

NEAR-DEATH EXPERIENCE, CONSCIOUSNESS, AND THE BRAIN

A NEW CONCEPT ABOUT THE CONTINUITY OF OUR CONSCIOUSNESS BASED ON RECENT SCIENTIFIC RESEARCH ON NEAR-DEATH EXPERIENCE IN SURVIVORS OF CARDIAC ARREST

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In this article first some general aspects of near-death experience will be discussed, followed by questions about consciousness and its relation to brain function. Details will be described from our prospective study on near-death experience in survivors of cardiac arrest in the Netherlands, which was published in the *Lancet* in 2001. In this study it could not be shown that physiological, psychological, or pharmacological factors caused these experiences after cardiac arrest. Neurophysiology in cardiac arrest and in a normal functioning brain will be explained. Finally, implications for consciousness studies will be discussed, and how it could be possible to explain the continuity of our consciousness. Scientific study of NDE pushes us to the limits of our medical and neurophysiologic ideas about the range of human consciousness and mind–brain relation.

KEYWORDS: Informational fields of consciousness, mind–brain relation, near-death experience.

INTRODUCTION

Some people who have survived a life-threatening crisis report an extraordinary experience. Near-death experiences (NDE) occur with increasing frequency because of improved survival rates resulting from modern techniques of resuscitation. The content of NDE and the effects on patients seem similar worldwide, across all cultures and all times. The subjective nature and absence of a frame of reference for this experience lead to individual, cultural, and religious factors determining the vocabulary used to describe and interpret the experience. NDE can be defined (Van Lommel et al., 2001) as the reported memory of the whole of impressions during a special state of consciousness, including a number of special elements such as out-of-body experience, pleasant feelings, seeing a tunnel, a

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light, deceased relatives, or a life review. Many circumstances are described during which NDE are reported, such as cardiac arrest (clinical death), shock after loss of blood, coma following traumatic brain injury or intra-cerebral haemorrhage, near-drowning (children!), or asphyxia, but also in serious diseases not immediately life-threatening. Similar experiences to near-death ones can occur during the terminal phase of illness, and are called deathbed visions (Osiris and Haraldson, 1977, 1986). Furthermore, identical experiences, so-called fear-death experiences, are mainly reported after situations in which death seemed unavoidable like serious traffic or mountaineering accidents (Heim, 1891). The NDE is transformational, causing profound changes of life-insight and loss of the fear of death (Van Lommel et al., 2001; Blackmore, 1993; Schröter-Kunhardt, 1999). According to a recent random inquiry in Germany (Schmied et al., 1999) and the United States (Gallup, 1982) about 4–5% of the total population in the Western world should have experienced an NDE. An NDE seems to be a relatively regularly occurring, and to many physicians an inexplicable phenomenon and hence an ignored result of survival in a critical medical situation. However, personally my scientific curiosity started to grow, because according to our current medical concepts it is not possible to experience consciousness during a cardiac arrest, when circulation and breathing have ceased.

Consciousness presents timely as well as everlasting experiences. Is there a start or an end to consciousness? How is consciousness related to the integrity of brain function? Is it possible to gain insight in this relationship? Should we consider the possibility of conscious experience when someone in coma has been declared brain dead by physicians, and organ transplantation is about to be started? Recently several books were published in the Netherlands about what patients had experienced in their consciousness during coma following a severe traffic accident, or during coma following complications with cerebral hypertension after surgery for a brain tumor, this last patient being declared brain dead by his neurologist and neurosurgeon, but fortunately the family refused to give permission for organ donation and after three weeks of coma he regained consciousness. These patients reported that during the period of their coma they had experienced clear consciousness with memories, emotions, and perception out of and above their body, “seeing” nurses, physicians, and family in and around the ICU. Does brain death really mean death, or is it just the beginning of the process of dying that can last for hours to days, and what happens to consciousness during this period? According to the many reports of an NDE we should consider the possibility that someone can experience consciousness during cardiac arrest, but should we also ask ourselves whether there could still be consciousness after someone really has died, when his body is cold?

And are our concepts about death correct? Could our fear of death not be based on ignorance about what death could be? Most of us believe that death is the end of our existence; we believe that it is the end of everything we are. We believe that the death of our body is the end of our identity, the end of our thoughts and memories, that it is the end of our consciousness. Most of us do not realize that during our life 500,000 cells die each second, each minute 30 million cells die, and each day about 50 billion cells in our body die and are being replaced, resulting in a new body about

each year. So cell death is totally different from body death when you eventually die. During our life our body changes continuously, each day, each minute, each second. Each year also about 98% of our molecules and atoms in our body are replaced. Each living being is in an unstable balance of two opposing processes of continual disintegration and integration. But no one realizes this constant change. And from where comes the continuity of our continually changing body? Cells are just the building blocks of our body, like the bricks of a house, but who coordinates the building of this house? When someone has died, only mortal remains are left: only matter. What about our consciousness when we die? “Is” someone his body, or do we “have” a body?

So what is death? Do we have to change our concepts about death, not only based on what has been thought and written about death in human history around the world in many cultures, in many religions and in all times, but also change our concepts about death based on insights from recent scientific research on NDE?

SCIENTIFIC STUDIES ON NEAR-DEATH EXPERIENCE

Several theories on the origin of an NDE have been proposed. Some think the experience is caused by physiological changes in the brain such as brain cells dying as a result of cerebral anoxia, and possibly also caused by release of endorphins, or by NMDA receptor blockade (Blackmore, 1993). Other theories encompass a psychological reaction to approaching death (Appelby, 1989) or a combination of such reaction and anoxia (Owens et al., 1990). But until recently there was no prospective and scientifically designed study to explain the cause and content of an NDE, all studies had been retrospective and very selective with respect to patients. In retrospective studies 5–30 years can elapse between occurrence of the experience and its investigation, which often prevents accurate assessment of medical and pharmacological factors. We wanted to know if there could be a physiological, pharmacological, psychological, or demographic explanation why people experience consciousness during a period of clinical death.

So, in 1988 we started a prospective study of 344 consecutive survivors of cardiac arrest in ten Dutch hospitals (Van Lommel et al., 2001) with the aim to investigate the frequency, the cause, and the content of an NDE. We studied patients who survived cardiac arrest, because this is a well-described life-threatening medical situation, where patients will ultimately die from irreversible damage to the brain if cardio-pulmonary resuscitation (CPR) is not initiated within 5 to 10 minutes. It is the closest model of the process of dying. The definition of clinical death was used for the period of unconsciousness caused by anoxia of the brain due to the arrest of circulation and breathing that happens during ventricular fibrillation in patients with acute myocardial infarction. We did a short standardized interview with sufficiently recovered patients within a few days of resuscitation, and asked whether they could remember the period of unconsciousness, and what they recalled. In cases where memories were reported, we coded the experiences according to a weighted core experience index. In this system the depth of the NDE was measured according to the reported elements of the content of the NDE.

The more elements were reported, the deeper the experience was and the higher the resulting score.

We (Van Lommel et al., 2001) found that 282 patients (82%) had no recollection of the period of cardiac arrest, of their period of unconsciousness, whereas 62 patients (18%) reported some recollection of the time of clinical death (NDE). Of these patients 41 (12%) had a core experience with a score of 6 or higher, and 21 (6%) had a superficial NDE. In the core group 23 patients (7%) reported a deep or very deep experience with a score of 10 or higher. In our study about 50% of the patients with an NDE reported awareness of being dead, or had positive emotions, about 25% of the patients had an out-of-body experience, 30% reported moving through a tunnel, about 25% had communication with “the Light” or observed colors, about 30% of the patients had an observation of a celestial landscape or had a meeting with deceased relatives, 13% experienced a life review, and 8% experienced a border.

What might distinguish the small percentage of patients who report an NDE from those who do not? We found *to our surprise* that neither the duration of cardiac arrest nor the duration of unconsciousness, nor the need for intubation in complicated CPR, nor induced cardiac arrest in electrophysiological stimulation (EPS) had any influence on the frequency of NDE. Neither could we find any relationship between the frequency of NDE and administered drugs, fear of death before the arrest, nor foreknowledge of NDE, gender, religion, or education. An NDE was more frequently reported at ages lower than 60 years, and also by patients who had had more than one CPR during their hospital stay, and by patients who had experienced an NDE previously. Patients with memory defects induced by lengthy CPR reported less frequently an NDE. Good short-term memory seems to be essential for remembering an NDE.

We (Van Lommel et al., 2001) additionally performed a longitudinal study with taped interviews of all late survivors with NDE 2 and 8 years following the cardiac arrest, along with a matched control group of survivors of cardiac arrest who did not report an NDE. This study was designed to assess whether the loss of fear of death, the transformation in attitude toward life and the enhanced intuitive sensibility is the result of having an NDE or just the result of the cardiac arrest itself. Only patients with an NDE did show transformation, and the long-lasting transformational effects of an experience that lasts only a few minutes was a surprising and unexpected finding.

As mentioned before, several theories have been proposed to explain an NDE. However, in our prospective study it could not be shown that psychological, pharmacological, or physiological factors caused these experiences after cardiac arrest. With a purely physiological explanation such as cerebral anoxia, most patients who had been clinically dead should report an NDE. All patients in our study had been unconscious because of anoxia of the brain resulting from their cardiac arrest.

Yet, neurophysiologic processes must play some part in NDE, because NDE-like experiences can be induced through electrical “stimulation” of some parts of the cortex in patients with epilepsy (Penfield, 1958), with high carbon dioxide levels (hypercarbia) (Meduna, 1950), in decreased cerebral perfusion resulting in local cerebral hypoxia, as in rapid acceleration during training of fighter pilots

(Whinnery and Whinnery, 1990), or as in hyperventilation followed by Valsalva maneuver (Lempert et al., 1994). Also NDE-like experiences have been reported after the use of drugs like ketamine (Jansen, 1996), LSD (Grof and Halifax, 1977), or mushrooms (Schröter-Kunhardt, 1999). These induced experiences can result in a period of unconsciousness, but can also sometimes consist of perception of sound, light, or flashes of recollections from the past. These recollections, however, consist of fragmented and random memories unlike the panoramic life-review that can occur in NDE. Also, exceptionally out-of-body experiences can occur during induced experiences. However, transformational processes are rarely reported after induced experiences. Thus, induced experiences are not identical to NDE.

Another theory holds that NDE might be a changing state of consciousness (transcendence, or the theory of continuity), in which memories, 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.

In three prospective studies with identical study design about the same percentage of NDE was found; 18% of 344 Dutch survivors of cardiac arrest reported an NDE (Van Lommel et al., 2001), 15.5% of 116 American survivors of cardiac arrest reported an NDE (Greyson, 2003), and 11% of 63 British survivors of cardiac arrest reported an NDE (Parnia et al., 2001). Only in our Dutch study the statistical relation between possible factors that can influence the occurrence of NDE could be studied.

Greyson (2003) writes in his comment that no one physiological or psychological model by itself could explain all the common features of NDE. The paradoxical occurrence of 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. Parnia et al. (2001) and Parnia and Fenwick (2002) write that the data from several NDE studies suggest that the NDE arises *during* unconsciousness, and this is a surprising conclusion, because when the brain is so dysfunctional that the patient is deeply comatose, the cerebral structures, which underpin subjective experience and memory, must be severely impaired. Complex experiences such as are 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, or at best a confusional state if some brain function is retained. The fact that in a cardiac arrest loss of cortical function precedes the rapid loss of brainstem activity lends further support to this view. An alternative explanation would be that the observed experiences arise during the loss of, or on regaining consciousness. The transition from consciousness to unconsciousness is rapid, and appearing immediate to the subject. Experiences that occur during the recovery of consciousness are confusional, which these were not. In fact, memory is a very sensitive indicator of brain injury and the length of amnesia before and after unconsciousness is an indicator of the severity of the

injury. Therefore, one should not expect that events that occur just prior to or just after loss of consciousness should be clearly recalled.

With lack of evidence for any other theories for NDE, the concept thus far assumed but never scientifically proven, that consciousness and memories are produced by large groups of neurons and are localized in the brain should be discussed. How could a clear consciousness outside one's body be experienced at the moment that the brain no longer functions during a period of clinical death, even with flat electroencephalogram (EEG) (Sabom, 1998)? Furthermore, even blind people have described veridical perceptions during out-of-body experiences at the time of their NDE (Ring and Cooper, 1999). Scientific study of NDE pushes us to the limits of our medical and neurophysiologic ideas about the range of human consciousness and mind-brain relation.

SOME ELEMENTS OF NDE

Before I discuss in greater detail some neurophysiologic aspects of brain functioning during cardiac arrest, I would like to reconsider certain elements of the NDE. First the *Out-of-Body Experience (OBE)*. In this experience people have veridical perceptions from a position outside and above their lifeless body. NDEers have the feeling that they have apparently taken off their body like an old coat and to their surprise they appear to have retained their own identity with the possibility of perception, emotions, and a very clear consciousness. 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 CPR. This proves that OBE cannot be a hallucination, because this means experiencing a perception that has no basis in "reality," neither can it be a delusion, which is an incorrect assessment of a correct perception. 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 surprised. Then he 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. He is deeply impressed by his experience and says he is no longer afraid of death.

The Holographic Life Review: During this life review the subject feels the presence and renewed experience of not only every act but also every thought from one's past life, and one realizes that all of it is an energy field that influences oneself 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. Hence there is during a life review a connection with the fields of consciousness of other persons as well as with your own fields of consciousness (*interconnectedness*). Patients survey their whole life in one glance; time and space do not seem to exist during such an experience. Instantaneously they are where they concentrate upon (*non-locality*), 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.

Also a *Preview* can be experienced, in which both future images from personal life events as well as more general images from the future occur. And again it seems as if time and space do not exist during this preview. If *deceased relatives* are *encountered* in an otherworldly dimension, they are usually recognized by their appearance, while communication is possible through thought transfer. Thus, during an NDE it is also possible to come into contact with fields of consciousness of deceased persons (*interconnectedness*). Sometimes persons are met whose death was impossible to have known; sometimes persons unknown to them are encountered during an NDE. Some patients can describe how they *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." The 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. About all people who have experienced an NDE *lose their fear of death*. This is due to the realization that there is a continuation of consciousness, retaining all thoughts and past events,

even when you have been declared dead by bystanders or even by doctors. You are separated from the lifeless body, retaining your identity and a clear consciousness with the ability of perception. Man appears to be more than just a body.

All these elements of an NDE were experienced *during* the period of cardiac arrest, *during* the period of apparent unconsciousness, *during* the period of clinical death! But how is it possible to explain these experiences during the period of temporary loss of all functions of the brain due to acute pan-cerebral ischemia? We know that patients with cardiac arrest are unconscious within seconds. But how do we know that the EEG is flat in those patients, and how can we study this?

NEUROPHYSIOLOGY DURING CARDIAC ARREST

Through many studies in both human and animal models, cerebral function has been shown to be severely compromised during cardiac arrest, with sudden loss of consciousness and of all body reflexes, but also with the abolition of brain-stem activity with the loss of the gag reflex and of the corneal reflex, and fixed and dilated pupils are clinical findings in those patients (Parnia and Fenwick, 2002). And also the function of the respiratory center, located close to the brainstem, fails, resulting in apnoea. Complete cessation of cerebral circulation is found in induced cardiac arrest due to ventricular fibrillation (VF) during threshold testing at implantation of internal defibrillators. This complete cerebral ischemic model can be used to study the result of anoxia of the brain. The middle cerebral artery blood flow, V_{mca} , which is a reliable trend monitor of the cerebral blood flow, decreases to 0 cm/sec immediately after the induction of VF (Gopalan et al., 1999). Electrical activity in both cerebral cortex and the deeper structures of the brain has been shown to be absent after a very short period of time. Monitoring of the electrical activity of the cortex (EEG) has shown that the first ischemic changes in the EEG are detected an average of 6.5 seconds from the onset of circulatory arrest, and with prolongation of the cerebral ischemia *always* progression to isoelectricity occurs within 10 to 20 (mean 15) seconds (De Vries et al., 1998; Clute and Levy, 1990; Losasso et al., 1992; Parnia and Fenwick, 2002). After defibrillation the V_{mca} , measured by transcranial Doppler technique, returns rapidly within 1–5 seconds after a cardiac arrest of short duration (Gopalan et al., 1999). However, in the case of a prolonged cardiac arrest of more than 37 seconds, normal EEG activity may not return for many minutes to hours after cardiac function has been restored, depending on the duration of the cardiac arrest, despite maintenance of adequate blood pressure in the recovery phase (Smith et al., 1990). Additionally, EEG recovery sometimes underestimates the metabolic recovery of the brain, and cerebral oxygen uptake may be depressed for a considerable time after restoration of circulation (De Vries et al., 1998).

In acute myocardial infarction the duration of cardiac arrest in the Coronary Care Unit is usually 60–120 seconds; in a hospital ward or in out-of-hospital arrest it even takes much longer.

Anoxia causes loss of function of our cell systems. The shutdown of electrical activity and of synaptic transmission in neurons may be thought of as a built-in protective or energy-sparing response (“ischemic penumbra”) (Coimbra, 1999).

With these functions inactive, resources can be used to maintain cell survival. Anoxia of only some minute's duration causes a *transient* loss of function of our cell systems; in prolonged anoxia cell death occurs with permanent functional loss. During an embolic event a small clot obstructs the blood flow in a small vessel of the cortex, resulting in anoxia of that part of the brain causing a functional loss of the cortex like hemiplegia, partial blindness, or aphasia. When the clot is dissolved or broken down within several minutes the lost cortical function is restored, and this is called a *transient* ischemic attack (TIA). However, when the clot obstructs the cerebral vessel for minutes to hours it will result in neuronal cell death, with a *permanent* loss of function of this part of the brain, and the diagnosis of cerebrovascular-accident (CVA) is made. So, *transient* anoxia results in *transient* loss of function, and in cardiac arrest global anoxia of the *entire* brain occurs within seconds, and timely and adequate CPR reverses this transient functional loss of the brain, because definitive damage of neurons has been prevented. Adequate external chest massage results in a minimal blood flow to the brain, resulting in a higher chance of reversibility of brain functions (Herlitz et al., 2002). But long-lasting anoxia, caused by cessation of blood flow to the brain for more than 5-10 minutes, results in irreversible damage and extensive cell death in the brain. The most vulnerable parts of the brain for anoxia are the neurons in the cortex and the neurons in the thalamus and the hippocampus (Fujioka et al., 2000; Kinney et al., 1994), both being an important connection between brainstem and cortex to support the possibility of conscious experience.

From studies of induced cardiac arrest we know that in our Dutch prospective study of patients who survived cardiac arrest (Van Lommel et al., 2001), as well as in the American (Greyson, 2003) and English study (Parnia et al., 2001), not only total lack of electrical activity of the cortex must have been the only possibility, but also the abolition of brain-stem activity. However, patients with an NDE can report a clear consciousness. And because of the occasional and verifiable out-of-body experiences, like the one involving the dentures in our study, we know that the NDE must happen *during* the period of unconsciousness, and *not* in the first or last seconds of cardiac arrest. So we have to come to the *surprising conclusion* that during cardiac arrest NDE is experienced during a transient functional loss of all functions of the cortex and of the brainstem. How could a clear consciousness outside one's body be experienced at the moment that the brain no longer functions during a period of clinical death, with a flat EEG? (Sabom, 1998) Such a brain would be roughly analogous to a computer with its power source unplugged and its circuits detached. It could not hallucinate; it could not do anything at all. As stated before, the paradoxical occurrence of heightened, lucid awareness and logical thought processes during a period of impaired cerebral perfusion during cardiac arrest raises particular perplexing questions for our current understanding of consciousness and its relation to brain function.

NEUROPHYSIOLOGY IN A NORMAL FUNCTIONING BRAIN

For decades, extensive research has been done to localize consciousness and memories *inside* the brain, so far without success. Also we should 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, even an increase in cerebral blood flow (Roland, 1981) is observed during such a non-material activity as thinking. Neurophysiologic studies have shown these aforesaid activities through EEG, MEG, fMRI, and PET-scanning (Desmedt et al., 1977; Roland and Friberg, 1985; Eccles, 1988). Specific areas of the brain have been shown to become 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.

It is still an unproven assumption that consciousness and memories emerge from brain function, because until now there is no scientific evidence for neural correlates of all aspects of subjective experience. Direct evidence of how neurons or neuronal networks could possibly produce the subjective essence of the mind and thoughts is currently lacking. And how should “unconscious” matter like our brain produce consciousness, although the brain only is composed of atoms, molecules, and cells with a lot of chemical and electrical processes? There are no known examples of neural–perceptual matches, so there are reasons to doubt that any neural representational system could match a perceptual experience in content, and hence reasons to doubt the truth of the “matching content” doctrine. Neural activation only reflects the use of structures. It is difficult to understand, how patterns of neural activation could themselves cause the qualitatively experienced aspects of sensations. 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 program that you are going to hear. Activating the radio does not influence the content of the program. The assumption in the “matching content” doctrine is that following activation of special neuronal networks you always will have the same content of thoughts or feelings. This seems extremely inexplicable, incredible, and unlikely because neural activation is simply neural activation; it is simply a way of coding information. How can differences in code ever give rise to differences in thoughts or feelings?

The brain contains about 100 billion neurons, 20 billion of which are located in the cortex. Several thousand neurons die each day, and there is a continuous renewal of the proteins and lipids constituting cellular membranes on a time-span basis ranging from several days to a few weeks (Romijn, 1997). Each neuron has tens to hundreds of synapses, which can stimulate or inhibit other neurons, and during life the cerebral cortex continuously adaptively modifies its neuronal network, including changing the number and location of synapses. Transportation of information along neurons occurs predominantly by means of their action potentials, and during cerebral activity the sum of all electromagnetic fields of billions of neurons continuously changes each nanosecond. Neither the number of neurons, nor the precise shape of the dendrites, nor the position of synapses, nor the firing of individual neurons seem to be crucial for information processing properties, but the derivative, the fleeting, highly ordered patterns of these changing

electromagnetic fields generated along the dendritic trees of specialized neuronal networks. These patterns should be thought of as the final product of chaotic, dynamically governed self-organization, which can be considered as a biological quantum coherence phenomenon (Romijn, 2002). This self-organization can be compared with a vortex in running water.

THE QUEST TO FIND CONSCIOUSNESS

How could consciousness be based on, or be correlated with these changing electromagnetic fields? In trying to find an answer to this question, the influence (inhibition as well as stimulation) of external localized magnetic and electrical fields on the constant changing electromagnetic fields of the neuronal networks during normal functioning of the brain should now be addressed.

Neurophysiologic research is being performed using transcranial magnetic stimulation (TMS), during the course of which localized magnetic fields are produced (Hallett, 2000). TMS can excite or inhibit different parts of the brain, depending on the amount of energy given, allowing functional mapping of cortical regions and creation of transient functional lesions. It allows assessing the function in focal brain regions on a millisecond scale, and it can study the contribution of cortical networks to specific cognitive functions. TMS can interfere with visual and motion perception, by interrupting cortical processing for 80–100 milliseconds. Intra-cortical inhibition and facilitation obtained during paired-pulse studies with TMS reflect the activity of inter-neurons in the cortex (Hallett, 2000).

Interrupting the electrical fields of local neuronal networks in parts of the cortex also disturbs the normal functioning of the brain. By localized electrical stimulation of the temporal and parietal lobe during surgery for epilepsy the neurosurgeon and Nobel prize-winner Wilder Penfield could sometimes induce flashes of recollection of the past (never a complete life review), experiences of light, sound, or music, and he described only once a kind of out-of-body experience (OBE) (Penfield, 1958, 1975). These experiences did not produce any life-attitude transformation. The effect of the external magnetic or electrical stimulation depends on the intensity and duration of energy given. Sometimes a stimulating effect occurs when only a small amount of energy is given. But during stimulation with higher energy, *inhibition* of local cortical functions occurs by extinction of the electrical and magnetic fields of cortical neuronal networks. Recently, a patient was described with induced OBE due to *inhibition* of cortical activity caused by more intense external electrical stimulation of neuronal networks in the gyrus angularis in a patient with epilepsy (Blanke et al., 2002), but also other causes of dysfunctional neuronal networks in the cortex can rarely cause an OBE (Blanke et al., 2004). We have to conclude that localized artificial stimulation with real photons (electrical or magnetic energy) disturbs and inhibits the constantly changing electromagnetic fields of our neuronal networks, thereby influencing and *inhibiting* the normal functions of our brain.

Could consciousness and memories be the product or the result of these constantly changing electromagnetic fields? Could these photons be the elementary

carriers of consciousness (Romijn, 2002)? Some researchers try to create artificial intelligence by computer technology, hoping to simulate programs evoking consciousness. But quantum physicist Roger Penrose (1996) argues that algorithmic computations cannot simulate mathematical reasoning. He offers a quantum mechanical hypothesis to explain the relation between consciousness and the brain (Hameroff and Penrose, 1995). And Simon Berkovitch has calculated that the brain has an absolutely inadequate capacity to produce and store all the informational processes of all our memories with associative thoughts from one's life. We would need 10^{24} operations per second, which is absolutely impossible for our neurons (Berkovitch, 1993). One should conclude that the brain has not enough computing capacity to store all memories with associative thoughts, has not enough retrieval abilities, and seems not to be able to elicit consciousness.

NEW CONCEPT

Science, I believe, is the search for explaining new mysteries rather than to stick with old facts and concepts. And 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. Frederik van Eeden, a famous Dutch M.D. and author mentioned already in 1890 in his lecture about progress in current science: "Personally I am more than ever convinced that the largest enemy of scientific progress is to reject and to refuse to study beforehand and out of prejudice seeming incomprehensible, strange and unknown facts" (Van Eeden, 1897, p. 226). So it is 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 the possibility to have clear consciousness with memories, with self-identity, with cognition, and the possibility of perception out and above one's lifeless body. And during NDE one can ultimately experience the return of one's consciousness back into the body, together with the feeling of bodily limitation. Almost all of the reported aspects of consciousness during cardiac arrest seem to be *quantum-like phenomena*. We should conclude, like many others, that quantum mechanical processes could have something critical to do with how consciousness and memories relate with the brain and the body during normal daily activities as well as during brain death or clinical death.

This is neither the place nor the time to go into quantum mechanics into more detail, but I would like to discuss just some basic aspects of quantum physics, because this seems necessary to understand my concept of the continuity of consciousness (Van Lommel, 2004). About what I have explained until now, there seems to be a striking similarity between the content of several aspects of our consciousness during NDE and some proven concepts in Quantum Mechanics, which has completely overturned the existing view of our material, manifest world, the so-called real-space. It tells us that particles can propagate like waves, and so can

be described by a quantum mechanical wave function. It can be proven that light in some experiments behaves like particles (photons), and in other experiments it behaves like waves, and both experiments are true, which also means that there is no objectivity, the consciousness of the researcher and his design of the experiment define the result. According to Bohr waves and particles are complementary aspects of light (Bohr and Kalckar 1997). The experiment of Aspect and colleagues (1982), based on Bell's theorem, has established non-locality in quantum mechanics (non-local interconnectedness). Non-locality happens because all events are interrelated and influence each other, implicating that there are no local causes for an event. Phase-space is an invisible, non-local, higher-dimensional space consisting of wave-fields of probability, where every past and future event is available as a possibility. The quantum physicist David Bohm has called this dimension the implicate order of being (Bohm, 1980), and Ervin Laszlo has called these informational fields the zero-point-field or the quantum vacuum (Laszlo, 2003, 2004). Within this so-called phase-space no matter is present, everything belongs to uncertainty, and neither measurements nor observations are possible by physicists (Heisenberg, 1971). The act of observation instantly changes a probability into an actuality by collapse of the wave function. Roger Penrose calls this resolution of multiple possibilities into one definitive state "objective reduction" (Penrose, 1996). So it seems that no observation is possible without fundamentally changing the observed subject; only subjectivity remains.

Quantum physics cannot explain the essence of consciousness nor the secret of life, but in my concept it is helpful for understanding the transition between the fields of consciousness in the phase-space (to be compared with the probability fields as we know from quantum mechanics) and the body-linked waking consciousness in the real-space, because these are the two complementary aspects of consciousness (Walach and Hartmann, 2000). Our whole and undivided consciousness with declarative memories finds its origin in, and is stored in this phase-space, and the brain only serves as a relay station for parts of our consciousness and parts of our memories to be received into our waking consciousness. This is like the Internet, which does not originate from the computer itself, but is only received by it. In this concept consciousness is not rooted in the measurable domain of physics, our manifest world. The eternal wave aspect of our indestructible consciousness in phase-space, with non-local interconnectedness, is *inherently* not measurable by physical means. The immeasurable can never be measured. This can be compared with gravitational forces, where only the physical effects can be measured, but the forces themselves are not directly demonstrable.

Life creates the transition from phase-space into our manifest real-space; according to our hypothesis life creates, under normal daily conditions when we are awake, the possibility to receive only some parts of these fields of consciousness (waves) into or as our waking consciousness, which belongs to our physical body (particles). During life, our consciousness has an aspect of waves as well as of particles, and there is a permanent interaction between these two aspects of consciousness. When we die, our consciousness will no longer have an aspect of particles, but only an eternal aspect of waves. The interface between our consciousness and our body is eliminated.

This concept (Van Lommel, 2004) is a complementary theory, like both the wave and particle aspects of light, and not a dualistic theory. Subjective (conscious) experiences and the corresponding objective physical properties are two fundamentally different manifestations of one and the same underlying deeper reality; they cannot be reduced to each other. The particle aspect, the physical aspect of consciousness in the material world, originates from the wave aspect of our consciousness from the phase-space by collapse of the wave function into particles (“objective reduction”), and these can be measured by means of EEG, MEG, fMRI, and PET scan.

Different neuronal networks function as interface for different aspects of our consciousness, as can be demonstrated by changing images during these registrations of fMRI or PET scan. So the function of neuronal networks should be regarded as receivers and conveyors, not as retainers of consciousness and memories. With this new concept about consciousness and the mind–brain relation all reported elements of an NDE during cardiac arrest could be explained. This concept is compatible with the non-local interconnectedness with fields of consciousness of other persons in phase-space. This remote, *non-local communication* seems to have been demonstrated scientifically by positioning subject pairs in two separate Faraday chambers, which effectively rules out any electromagnetic transfer mechanism. A visual pattern-reversal stimulus is used to elicit visual evoked responses in the EEG registration of the stimulated subject, and this is instantaneously received by the non-stimulated subject resulting in an immediate change of activity in his EEG-registration (Thaheld, 2003; Wackermann et al., 2003).

In trying to understand this concept of quantum mechanical mutual interaction between the invisible phase-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 are even permeating us, as well as permeating structures like walls and buildings, also at this very moment. 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. 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 is not located inside our laptop. We can receive what is transmitted with the speed of light from a distance of some hundreds or thousands of miles. And if we switch off the TV set, the reception disappears, but the transmission continues. The information transmitted remains present within the electromagnetic fields. The connection has been interrupted, but it is not vanished and still can be received elsewhere by using another TV set (“non-locality”).

According to my concept, based on the universal reported aspects of consciousness experienced during cardiac arrest, we can conclude that the informational

fields of our consciousness, consisting of waves, are rooted in phase-space, in an invisible dimension without time and space, and are present around and through us, permeating our body. They 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 camera and TV set. And as soon as the function of the brain has been lost, as in clinical death during a cardiac arrest or during brain death, memories and consciousness do still exist, but the reception ability is lost, the connection, or interface, is interrupted. Consciousness can be experienced during such a period of a non-functioning brain, and this is what we call an NDE. So in my concept consciousness is *not physically rooted!*

CONCLUSION

The inevitable conclusion that consciousness can be experienced independently of brain function might well induce a huge change in the scientific paradigm in western medicine, and 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. Such understanding also fundamentally changes one's opinion about death, because of the almost unavoidable conclusion that at the time of physical death consciousness will continue to be experienced in another dimension, in an invisible and immaterial world, the phase-space, in which all past, present, and future is enclosed. "Death is only the end of our physical aspects." 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, without a functioning brain. But it has been clearly shown that during NDE consciousness is experienced independently of brain function! So we have a body, and without a body we still can have conscious experiences! And we should also realize that the world as we see it around us as well as during NDE derives its subjective reality only from our conscious awareness, from our consciousness.

There are still more questions than answers, but, based on the aforementioned theoretical aspects of the obviously experienced continuity of our consciousness, we finally should consider the possibility that death, like birth, may well be a mere passing from one state of consciousness to another. We can also conclude that our waking consciousness, which we experience as our daily consciousness, is only a part of our whole and undivided consciousness. The interconnectedness with this enhanced consciousness can be experienced during a critical medical situation (a NDE), during an acute situation of apparently unavoidable death in an (imminent) traffic accident ("fear-death" experience), during meditation or deep relaxation (enlightened experience, or experience of "oneness"), during changing states of consciousness during regression therapy, hypnosis, isolation, or the use

of drugs like LSD, or during the terminal phase of life (death-bed vision). The interconnectedness with these informative fields of consciousness also explains enhanced intuition, and prognostic dreams and visions, and it explains apparitions at the moment of death and in the period following death, like being in contact with the consciousness of dying persons on a distance, or of deceased relatives, the so-called peri- and postmortal experiences or after-death communication.

This extended or enhanced consciousness is based on indestructible and constant evolving fields of information, where all knowledge, wisdom, and Unconditional Love are present and available, and these fields of consciousness are stored in a dimension without our concept of time and space, with non-local and universal interconnectedness. One could call this our Higher consciousness, Divine consciousness, or Cosmic consciousness. Ervin Laszlo has called these informational fields of consciousness the zero-point-field or Akasha Field in the quantum vacuum or even better in the cosmic plenum, with a holographic cosmic memory by interference patterns of scalar wave fields (Laszlo, 2004). Holographic organization is based on a field concept of order in which information about an object as a whole is encoded as an interference pattern in energy waveforms distributed throughout the field. This makes it possible to retrieve information about the object as a whole from any location within the field, because the interference patterns that code the wave function extend throughout the range wave propagations and endure indefinitely in time. Because all matter, also our material body, is 99.99% emptiness (“vacuum”), all our body cells (and also our DNA) are continuously invaded by and in contact with these informative fields of consciousness. When at last, following a dying period that can last for hours to days, our body has definitively died, only “dead” matter remains, and we can only be in contact with, or we have become a part of these eternal and indestructible fields of consciousness.

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