come about? Why does a person's life change so radically after an NDE? I was unable to accept some of the answers to these questions, because they seemed incomplete, incorrect, or unfounded. I grew up in an academic environment in which I had been taught that there is a reductionist and materialist explanation for everything. And up until that point I had always accepted this as indisputably true.

Some scientists do not believe in questions that cannot be answered, but they do believe in wrongly formulated questions. The year 2005 saw the publication of a special anniversary issue of the journal *Science*, featuring 125 questions that scientists have so far failed to solve (Kennedy and Norman, 2005). The most important unanswered question, 'What is the universe made of?', was followed by 'What is the biological basis of consciousness?' I would reformulate this second question as follows: is there a biological basis of consciousness (at all)? We can also distinguish between both temporary and timeless aspects of our consciousness. This prompts the following question: is it possible to speak of a beginning of our consciousness and will our consciousness ever end?

In order to answer these questions, we need a better understanding of the relationship between brain function and consciousness. We shall have to start by examining whether there is any indication that consciousness can be experienced during sleep, general anaesthesia, coma, brain death, clinical death, the process of dying and, finally, after confirmed death. If the answers to any of these questions are positive, we must look for scientific explanations and scrutinize the relationship between brain function and consciousness in these different situations. By studying everything that has been thought and written about death throughout history, in all times, cultures, and religions, we may be able to form a different or better picture of death. But we may achieve the same on the basis of findings from recent scientific research into near-death experiences. It has emerged that most people lose all fear of death after an NDE. Their experience tells them that death is not the end of everything and that 'life' goes on in one way or another. According to most people with an NDE, death is nothing other than a different way of being with an enhanced and broadened consciousness, which is everywhere at once because it is no longer tied to a body. This is what someone wrote to me after his NDE: 'It is outside my domain to discuss something that can only be proven by death. However, for me personally this experience was decisive in convincing me that consciousness endures beyond the grave. Death turned out to be not death, but another form of life' (van Lommel, 2010).

The Dutch Prospective Study on NDE in Survivors of Cardiac Arrest

In order to obtain more reliable data to corroborate or refute the existing theories on the cause and content of an NDE, we needed a properly designed scientific study. This was the reason why in 1988 Ruud van Wees and Vincent Meijers, both psychologists who wrote their doctoral theses on NDE, and I, a cardiologist with an interest in the subject, started designing a prospective study in the Netherlands (van Lommel *et al.*, 2001). This study was carried out under the auspices of

Merkawah, the Dutch branch of the International Association of Near-Death Studies, IANDS, the Netherlands. At that point, no large-scale prospective studies into NDEs had been undertaken anywhere in the world. Our study aimed to include all consecutive patients who had survived a cardiac arrest in one of the 10 participating Dutch hospitals. In other words, this prospective study would only be carried out among patients with a proven life-threatening crisis. All of these patients would have died of their cardiac arrest had they not been resuscitated within five to ten minutes. This kind of design also creates a control group of patients who have survived a cardiac arrest but who have no recollection of the period of unconsciousness. In a prospective study such patients are asked, within a few days of their resuscitation, whether they have any recollection of the period of their cardiac arrest, i.e. of the period of their unconsciousness. All patients' medical and other data are carefully recorded before, during, and after their resuscitation. The advantage of this prospective study design was that all procedures were defined in advance and no selection bias could occur.

We had a record of the electrocardiogram, or ECG, for all patients included in our study. An ECG displays the electrical activity of the heart. In cardiac arrest patients this ECG record always displays a normally lethal arrhythmia (ventricular fibrillation) or an asystole (a flat line on the ECG). In the event of resuscitation outside the hospital we were given the ECG done by the ambulance staff. Following successful resuscitation we carefully recorded the demographic data of all patients, including age, sex, education, religion, foreknowledge of NDE, and whether or not they had had an earlier NDE. They were also asked whether they had been afraid just before their cardiac arrest. Likewise, we carefully recorded all medical information, like: what was the duration of the actual cardiac arrest? What was the duration of unconsciousness? How often did the patient require resuscitation and defibrillation? What medication, and in what dosage, was administered to the patient before, during, and after resuscitation? We also recorded how many days after resuscitation the interview took place, whether the patient was lucid during the interview, and whether his or her short-term memory was functioning well. Within four years, between 1988 and 1992, 344 successive patients who had undergone a total of 509 successful resuscitations were included in the study. In other words, all the patients in our study had been clinically dead. Clinical death is defined as the period of unconsciousness caused by total lack of oxygen in the brain (anoxia) because of the arrest of circulation, breathing, or both, as caused by cardiac arrest in patients with an acute myocardial infarction. If in this situation no resuscitation is initiated within five to ten minutes, the brain cells will be irreversibly damaged and the patient will always die.

A longitudinal study into life changes was based on interviews after two and eight years with all patients who had reported an NDE and who were still alive, as well as with a control group of post-resuscitation patients who were matched for age and sex, but who had not reported an NDE. The question was whether the customary changes in attitude to life after an NDE were the result of surviving a cardiac arrest or whether these changes were caused by the experience of an NDE. This question had never been subject to scientific and systematic research with prospective design before. The Dutch study was published in *The Lancet* in December 2001 (van Lommel *et al.*, 2001).

Results of the Prospective Study

If patients reported memories from the period of unconsciousness, the experiences were scored according to a certain index, the WCEI, or 'Weighted Core Experience Index' (Ring, 1980). The higher the number of elements reported, the higher the score and the deeper the NDE. Our study found that 282 patients (82%) had no recollection of the period of their unconsciousness, whereas 62 patients — 18% of the 344 patients — reported an NDE. Of these 62 patients with memories, 21 patients (6%) had some recollection; having experienced only some elements, they had a superficial NDE with a low score. And 42 patients (12%) reported a core experience: 18 patients had a moderately deep NDE, 17 patients reported a deep NDE, and 6 patients a very deep NDE. The following elements were reported: half of the patients with an NDE were aware of being dead and had positive emotions, 30% had a tunnel experience, observed a celestial landscape, or met with deceased persons, approximately a quarter had an out-of-body experience, communication with 'the light', or perception of colours, 13% had a life review, and 8% experienced the presence of a border. In other words, all the familiar elements of an NDE were reported in our study, with the exception of a frightening or negative NDE.

Were there any reasons why some people do but most people do not recollect the period of their unconsciousness? In order to answer this question we compared the recorded data of the 62 patients with an NDE to the data of the 282 patients without an NDE. To our surprise we did not identify any significant differences in the duration of the cardiac arrest (2 minutes or 8 minutes), no differences in the duration of unconsciousness (5 minutes or 3 weeks in coma), and no differences in whether or not intubation was necessary for artificial respiration in seriously ill patients who remained in a coma for days or weeks after a complicated resuscitation. Nor did we find statistical differences in the 30 patients who had a cardiac arrest during electrophysiological stimulation (EPS) in the catheterization laboratory and whose heart rhythms were always re-established via defibrillation (an electric shock) within 15 to 30 seconds. So we failed to identify any differences between the patients with a very long or a very brief cardiac arrest. The degree or gravity of the lack of oxygen in the brain (anoxia) appeared to be irrelevant. Likewise, it was established that medication played no role. Most patients suffering a myocardial infarction receive morphine-type painkillers, while people who are put on a respirator following complicated resuscitation are given extremely high doses of sedatives. A psychological cause such as the infrequently noted fear of death did not affect the occurrence of an NDE either, although it did affect the depth of the experience. Whether or not patients had heard or read anything about NDE in the past made no difference either. Any kind of religious belief, or indeed its absence in non-religious people or atheists, was irrelevant and the same was true for the standard of education reached. Factors that do affect the frequency of an NDE are an age below 60 and if patients required several resuscitations during their stay in hospital, the chances of an NDE report were greater. Remarkably, we found that patients who had had an NDE in the past also reported significantly more frequent NDEs in our study. A complicated resuscitation can result in a long coma and most patients who have been unconscious on a respirator for days or weeks are more likely to suffer short-term memory defects as a result of permanent brain damage. These patients reported significantly fewer NDEs in our study. This suggests that a good short-term memory is essential for remembering an NDE.

We were particularly surprised to find no medical explanation for the occurrence of an NDE. All the patients in our study had been clinically dead and only a small percentage reported an enhanced consciousness with lucid thoughts, emotions, memories, and sometimes perception from a position outside and above their lifeless body while doctors and nursing staff were carrying out resuscitation. If there was a physiological explanation such as a lack of oxygen in the brain (anoxia) for the occurrence of this enhanced consciousness, one might have expected all patients in our study to have reported an NDE. They had all been unconscious as a result of their cardiac arrest, which caused the loss of blood pressure, the cessation of breathing, and the loss of all body and brainstem reflexes. And it is also well established that people without any lack of oxygen in the brain, like in depression or meditation, can experience an 'NDE'. Likewise the gravity of the medical situation, such as long-term coma after a complicated resuscitation, failed to explain why patients did or did not report an NDE, except in the case of lingering memory defects. The psychological explanation is doubtful because most patients did not experience any fear of death during their cardiac arrest as it occurred so suddenly they failed to notice it. In most cases they were left without any recollection of their resuscitation. This is borne out by Greyson's (2003) study which only collected the subjective data of patients after their resuscitation and showed that most patients did not even realize they had had a cardiac arrest. This is similar to fainting. When people regain consciousness they have no clear idea of what happened. A pharmacological explanation could be excluded as well as the medication had no effect on whether or not patients reported an NDE.

Results of the Longitudinal Study

The later interviews in our Dutch longitudinal study were conducted using a standardized inventory featuring 34 life-change questions (Ring, 1984). Among the 74 patients who consented to be interviewed after two years, 13 of the total of 34 factors listed in the questionnaire turned out to be significantly different for people with or without an NDE. The second interviews showed that, in people with an NDE, fear of death in particular had significantly decreased while belief in an afterlife had significantly increased. We then compared these 13 factors, which had been so significantly different between the two groups with and without NDE after two years, in the same patients after eight years. It struck us that after eight years the people without NDE were also undergoing unmistakable processes of transformation. Nevertheless, clear differences remained between people with and without NDE, although by now these differences had become a little less marked. We were also surprised to find that the processes of transformation that had begun in people with NDE after two years had clearly intensified after eight years. The same was true for the people without NDE. In summary, we could say that eight years after their cardiac arrest all patients had changed in many respects, showing more interest in nature, the environment, and social justice, displaying more love and emotions and being more supportive and involved in family life. Nevertheless, the people who had experienced an NDE during their cardiac arrest continued to be clearly different. In particular, they were less afraid of death and had a stronger belief in an afterlife. We saw in them a greater interest in spirituality and questions about the purpose of life, as well as a greater acceptance of and love for oneself and others. Likewise, they displayed a greater appreciation of ordinary things, whereas their interest in possessions and power had decreased. The conversations also revealed that people had acquired enhanced intuitive feelings after an NDE, along with a strong sense of connectedness with others and with nature. Or, as many of them put it, they had acquired ‘paranormal gifts’. The sudden occurrence of this enhanced intuition can be quite problematic, as people suddenly have a very acute sense of others, which can be extremely intimidating, and also experience clairvoyance, precognition, and visions (‘non-local perception’). This intuitive sense can be quite extreme, with people ‘sensing’ feelings and sadness in others, or having the sense of knowing when someone will die — which usually proved to be accurate (van Lommel, 2010). The integration and acceptance of an NDE is a process that may take many years because of its far-reaching impact on people’s pre-NDE understanding of life and value system. Finally, it is quite remarkable to see a cardiac arrest lasting just a few minutes give rise to such a lifelong process of transformation.

Conclusions of the Dutch Study on NDE

Only the large-scale Dutch study allowed for statistical analysis of the factors that may determine whether or not an NDE occurs. It thus ruled out the aforementioned possible physiological, psychological, and pharmacological explanations for the occurrence of an NDE. Our study was also the first to include a longitudinal component with interviews after two and eight years, which allowed us to compare the processes of transformation between people with and without NDE. We identified a distinct pattern of change in people with an NDE and revealed that integrating these changes into daily life is a long and arduous process. And we reached the inevitable conclusion that patients experienced all the aforementioned NDE elements during the period of their cardiac arrest, during the total cessation of blood supply to the brain. Nevertheless, the question how this could be possible remained unanswered.

Other Prospective Studies on NDE

Bruce Greyson, who published a prospective study in 116 survivors of cardiac arrest in the USA (Greyson, 2003), found that 15.5% of the patients reported an NDE: 9.5% reported a core NDE and 6% a superficial NDE. He writes that

> no one physiological or psychological model by itself could explain all the common features of an NDE. The paradoxical occurrence of a heightened, lucid awareness and logical thought processes during a period of impaired cerebral perfusion raises particular 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. (*ibid.*, p. 275)

The British prospective study by Sam Parnia and Peter Fenwick (Parnia *et al.*, 2001) included 63 patients who survived their cardiac arrest. They found in their study that 11% reported an NDE: 6.3% reported a core NDE and 4.8% a superficial NDE. They write that the NDE-reports suggest that the NDE occurs during the period of unconsciousness. This is a surprising conclusion, in their view, because

> when the brain is so dysfunctional that the patient is deeply comatose, those cerebral structures, which underpin subjective experience and memory, must be severely impaired. Complex experiences as reported in the NDE should not arise or be retained in memory. Such patients would be expected to have no subjective experience, as was the case in the vast majority of patients who survive cardiac arrest, since all centres in the brain that are responsible for generating conscious experiences have stopped functioning as a result of the lack of oxygen. (*ibid.*, p. 151)

Another frequently cited explanation might be that the observed experiences occur during the early phases of the cessation or during the recovery of consciousness. Parnia and Fenwick, however, claim that 'the verifiable elements of an out-of-body experience during unconsciousness, such as patients' reports on their resuscitation, render this extremely unlikely' (*ibid.*, p. 151).

Over a period of four years Penny Sartori carried out a smaller study into NDE in 39 survivors of cardiac arrest in the UK (Sartori, 2006). She found that 23% reported an NDE: 18% reported a core NDE and 5% a superficial NDE. She concludes that 'according to mainstream science, it is quite impossible to find a scientific explanation for the NDE as long as we "believe" that consciousness is only a side effect of a functioning brain'. The fact that people report lucid experiences in their consciousness when brain activity has ceased is, in her view, 'difficult to reconcile with current medical opinion' (*ibid.*, p. 25).

Some Typical Elements of an NDE

Before discussing some of our current medical and neurophysiological ideas about consciousness and the function of our brain in more detail, I would like to reconsider certain elements of the NDE that were experienced during a transient period of a non-functioning brain during cardiac arrest: an out-of body experience, a holographic life review, a meeting with deceased relatives, and a conscious return into the body.

Out-of-body experience (OBE): In this experience people have veridical perceptions from a position outside and above their lifeless body. This out-of-body experience is scientifically important because doctors, nurses, and relatives can verify the reported perceptions, and they can also corroborate the precise moment the NDE with OBE occurred during the period of cardiopulmonary resuscitation (CPR). And it is important to mention that until now it has been impossible to induce a real out-of-body experience with veridical perception from a position out of and above the body by any method whatsoever (Penfield, 1975), despite incorrect suggestions about this possibility in the medical literature while just describing bodily illusions (Blanke *et al.*, 2002; 2004; 2008; De Ridder *et al.*, 2007). In a recent review of 93 corroborated reports of potentially verifiable out-of-body perceptions during NDE it was found that about 90% were completely accurate, 8% contained some minor error, and only 2% were completely erroneous (Holden, 2009). This strongly suggests that OBE cannot be an hallucination, i.e. experiencing a perception that has no basis in 'reality', like in psychosis, neither can it be a delusion, which is an incorrect assessment of a correct perception, nor an illusion, which means a misapprehension or misleading image. So the question arises: should an OBE be considered as a kind of non-sensory perception?

This is the report of a nurse of a Coronary Care Unit (van Lommel *et al.*, 2001):

> During night shift an ambulance brings in a 44-year old cyanotic, comatose man into the coronary care unit. He was found in coma about 30 minutes before in a meadow. When we go to intubate the patient, he turns out to have dentures in his mouth. I remove these upper dentures and put them onto the 'crash cart.' After about an hour and a half the patient has sufficient heart rhythm and blood pressure, but he is still ventilated and intubated, and he is still comatose. He is transferred to the intensive care unit to continue the necessary artificial respiration. Only after more than a week do I meet again with the patient, who is by now back on the cardiac ward. The moment he sees me he says: 'O, that nurse knows where my dentures are.' I am very, very surprised. Then

> the patient elucidates: 'You were there when I was brought into hospital and you took my dentures out of my mouth and put them onto that cart, it had all these bottles on it and there was this sliding drawer underneath, and there you put my teeth.' I was especially amazed because I remembered this happening while the man was in deep coma and in the process of CPR. It appeared that the man had seen himself lying in bed, that he had perceived from above how nurses and doctors had been busy with the CPR. He was also able to describe correctly and in detail the small room in which he had been resuscitated as well as the appearance of those present like myself.

Most scientists are reluctant to accept the possibility of veridical perception from a position out of and above the lifeless body, because this could be the decisive evidence that conscious perception is possible outside the body, and so deliberately they call these perceptions just anecdotes. These scientists want to have more 'objective' proof, and of course most NDE researchers will agree. This is why hidden signs or targets have been put close to the ceiling in resuscitation rooms, coronary care units, and intensive care units with the purpose that these hidden signs, not visible from the bed, could be an objective proof for veridical perception if patients during cardiac arrest are able to perceive details of their resuscitation from a position out of and above their lifeless body during their CPR, and that later these perceptions can be corroborated by doctors, nurses, and relatives. But until now there has been no published case where a patient during CPR has perceived this hidden sign despite perceiving veridical details of their resuscitation previously unknown to them. Could there be a plausible explanation for this impossibility to 'prove' the reported perception during OBE by a hidden sign? This lack of 'objective proof' could be caused by so-called 'inattentional blindness', also known as 'perceptual blindness' (Mack and Rock,1998; Simons and Rensink, 2005). This is the phenomenon of not being able to perceive things that are in plain sight. It can be a result of having no internal frame of reference to perceive the unseen object, or it can be caused by the lack of mental focus or attention caused by mental distractions. This inattentional blindness is the failure to notice a fully visible, but unexpected, object because attention was engaged on another task, event, or object, because humans have a limited capacity for attention and intention which thus limits the amount of information processed at any particular time (Most *et al.*, 2005; Chun and Marois, 2002). Only if we have the intention to decide where to place the attention will we perceive consciously the event or object we focus upon. Studies of inattentional blindness demonstrate that people fail to report having noticed an unexpected object (Koivisto and Revonsuo, 2008). The information from the unexpected object is filtered from awareness by the time people are asked about it. Evidence for inattentional blindness comes mostly from relatively simple laboratory tasks (Simons and Chabris, 1999), but the phenomenon likely has many daily analogues. For example, automobile accident reports frequently report driver claims that they 'looked but failed to see' the other vehicle. Recent evidence suggests that talking on a mobile phone, for example, dramatically increases the probability of missing an unexpected object (Scholl *et al.*, 2003). Based on the many corroborated cases of veridical perception from a position out of and above the body during NDE it seems obvious that perception really can occur during an OBE, and that missing a hidden target during an OBE must be the result of a lack of intention and attention for this unexpected hidden object because patients are too surprised to be able to 'see' the resuscitation of their own lifeless body from above during their cardiac arrest or surgery.

Life review: During a holographic life review the subject feels the presence and renewed experience of not only every act but also every thought from one's life, and one realizes that in some way we are connected to others and to ourselves such that we influence ourselves as well as others. All that has been done and thought seems to be significant and stored. Because one is connected with the memories, emotions, and consciousness of another person, you experience the consequences of your own thoughts, words, and actions to that other person at the very moment in the past that they occurred (interconnectedness or entanglement). They understand now what in some religions and cultures is known as the cosmic law that everything one does to others will ultimately be returned to oneself. Patients survey their whole life in one glance; time and space do not seem to exist during such an experience ('non-locality'). Instantaneously they are where they concentrate upon, and they can talk for hours about the content of the life review even though the resuscitation only took minutes. Quotation (van Lommel, 2004):

> All of my life up till the present seemed to be placed before me in a kind of panoramic, three-dimensional review, and each event seemed to be accompanied by a consciousness of good or evil or with an insight into cause or effect. Not only did I perceive everything from my own viewpoint, but I also knew the thoughts of everyone involved in the event, as if I had their thoughts within me. This meant that I perceived not only what I had done or thought, but even in what way it had influenced others, as if I saw things with all-seeing eyes. And so, even your thoughts are apparently not wiped out. And all the time during the review the

> importance of love was emphasised. Looking back, I cannot say how long this life review and life insight lasted, it may have been long, for every subject came up, but at the same time it seemed just a fraction of a second, because I perceived it all at the same moment. Time and distance seemed not to exist. I was in all places at the same time, and sometimes my attention was drawn to something, and then I would be present there.

Preview: Also a preview, or flash-forward, can be experienced, in which both future images from personal life events as well as more general images from the future occur. Again it seems as if time and space do not exist during this preview (non-locality).

Meeting deceased relatives: If deceased acquaintances or relatives are encountered in an otherworldly dimension, they are usually recognized by their appearance, and communication is possible through what is experienced as thought transfer. Thus, it is also possible to come into contact with fields of consciousness of deceased persons (interconnectedness), even if it was not possible to know that these relatives had died. So apparently a kind of personal identity ('Self') is still accessible in the non-physical dimension. Quotation (van Lommel, 2004):

> During my cardiac arrest I had an extensive experience (…) and later I saw, apart from my deceased grandmother, a man who had looked at me lovingly, but whom I did not know. More than 10 years later, at my mother's deathbed, she confessed to me that I had been born out of an extramarital relationship, my father being a Jewish man who had been deported and killed during the second World War, and my mother showed me his picture. The unknown man that I had seen more than 10 years before during my NDE turned out to be my biological father.

Conscious return into the body: Some patients can describe how they consciously returned into their body, mostly through the top of the head, after they had come to understand that 'it wasn't their time yet' or that 'they still had a task to fulfil'. This conscious return into the body is experienced as something very oppressive. They regain consciousness in their body and realize that they are 'locked up' in their damaged body, meaning again all the pain and restriction of their disease or injury. Quotation (van Lommel 2004):

> And when I regained consciousness in my body, it was so terrible, so terrible… that experience was so beautiful, I never would have liked to come back, I wanted to stay there… and still I came back. And from that moment on it was a very difficult experience to live my life again in my body, with all the limitations I felt in that period.

Theories about NDE

The Never Proven Assumption that the Brain Produces Consciousness

With our current medical and scientific concepts it seems indeed impossible to explain all aspects of the subjective experiences as reported by patients with an NDE during a transient loss of all functions of the brain. Scientific studies into the phenomenon of NDE highlight the limitations of our current medical and neurophysiological ideas about the various aspects of human consciousness and the relationship between consciousness and memories on the one hand and the brain on the other. The prevailing paradigm holds that memories and consciousness are produced by large groups of neurons or neural networks. For want of evidence for the aforementioned explanations for the cause and content of an NDE the commonly accepted but never proven assumption that consciousness is localized in the brain should be questioned. After all, how can an extremely lucid consciousness be experienced outside the body at a time when the brain has a transient loss of all functions during a period of clinical death, even with a flat EEG? Furthermore, even blind people have described veridical perceptions during out-of-body experiences at the time of their NDE (Ring and Cooper, 1999).

Anoxia (Lack of Oxygen)

For the majority of scientists the most common explanation for NDE is still an extremely severe and life-threatening total lack of oxygen in the brain. This should result in the experience of a tunnel by anoxia of the retina, and in the blockage of NMDA-receptors in the brain and in the release of endorphin, a kind of morphine produced by the body itself, causing hallucinations and a sense of peace and bliss (Woerlee, 2003; Blackmore, 1993). This theory seems inapplicable, however, because an NDE is actually accompanied by an enhanced and lucid consciousness with memories, and because it can also be experienced under circumstances such as an imminent traffic accident (a 'fear-death' experience), during a depression, meditation, or isolation (van Lommel, 2010), or as a 'shared-death' experience (Moody, 2010), neither of which involves oxygen deficiency. In the recently published four prospective studies on NDE in survivors of cardiac arrest, the lack of oxygen by itself could not explain the cause and content of NDE (van Lommel *et al.*, 2001; Greyson, 2003; Parnia *et al.*, 2001; Sartori, 2006). Moreover, an hallucination is an observation that is not rooted in reality, which is not consistent with descriptions of out-of-body experiences that are open to verification and corroboration by witnesses. Besides, to experience hallucinations one requires a functioning brain.

High CO_2

And yet, neurophysiological processes like a transient loss or inhibition of certain neuronal networks could play some part in NDE, because sometimes NDE-like experiences can be induced through electrical 'stimulation' (inhibition) of some parts of the cortex in patients with epilepsy (Penfield, 1958), or with induced high carbon dioxide levels (hypercarbia) in the brain (Meduna, 1950). Even recently it was suggested that NDEs could be caused by high levels of CO_2 in patients during out-of-hospital cardiac arrest. In a study of 52 survivors of cardiac arrest 21% of them reported an NDE, and a significant correlation was found between higher amount of CO_2 in the exhalation air (end-tidal CO_2) and with higher arterial blood pressures of CO_2 (Klemenc-Ketis *et al.*, 2010). However, this study included only patients with an out-of-hospital cardiac arrest, where arterial blood samples were taken only in the first 5 minutes after hospital admission, meaning that most of them already had rhythm and blood pressure after successful CPR outside the hospital. It was not mentioned how accurate and when the end-tidal CO_2 was measured during and after the cardiac arrest and during the transport to the hospital. Their main conclusion was that high levels of CO_2 in the blood in this study were associated with a slightly higher incidence of NDEs, but this does not explain why the majority of patients with high CO_2 still do not report an NDE. So the conclusion that high CO_2 levels could explain the cause of an NDE seems to be preliminary at least. But this study caused a worldwide sensation in newspapers and journals for the general public, where continually and wrongly it was claimed that it was now clear and scientifically proven that a higher amount of CO_2 in the exhalation air and in the arterial blood in survivors of cardiac arrest in this study was the cause for experiencing an NDE. It was obviously forgotten that correlation is something totally different from causation for the occurrence of an NDE.

Hypoxia (Oxygen Deficiency)

In the case of oxygen deficiency in the brain (*hypoxia*, or deprivation of adequate oxygen supply), as can be seen in low blood pressure (shock), heart failure, or asphyxia, the result is not unconsciousness but confusion and agitation. Brain damage after waking from a coma is also associated with confusion, fear, agitation, memory defects, and muddled speech. A study of fighter jet pilots is often cited as a possible explanatory model for NDE (Whinnery and Whinnery, 1990). Having been placed in a centrifuge, these pilots experienced momentary oxygen deficiency in the brain when the enormous increase in gravity caused their blood to drop to their feet. Fighter jet pilots can indeed lose consciousness, and often experience convulsions, like those seen in epilepsy, or tingling around the mouth and in the arms and legs, as well as confusion upon waking. Sometimes they also experience some elements that are reminiscent of an NDE, such as a kind of tunnel vision, a sensation of light, a peaceful sense of floating without veridical perception, or the observation of brief, fragmented images from the past (*ibid.*). These recollections, however, consist of fragmented and random memories unlike the panoramic life review during NDE. They seldom also see images of living persons, but never of deceased people. A similar kind of unconsciousness, sometimes accompanied by the experiences reported by pilots, occurs after fainting induced by hyperventilation, followed by a so-called Valsalva manoeuvre (Lempert *et al.*, 1994). The latter involves trying to push air from the body with the mouth and nose closed, which slows the heartbeat and lowers blood pressure, and results in a short-lived oxygen deficiency in the brain. The effects of this type of faint have also been wrongly compared to an NDE (*ibid.*).

Use of Drugs

NDE-like experiences have also been reported after the use of drugs like ketamine (Jansen, 1996), LSD (Grof and Halifax, 1977), and DMT, or drugs made from mushrooms (psilocybin) or from cactus (mescaline) (Strassman, 2001). All these induced experiences can sometimes result in a period of unconsciousness, but can also in some cases consist of a feeling of being out of body, mostly without veridical perception, and also a perception of sound, light, or flashes of recollections from the past are sometimes mentioned. These recollections, however, consist of fragmented and random memories unlike the panoramic life review during NDE as was mentioned before. Furthermore, transformation is rarely reported after induced experiences. Thus, induced experiences are usually not identical to NDE (van Lommel, 2010).

An NDE is a Changing State of Consciousness

Another theory about NDE holds that an NDE might be a changing state of consciousness (the theory of continuity), in which memories, Self-identity, and cognition, with emotion, function independently from the unconscious body, and retain the possibility of non-sensory perception. Obviously, during NDE enhanced consciousness is experienced independently from the normal body-linked waking consciousness, during the period of cardiac arrest, during the period of apparent unconsciousness.

Complete Loss of Brain Function During Cardiac Arrest

Through many studies with induced cardiac arrest in both human and animal models cerebral function has been shown to be severely compromised during cardiac arrest, with complete cessation of cerebral blood flow immediate following ventricular fibrillation (Gopalan *et al.*, 1999), and with the clinical findings of the sudden loss of consciousness and of all body reflexes, caused by the loss of function of the cortex, and also with the abolition of brainstem activity (all brainstem reflexes) with the loss of the gag reflex, of the corneal reflex, and fixed and dilated pupils (van Lommel, 2010). And also the function of the respiratory centre, located close to the brainstem, fails, resulting in apnoea (no breathing). But the most important question is of course: do we know exactly what happens in the brain when the heart stops? The brain accounts for only 2% of overall body weight, but it uses 15–20% of the body's total energy supply, primarily for maintaining the membrane potential (the electric charge across a cell membrane) of the nerve cells, or neurons. Total loss of oxygen supply causes a functional loss of all cell systems and organs in the body. However, in anoxia of only a few minutes' duration (transient anoxia) this loss may be temporary, but in prolonged anoxia cell death occurs with permanent functional loss. Some cells respond better to anoxia than others. Neurons respond badly, because their sole source of energy is glucose. Unlike the muscle cells in our body, our brains do not store glucose in the form of glycogen as a ready supply of cell energy. The parts of the brain that are most susceptible to anoxia are the neurons in the cerebral cortex, and in the hippocampus and the thalamus, which form an important link between the brainstem and cerebral cortex (Fujioka *et al.*, 2000; Kinney *et al.*, 1994). The total loss of oxygen supply reduces these structures to utter chaos and wipes out their connections. Synapses are the junctions that enable communication between neurons, and when these synapses stop functioning cooperation and coordination between neuronal networks in the brain is no longer possible.

No Blood Flow to the Brain

If the absence of blood flow to the brain ('no-flow') prevents the supply of glucose and oxygen, a neuron's first symptom will be the inability to maintain its membrane potential, resulting in the loss of neuronal function (Van Dijk, 2004). The acute loss of electrical and synaptic activity in neurons can be seen as the cell's inbuilt defence and energy-saving response and is called a 'pilot light state'. When the electrical functions of neurons cease, the remaining energy sources can be deployed very briefly for the cell's survival. In the case of short-term oxygen deficiency dysfunction can be temporary and recovery is still possible, because the neurons will remain viable for a few more minutes. During a cardiac arrest the entire brain is deprived of oxygen, resulting in the loss of consciousness, of all body and brainstem reflexes, and of respiration. This period of 'clinical death' is usually reversible, i.e. temporary, if cardiopulmonary resuscitation (CPR) is initiated within five to ten minutes. Within seconds, a cardiac arrest will result in a total loss of oxygen supply and a build-up of carbon dioxide (CO_2) in the brain. This situation cannot be remedied during the resuscitation procedure itself, but only after the cardiac rhythm has been re-established through defibrillation (an electric shock). A delay in starting adequate resuscitation may result in the death of a great many brain cells and thus in brain death, and most patients will ultimately die. A study carried out at a coronary care unit has shown that patients whose resuscitation was started within one minute had a 33% chance of survival, compared to only 14% for those who, due to circumstances, were only resuscitated after more than a minute since the onset of unconsciousness (Herlitz *et al.*, 2000).

Low Blood Flow to the Brain in Effective CPR Prolongs the Viability of the Brain

Research has shown that external heart massage during CPR cannot pump enough blood to the brain to restore brain function. Nobody has ever regained consciousness during external resuscitation of the heart. This always requires defibrillation to re-establish the cardiac rhythm. Without restoration of normal blood pressure and the resumption of cardiac output, which only can be achieved by successful defibrillation, a long duration of CPR is considered an indication of poor outcome and high mortality because CPR alone cannot ultimately prevent the irreversible damage of brain cells (Peberdy *et al.*, 2003). During CPR, blood supply to the brain is 5–10% of its normal value (White *et al.*,1983), and during external heart massage the systolic pressure will usually reach approximately 50 mmHg, with an average of 20 mmHg because of the low diastolic pressure. The maximum average blood pressure during proper resuscitation is 30–40 mmHg (Paradis *et al.*, 1989), which is still far too low for the blood to deliver enough oxygen and glucose to the brain. The administration of certain medication during resuscitation can increase blood pressure a little (Paradis *et al.*, 1991), but it will remain well below normal. Furthermore, in the absence of a normal blood supply, the brain cells are likely to swell (oedema), which results in increased pressure in the brain (intracranial pressure), and also an increase of cerebral vascular resistance occurs. This is why it was found in animal studies that it actually requires a higher than normal blood pressure to maintain adequate cerebral perfusion and to supply the brain with sufficiently oxygenated blood and to enable the removal of carbon dioxide (Fisher and Hossman, 1996). During resuscitation, blood gases (O_2 and CO_2) are sometimes measured to determine the severity of the oxygen deficiency in the blood. However, normal levels of oxygen and carbon dioxide do not guarantee that enough arterial blood, and thus enough oxygen, will reach the brain during resuscitation.

To summarize: we know that proper resuscitation, with adequate external heart massage and mouth-to-mouth respiration or respiration via a mask, will produce minimal blood flow (‘low-flow’) to the brain, which increases the chances of recovery of brain function after the cardiac arrest has been successfully treated with defibrillation. By this minimal cerebral blood flow the no longer functioning neurons will be able to survive for a longer period of time in the minimal energy state (‘pilot light state’), also called ‘hibernation’ or ‘ischemic penumbra’ of the brain (Coimbra, 1999), because it prolongs the period of reversibility (viability) before neuronal cell death and brain death occur.

Flatline EEG

How do we know for sure that the EEG is flat in those patients with cardiac arrest, and how can we study this? In normal circumstances no attempts are made to register an EEG during cardiac arrest, because this takes far too much time, and patients need to be successfully resuscitated and defibrillated as soon as possible. But there have been some cases in which the electrical activity of the brain was measured (EEG) during a cardiac arrest, for example during surgery. Following the cardiac arrest ('no-flow'), the EEG flatlined after an average of fifteen seconds and remained flat despite external resuscitation ('low flow') (Hossmann and Kleihues, 1973; Moss and Rockoff, 1980; Clute and Levy, 1990; Losasso *et al.*, 1992). A persistent flatline EEG during external CPR has also been shown in animal studies (Birchner *et al.*, 1980). Monitoring of the electrical activity of the cortex (EEG) has shown that the first ischemic changes during induced cardiac arrest in humans are detected an average of 6.5 seconds after circulatory arrest. Ischemic changes in the EEG show a decrease of power in fast activity and in delta activity and an increase of slow delta I activity, sometimes also an increase in amplitude of theta activity, progressively and ultimately declining to iso-electricity. But more often initial slowing and attenuation of the EEG waves is the first sign of cerebral ischemia. With prolongation of the cerebral ischemia, progression to a flatline EEG always occurs within 10–20 (mean 15) seconds from the onset of cardiac arrest (De Vries *et al.*, 1998; Clute and Levy, 1990; Losasso *et al.*, 1992; Parnia and Fenwick, 2002), and the EEG remains flat during the cardiac arrest until cardiac output has been restored by defibrillation (Fisher and Hossman, 1996; Marshall *et al.*, 2001). In tests on animals auditory evoked potentials, or measures of brainstem viability, can no longer be induced, which means that the reaction caused in a normal functioning brainstem by sound stimulation is no longer produced (Brantson *et al.*, 1984; Gua *et al.*, 1995).

Reperfusion Injury

If the cardiac arrest lasts longer than 37 seconds, the EEG will not normalize immediately after cardiac output has been returned. Despite maintaining normal blood pressure in the period following resuscitation, this normalization ultimately depends on the duration of the cardiac arrest. After a complicated resuscitation with persistent coma it can take hours to days for the EEG to get back to normal (Mayer and Marx, 1972; Smith *et al.*, 1990). The longer the cardiac arrest, the greater the brain damage, the longer the coma, and the longer the EEG remains flat or highly irregular. Besides, normalization of the EEG may actually create an overly positive impression of the recovery of the brain's metabolism. Following restoration of the heartbeat and blood circulation, oxygen uptake in the brain may be reduced for a considerable period of time, which is caused by this so-called reperfusion injury (Mayer and Marx, 1972; Buunk *et al.*, 2000; Losasso *et al.*, 1992). Also, in animal studies with induced cardiac arrest the post-arrest cortical hypoperfusion syndrome is prolonged with cortical flow remaining below 20% of normal up to 18 hours post arrest (White *et al.*, 1983).

Patients with a myocardial infarction who suffer a cardiac arrest in the coronary care unit will usually be successfully resuscitated within 60 to 120 seconds; at a nursing ward, however, this will take at least 2–5 minutes. In the event of a cardiac arrest in the street (a so-called 'out-of-hospital' arrest) it will take, at best, 5–10 minutes for a patient to be successfully resuscitated, but usually longer, resulting in the death of nearly 90% (82–98%) of these patients with an out-of-hospital arrest (Lombardi *et al.*, 1994; de Vreede-Swagemakers *et al.*, 1997). So it seems rational to assume that all 562 survivors of cardiac arrest in the four prospective studies on NDE should have had a flat EEG because no patient had been resuscitated within 20 seconds (van Lommel, 2010).

Enhanced Consciousness is Experienced During Cardiac Arrest with Flatline EEG

So there are good reasons to assume that our consciousness does not always coincide with the functioning of our brain: enhanced consciousness, with unaltered self-identity, can sometimes be experienced separately from the body. The quite often proposed objection that a flatline EEG does not rule out any brain activity, because it is mainly a registration of electrical activity of the cerebral cortex, misses the mark. The issue is not whether there is any non-measurable brain activity of any kind whatsoever, but whether there is measurable brain activity of the specific form, and in different neural networks, as regarded by contemporary neuroscience as the necessary condition of conscious experience, the so-called neuronal global workspace (Cho *et al.*, 1997; Dehaene *et al.*, 1998). And it has been shown in several studies in patients with induced cardiac arrest that there was no such measurable and specific brain activity during cardiac arrest. Additionally, research drawing on magnetic resonance imaging (fMRI) has shown that the joint and simultaneous activity of the cerebral cortex and brainstem with their shared pathways (hippocampus and thalamus) is a prerequisite for conscious experience. As stated before, exactly these parts of the brain, the neurons in the cerebral cortex, the hippocampus, and the thalamus, are most susceptible to oxygen deficiency (Fujioka *et al.*, 2000; Kinney *et al.*, 1994). A flatline EEG is also one of the major diagnostic tools for the diagnosis of brain death, and in those cases the objection about not ruling out any brain activity whatsoever is never mentioned. Moreover, although measurable EEG activity in the brain can be recorded during deep sleep (no-REM phase) or during general anaesthesia, no consciousness is experienced because there is no integration of information and no communication between the different neural networks (Massimini *et al.*, 2005; Alkire and Miller, 2005; Alkire *et al.*, 2008). So even in circumstances where brain activity can be measured, sometimes no consciousness is experienced.

A functioning system for communication between neural networks with integration of information seems essential for experiencing consciousness, and this does not occur during deep sleep or anaesthesia (Ferrarelli *et al.*, 2010), let alone during cardiac arrest, because, as mentioned before, a complete loss of brain function during induced cardiac arrest has been demonstrated in several human and animal studies. It seems needless to state again that during cardiac arrest a non-functioning brain with a flatline EEG does not implicate that the brain is dead, nor that all neuronal networks must have died: during clinical death, which is the period of complete cessation of cerebral perfusion during cardiac arrest, there is a transient loss of all functions of the cortex and brainstem until adequate circulation and blood pressure are successfully restored by defibrillation.

Consciousness and Brain Function

For decades, extensive research has been done to localize consciousness and memories inside the brain, so far without success. We should also ask ourselves how a non-material activity such as concentrated attention or thinking can correspond to an observable (material) reaction in the form of measurable electrical, magnetic, and chemical activity at a certain place in the brain by EEG, MEG and PET-scan, and in the form of increased blood flow by fMRI. Neuroimaging studies have shown these aforesaid activities, with specific areas of the brain becoming metabolically active in response to a thought or feeling. However, although providing evidence for the role of neuronal networks as an intermediary for the manifestation of thoughts (neural correlates), those studies do not necessarily imply that those cells also produce the thoughts. A correlation doesn’t elucidate anything about cause or result. And how should ‘unconscious’ matter like our brain ‘produce’ consciousness, while the brain is only composed of atoms and molecules in cells with a lot of chemical and electrical processes? Direct evidence of how neurons or neuronal networks could possibly produce the subjective essence of the mind and thoughts is currently lacking. We cannot measure what we think or feel (van Lommel, 2010). There are no known examples of neural-perceptual matches, and hence there are reasons to doubt the truth of the 'matching content' doctrine. The assumption in the 'matching content' doctrine is that following activation of special neuronal networks you will always have the same content of thoughts or feelings. This seems extremely unlikely, because neural activation is simply neural activation; it only reflects the use of structures. This could be compared with a radio: you can activate the radio by turning it on, and you can activate a certain wavelength by tuning in on a special channel, but you will not have any influence on the content of the programme you are going to hear. Activating the radio does not influence the content of the programme, and neural activation alone does not explain the content of emotions or sensations. It seems fair to conclude that current knowledge does not permit us to reduce consciousness only to activities and processes in the brain: the explanatory gap between the brain and consciousness has never been bridged because a certain neuronal state is not the same as a certain state of consciousness.

Additionally, the debate about information storage, memory, and retrieval capacity in the brain is complicated by an article in *Science* with the provocative title 'Is Your Brain Really Necessary?'(Lewin, 1980). This article was written in response to English neurologist John Lorber's description of a healthy young man with a university degree in mathematics and an IQ of 126. A brain scan had revealed a severe case of hydrocephalus: 95% of his skull was filled with cerebrospinal fluid and his cerebral cortex measured only about 2 mm thick, leaving barely any brain tissue. The weight of his remaining brain was estimated at 100 grams (compared to a normal weight of 1,500 grams), and yet his mental function was unimpaired. It seems scarcely possible to reconcile this exceptional case with our current belief that memories and consciousness are produced and stored in the brain.

Neuroplasticity:
The Mind Can Change the Brain

Many studies have shown that the human mind can change the function and the structure of the brain: under the influence of mindfulness, emotions, expectations, active thought processes, as well as physical activities, the neural networks and electromagnetic activity of the brain undergo constant change. How could this change be scientifically explained if the assumption should be true that consciousness is only a side effect of a functioning brain, or when consciousness is defined as only being an 'illusion'?

Throughout life there is a process of constant adaptation in the cerebral cortex, because our mental, intellectual, and physical activities affect both the number and the location of the synapses, the connections between neurons. This process of ongoing adaptation is called neuroplasticity. At a young age, up to about four, the brain is remarkably plastic. There is evidence that during this period of maximum plasticity some hundred thousand synapses are lost and regenerated every second (Huttenlocher, 1984). An extreme example of neuroplasticity is the case of a three-year-old girl whose left brain needed to be surgically removed because of serious chronic encephalitis with symptoms of epilepsy. If adults were to undergo this kind of intervention the consequences would be disastrous: the patients would be unable to speak or understand language, would be left paralysed on the right side, and lose sight in one eye. But a year after her operation this girl showed almost no more symptoms. The one-sided paralysis was as good as gone and she could think clearly. She is now developing normally, fluent in two languages, running and jumping about, and doing well in school (Acosta *et al.*, 2002; Borgstein and Grootendorst, 2002). The only possible explanation for this remarkable adaptability is that the new connections forged by plasticity allowed all brain function to be assumed by the remaining right half of the brain. The girl can do as much with only half a brain as other people with both halves. With practice and the will to get better she was able to completely reprogramme her brain.

Placebo

Several scientific studies have shown that the mind can influence or determine brain function to a considerable degree. In a study of cognitive behavioural therapy and placebo treatment for depression, fMRI studies and PET scans found a permanent change in activity distribution in certain regions of the brain (Mayberg *et al.*, 2002). The brain scans of depressed patients receiving placebo treatment showed neurological improvements in certain parts of the brain that were identical to those seen in depressed patients receiving cognitive therapy or antidepressants. The mere thought of receiving proper treatment triggered a clear objective change in brain function among the depressed patients in the placebo group. The placebo effect has not only been studied in patients suffering from depression, but also in patients with Parkinson's disease, during the administration of pain stimuli, and during the measurement of changes in immune response (Wager *et al.*, 2004; Benedetti *et al.*, 2005). In all of these studies, the changed expectations triggered by the placebo effect produced demonstrably different response patterns in both body and brain. Placebo treatment and positive pain manipulation had a favourable impact on some brain centres thanks to the release of endorphin-like substances, while the fMRI showed increased activity in the prefrontal cortex thanks to the raised expectations and changed attention processes. In Parkinson's patients who received placebo treatment, certain brain centres released more dopamine, which significantly reduced muscular stiffness.

Mindfulness and Cognitive Therapy

Cognitive behavioural therapy can have the same effect as a placebo. Extensive neurological research was carried out in patients with obsessive-compulsive disorder, and with the help of PET scans abnormalities in some brain circuits were found. Intensive cognitive behavioural therapy, which taught these patients to harness the positive power of the mind to change abnormal compulsive thoughts, resulted in subjective and objective improvement of clinical symptoms, while a repeat brain scan showed clear neurological improvements (Schwartz and Begley, 2002). A new practical application is also 'mindfulness-based cognitive therapy' (MBCT) for patients with depression, stress, fear (phobia), pain, and physical ailments such as psoriasis, whereby a combination of cognitive therapy and meditation with 'mindfulness' produces distinct clinical improvements and fMRI registers clear changes, especially in the prefrontal cortex (Davidson *et al.*, 2003). These cognitive therapeutic changes seem to be the result of neuroplasticity. MBCT also boosted these patients' immune function after an influenza vaccination (Davidson *et al.*, 2003). Research has also shown that when somebody's expectations are manipulated intentionally (through stimulation or self-regulation) or unintentionally (through placebo) this not only results in a positive impact on their (subjective) sense of well-being and in an (objective) reduction of symptoms, but also brings about an actual biological change in the brain (Beauregard, 2007).

Meditation

Meditation can also produce temporary and permanent changes in brain function. A study showed that the quantitative EEG (or QEEG) of meditating volunteers displayed more gamma waves, while the

EEG of meditating Buddhist monks, who have spent tens of thousands of hours engaged in meditation, displayed a much higher gamma activity (25–42 Hz), especially fronto-parietal (forehead and sides of the head), which did not disappear after the monks had stopped meditating (Lutz *et al.*, 2004). The results of these studies indicate both an acute change during meditation and a permanent change in brain activity as a result of neuroplasticity cultivated by many years of meditation. Consciousness is capable of changing the anatomical structure and associated function of the brain.

All these studies have shown that the human mind can change the brain. There is unmistakable interaction between the mind and the brain, but not just in the sense of cause and effect. As such, it would be incorrect to claim that consciousness can only be a product of brain function: how could a product, or even an 'illusion', be able to change our brain?

No Uniform View about the Relationship between Consciousness and the Brain

In the last few decades many articles and books have been published about consciousness, but up to now there are no uniform scientific views about the relationship between consciousness and the brain (Chalmers, 1996). Most of the people who carry out research into consciousness, such as neuroscientists, psychologists, psychiatrists, and philosophers, are still of the opinion that there is a materialist and reductionist explanation for consciousness. The well-known philosopher Daniel Dennett still believes, and many with him, that consciousness is nothing other than matter (Dennett, 1991), and that our subjective experience that our consciousness is something purely personal and differs from someone else's consciousness is merely an 'illusion'. According to these scientists, consciousness originates entirely from the matter that constitutes our brain. If this were true then everything we experience in our consciousness would be nothing but the expression of a machine controlled by classical physics and chemistry, and our behaviour the inexorable outcome of nerve cell activity in our brain. The notion that all subjective thoughts and feelings are produced by nothing other than the brain's activity also suggests that it is an illusion to believe in free will. This viewpoint has serious implications for concepts such as moral responsibility and personal freedom.

To many others consciousness seems to resist a materialistic explanation, so besides several materialistic concepts there is also an 'interactionistic-dualistic' model, where consciousness and the brain are totally different entities with different fundamental properties but somehow are able to interact with each other (Popper and Eccles, 1977). And finally there is a concept of 'phenomalism' or 'immaterial (or neutral) monism', which is also called 'panpsychism' or 'idealism'. According to this model all material, physical systems should have a form of subjectivity at a fundamental level, and intrinsic properties of the physical world should be themselves phenomenal properties. If so, then consciousness and physical reality are deeply intertwined. This view acknowledges a clear causal role for consciousness in the physical world, and so consciousness should be regarded as a fundamental property of the universe (Chalmers, 2002).

Summary of Conclusions from Research on NDE, Consciousness, and Brain Function

In summarizing the aforementioned NDE studies, one can conclude that at present more and more experiences are reported by serious and reliable people who to their own surprise and confusion have experienced an enhanced consciousness independently of their physical body. These experiences have been reported in all times, in all cultures, and in all religions (van Lommel, 2010). In several prospective empirical studies it has been strongly suggested that an enhanced and clear consciousness, with unaltered Self-identity, can be experienced during the period of cardiac arrest (clinical death) when global cerebral function can at best be described as severely impaired and at worst non-functional (van Lommel *et al.*, 2001; Greyson, 2003; Parnia *et al.*, 2001; Sartori, 2006). And based on these well documented prospective studies about NDE in survivors of cardiac arrest one has to come to the conclusion that current scientific views fail to explain the cause and content of an NDE (van Lommel *et al.*, 2001; Greyson, 2003; Parnia *et al.*, 2001; Sartori, 2006). Additionally, it seems indeed scientifically proven that during cardiac arrest no activity of the cortex and the brainstem can be measured, and also the clinical findings point out the transient loss of all functions of the brain (De Vries *et al.*, 1998; Clute and Levy, 1990; Losasso *et al.*, 1992; Parnia and Fenwick, 2002). All scientists who performed prospective studies on NDE came to the same conclusion: lack of oxygen by itself cannot explain the cause and content of NDE (van Lommel *et al.*, 2001; Greyson, 2003; Parnia *et al.*, 2001; Sartori, 2006). And this view is also supported by the fact that an NDE can be reported by people who did not have life threatening illnesses but were in fear of death, in depression, or in meditation (Greyson *et al.*, 2009; Carter, 2010; van Lommel, 2010).

In studying the function of the brain it has been proven that under normal daily circumstances, during deep sleep, and during general anaesthesia a functioning network and a cooperation between many different centres of the brain is a prerequisite for the experience of our waking consciousness (Massimini *et al.*, 2005; Alkire and Miller, 2005; Alkire *et al.*, 2008; Ferrarelli *et al.*, 2010). This is never the case during a cardiac arrest (De Vries *et al.*, 1998; Clute and Levy, 1990; Losasso *et al.*, 1992; Parnia and Fenwick, 2002). It is also intriguing that it has been scientifically proven that changes in consciousness can change the structure and function of the brain. This is called neuroplasticity (Schwartz and Begley, 2002; Davidson *et al.*, 2003; Benedetti *et al.*, 2005; Beauregard, 2007).

About Concepts in Science

When empirical scientific studies discover phenomena or facts that are inconsistent with current scientific theories, so-called anomalies, these new facts must not be denied, suppressed, or even ridiculed, as is still quite common these days. In the event of new findings the existing theories ought to be developed or adjusted, and if necessary rejected and replaced. We need new ways of thinking and new kinds of science to study consciousness and acquire a better understanding of the effects of consciousness. Some scientists, such as the philosopher David Chalmers, are more receptive and take consciousness seriously: 'Consciousness poses the most baffling problems in the science of the mind. There is nothing that we know more intimately than conscious experience, but there is nothing that is harder to explain' (Chalmers, 1995, p. 200). Chalmers has specialized in the problem of consciousness and has written a review of the various theories that seek to explain the relationship between consciousness and the brain (Chalmers, 2002).

In the past, too, new kinds of science developed when prevailing scientific concepts could no longer explain certain phenomena. At the start of the previous century, for instance, quantum physics emerged because certain findings could no longer be accounted for with classical physics. Quantum physics upset the established view of our material world. The slow acceptance of the new insights provided by quantum physics can be attributed to the materialist worldview we have been raised with. According to some quantum physicists, quantum physics even assigns to our consciousness a decisive role in creating and experiencing the physical world as we perceive it. This not yet commonly accepted interpretation holds that our picture of reality is based on the information received by our consciousness. This transforms modern science into a subjective science with a fundamental role for consciousness. The quantum physicist Werner Heisenberg formulates it as follows: 'Science no longer is in the position of observer of nature, but rather recognizes itself as part of the interplay between man and nature. The scientific method… changes and transforms its object: the procedure can no longer keep its distance from the object' (Heisenberg, 1958, p. 21).

For me science means asking questions with an open mind. Science should be the search for explaining new mysteries, rather than sticking with old concepts. He who has never changed his mind because he could not accept new concepts has rarely learned something. We desperately need a real paradigm shift in science to understand consciousness and its relation with brain function, and I sincerely hope that quantum physicist Max Planck was wrong when he said in 1934: 'A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it' (Planck, 1948, pp. 33–4). In my opinion, current science must reconsider its hypotheses about the nature of perceptible reality, because these ideas have led to the neglect or denial of significant areas of consciousness. Current science usually starts from a reality based solely on objective, physical phenomena. It detests subjectivity and enshrines objectivity, because it wants to depend on objective data rather than on subjective experiences. Yet at the same time one can (intuitively) sense that besides objective, sensory perception there is a role for subjective aspects such as feelings, inspiration, and intuition. As stated before, current scientific techniques are incapable of measuring or demonstrating the content of thoughts, feelings, and emotions. A purely materialist analysis of a living being cannot reveal the content and nature of our consciousness.

Non-local Consciousness

So it is indeed a scientific challenge to discuss new hypotheses that could explain the reported interconnectedness with the consciousness of other persons and of deceased relatives, to explain the possibility to experience instantaneously and simultaneously (non-locality) a review and a preview of someone's life in a dimension without our conventional body-linked concept of time and space, where all past, present, and future events exist and are available, and the possibility to have clear and enhanced consciousness with persistent and unaltered 'Self'-identity, with memories, with cognition, with emotion, with the possibility of perception out and above the lifeless body, and even with the experience of the conscious return into the body.

In some articles (van Lommel, 2004; 2006) and in my recent book (van Lommel, 2010) I describe a concept in which our endless consciousness with declarative memories finds its origin in, and is stored in, a non-local dimension as wave-fields of information, and the brain only serves as a relay station for parts of these wave-fields of consciousness to be received into or as our waking consciousness. The latter relates to our physical body. These informational fields of our non-local consciousness become available as our waking consciousness only through our functioning brain in the shape of measurable and changing electromagnetic fields. Could our brain be compared to the TV set, which receives electromagnetic waves and transforms them into image and sound? Could it as well be compared to the TV camera, which transforms image and sound into electromagnetic waves? These waves hold the essence of all information, but are only perceivable by our senses through suitable instruments like the camera and TV set. The function of the brain should be compared with a transceiver, a transmitter/receiver, or interface. Thus there are two complementary aspects of consciousness, which cannot be reduced one to the other, and the function of neuronal networks should be regarded as receivers and conveyors, not as retainers of consciousness and memories.

This view is highly compatible with the concept of 'phenomalism' or 'immaterial (or neutral) monism' (Chalmers, 2002). In this concept, consciousness is not rooted in the measurable domain of physics, our manifest world. This also means that the wave aspect of our indestructible consciousness in the non-local space is inherently not measurable by physical means. However, the physical aspect of consciousness, which presumably originates from the wave aspect of our consciousness through collapse of the wave function, can be measured by means of neuroimaging techniques like EEG, fMRI, and PET scan. The impossibility to objectively measure or prove this non-local aspect of consciousness, which also has been called 'transpersonal', 'enhanced', 'higher', 'divine', or 'cosmic' consciousness, could be compared to gravitational fields, of which only the physical effects throughout the universe can be measured, but the fields themselves are not directly demonstrable.

One cannot avoid the conclusion that endless or non-local consciousness, with an apparently unaltered 'Self-identity', has always existed and will always exist independently from the body, because there is no beginning nor will there ever be an end to our consciousness. There is a kind of biological basis of our waking consciousness, because during life our physical body functions as an interface or place of resonance. But there is no biological basis of our whole, endless, or enhanced consciousness because it is rooted in a non-local space. Our non-local consciousness resides not in our brain and is not limited to our brain. So our brain seems to have a facilitating and not a producing function to experience consciousness.

Comparison with Worldwide Communication

In trying to understand this concept of interaction between the invisible non-local space and our visible, material body, it seems appropriate to compare it with modern worldwide communication. There is a continuous exchange of objective information by means of electromagnetic fields for radio, TV, mobile telephone, or laptop computer. We are not consciously aware of the vast amounts of electromagnetic fields that constantly, day and night, exist around us and even permeates us, as well as permeating structures like walls and buildings. At each moment we are invaded by hundreds of thousands of telephone calls, by hundreds of radio and TV programmes, and by innumerable websites. We only become aware of these electromagnetic informative fields at the moment we use our mobile telephone or by switching on our radio, TV, or laptop computer. What we receive is neither inside the instrument, nor in the components, but thanks to the receiver the information from the electromagnetic fields becomes observable to our senses and hence perception occurs in our consciousness. The voice we hear over our telephone is not inside the telephone. The concert we hear over our radio is transmitted to our radio. The images and music we hear and see on TV are transmitted to our TV set. The internet, with more than a billion websites, can be received at about the same moment in the USA, in Europe, and in Australia, and is obviously not located in, nor produced by, our laptop.

Nothing New

It is quite interesting to mention that the conclusion that our brain functions as a transceiver and not as a producer of consciousness is in striking concurrence with the view that was expressed about a century ago. Already in 1898 William James wrote that the brain's role in the experience of consciousness is not a productive, but a permissive or transmissive role; that is, it admits or transmits information. In his view, consciousness does not originate in this physical world, but already exists in another, transcendental sphere; access to aspects of consciousness depends on the personal ‘threshold of consciousness’, which for some people is lower than for others, and which allows them to experience various aspects of enhanced consciousness. James draws on abnormal experiences of consciousness to support his theory: ‘The whole drift of my education goes to persuade me that the world of our present consciousness is only one out of many worlds of consciousness that exist, and that those other worlds must contain experiences which have a meaning for our life also.’ He stated: ‘The total expression of human experience, as I view it objectively, invincibly urges me beyond the narrow “scientific” bounds’, and he also writes about ‘the continuity of consciousness’ (James, 1898). Other scientists and philosophers shared the same view a century ago (Myers, 1903; Bergson, 1896/1994). And recently, based on totally different neuroscientific research, Alva Noë writes in his book:

> All scientific theories rest on assumptions. It is important that these assumptions be true. I will try to convince the reader that this startling assumption of consciousness research that consciousness is a neuroscientific phenomenon and that it happens in the brain is badly mistaken. Consciousness does not happen in the brain. What determines and controls the character of conscious experience is not the associated neural activity. That is why we have been unable to come up with a good explanation of its neural basis. (Noë, 2009)

Noë proposes that the brain’s job is that of facilitating a dynamic pattern of interaction among brain, body, and world.

Conclusion

By making a scientific case for consciousness as a non-local and thus ubiquitous phenomenon, this view can contribute to new ideas about the relationship between consciousness and the brain. I am aware that this concept can be little more than a stimulus for further study and debate, because at present we lack definitive answers to the many important questions about our consciousness and its relation with brain function. I have no doubt that in the future, too, many questions about consciousness and the mystery of life and death will remain unanswered. However, faced with extraordinary or anomalous findings we must question a purely materialist paradigm in science. A near-death experience is one such extraordinary finding. Scientific studies on NDE challenge our current concepts about consciousness and its relation with brain function.

Moreover, the findings and conclusions of recent NDE research may result in a fundamental change of one's opinion about death, because of the almost unavoidable conclusion that at the time of physical death consciousness, with persistent Self-identity, will continue to be experienced in another dimension, in which all past, present, and future is enclosed. As someone with an NDE wrote to me: 'Death is only the end of our physical aspects.' But we should acknowledge that research on NDE cannot give us the irrefutable scientific proof of this conclusion, because people with an NDE did not quite die, but they all were very close to death, and without a functioning brain. As I have explained before, it has been strongly suggested that during NDE enhanced consciousness with persistent and unaltered Self-identity was experienced independently of brain function. Without a body we may still have conscious experiences. Recently someone with an NDE wrote me: 'I can live without my body, but apparently my body can not live without me.'

The conclusion seems compelling that endless or non-local consciousness has and always will exist independently from the body. For this reason we indeed should seriously consider the possibility that death, like birth, can only be a transition to another state of consciousness, and that during life the body functions as an interface or place of resonance. This view of a non-local consciousness also allows us to understand a wide variety of special states of consciousness, such as mystical and religious experiences, deathbed visions (end-of-life experiences), shared death experiences, peri-mortem and post-mortem experiences (after death communication, or non-local interconnectedness with the consciousness of deceased relatives), heightened intuitive feelings and prognostic dreams (non-local information exchange), remote viewing (non-local perception), and perhaps even the effect of consciousness on matter like in neuroplasticity (non-local perturbation) (van Lommel, 2010).

Some Implications of NDE Studies

'It is worth dying to find out what life is.' — T.S. Eliot

Finally, I would like to reconsider some of the implications of NDE and non-local consciousness in relation to ethical, medical, and social issues in our predominantly materialist western society. If it were really true that the essence of our endless or non-local consciousness predates our birth and will survive the death of our physical body in a non-local dimension, there would be no beginning nor end to our consciousness. There would be a continuity of consciousness beyond time and space. These conclusions of NDE research are important for many aspects in healthcare, because this view of consciousness as a non-local phenomenon might well induce a huge change in the scientific paradigm in western medicine. It could have practical implications in actual medical and ethical problems such as the care for comatose or dying patients, euthanasia, abortion, and the removal of organs for transplantation from somebody in the dying process with a beating heart in a warm body but with a diagnosis of brain death.

Healthcare

Knowledge of near-death experience can be of great practical significance to healthcare practitioners and to dying patients and their families. They all ought to be aware of the extraordinary conscious experiences that may occur during a period of clinical death or coma, around the deathbed and the dying (end-of-life experiences and shared-death experiences), or even after death (after death communication, or peri- and post-mortem experiences). All these experiences often result in significant life changes, including the loss of the fear of death. By accommodating rather than judging these experiences, patients and their families are given a chance to integrate them into the rest of their lives. NDEs are much more common than previously assumed, and the personal consequences of such an experience are far more profound than doctors, nurses, and relatives ever imagined. Openness, sympathy, and proper support help people with an NDE to accept and integrate this experience. Fear of death and of the process of dying often informs decisions on ethical and medical issues on the part of doctors, patients, and families. A new perspective on death, which conceives of a continuity of consciousness after physical death, will have consequences for the way in which healthcare providers deal with patients in coma, with resuscitated, seriously ill, or dying patients, and also with stories about contact with the consciousness of deceased relatives. Continuing improvement of the quality of healthcare is not just contingent on technical and medical advances, but also on compassion for individual patients and their families.

Life Insight Experience

Apparently, an NDE is both an existential crisis and an intense lesson in life. People change after an NDE as it gives them a conscious experience of a non-local dimension in which time and distance play no role, in which past and future can be glimpsed, where they feel complete and healed and where they experience unlimited knowledge and unconditional love. These life changes mainly spring from the insight that love and compassion for oneself, for others, and for nature are major prerequisites for life. Following an NDE most people realize that everything and everyone is connected, that every thought has an effect on both oneself and the other, and that our consciousness continues beyond physical death. Regarding what we can learn from people who are willing to share their NDE with others, I would like to quote Dag Hammerskjöld: 'Our ideas about death define how we live our life' (Hammerskjöld, 1964). Because as long as we believe that death is the end of everything we are, we will give our energy towards the temporary and material aspects of our life. We should recognize that our view of the world is wrong, because we do not realize that the world, as we see it, only derives its (subjective) reality from our consciousness. Because it is only our consciousness that is determining how we see this world. If we are in love, the world around us is beautiful, when we are depressed our world is like hell, and when we are frightened (made terrified by politicians and by the press) our world will be full of terror. 'The mind in its own place, and in itself, can make a heaven of hell', wrote John Milton as early as 1667 in his poem 'Paradise Lost' (Milton, 1674).

Finally

It often takes an NDE to get people to think about the possibility of experiencing consciousness independently of the body and to realize that presumably consciousness always has been and always will be, that everything and everybody is connected, that all of our thoughts will exist forever, and that death as such does not exist. But also the results and conclusions of scientific studies on NDE provide an opportunity to reconsider our relationship with ourselves, our fellow man, and nature, but only if we are willing and able to ask open questions and abandon preconceptions. Studies into NDE may help the scientific community to reconsider some assumptions about life and death, and about consciousness and its relation with brain function.

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