The Phenomenology of the Independent Self-conscious Mind (Draft 10/22/2006)

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ABSTRACT: The out-of-body phase of the near-death experience, where the locus of awareness is no longer in the body, provides details of the phenomenon of the independent self-conscious mind. With these details, one can isolate the attributes and faculties of the self-conscious mind from those of the brain. The phenomenology of the out-of-body experience thus acts as a Rosetta stone in deciphering mind-body phenomena. This view is very similar to the dualist interactionist model of Popper and Eccles (1977) but with several differences. Counterintuitive mind-body phenomena such as antedating, apparent delays in awareness of voluntary actions, and phantom limbs can be reassessed, showing that the non-material mind is accessible to scientific study. The objection that the operation of a non-material self-conscious mind within the brain violates the current laws of physics is probably correct: the independent self-conscious mind constitutes a new dimension of reality and current physical laws need to be extended, as they have been in the past, to encompass the new phenomena. The laws of mind and the mind's relationship to the physical dimension of reality need to be investigated scientifically. The proper way to do this is to investigate the phenomena of mind and body in detail. Consideration of the independent self-conscious mind in mind-body phenomena should give useful insights into a number of ordinary mental phenomena such as memory processes, and into solutions to problems such as effective strategies for treatment of autistic spectrum disorders or for rehabilitation from stroke.

KEY WORDS: near-death experience, out-of-body experience, phenomenology, mind-body problem, self-conscious mind

In the near-death experience (NDE), the locus of the experiencer's self-conscious awareness shifts from the normal location within the body to outside the body. The experiencer frequently finds herself hovering several feet over her physical body, watching the efforts to revive her. This shift of consciousness outside the body is a primary characteristic of most NDEs. The NDE typically begins with the transition outside of the body, followed by experiences of the immediate physical environs, and ends with a return to the body. While outside the body, the experiencer retains the faculties of vision, thought, volition, memory, feelings and self-awareness, in short, nearly all of the faculties of ordinary conscious experience. In a number of cases, the NDE has been shown to have occurred when the body and brain were clinically dead, as in cardiac arrest, that is, with a flatline EEG, no pulse or respiration, and lack of pupil or gag reflexes (van Lommel et al., 2001). Van Lommel established that cardiac arrest patients were clinically dead but still had rich cognitive experiences during the period of complete loss of cortical and brain stem activity, including having veridical experiences of their immediate physical environs that were later verified.

The fact that self-conscious awareness can operate with one's full mental faculties outside of the body, when the body and brain have ceased to function, contradicts the prevalent view of neuroscience that consciousness can occur only when there is physical brain activity. Yet the near death experiencer has a continuity of self-conscious awareness from being within the body, through the transition outside the body, frequently with veridical experiences of the world, and finally transitioning back into the body. The NDE appears to be a continuous, seamless experience of the *same self*, a self who retains a continuity of memory from before the beginning of the NDE to after the return to the body, much like any other significant life experience a person may have.

The operation of self-conscious awareness independent of the brain's operation suggests that consciousness operates in a particular way while we are in our ordinary conscious state in the body. Indeed, if our self-conscious awareness can separate from our body and operate independently of it for a time, albeit under the extraordinary circumstances of an NDE, the self-conscious awareness most likely operates as an independent entity *as well* while we are in the body, although it is intimately united with the body and brain.

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Thus, the phenomena associated with the out-of-body experience (OBE) component of the NDE, where the experiencer feels separated from the body but still has veridical experiences of the ordinary physical environs, can give us indications of what aspects of consciousness are in fact independent of the brain. Conversely, the phenomena of consciousness which are associated with physiological brain activity can give us indications of how our consciousness operates when united with the brain.

The enigma of consciousness can thus be unraveled or decoded by studying the phenomenology of these two aspects of conscious experience, the OBE associated with NDEs and the neural correlates of consciousness. The present paper examines both of these aspects phenomenologically. We focus on relevant aspects of the NDE OBE and of various brain phenomena. Other aspects of NDEs beyond the OBE phase may provide additional insights but are not considered in the present paper.

Phenomenology

The term *phenomenology* describes both a method of study of phenomena and the description and classification of the phenomena from that study. There are several different phenomenological methods used in cognitive science (e.g., Blackmore, 2006, p. 265) but ours is based on the one described by Arthur Zajonc (1999), namely a method of inquiry based on the three stages of inquiry proposed by J. W. von Goethe: (1) “empirical phenomena” which are the ordinary observations an attentive observer would make, (2) “scientific phenomena” which are examined through systematic experimentation, and (3) “pure or archetypal phenomena” which permit a direct intuition of or perceptual encounter with the laws of nature. The last step occurs not through abstraction and construction of models but rather by refining the phenomena themselves to arrive at the essence or core of the phenomena.

The form of phenomenology derived from Goethe’s approach is similar to the phenomenology of Edmund Husserl but goes beyond it in that it admits of more than first-person accounts of consciousness. It is also very similar to the neurophenomenology of Francisco Varela (1996) in that it studies phenomena in their first-person experiential aspects in conjunction with the associated neurological aspects. However, it differs from neurophenomenology in degree, in treating the first-person aspects *foremost,* with neurological experimental reports as supportive.

In his investigations, Goethe was very reluctant to proceed immediately to define the causes of observational patterns in terms of underlying mechanisms, but allowed for this when it was sensible to do so. It is possible to remain at every stage of explanation within the phenomenal and still rise to the level of theory (Zajonc, 1999). For Goethe, the phenomenal facts themselves *are* the theory: “Don’t look for anything behind the phenomena; they themselves are the theory.” “Let the facts themselves speak for their theory.” (Bortoft, 1996, p. 71)

Thus, in order to explain consciousness, we need to look foremost at consciousness itself and every way in which consciousness manifests as phenomena, including, of course, neurological experimental results. The first-person experiences of experimental subjects or patients are essential to understanding the relationships between consciousness and neurological phenomena and will lead to a comprehensive theory of consciousness.

The Near-Death Experience

The near-death experience typically occurs when a person has a medical crisis which brings the person close to death or when a person experiences intense physical or emotional danger (Greyson, 2000a). Raymond Moody (1975) described 15 common elements which recurred in reports of NDEs. These elements include ineffability, hearing oneself pronounced dead, having feelings of peace, having unusual auditory experiences such as ringing or buzzing, passing through a dark region or tunnel, feeling oneself separated from the physical body – usually with perception of the physical environs including seeing one’s own body, encountering deceased relatives or friends, meeting a “being of light”, experiencing a panoramic review of the events of one’s life, experiencing coming back into the body, and telling others of the experience including corroborating events witnessed while out of the body. Moody reported that very many individual near-death experiences included 8 or more of these common elements but it was rare that any two experiences had exactly the same elements and only a few experiences included as many as 12 of the 15 elements.

NDEs are reported to occur during a wide range of life-threatening medical conditions including cardiac arrest in myocardial infarction, anaphylactic shock, cerebral hemorrhage, and so on, in attempted suicide, severe injury due to accidents and falls, and near drowning. NDEs are also reported with serious illnesses which are not immediately life-threatening and with people who appear to be threatened with unavoidable serious injury or death but who are not actually injured. The latter experiences, sometimes called anticipatory NDEs, may occur with a traffic accident or a mountaineering fall where injury is averted at the last instant.

Certain features of NDEs are more commonly reported in individuals who have come closer to death, as measured by medical records (Owens, Cook and Stevenson, 1990). Such features include the experience of a strong light (for example, at the end of a tunnel or emanating from a being of light) and enhanced cognitive functions (such as increased clarity of thought or perceptual clarity, or increased control of cognition).

NDEs are reported by about 30% of people who come close to death (cf. Greyson, 2000a) or about 4-5% of the total population (Gallup and Proctor, 1982). However, prospective studies of cardiac patients who were successfully resuscitated after cardiac arrest indicate that the incidence of NDEs in this subgroup is much lower – 18% reported by Pim van Lommel et al. (2001), 6% reported by Sam Parnia et al. (2001), 23% reported by Janet Schwaninger et al. (2002) and 10% reported by Bruce Greyson (2003). The combination of the data from these prospective studies results in an overall rate of about 15% for cardiac arrest patients. One explanation of the difference is that lengthy cardiopulmonary resuscitation can induce memory loss which may significantly reduce the number of reported NDEs (Dougherty, 1994; Sauvé et al., 1996; van Lommel et al., 2001, p. 2042).

A number of both physiological and psychological explanatory hypotheses have been proposed to explain NDEs (Greyson, 1998). One psychological hypothesis is that the NDE is a form of *depersonalization*, that is, a feeling of being separated from both the world and one's own identity, or feeling that life is unreal and dreamlike. Depersonalization is typically unpleasant with feelings of anxiety, panic and emptiness, does not include a sense of being "out of the body", and occurs more frequently in young adults and more frequently in women. In contrast, the elements of the NDE are typically pleasant with feelings of peace, calm, joy and love, and the NDEr continues to have a clear sense of personal identity through the experience. NDEs typically involve clarity of thought and increased alertness, have an out-of-body component, and have no characteristic age group and an equal gender distribution.

Another psychological hypothesis is that the NDE is a form of *dissociation*, that is, some degree of separation of thoughts, emotions, sensations or memories from one's ordinary consciousness. Non-pathological dissociative responses are present to some degree in most people, such as daydreaming, absorption in performing a task or absorption while watching television, whereas pathological symptoms of dissociation, such as having no memory of a significant life event or feeling that one's body is not one's own, may result from severe psychological or physical trauma such as rape, sexual abuse, or being a hostage. Many NDEs include features that are consistent with dissociation such as the disconnection from the body in an OBE, and elements of the NDE can be triggered by the perceived threat of physical harm, even when no physical harm actually occurs. A study of NDErs using the Dissociative Experiences Scale (Greyson, 2000b) showed that people reporting NDEs reported more dissociative symptoms than the comparison group, and that the NDE "depth" was positively correlated with dissociative symptoms. However, the level of symptoms exhibited by NDErs was considerably lower than the level associated with pathological dissociative disorders. NDErs do not show the level of distress or impairment that patients with dissociative disorders do. Thus, the NDEr responds to his experience with a non-pathological level of dissociative response to stress.

The physiological explanatory hypotheses for the NDE include hypoxia (insufficient oxygen), hypercarbia (excessive carbon dioxide levels), the release of endorphins or various neurotransmitters, neural electrical activity in the right temporal lobe or the limbic system, the presence of various drugs or as yet unidentified endogenous equivalents, and so on. In general these explanations suffer from the fact that these conditions are not present in all cases of NDE. No physiological theory has yet been proposed that can satisfactorily explain all of the common elements of NDEs (Greyson, 1998). It may be possible that a physiological response serves to *trigger* the NDE, and it may also be possible that a multifaceted physiological explanatory model can account for all of the aspects of the NDE (Blackmore, 1993). However, such explanations would need to include anticipatory NDEs, where the NDE is clearly triggered by a perceived threat of serious injury or death, but no physical injury in fact occurs.

The OBE component of the NDE

The focus of the present paper is the OBE component of the NDE. The phenomenology of the OBE occurring during NDE should help in understanding the nature of consciousness, since the NDEr's consciousness appears to separate from the physical body at the start of the OBE and later appears to reunite with the body. Furthermore, during the OBE component, perceptions of the NDEr's physical environs are made which appear to be veridical, and their veridicality can potentially be corroborated.

The proportion of NDErs who report an OBE as part of their experience has variously been reported as 75% (Greyson and Stevenson, 1980), 83% (Greyson, 1983) and 100% (Sabom, 1982). The difference among these different studies may be due to the definition of OBE. The OBE is defined as the experience of one's consciousness being separated from one's physical body. In the weighted core experience index (WCEI) for NDE, Kenneth Ring (1980) assigned a score of 2 if the individual described a "clear out-of-body experience" and 1 if the individual had a sense of bodily separation without this. In his NDE scale, Bruce Greyson (1983) assigned 2 if the individual clearly left the body and existed outside it and 1 if the individual lost awareness of the body.

A striking example of the clear experience of separation from the body is the case of George Ritchie (Ritchie and Sherrill, 1978, p. 36; Ritchie, 1998, p. 51), which includes a very elaborate NDE and an unusual OBE with apparent veridical perceptions. Private Ritchie, age 20, a recent recruit in the Army, died of acute double pneumonia in the hospital at Camp Barkeley, located near Abilene, Texas, around 3 AM on December 22, 1943. Ritchie had been unconscious but woke up and found himself sitting on his bed with another person lying in the bed. He remembered his urgent need to get to Richmond for the beginning of his medical training and realized that he had missed the train. Ritchie rushed out of the hospital, passing straight through its heavy metal front doors, and found himself flying rapidly, about 500 feet up, over the frozen landscape. The night was clear and crisp but he did not feel cold. He saw that he was traveling east from the position of the North Star in the night sky.

Ritchie came upon a broad river with a long high bridge and a sizeable city on the far bank. He felt he should stop to get directions to Richmond and "landed" outside a white red-roofed all-night cafe on a corner, with a blue neon "Cafe" sign above the door and a "Pabst Blue Ribbon Beer" sign in the large right front window. In trying to speak to a passerby, Ritchie realized that others could not see him. When he leaned on the guy wire of a telephone pole, his body passed right through, and he realized that somehow he had been separated from his body and now needed to get back to it. Ritchie rapidly returned to the hospital but had difficulty finding his body in the 2300-bed hospital. He finally recognized his body by the ring on his hand. A sheet had been placed over his head and he realized that he had died. Still, he was awake, thinking and experiencing, only without a body. Frantically Ritchie clawed at the sheet to draw it back but grasped only air. Ritchie then encountered a Being of Light whom he understood to be Christ. He had a life review and further extensive experiences in other realms. Ritchie ultimately returned to his body under the sheet, his throat on fire and his chest in pain. An orderly noticed his hand had moved and persuaded the doctor to inject adrenalin directly into his heart muscle, an unusual medical procedure at that time. Ritchie revived and ultimately recovered.

Ten months later, after flunking out of medical training, Ritchie was driving with three Army buddies back to Camp Barkeley to finish basic training. They drove south from Cincinnati, following the Mississippi River, and came to Vicksburg where they stayed over night. The next morning, Ritchie recognized how the river flowed next to Vicksburg and as they drove through the city, he recognized that up the street they would come to the cafe where he had "landed" the previous December. Ritchie sat there in the car in front of the cafe. He recognized the neon sign (now out), the Pabst sign in the window and guy wire, exactly as they had appeared earlier. The all-night cafe was 524 miles directly due east of the hospital door at Camp Barkeley.

Thus, George Ritchie's story is unique for the clarity and duration of the OBE component and for its evident veridical perceptions of physical reality. These aspects probably resulted from the unusual circumstance of having a strong desire (not to miss the start of his medical training) at the time of his "death". This desire propelled him away from the hospital to a strange city many miles away whereas most NDE out-of-body experiences remain in the general vicinity of the NDEr's body.

The phenomenology of the near-death experience has been documented by a number of researchers (Moody, 1975; Moody and Perry, 1988; Greyson and Stevenson, 1980; Sabom, 1982; Valarino, 1997; Ring and Cooper, 1999). If we focus specifically on the OBE component from these phenomenological descriptions and from general reports of NDE OBEs in the literature, we can develop a more elaborate description of the NDE which emphasizes the OBE component. Thus, the typical elements of the NDE scenario which includes an OBE are listed here. Several of these elements would not be present in an NDE which did not include an OBE component.

1. The person experiences a physical trauma such as an accident, or a sudden illness such as cardiac arrest.
2. The person has feelings of peace and a lack of physical pain.
3. There may be a tingling sensation or sound and the person finds her awareness hovering over her physical body near the ceiling, observing as medical personnel work to revive her. After a while, she recognizes that she is observing her own body, but she is undisturbed by this realization.
4. The person may see that she has a non-material body shape and, less frequently, may see a cord or line attaching to the physical body. Her "body" feels weightless and she feels no pain even when the doctors perform procedures that would ordinarily be painful.
5. The person's perceptions are enhanced, she can move at will by thinking or wishing it, and she "hears" others in the room speak by thought transfer. She can recall things from her earlier life and from recent events.
6. The person may experience further aspects of an NDE: a dark tunnel, a life review, coming into a light, meeting deceased relatives and so on. She may realize or be told that she must return to her body.
7. The person returns to the body and may at this point have additional perceptions of the physical environs.

8. The person reunites with the physical body. She either jumps back, is pushed back, gradually falls back through the tunnel, or snaps back instantly into the physical body. Her perspective is now in the body, looking up. Physical pain returns. She may lose consciousness at this point.
9. After physical recovery, the person relates the experience to others. She wishes to verify her experience and she seeks out others to confirm that what she saw actually happened, or she verifies the events on her own.
10. The memory of the experience is vivid and long-lasting and, after a time, the experience is integrated as one of the person's life experiences along with other possible after effects (Greyson and Stevenson, 1980).

A more detailed phenomenology specifically of the OBE component of the NDE is warranted which we present in the subsequent sections: the continuity of consciousness during the NDE OBE, the veridicality of perceptions during the NDE OBE, a comparison of the NDE OBE versus other types of OBE, and finally the phenomenology of the NDE OBE.

Continuity of consciousness with the complete cessation of brain function

To develop an understanding of the relationship of consciousness during an NDE with the functioning of the brain, several researchers have focused on prospective studies of cardiac arrest survivors to provide an unambiguous model of the NDE during the dying process (Parnia et al., 2001; Parnia and Fenwick, 2002). The NDE occurs with reasonable frequency during cardiac arrest, sometimes with an OBE phase which includes veridical elements (Sabom, 1982; Sabom, 1998; van Lommel et al., 2001). The physiology of cardiac function, respiratory function, cerebral electrical activity and cerebral blood flow following cardiac arrest is well-known and corresponds to the criteria for determination of death: no cardiac output, no spontaneous respiration and fixed, dilated pupils. Within 10 sec after an arrest, blood flow to the brain, electrical brain activity and brain stem function all rapidly cease and the patient rapidly loses consciousness. For a period, the patient may be considered clinically dead, even if she is subsequently successfully resuscitated. Nevertheless, during the arrest, some patients report vivid, conscious out-of-body experiences of themselves and their physical environs that are characteristic of the NDE.

Within the first 10 seconds or so of cardiac arrest, the velocity of blood flow in the middle cerebral artery (V_{mca}) drops to zero cm/sec and blood pressure drops to less than 20 mmHg (Gopalan et al., 1999; de Vries et al., 1998; Clute and Levy, 1990; Parnia and Fenwick, 2002). V_{mca} is a reliable measure of overall cerebral blood flow. Also during the initial 10 seconds or so, the patient's electroencephalograph (EEG) changes first by a short term increase in alpha frequencies, then a drop in both alpha and beta frequencies, an increase in delta frequencies and finally a decrease in delta frequencies (Visser et al., 2001). The EEG then declines to zero or isoelectricity (flatline) within 10-20 seconds after the arrest (de Vries et al., 1998; Clute and Levy, 1990; Losasso et al., 1992; Vriens et al., 1996). The patient loses consciousness prior to isoelectricity, during the increased delta activity, that is, about 10 seconds after cardiac arrest (Aminoff et al., 1988; Brenner, 1997). Also just prior to isoelectricity, the patient may exhibit short muscle spasms and jerking (Brenner, 1997). With the decline of cortical electrical activity, brain stem electrical activity also declines simultaneously to isoelectricity. This effect is observed directly by monitoring auditory evoked potentials during induced cardiac arrest in hypothermic circulatory arrest procedures for treatment of cerebral circulatory aneurysms (Spetzler et al., 1988). Brain stem isoelectricity is also consistent with the observed loss of consciousness, and general loss of autonomic function and reflexes associated with brain stem electrical activity: there is no spontaneous respiration and no pupillary response to light, corneal reflex, gag reflex or cough reflex. Since brain stem electrical activity mirrors cortical electrical activity as a result of the level of cerebral blood flow, it is reasonable to infer that *all* brain electrical activity ceases in the first 15 sec, on average, of cardiac arrest.

With the onset of cardiopulmonary resuscitation (CPR), such as chest compressions, defibrillation shock, artificial respiration and the administration of drugs, low level cerebral blood flow (reperfusion) can resume. With reperfusion, the EEG may begin to recover, even before cardiac function is restored (e.g., Losasso, 1992). EEG recovery follows the pattern of EEG changes at cardiac arrest in reverse order (Brenner, 1997). As the arrest duration increases, EEG recovery time (the time, measured from cardiac recovery, to return to normal EEG) increases even more. For example, an arrest of 40 sec duration will result in an EEG recovery time of about an additional 80 sec (de Vries et al., 1997; Vriens et al., 1996). Even after short periods of unconsciousness of 60-90 sec, the patient is usually dazed, slow to respond or confused for about 30 sec after regaining consciousness (Aminoff et al., 1988).

If the arrest lasts longer than a threshold of about 37 seconds, when circulation then resumes, there is a period of cerebral "hyperfusion" where blood flow and oxygen uptake in the brain is much greater than normal (Smith et al., 1990; de Vries et al., 1998). Data for longer periods of cardiac arrest are available from animal experiments. In induced cerebral ischemia in rabbits from 2.5 to 15 min, Ames et al. (1968) found that specific regions of the brain develop circulatory defects which inhibit or prevent reperfusion, a phenomenon called "multifocal no-reflow". The no-reflow defects occur during the arrest and increase in number as the duration of ischemia increases. The defects are probably caused by reduced post-arrest blood pressure, increased blood viscosity, disseminated blood clots, and compression of blood vessels due to swelling (Buunk et al., 2000). If the defects are too severe, the global hyperfusion and hyperoxia that ensue are not able adequately to re-oxygenate the affected regions Thus, the longer the cerebral ischemia, the larger the areas of permanent damage that can occur. The regions that were most susceptible to no-reflow damage in animal experiments were the striatum, thalamus and hippocampus as well as various regions of the cortex (Kågström et al., 1983). These results are consistent with findings in humans (Kinney et al., 1994; Fujioka et al., 2000) and are consistent with observed cognitive and memory deficits in cardiac arrest survivors (Dougherty, 1994; Sauvé et al., 1996).

In cardiac care units, the usual duration of cardiac arrest is 1 to 2 min (van Lommel, 2006), 5 min in non-monitored hospital wards (Herlitz et al., 2001) and even longer in an out-of-hospital cardiac arrest. In the prospective study of 344 cardiac arrests by van Lommel et al. (2001), 234 (68%) of the 344 patients were successfully resuscitated in the hospital. Of these, 190 (81%) were resuscitated within 2 min of arrest and 187 (80%) were unconscious less than 5 min. Another 30 patients who were resuscitated in-hospital (13%) were resuscitated within 1 min of arrest and were unconscious less than 2 min. Of the 344 patients in the study, 101 (29%) received CPR outside hospital (usually in an ambulance) and another 9 (3%) were resuscitated both out of and in the hospital. Of these 110 patients, 88 (80%) were in arrest longer than 2 min and 62 (56%) were unconscious longer than 10 min. Only 12 patients (9%) were in arrest longer than 10 min. Overall, 123 (36%) of the 344 patients were unconscious longer than 60 min. The overall mean duration of cardiac arrest in this study was 3.8 min and the mean duration of unconsciousness was 109 min (n=344).

These statistics are probably typical of cardiac arrest resuscitation in general. Thus, the typical in-hospital cardiac arrest survivor is in arrest for 1 to 2 minutes and is unconscious 2.5 to 5 minutes. The typical out-of-hospital cardiac arrest survivor is in arrest for about 4 to 10 min and is unconscious about 10 to 60 min or longer.

From the foregoing description of cardiac arrest physiology, the *period of global cerebral isoelectricity* typically goes from 15 sec after the arrest to 5-10 sec after the start of CPR (chest compressions or defibrillation) but reverts to isoelectricity when chest compressions are stopped, if cardiac function has not started. Even with the restart of electrical activity, the EEG does not return to normal for a considerable time after rhythmic delta activity reappears, depending on the length of the arrest (de Vries et al., 1997; Vriens et al., 1996). In a best case scenario of an arrest of only 40 sec, the EEG recovery time would be an additional 80 sec. In longer arrest times, the EEG recovery time and corresponding cognitive functions would be influenced by the multifocal no-reflow effects that occur, and would be considerably longer. Similarly, the *period of unconsciousness* goes from 10 sec after the arrest to some time after the return of normal EEG, probably followed by a period of dull or confused consciousness. In cardiac arrests of 2 min or longer, the duration of unconsciousness is probably most influenced by multifocal no-reflow effects.

During the period of global cerebral isoelectricity and loss of consciousness, some cardiac arrest survivors report vivid NDEs which include OBEs with veridical perceptions of the events of their resuscitation. The Michael Sabom study (1982) consisted of 106 patients who had survived a non-surgical episode of unconsciousness and coming close to death, including 78 cardiac arrests, 20 comas, 7 life-threatening accidents and 1 suicide attempt. Of these 106 patients, 61 reported an NDE following the near-death crisis event. Note that these near-death events that included NDE were not necessarily the event that brought the patient to Sabom's attention. Of the 61 NDErs, 32 claimed to have seen some part of their resuscitation in an OBE, but 26 of these were unable to provide sufficient details for verification, because the patient's attention was directed at other things than the details of the resuscitation, for example the feeling of freedom or the patient's amazement at what was happening to him. The remaining 6 patients, all cardiac arrest cases, did provide details that could be analyzed. Of these 6 cardiac survivors, 4 were interviewed within 1 year of the near-death crisis event, one within 4 years and one within 5 years.

In each of these six cases, the details provided from the OBE perception corresponded accurately both with current medical procedures, such as the use of chest compression, defibrillation and drawing blood for blood gas analysis, and with the patient's medical records to the extent they existed and contained details. Many of the OBE perceptions were of events that occurred during the period of likely cerebral isoelectricity, describing the events prior to CPR and the beginning steps of CPR. Furthermore, the patients experienced no break or change of conscious experience, even when electrical brain activity likely started up again, until there was a clear transition back to the body. In five of the 6 cases, the patient gave a definite description of this transition, generally describing it as a switch of perspective from being out of the body looking down to being within the body looking up. These transitions were associated with coming back to consciousness within the body.

In the first three of Sabom's cases, the description provided by the patient during the period of likely isoelectricity was accurate compared with the medical record.

- Case 1: the patient described having collapsed on the floor, could see the floor from above, was lifted and put on a stretcher; the doctor gave a strong blow to the chest and then did chest compressions. The medical record described that the patient collapsed in the hall, had no pulse or respiration and CPR was begun.

- Case 2: the patient described having an IV inserted, having chest compressions and a needle inserted for "something about blood gases". The medical record described the patient as unconscious, an IV was started, a large intravenous injection of glucose given (with no response), then "full resuscitative measures" were started and arterial blood was drawn. Interestingly, no defibrillation was noted by the patient or mentioned in the medical record.

- Case 3: the patient described vomiting and then passing out and looking down from above, and the nurse administering one defibrillation shock which pulled the patient back into the body. The medical record describes the patient vomiting and then developing ventricular fibrillation (cardiac arrest) which "responded promptly to defibrillation".

Furthermore, the balance of the descriptions in these three cases, beyond the period of likely isoelectricity, was consistent with the balance of the respective medical records. In the other three cases, the medical record was not available or was only a minimal description. Nevertheless, the patient accounts contained purely visual perceptions which were either later verified or found likely to be accurate:

- Case 4: the patient described the use of a defibrillator machine after the start of CPR chest compressions. The machine had a meter face which had two needles, one fixed and one movable, the latter which gradually moved up. (This probably describes a meter which sets the watt-seconds of the defibrillation and measures the charging of the machine to that setting.) The nurse or doctor moved the fixed needle each time before the defibrillation and the other needle gradually moved up. The patient then described the defibrillator paddles as round disks with buttons on top of the handle which are used to deliver the shock. The patient then describes a sequence of resuscitation consisting of a defibrillator shock between one-third and half scale, chest compressions, a stronger shock (over half scale), chest compressions, and a stronger shock (about three-quarters), after which the patient felt he was returning to (ordinary) consciousness. It is not clear whether there were chest compressions prior to the first defibrillation. If there were not, then these purely visual perceptions likely began during isoelectricity; otherwise, they were certainly made during a period of unconsciousness. The description of the defibrillator is consistent with defibrillators which were in common use at the time (1973) and the description of progressively stronger defibrillations interspersed with chest compressions is also consistent with common medical practice. The patient denied ever having seen such a defibrillator or CPR procedure before. The purely visual perceptions of the setting and the movement of the two needles could only have been made while the machine was in use, a fact which helps confirm that the perceptions occurred during the procedure and not at some other time.

- Case 5: the patient described that "shots" were first administered in the groin, the doctor then started to insert a needle in his body on one side by the arm pit, but then changed his mind and decided to put it in on the other side, next to the heart. (This procedure was probably an attempt to enter the subclavian vein, below the collarbone, to administer drugs or insert a catheter.) After the resuscitation, the patient reported telling the doctor that he observed that the doctor changed his mind and went on the other side to do this procedure, and the doctor confirmed his report. From the patient's description, arterial blood was first drawn, then the subclavian procedure was done, and then defibrillation was performed. The medical record described that full CPR was instituted and blood gases were drawn. From the patient's description, it is not clear when, how much or even whether chest compressions were done, so it is not clear whether the visual perception of the doctor changing his mind and moving to the patient's other side occurred during likely isoelectricity. In any case, it occurred while the patient was unconscious.

- Case 6: the patient described the use of chest compressions, defibrillation and injection into the heart as he was ascending higher and higher out of the body. The patient then described seeing, while he was still unconscious, his wife, his oldest son and his oldest daughter down the hall, talking to the doctor. Sabom was able to confirm his account independently with both the wife and daughter. The wife had come to visit, unannounced, with two of their six adult children and they were at least 10 rooms down the hall from the patient's room when the cardiac arrest occurred. The nurse stopped them from approaching further. The patient was wheeled into the hall but was never facing the direction of his family members and was taken to another floor without passing them in the hall. The patient accurately identified who was with his wife even though the family visit was not expected and the wife would bring along any one or two of his six children to visit. The wife also confirmed the conversation with the doctor at the time. Again, this purely visual perception occurred during unconsciousness.

The Sabom study shows the difficulty in verifying accounts of veridical perception during an NDE OBE. The patient generally can provide very specific details of the event as perceived during the OBE, but the medical record usually provides only those details that are necessary for on-going medical care. Unless the doctors, nurses and staff are interviewed within a short time of the event, their memories are not likely to be detailed or accurate. These difficulties are limitations resulting from the research study procedures and can be overcome. A protocol of independent interviews of both patients and staff as soon as possible after the event would provide verification both of the patient's detailed OBE perceptions and the patient's specific medical condition at the time.

To help verify that the OBE perceptions came from actual perception of the events, Sabom sought to eliminate the possibility that the patient's perceptions could be attributed to imagination based on prior general knowledge of CPR procedures (derived, for example, from television shows), to expectations based on prior experience with cardiac procedures from earlier medical events, or simply to lucky guesses. Sabom interviewed a control group of 25 cardiac patients with similar backgrounds to those patients reporting OBEs, having an average duration of known heart disease of more than 5 years, with prior experience of hospitalizations for heart attack, heart catheterization, open heart surgery, cardiac arrest without an NDE and so on. The controls also admitted to regular television viewing at home, and thus would have a good general knowledge of CPR. The controls were asked to describe in visual detail what they would reasonably expect to see from the corner of a hospital room during CPR of a cardiac arrest patient. Twenty-three of the 25 controls made some attempt to describe the CPR procedure. Of these, 20 made a major error in their descriptive accounts, most commonly the use of mouth-to-mouth breathing, which is only rarely used in a hospital setting. The other three gave limited descriptions of CPR procedure with no obvious error. One of these controls omitted key elements such as chest compressions and artificial ventilation and the other two had witnessed actual resuscitations in hospital environments.

Sabom concluded that the control results suggest that the CPR descriptions from NDE OBEs were not based solely on the patients' prior general knowledge of CPR. Furthermore, there is a strong correspondence between the OBE perceptions and the actual procedures described in the medical record. The OBE accounts contain numerous specific details that were missing from the controls' descriptions. Sabom also concluded that the medical staff very likely did not provide additional details about the patient's CPR procedure because there was no conceivable reason to do so. Moreover, it was unlikely that the patients pieced together the portrayal of the resuscitation from visual, auditory, or (we would add) tactile perceptions made in a semiconscious state because the perceptions of the details were visual in nature, but outside of the visual field of the patient's physical eyes and could not be derived from auditory (or tactile) sensory information. We would add that some of the perceptions were made after arrest and prior to the start of CPR, during the period of likely complete cerebral isoelectricity, when no perceptions, even subliminal, would be possible. We would also add that although some details can be inferred after the fact from more lasting physical effects, for example the placement of the defibrillator paddles from burns or soreness on the chest, the fact of chest compressions from chest soreness or cracked ribs, and the placement of an IV from the fact that the IV was still there on awakening, these details alone cannot explain the close correspondence of the patient's account of the sequence of events with the medical record, nor the details that are purely visual in nature, such as the defibrillator switches and needles in case 4.

Sam Parnia (2006, p. 77) documented a second example of veridical perception during an OBE, an account by Richard Mansfield, an experienced cardiologist who was the cardiac team leader resuscitating a 32-year-old man in cardiac arrest. The patient was observed initially with no pulse, no breathing and was in asystole (a completely flatline electrocardiogram). The resuscitation included intubation, three-minute cycles of chest compressions, adrenalin and atropine. Despite these efforts over a period of more than 30 minutes, the patient remained pulseless and in asystole. Before stopping the efforts, Mansfield rechecked that the heart monitor and leads were working properly and that there was still no pulse. The resuscitation was stopped and the team accepted that the patient was dead. Mansfield left the room to write the medical records and was out for about 15 minutes. He re-entered the room to check how many vials of adrenalin had been administered and noticed that the patient appeared to be definitely pinker than when the doctor had left earlier. Mansfield rechecked the patient's groin and found a pulse. The resuscitation was resumed and the patient ultimately was stabilized and transferred to intensive care.

About a week later Mansfield interviewed the patient. The patient had not suffered any brain damage, despite being in asystole for more than 30 minutes and without any assistance in the form of heart compression or oxygen for another 15 minutes. Moreover, the patient described how he had observed everything from above and described in detail all that had happened: everything the doctor had said and done in the procedure including going out of the room, coming back later, looking across at the patient, rechecking the pulse and restarting the resuscitation. The patient was able to recount all of the details correctly, according to Mansfield.

During the periods of chest compressions in this resuscitation, it is likely that some cerebral electrical activity started up, but since the patient remained in asystole, as soon as the chest compressions stopped, global cerebral ischemia would resume and the brain would return to isoelectricity. At some point after Mansfield left the room, the patient's heart must have spontaneously restarted. Nevertheless the patient remained unconscious and was ultimately stabilized and transferred to intensive care. Despite the probable intermittent periods of cerebral isoelectricity, the patient was able to perceive all of the events of the resuscitation from above. In particular, the patient accurately described the decision to stop the resuscitation and the doctor leaving the room, a time when the patient was confirmed by the doctor as still being pulseless and in asystole, and therefore very likely in complete cerebral isoelectricity. The details of the patient's account were not described by Mansfield, but we can assume that the patient's perceptions occurred with no lapses of consciousness, as when electrical brain activity might have restarted. Had there been a lapse of consciousness, the patient's description periodically of beginning to lose consciousness or of being drawn back to the body would certainly have been noted.

Thus, we have an additional account of veridical perceptions during an apparent NDE OBE, during periods of almost certain cerebral isoelectricity, in this case an account not from the NDEr himself but from the person who would be most able to verify the accuracy of the details of the NDEr's apparent perceptions. Furthermore, the details were verified as completely accurate within about a week of the incident. Mansfield's account deserves further independent investigation, for example, to gather and correlate the details from Mansfield, the patient and other personnel who were present, and from the written medical records. Unfortunately, because of the lapse of more than 15 years now, such an investigation would be problematic (Parnia, personal communication, September 25, 2006). A more rigorous treatment of such accounts of apparent veridical perceptions at the time of the medical event would provide more definitive corroboration.

A third example of the apparent continuity of consciousness through a period of complete cessation of cerebral activity was documented by Sabom (1998). Pam Reynolds, age 35, underwent surgery in 1991 for a large basilar artery aneurysm at the base of her brain. The complex procedure involved hypothermic cardiac arrest which included lowering her body temperature to 60 degrees F, stopping her heart and breathing and draining the blood from her brain. At this point, Reynolds was in "standstill" and, by all measures, was dead. The aneurysm was then excised, her blood and body temperature restored, and her heart and breathing restarted.

Anesthesia was induced at 7:15am, Reynolds' eyes were taped shut and molded ear plugs were placed in her ears that emitted 100 dB clicks. At 8:40 her body was draped and around 8:45 Reynolds experienced an NDE OBE, as the surgeon began cutting through her skull with a specialized pneumatic surgical saw to access her brain. Her vision in the OBE was more focused and clearer than normal. As she hovered over the surgeon's shoulder, she noticed that the saw resembled an electric toothbrush with a peculiar shape. It used interchangeable blades which were kept in a container resembling a socket wrench case. Reynolds also heard comments from a female doctor about her veins and arteries being too small. Reynolds continued to have a deep NDE involving a tunnel vortex, entering an incredibly bright light and meeting a number of deceased relatives.

During the time of her NDE, the surgical procedure continued: blood cooling started at 10:50 and Reynolds' heart was stopped at 11:05. The EEG monitor registered isoelectricity and brain stem function, measured by electrical pulses in response to the audio clicks in her ears, also went to zero. Reynolds was brought to standstill about 11:25 with the blood drained from her body. The surgical excision of the aneurysm was completed and her blood flow was restarted. At this point, the EEG and brain stem monitors showed resumption of electrical activity and cardiac function was started. At 12:00 Reynolds' heart went into ventricular fibrillation and two defibrillations were applied to restart her heart. In her NDE, Reynolds was brought back through the tunnel by her deceased uncle and saw her body. She did not want to get back into the body, because it looked terrible to her, like a corpse. Nevertheless, with a little push, she reentered her body. At 12:32, the bypass machine was removed and the surgical wounds were closed. At this point, Reynolds remembers hearing the surgical team playing a particular song in the background.

Later, Sabom verified that Reynolds' perceptions of the surgical saw and of the doctor's comment about her veins were accurate. However, both of these perceptions occurred around 8:45, while Reynolds was under anesthesia but well prior to cerebral isoelectricity, which went from about 11:05 until perhaps 11:45. There was another brief period of isoelectricity, perhaps 1-2 min long, during the ventricular fibrillation event at 12:00. The time of returning to the body can be estimated at between about 12:05 and the time of the surgical closure procedures, because Reynolds could identify music being played in the background after she had reentered her body.

In this account, we have a conscious NDE OBE with veridical perceptions during a surgical procedure but not during cerebral isoelectricity. However, the NDE continued *without interruption* through an extended period of probably 40 min of monitored cortical and brain stem isoelectricity which was documented. Reynolds' account does not indicate a sense at any point of her NDE that her consciousness was diminishing or fading, or that she was being drawn back to her body, except after the resumption of cardiac function when she was "pushed" back into her body. Thus, while the veridical perceptions occurred at a point when Reynolds was under anesthesia and therefore unconscious, they occurred while there was still full electrical brain activity. Nevertheless, the initial OBE phase was part of a continuous conscious experience which spanned an extended period of global cerebral isoelectricity.

In a cardiac arrest, the onset of global cerebral ischemia and cerebral isoelectricity causes the loss of consciousness in most patients. However, a few patients experience a continuity of consciousness, generally with a perspective out of their body and looking down. The patient generally experiences no disruption in consciousness (except for the change in perspective) at a time when all electrical brain activity has almost certainly ceased. The patient experiences a lucid, vivid consciousness of the physical environs and still possesses all of the faculties and attributes of ordinary consciousness in the body, namely, perception, volition, feelings, thought and memory of prior events. The patient experiences a complete continuity of consciousness even when the cerebral electrical activity resumes, until there is a clear transition back to the body, at which point the patient's consciousness continues, now with an in-the-body perspective, or the patient becomes unconscious and wakes up later in the body. The NDE becomes integrated seamlessly into the patient's ordinary memory, as another of life's experiences. During the entire period of out-of-body consciousness, the patient appears completely unresponsive and unconscious to medical personnel.

Thus, the phenomenon of NDE during cardiac arrest, with veridical out-of-body experiences of the physical environs during the period of global cerebral isoelectricity, challenges the hypothesis that consciousness is dependent on brain function. Ordinarily this hypothesis is correct, because the loss of electrical brain activity nearly always results in unconsciousness. However, the rare cases of NDE during cardiac arrest demonstrate that there are notable exceptions. The phenomenology of these exceptions shows that, once separated from brain function in an NDE, the patient's consciousness continues in an OBE even though the brain's electrical activity resumes, and that the consciousness will continue to operate independently until there is a reuniting with the body. The patient's consciousness functions with all of the attributes of ordinary consciousness, in a *continuity of self-conscious experience* which spans the time the patient was in the body, through the separated out-of-body experiences, back through the time of reuniting with the body. The patient experiences the transitions out of and back into the body as natural, albeit unusual, occurrences, and is able to integrate the entire experience in memory as one of the experiences of life.

Veridicality of the NDE OBE

The foregoing account of the continuity of consciousness during periods of global cerebral isoelectricity rests on the validity of veridical perceptions during the NDE OBE because these perceptions establish that the NDE consciousness occurred at a time of global cerebral isoelectricity or unconsciousness. The validity of these perceptions depend on corroborative evidence that the perceptions were real (that is, "veridical") and that they could not have been imagined or mentally constructed at some other time, for example, having been inferred from subliminal sensory awareness during anesthesia, from prior general knowledge, from expectations derived from earlier experiences, from information supplied by others after the fact, from lasting physical aftereffects (e.g., soreness or burns from a defibrillation), or from lucky guesses.

When a person experiences an NDE with out-of-body perceptions of the immediate surroundings, the natural desire is to check that the events or things perceived were real and actually happened. As a rule, such perceptions are found *informally* to be veridical, that is, they appeared real, were checked with witnesses, and were verified. In contrast, reports that perceptions in an NDE were found to be *non-veridical* are very rare. Thus, one would expect that NDE OBE perceptions would be easily proven formally to be veridical. However, in only a few cases have NDE researchers taken extra steps to corroborate more thoroughly what was perceived by checking independently more than one source. Such research includes, for example, Michael Sabom (1982; 1998), Kenneth Ring and Sharon Cooper (1997; 1999), and Emily Cook, et al. (1998). Susan Blackmore has recently asserted (2004, p. 364) that in no case of alleged veridical perception in an NDE has even minimal independent corroboration been provided. Blackmore's assertion is overstated but it demonstrates that the level of corroboration of claims of veridical perception is open to skepticism.

When we say a perception is *veridical,* we usually mean that it corresponds to the facts of reality, that is, it is of something that is objectively real. When a researcher *verifies* a claim, she proves it is true or accurate by evidence or testimony, and when she *corroborates* a claim, she confirms it and "makes it stronger," usually by checking it from more than one source or perspective. Thus an account of *veridical* perception is *verified* by demonstrating with evidence or testimony that the perception was of something that actually occurred in objective reality at the time it was claimed to be perceived. The verification is *corroborated* when the account is checked from more than one source or perspective.

There are hundreds of accounts of purported veridical NDE OBE perceptions. Usually they are checked by the NDEr himself soon after the experience. The perceptions are frequently verified by asking one other witness, as in "I told the doctor what I saw and he said it happened just that way." Usually there is no independent checking of the details, and since the event frequently occurred long before it is recounted to a researcher, independent checking of details from different people or of physical evidence is no longer possible.

Emily Kelly et al. (1999-2000) outlined the general requirements for verification and corroboration of paranormal perception: the experiencer recounts the paranormal experience to others soon after the experience, these others attest to when and what the experiencer told them, and an independent investigator confirms that the perceived events occurred as the experiencer described them. These requirements provide a framework for more elaborate requirements for corroborating alleged veridical NDE OBE perceptions, which might include:

- The NDEr gives an account of the perceived events reasonably soon after the experience such that details are not lost in memory or altered in the retelling and are not confounded by what the NDEr may unintentionally learn from others in sharing the story. Ideally the account should be written down in as much detail as possible before it is shared, especially before it is shared with those who might be able to verify the details.

- The investigator interviews the NDEr and compares this account with the version contemporaneously given to others and the written version if there is one. As much as possible, the investigator needs to verify that the NDEr could not have gained prior knowledge related to the events and did not gain specific knowledge about the events afterward by normal means (e.g., information given afterward by medical staff or a witness to the events).
- The investigator compares the NDEr's account with the testimony of witnesses, interviewed separately, to verify the details of the account. The investigator probes specifically for any elements that are not consistent with the NDEr's account. The timing, sequence of events and details all need to be compared. Details might include who was present, where were they situated, what were they wearing, how items were placed in the room, and so on. Sketches could be made independently by the NDEr and witnesses and then compared. It is important to demonstrate that the perception occurred at the time of the event and was not constructed or imagined either before the event or later.
- The investigator probes for additional details of the NDEr's account which were not part of the original story and separately verifies these details with the appropriate witnesses.
- The investigator compares the NDEr account with all available evidence: physical evidence, medical records, etc. Additional testimony from the NDEr or witnesses may be needed to clarify these details.

These requirements relate to the gathering of the information for comparison and corroboration. Consideration should also be given to the *kind of perceptions* themselves, such that they will unambiguously eliminate other possible explanations such as those posed by Blackmore (1993, ch. 6). Blackmore posited that the unconscious patient could build a mental model of reality in a bird's-eye view from physical sensory cues that are subliminally perceived. Such cues could be visual, auditory, tactile, or proprioceptive. Furthermore, the NDEr could make inferences from aftereffects of the event such as soreness from a medical procedure or could gain knowledge from overheard conversations, even subliminally overheard from other people (e.g., nurses, doctors), prior to or after the event. Therefore, the perceptions to be verified should be purely visual information which is visible only out of the line of physical sight (even though the patient's eyes are closed). The information should have a uniqueness and level of detail that can't be inferred, guessed or derived from prior knowledge or knowledge from other sources. The most convincing case that a veridical perception was obtained through paranormal means can be made if it occurred during a period of global cerebral isoelectricity, as in the initial seconds after cardiac arrest, because at that time all brain function has ceased. However, veridical perceptions made during periods of unconsciousness can also be corroborated if it can be demonstrated that all other possible sources of sensory cues were absent.

These are daunting requirements but we believe they can be satisfied with judicious, painstaking investigation of the details of contemporaneously reported NDE OBEs and possibly also older NDE accounts. A number of purported veridical NDE OBEs have had good verification but have generally fallen short in the degree of independent corroboration. To illustrate the difficulties of verification and corroboration, we present several well-known NDE OBE cases purporting veridical perceptions, several of which we have already described in previous sections:

- George Ritchie's account (Ritchie and Sherrill, 1978), described previously: Ritchie verified his veridical perception of the all-night cafe 500 miles to the east of his physical body when he encountered the cafe by chance 10 months after the event but, understandably, he did not tell anyone about this until later. Ritchie intimated to Nurse Lt. Retta Irvine shortly after the event, that he had had a deeply moving experience when he "died" but he did not give details. He then related the account fully about a year later to an Air Force sergeant and later still to his future wife. The medical account was confirmed by the doctor in charge of the medical ward in a notarized statement. Ritchie's medical treatment at the time of his being pronounced dead and the fact that he related his experience in general terms were confirmed in a notarized statement by Lt. Irvine (Ritchie, 1998).

  It is difficult to conceive how Ritchie could have developed a mental model of flying over the frozen east Texas plains, coming to a large river with a city on the other shore, and then stopping above an all-night cafe that had very specific features. Even so, there is no *independent* verification of Ritchie's account, where the description of the cafe was given prior to his seeing it 10 months later, which could then be compared with the actual building. Thus, there is no corroboration of the veridical perceptions themselves. Furthermore, while the general details of his account coincide with the accounts given verbally at the time about his treatment, the corroborative written statements were made after some 14 years and are very general.

- Sabom (1982) case 6, described previously: The patient saw his wife and two of his children talking to the doctor down the hall from where his resuscitation started. His wife verified that the three were there unannounced and that her husband could not have seen them. Sabom checked the accounts within 13 months of the event and also verified the general facts with the patient's daughter who was also present. Unfortunately, the patient did not give an account prior to telling his wife, so facts from the two accounts could easily have been mixed up. More details could be obtained which were not shared between the patient and his wife, for example, the identity of the doctor or what the family members were wearing. These facts could then be verified independently among the witnesses. Also, the doctor and the nurse (who had stopped the family in the hall) could be interviewed to corroborate further the two accounts.

- Richard Mansfield's account (Parnia, 2006), described previously: Mansfield confirmed that his patient accurately described the events of his resuscitation even though he was unconscious and remained in asystole as the medical team abandoned the resuscitation. Unfortunately there is no statement from the patient himself and no medical records to compare, so there is no independent verification of the facts. Many more details could be obtained and checked with other sources to corroborate the facts. As with other examples, this event occurred many years ago, so the possibility that further investigation would yield any corroboration is remote.

- Pam Reynolds' account (Sabom, 1998), described previously: Reynolds accurately described her visual perception of the bone saw and its case of interchangeable blades, as Sabom verified. At the time, she was under general anesthesia and her eyes were taped shut but she was not in "standstill". Even though it was impossible for her to see, it is possible that she could still hear, even if subliminally, and feel the saw as it was being used. From prior knowledge of dentist drills (which also look somewhat like an electric toothbrush), with similar trays of drill bits, it would be possible to develop a mental picture of the bone saw that is fairly accurate. However, there are a number of details about the bone saw which are not at all like an electric toothbrush or a dentist's drill, as can be seen from pictures of the saw and its case. Reynolds also gave some description of who was present in the operating theater. Thus, it would be possible to have Reynolds draw sketches of the bone saw and its case and also the layout of equipment and positions of the medical staff in the operating theater. One or more doctors could also independently sketch these latter details. Reynolds' sketches could then be compared against the other pictures.

- Misplaced patient dentures (van Lommel et al., 2001): The cardiac patient in question, age 44, was brought to the hospital in cardiac arrest and received chest compressions and defibrillation without intubation. The patient's heart rhythm was still not stable and the coronary care unit nurse sought to intubate him but found that the man had upper dentures. The nurse removed the dentures and placed them onto the "crash car." The CPR continued and eventually patient's rhythm stabilized. After more than a week, the patient had recovered and identified the nurse when he came to distribute medicine. The patient had perceptions from above, was able to describe correctly in detail the room where the CPR had been done and the people who were present. The patient correctly identified the nurse as the one who had removed the dentures and placed them on the crash car, which had a number of bottles on it and a sliding drawer underneath where the nurse placed the dentures.

  Evidently there was no further verification of details, and in that case there was no *independent* verification of the patient's account, since the patient's account and the nurse's verification apparently happened at the same time, with a good chance of unintentional collaboration. Furthermore, it was not reported what the patient's cardiac state was at the time the dentures were removed. If chest compressions had been stopped for the intubation procedure and if the patient's heart had returned to ventricular fibrillation, then a case could be made that these perceptions were made during cerebral isoelectricity. In any case, the patient could infer that his dentures were removed because he woke up without them and it's possible he could have subliminally felt them being removed, heard the bottles jiggling on the cart and the drawer opening, heard the nurse's voice and so on. In other words, there is insufficient information to eliminate other possible explanations of the patient's purported veridical perception. Further independent probing of details from the patient and the staff who were present might reveal purely visual perceptions that could be verified and corroborated as veridical out-of-body perceptions.

- Maria's shoe (Clark, 1984; Sharp, 1995; Ring and Valarino, 1998): Maria was an Hispanic migrant worker who suffered a heart attack in 1977. After a few days in the cardiac care unit of the hospital, she suffered cardiac arrest and was quickly resuscitated but remained in a coma for several hours. The next day, she recounted to Kimberly Clark, a social worker who was helping her, that during the arrest she had perceptions of her body from near the ceiling, of the medical staff present, of the medical equipment and the electrocardiogram paper that had fallen on the floor. She was distracted and "moved" out above the hospital emergency entrance and was distracted again by something she saw on a third floor window ledge. This was a well-worn dark-blue man's left tennis shoe which had a scuffed spot where the little toe would go and a lace that was tucked under the heel.

  Clark searched first outside the hospital from the ground and then inside going from room to room on the third floor checking the window ledges. Clark found the shoe on a ledge on the north side of the hospital's west wing but from her vantage point could see only the top of the shoe and the inside. When she retrieved the shoe, Clark found that it matched Maria's description exactly, with the scuffed area and shoe lace under the heel. When Clark returned to Maria, she first asked whether Maria remembered what the inside of the shoe looked like. No, Maria had not been

> quite high enough to see inside the shoe. Then Clark showed Maria the shoe and the story of her seeing the shoe during cardiac arrest was shared with numerous nurses and doctors who all came to see Maria and the shoe. Here we have an apparent veridical, purely visual perception whose vantage point could not have been made from any perspective except from outside of the building.
>
> Unfortunately, Maria was never interviewed separately and the famous shoe has been lost, so that its condition cannot be checked for further details. Maria's medical records have not been checked and hospital staff members have not been interviewed to verify that they were told about the incident shortly after it happened. Therefore, although the veridical perception was verified by Clark by physical evidence shortly after it happened, the account remains uncorroborated by any other source.

In order to establish that purported veridical perceptions are indeed veridical, NDE researchers need to be more exacting, as these examples hopefully demonstrate, in follow-up and investigation, in interviewing NDErs about their experience and in corroborating their accounts with evidence and independent testimony from witnesses.

One promising approach to corroborating veridical perceptions in on-going prospective NDE studies is the use of hidden visual targets in hospital rooms where NDEs are most likely to occur (Greyson, 2000a, p. 343; Parnia et al., 2001). If the patient has an OBE, her visual perspective will allow her to see the hidden target and later report its contents. Several attempts with hidden targets have been made but so far have been unsuccessful due to the low number of NDEs in the target rooms. Also it appears that NDErs focus their attention more on the activity of the resuscitation and do not look around the room, so no positive results have been reported yet.

There are three aspects of NDE OBE phenomenology which can help with this problem. First, a few NDErs have commented on what has caught their interest and attention during the OBE (e.g., Sabom, 1982, p. 97). Patients tend to direct their interest based on human connections (e.g., the nurse, their spouse) and the positive feelings that they sense from these people. Secondly, in a number of cases, the NDEr has responded to repeated calling out of her name or to the doctor declaring, "Jenny, you cannot die!" and she has have returned to her body. Thus, the NDEr will "hear" and direct their attention to someone who directly addresses them. Finally, a number of NDErs report that they can "hear" words spoken not by direct hearing but by apparent telepathy.

Therefore, we suggest that existing hidden target studies could be enhanced by investigators who follow a preset, randomized verbal protocol, which is communicated to the patient mentally when the patient is likely to be having an NDE. The investigator can get the patient's attention by addressing him by name, with a warm, caring attitude, and then mentally recite the prescribed message. The presentation would include one or more easily identifiable, randomized visual cues which would be out of the patient's physical line of sight (e.g., something distinctive that the investigator is wearing on the front). The investigator would then leave and document the details of the presentation and the medical events occurring with the patient at the time. A second investigator, with no knowledge of the specific presentation used, would later interview the patient and document the results, including having the patient identify the other investigator from a picture line-up of possible investigators. This procedure could be integrated with existing hidden targets by pointing and mentally directing the patient's attention to note what is displayed on the target. It could also be used without hidden targets by showing a randomly pre-selected picture to the patient as part of the protocol.

In summary, the OBE component of NDEs frequently includes veridical perceptions which are informally verified by the NDEr. Perceptions which prove to be *non-veridical* upon checking are rarely reported. A few NDE researchers have verified and to some extent corroborated the NDEr's veridical perceptions with very convincing results, but a full verification and corroboration that eliminates all possible alternate explanations has not yet been possible for a variety of reasons. NDE researchers need to continue to pursue rigorous investigation of recent NDEs. The most success is likely to occur in prospective studies using hidden targets, perhaps with the enhancements we suggest.

Thus, the evidence so far of veridical perception during the NDE OBE is strong but veridicality has by no means been demonstrated conclusively. Nevertheless, what has thus far been demonstrated strongly suggests that the NDEr's consciousness operates completely independently of the body during the NDE OBE.

Comparison with other types of OBEs

The out-of-body experience, where one feels one's center of awareness is located out of the physical body, is not unique to NDEs. In addition to their appearance in NDEs, OBEs can be experienced spontaneously, can be willed voluntarily or self-produced, and can be induced with hypnosis, with electrical stimulation of the right temporal-parietal junction of the cerebral cortex, and with the use of drugs such as cannabis, psychedelics and ketamine, and can appear in connection with dreaming, sleep paralysis and depression (Blackmore, 1982 & 1992). Blackmore estimated that OBEs occur in about 10% of the population, although other researchers tend to put the figure higher.

The phenomenological features and qualities of OBEs appear to differ depending on how the OBE came about. In particular, the NDE OBE has several features which distinguish it from other types of OBEs:

- The NDE OBEr is in a medical crisis which brings the person close to death or when a person experiences intense physical or emotional danger compared with other preconditions in which OBEs occur. In contrast, the other OBErs generally are physically relaxed, mentally calm, and may be dreaming (Twemlow et al., 1982).

- The NDE OBEr generally will more likely experience the other aspects of the NDE than other OBErs, such as hearing a noise early in the experience, seeing his physical body at a distance, traveling through a tunnel, seeing other beings in non-material form, and encountering a being of light (Gabbard et al., 1981).

- The veridicality of perceptions in the NDE OBE when checked informally is nearly always verified (i.e., reports of *non-veridical* perceptions are rare), but non-veridical elements, fragmentary or distorted perceptions, dream-like qualities or complete hallucinations are reported in other kinds of OBEs, such as spontaneous OBE (Blackmore, 1983), OBE induced by electrical brain stimulation or temporal lobe seizure (Blanke et al., 2002; Blanke et al., 2004), willed OBE (Blackmore, 1982 & 1992), ketamine induced OBE (Jansen, 2000) and sleep paralysis OBE (Buzzi and Cirignotta, 2000; Terrillon and Marques-Bonham, 2001). Note that the veridicality of NDE OBEs has not been demonstrated conclusively (see previous section).

So far, researchers have not established a consistent typology or scale for OBEs (Alvarado, 1997). While it is generally agreed that NDE OBEs are different from other kinds of OBE (Gabbard and Twemlow, 1984), Alvarado (2000) pointed out that most, if not all, OBE surveys have included some NDE OBE cases in the results. These inclusions have probably masked phenomenological differences between the two different kinds of OBE.

In contrast to other kinds of OBE, the NDE as a whole, including its OBE component, appears to be a cohesive phenomenon, where all of the elements belong together, even though a particular person's NDE may involve only a small subset of those elements. Indeed, Rense Lange, Bruce Greyson and James Houran (2004) validated the Greyson NDE scale (Greyson, 1983 & 1990) using the Rasch rating scale model (Rasch, 1980) and showed that the NDE, including the OBE component, is a "core" experience that is consistent across different demographics and different depths of the NDE. The NDE OBE component then differs from other OBEs because of its distinctive quality as part of the overall NDE.

One interesting difference with the NDE OBE is the relationship of person's awareness to the physical body. The NDEr typically is unconscious and near death or is clinically dead, whereas all of the other types of OBErs are conscious within the body prior to the OBE. (We will defer the case of anticipated NDEs for the moment). In fact, in a number of cases, the OBEr remains connected to the physical body to some extent *during* the OBE, that is, she is talking to someone else in the room, she is walking down the street, she is dancing or acting on a stage, she is under hypnosis, she is dreaming, etc. Thus, during the non-NDE OBE, some part of the OBEr's consciousness is still associated with the physical body. In fact, in many such cases, the consciousness appears to be split between the physical body and the out-of-body "body". In contrast, in the NDE OBE, the consciousness within the body is severely compromised: the NDEr may be alive but is completely unconscious or is clinically dead.

We suggest that the phenomenological difference between NDE OBEs and other types of OBE is due to the degree of apparent "connection" of the consciousness with the body, or put another way, the degree of apparent "separation" of the consciousness from the body. The NDE OBE shows a greater "separation" which results in more purportedly veridical out-of-body perceptions, and that level of "separation" brings about the further aspects of the NDE. Other types of OBE have varying but lesser degrees of "separation" from the body and typically have less veridical out-of-body perceptions (showing some non-veridical elements or even completely non-veridical perceptions), and none of the other aspects of NDE ensue. The *anticipatory* NDE may occur because the circumstances that trigger it, the perceived threat of immediate and unavoidable serious injury or death, are so extreme that an NDE ensues. This is consistent with the findings of Owens, Cook and Stevenson (1990) that NDErs who were not in fact close to death still generally reported that they felt they were near death or were dead at the time. These NDErs experienced an OBE in the same proportion as those NDErs who were close to death but do not experience other elements of the NDE that are associated with "deeper" experiences (a bright light, a tunnel, a life review, etc.).

Thus, the comparison of the NDE OBE with other types of OBEs suggests that the NDE OBEr's consciousness separates to a great degree from the physical body, greater than the other OBE types. If separation of consciousness from the brain and body is in fact happening, the degree of separation and the process of separation are probably different among the different types of OBEs.

Phenomenology of the NDE OBE

It is important for the present discussion to develop the phenomenology of the NDE OBE more fully and in more detail from various more general phenomenological descriptions of the NDE, such as in Raymond Moody (1975), Moody and Paul Perry (1988), Bruce Greyson and Ian Stevenson (1980), Michael Sabom (1982), Evelyn Valarino (1997), and Kenneth Ring and Sharon Cooper (1999), and from individual NDE accounts in the literature. In looking specifically at the NDE OBE component, we find:

- The process of leaving the body is usually accompanied by tingling sensations or a hissing or whooshing sound. There doesn't appear to be a consistent part of the body through which the non-material body leaves the physical body. A few NDE OBErs observe a thin thread or cord attaching their non-material body to the physical body.

- The locus of consciousness shifts from within the physical body to outside and appears to have an independent existence. The NDE OBEr can generally perceive her immediate physical surroundings including her physical body, with a perspective some 8 feet above. There is a continuity of the individual's sense of self which continues from being in the body, to out of the body, and then back to the body. There is a continuity of memory as well. The individual feels herself to be the same person throughout the experience.

- The individual feels no pain, as in physical bodily pain, even when painful medical procedures are performed on the body (Sabom, 1982, p. 100). However, during hellish types of NDEs, the individual apparently can experience injury to the non-material "body" and emotional pain (Storm, 2000, p. 20; Dovel, 2003, p. 87). The individual feels weightless and tireless, and is completely at peace. She has the feeling that she has been freed from the body and there is typically elation at that sense of freedom.

- Some 58% of individuals report that they have some sort of non-material body during the NDE (Greyson and Stevenson, 1980), either shaped like the physical body or like a sphere or ovoid (Lundahl and Widdison, 1997, p. 108). For others, their consciousness appears to be a single point or focus. A surprising number of people who had their NDE during infancy or childhood report that they were adults during their NDE (Moody and Perry, 1988, pp. 74-76). Others report their NDE OBE was experienced while an infant, but their experience appears to have been from an adult perspective, with fully developed perception, memory and thought (Atwater and Morgan, 2000, p. 55).

- Existing sensorimotor or structural defects or disabilities such as blindness, deafness, lameness or missing limbs are absent in most NDErs, but not in all cases. In one study, out of 60 NDErs who reported having a non-material "body", 46 had no pre-existing defects, 12 reported such defects were absent, while 2 reported such defects were still present (Greyson and Stevenson, 1980). Those NDErs who are blind or visually impaired generally find that they no longer have visual defects during the NDE (Ring and Cooper, 1997).

- The ordinary mental and cognitive faculties of perception, thought, will, memory, feelings, and conscience are present, although sometimes in modified form as are detailed below. There is enhanced clarity of thought, perception and memory, with lucid mental processes when separated from the body. The NDEr's volition operates without any constraint or limitation of the physical body. The individual can direct movement simply by thinking or desiring it and then moves very quickly or seemingly instantaneously.

- The individual has visual perception but the perception has much greater acuity than in the body. Vision during the NDE OBE appears still to require light (Ritchie, 1978, p. 37). The NDE OBEr also has a kind of "wrap-around" vision, which can simultaneously see 360 degrees around an object, through it and within it (Benedict, 1996, p. 42; Ring and Cooper, 1999, p. 162). The wrap-around vision appears to operate effortlessly. The visual acuity and wrap-around vision is probably partly explained by the ability of the NDEr to will to focus her attention without the limitations of the physical eyes or the constraint of a particular perspective dictated by the position of the physical body. The vision during the NDE OBE appears to be a special form of perception, a kind of simultaneous seeing and knowing, which was termed "mindsight" by Ring and Cooper (1999).

- Visual perception also appears to work for objects not visible to ordinary physical sight. The NDE OBEr can sometimes see his own non-material "body", such as his limbs and clothing, and even describe details of the limb's structure (Moody and Perry, 1988, p. 10). The NDEr can see other individuals who are also out-of-the-body during the NDE in so-called "group" NDEs (Eulitt and Hoyer, 2001; Gibson, 1999, p. 128). These fellow NDErs are also seen to have a bodily form.

- The individual can sometimes hear physical sounds such as the beeping of monitoring machines or the hum of fluorescent lights, but many report not hearing anything in the immediate physical environs. The individual can also "hear" people speak via thought transfer or telepathy.

- Some individuals report that they can sense the texture of surfaces of objects by touch, or that there appears to be a slight resistance in passing through solid objects, but in general there is no interaction between the NDEr's "body" and physical objects. The NDEr's "body" appears to be completely non-material. The NDEr can't be heard when speaking and is invisible to ordinary sight.

- The process of returning to body can be a gradual return such as walking back or falling back through the tunnel, or a quick snapping back into the body, or simply waking up instantly back in the body. The self-conscious perspective then returns to being within the physical body. The individual's memory of NDE and OBE events is generally very vivid and long lasting upon returning to the body.

Table 1 summarizes a comparison of the faculties generally associated with the NDE OBE with those of the physical body. The overall gestalt of the NDE OBE is that the individual possesses all of the perceptual, mental, volitional, emotional and memory faculties as within the body and frequently retains a spatial albeit non-material form. However a number of the faculties are enhanced, mostly by being freed from the body. When the NDE OBEr returns to the body, all of the body characteristics return: weight, fatigue, physical pain, and physical disabilities. The individual's in-body consciousness is restored and she can operate as a physically embodied person again.

Table 1
Summary of faculties and attributes associated with out-of-body and in-body experiences

Faculty or attribute	Out of body	In body
Vision	Yes, enhanced acuity, 360 degrees	Yes
Hearing	Yes, in some cases or by telepathy	Yes
Will, intention, volition	Yes, appears to work instantaneously	Yes, works through bodily movement
Emotions, feelings, conscience	Yes	Yes
Thought	Yes	Yes
Memory	Yes	Yes
Spatial form	Frequently (the form is body-like)	Yes
Physical materiality, weight	None	Yes
Physical pain	None	Yes
Tiredness	None	Yes
Physical disabilities	None	Yes, if disabilities are present
Interaction with physical objects	None, no audible speech	Yes

Thus, the individual during the NDE OBE appears to be a complete human being, the *same* human being as was present prior to the NDE, except for the physical body. The phenomenon of apparent separation of consciousness in the NDE OBE is a coherent and self-consistent experience, which implies a separation *in fact* of consciousness from the physical body.

The OBE component of the NDE thus provides three basic phenomena which strongly suggest that during the NDE, the individual's consciousness operates completely independently of the body with all of its normal faculties and attributes intact. 1) The phenomenon of NDE during cardiac arrest, which demonstrates a continuity of consciousness, including veridical out-of-body experiences, during periods of global cerebral isoelectricity, strongly suggests that consciousness can continue with no electrical brain function. 2) The phenomenon of veridical perception during the NDE OBE which could only have occurred if consciousness had operated in a location distant from the body strongly suggests that consciousness can separate and operate independently of the body. 3) The coherent, self-consistent phenomenology of the NDE OBE suggests that the same human being exists *out of the body* during the NDE, freed of the constraints and limitations of the body during this time, and exists *within the body* before and after the NDE.

These three phenomena taken together strongly suggest that our consciousness is an entity in and of itself which ordinarily operates within the body but which can at times separate from the body and operate independently of it.

The Independent Self-Conscious Mind

The NDE OBE strongly suggests that consciousness can operate completely independently of the body and still possess all of the faculties and attributes of ordinary consciousness in the body, namely, perception, volition, feelings, thought and memory. With cases of cardiac arrest especially, it can be demonstrated that there is no physiological functioning of the brain or brain stem during significant portions of the OBE. Furthermore, the quality of awareness is not diminished during the OBE as in a dream-like state, but rather is the same as or even more intense than ordinary waking consciousness.

The transitions out of the body and back to the body occur seamlessly, that is, there is a continuous sense of selfhood and memory through both transitions, although there may be a transient loss of consciousness during the transitions. The experiencer feels herself to be the same self in transitioning out of body, as well as returning to it, having the same memories. The memories of events experienced while out of the body are integrated seamlessly with the experiencer's memories, both before and after the NDE. In short, the experiencer's self-conscious awareness, or sense of self, is felt to be entirely the *same self* before, during, and after the NDE. The experience is that one's unified conscious self has gone through the near-death experience, much like going through any other significant life experience.

Are there other phenomena that would suggest that there is a unified conscious self even when we are *not* having an OBE? We present three such phenomena here: electrical brain stimulation, subjective backward referral of sensory experiences, and large-scale neural synchrony.

Electrical brain stimulation

Siegward-M. Elsas (2005) has pointed out that direct stimulation of brain areas by an electrode using a small electrical current of a few milliamperes will produce, depending on the area stimulated, either conscious sensations (e.g., lights, sounds, tactile feelings), uncoordinated muscle movements or fragmentary memory sequences. The difference between such experiences and ordinary consciousness is that the experiences under brain stimulation have the character of being involuntary and artificially induced or imposed from outside. The induced sensations appear to be "added" to conscious awareness. The normal awareness of the patient's surroundings continues. In cases where muscle movements are induced, the stimulation inhibits ordinary voluntary movements of that part of the body.

Direct stimulation of the brain with an electrode is generally done in conjunction with brain surgery to treat epileptic seizures. The stimulation can be done while the patient is conscious, because the stimulation does not cause pain directly. Different points of the brain are stimulated in order to locate the areas that may need to be excised to eliminate the seizures. The patient is able to report what is experienced as the stimulation is performed. Brain regions can also be stimulated without the use of surgery using other techniques such as transcranial magnetic stimulation (TMS).

Different effects result from electrical stimulation, depending on what parts of the cortex are stimulated. For example, stimulation of primary *sensory* areas tends to induce simple hallucinations of ringing, hissing or thumping sounds, colored flashes, lines, circles or rings, or a tingling feeling or tactile pressure. Again, these are felt to be artificially induced. Stimulation of secondary and tertiary sensory areas, such as Wernicke's area (associated with speech comprehension), induces a temporary loss of function, rather than hallucinatory percepts. Stimulation of the gray matter within the calcarine fissure of the left occipital lobe, for example, can induce both hallucinatory figures and temporary blindness, inducing the patient to see simple colored figures to the right while also inducing partial or complete blindness of ordinary vision in the right visual field (Nikas et al., 2001).

Furthermore, stimulation of the primary *motor* cortex (precentral gyrus) induces uncoordinated muscle twitches or contractions, while at the same time inhibiting voluntary movements. The brain stimulation generally results in paralysis of the delicate or fine movements, say of the hand, while at the same time evoking crude movements such as clutching (Penfield, 1975). Similarly, stimulation of the higher level "supplementary motor area" can induce more complex muscle movements or even a feeling of the urge to move. However, such induced movements and feelings are always perceived by the patient as involuntary and as imposed by the experimenter. Stimulation of other complex motor areas can lead to complete inhibition of function. For example, stimulation of Broca's area, governing the formation of speech, can lead to local speech interference (such as hesitation, slurring, or repetition) or aphasic arrest (Nikas et al., 2001). In the last case, the patient is either unable to find certain words when speaking or is completely speechless; when the electrode is withdrawn, words might come in a rush, in an effort by the patient to express what he had been trying to say.

Finally, stimulation of regions of the *temporal lobe*, including the hippocampus and entorhinal cortex, can induce complex feelings of fear or of *déjà vu,* or fragmentary visual and auditory memory sequences. A patient may recall a very specific fragment of a prior visual experience, or a particular tune or fragment of a conversation. With stimulation of temporal areas as well, the patient similarly is aware that the sensations are not self-initiated feelings or memories, but rather are artificially induced by the experimenter.

Thus, cortical electrical stimulation induces internal conscious experiences, but the patients clearly recognize that the spontaneous movements, percepts, feelings or memories are not real. Instead, they occur out of context of the patient's normal conscious awareness – they appear to be artificially imposed from the outside and have the character of involuntary or hallucinatory events. In perception, we direct attention to the things we perceive in the world, and our perceptions have the quality of reality. With electrical stimulation, the perceptions appear to the patient spontaneously, as hallucinations, without a connection to the world. Indeed, the patient feels that they are superimposed on the ordinary conscious experience of the world. Similarly with memories induced by electrical stimulation, the memories are indeed personal memories but appear out of the blue, not as something the patient is trying to recall but as something that has been imposed on the patient's ordinary experience of the world. Similarly with motor functions induced by stimulation, the patient feels that the induced muscle movement is random and is not the result of the patient's intention or inner activity.

Elsas concluded that "electrical brain activity in itself is not sufficient to produce meaningful movements or inner experiences." Meaningful movements or inner experiences would require that the electrical activity be associated with actual perceptions of external realities, with movements that are initiated by our intentions, and with memories that are recalled by our inner activity. To carry Elsas' reasoning further, we can say that something other than electrical activity must be involved in ordinary conscious experiences, such that they feel to us to be *our* perceptions, intentions and memories. Otherwise electrical stimulation would give us such experiences.

The electrical stimulations are injected into the middle of the ongoing electrical processes that are associated with our conscious experience. The external stimulations result in conscious experiences that are repeatable, so clearly electrical brain activity is a cause of conscious experience. But other factors also appear to be involved in our ordinary consciousness, such that our experiences feel to us to be at our initiation or the result of our inner activity. Electrical stimulation in some cases *inhibits* the functioning of ordinary conscious processes, for example, inhibiting the functioning of ordinary acts of volition. If electrical activity inhibits the functioning of our will, something other than electrical activity must be involved when we have an intention to move, to direct our attention to look at something, to recall a memory, or to say something, but is not itself a form of electrical activity.

Thus, the phenomena of brain stimulation strongly suggest that there is some agency or process that itself is not electrical activity, but which interfaces in some way with the electrical activity of the brain to bring about the effect that our ordinary conscious experiences feel like they are our perceptions, intentions and memory, and whereby our intentions are effective in bringing about movement, perception and speech. Were this agency itself a type of electrical activity in a particular part of the brain, that area could be stimulated and result in conscious experiences that appear identical to ordinary consciousness. No such "seat of consciousness" in the brain has been found. Yet we do experience ourselves as a unified conscious self, so this agency must somehow induce the experience of the conscious self.

Subjective backward referral of sensory experiences

Benjamin Libet (2004) has summarized several decades of his research on mind-brain phenomena. Three phenomena which he studied are of particular interest to the present discussion, namely, the requirement for direct cortical stimulation to continue at least a half-second to produce a sensation, the half-second delay in our awareness of a skin stimulus, and the automatic backward referral or "antedating" of our sensory experiences.

In an early series of experiments, Libet explored direct electrical stimulation of the somatosensory cortex (see previous section) which produces a conscious tingling sensation or other responses in the part of the body which "projects" via neural pathways to that part of the cortex. For a weak current (1-2 milliamperes), Libet found that a series or "train" of pulses would produce a conscious sensation. Libet wanted to find the minimum conditions where conscious sensation still occurred, by varying the electric voltage/current, the rate of electrical pulses, and the duration of the stimulation. Libet found that the cortical stimulation had to last at least 0.5 seconds before there was a conscious sensation. Stimulus trains that lasted less than 0.5 seconds were simply not felt.

With the electrical stimulation, Libet also measured electrical activity near the stimulus site, called direct cortical responses (DCRs). In this way, the cortex responds to the direct stimulation with additional adjacent electrical activity. Thus, there appears to be a requirement of at least 500 msec of electrical activity in the brain (the stimulus pulses and the DCRs) to produce a conscious sensation. The question then was whether this half-second requirement of electrical activity also holds when the sensation is evoked directly by stimulating the skin.

To address this question, Libet in subsequent experiments focused on skin stimulation and measured the electrical activity in the brain. Libet stimulated the subject's skin with a single stimulus pulse and measured the electrical brain activity at the point where the stimulated skin area "projects" to the sensory cortex. Within 10-50 msec of the skin stimulus, there is an initial "evoked potential" (EP) at the sensory cortex site, depending on how long the projection pathway is to the brain, taking for example a shorter time from the hand than from the foot.

The size or amplitude of the EP depends on the strength of the skin stimulus, with a larger electrical response for a stronger skin stimulus, but the EP is usually very short in duration, perhaps only 15-20 msec. Following the initial EP, there are a number of "event related potentials" (ERPs) which represent further neuronal responses in the cortex. The ERPs are broadly distributed across the cortex and typically last for hundreds of milliseconds, as a kind of echo of the original stimulus and initial evoked potential. Again, the ERP amplitude is higher for stronger skin stimuli and their *duration* also increases for stronger skin stimuli. Thus, for a stronger skin stimulus, there will be a larger initial EP and larger ERPs, and the ERPs will last relatively longer. The skin stimulus strength is mirrored in the brain electrical activity by an *increased amplitude* and a *longer duration*.

Libet found that subjects did not feel the skin stimulus unless it was strong enough to evoke ERPs that lasted at least 500 msec. If the stimulus produced ERPs that lasted only 400 msec, say, the subjects felt nothing. This corresponds nicely with the result for direct brain stimulation. The brain stimulation pulses and associated DCRs appear to function like the ERPs: there must be at least 0.5 seconds of electrical activity for the subject to feel a sensation.

Thus, it would appear that our tactile sensory awareness is always delayed by about 0.5 seconds: we do not become consciously aware of skin stimulation, for example, until a half-second after the stimulus occurred. But this result seems to contradict our experience, because we don't feel as if there is such a relatively long delay in our sensations. Libet found that we automatically compensate for this delay by subjectively referring, or *antedating*, the onset of the sensory experience to the time the stimulus actually occurred.

In a third set of experiments, Libet in effect combined the first two experiments, inducing simultaneously both a *skin* stimulus and direct *cortical* stimulus to compare the two effects. He had subjects compare the relative time a skin stimulus (to one hand, say) was felt compared with a cortical electrical stimulus (projecting to the other hand). Was the skin stimulus felt earlier or later than the cortical stimulus?

If the two stimuli are started precisely at the same time, the electrical activity in the two sites in the brain will be similar. The cortical stimulation will proceed for 500 msec and the subject will feel that sensation 500 msec after it started. At the same time, the skin stimulus would produce an EP and ERPs which would also last 500 msec and the subject would also feel the skin sensation, after the same 500 msec delay. In other words, they should feel like they happen at the same time.

In fact, the skin stimulus is felt to occur *earlier* than the cortical stimulus. Now if the skin stimulus is delayed for some time, even up to 400 msec *after* the cortical stimulus is started, it still feels to have come earlier. It is only when the skin stimulus is delayed more than 500 msec after the cortical stimulus that the skin sensation appears to occur later than the cortical stimulus, to the subject.

Thus, the subject appears to be referring the onset of the skin stimulus *back to the time that it actually occurred*, even though the subject doesn't become consciously aware of the skin sensation, in fact, until 0.5 seconds after it occurred. The subject compensates for the built-in sensory delays by subjectively "antedating" them to when the initial evoked potential (EP) first appears in the cortex. With the electrical brain stimulation, there is no initial, primary evoked potential in the cortex (only later DCRs), and no backward referral or antedating occurs.

Thus, Libet found that we automatically adjust our sense of when an external stimulus occurred to when the first occurrence of an electrical response to the stimulus appears, even though this initial evoked potential is subliminal to begin with. If the stimulus is strong enough and the ERPs continue 500 msec or longer, we become aware of the stimulus and accurately refer the sensation to the correct area of our body and back to the time of the primary EP. The sensation and its timing remain only subliminally "perceived" until at least 500 msec after the stimulus, almost as if it is in the process of coming to awareness. If the stimulus is strong enough, the sensation does come to awareness, but we somehow know when and where it actually started from our subliminal experience.

How can this happen? The primary evoked potential (EP) is highly localized to the particular region of the primary sensory cortex (the postcentral gyrus) associated with the particular part of the body that feels the sensation. The later ERPs are not confined to the primary sensory cortex, but rather are broadly distributed in the cortex. The primary EP serves to provide the signal both to *when* the sensation occurred and *where* it occurred in the body. Once the initial EP pulse is gone (lasting only about 20 msec), all further related electrical activity is distributed.

Thus, there is no apparent electrical neural mechanism that can mediate our subjective backward spatial and temporal referral to the subliminal primary EP (Libet, 2004, p. 85-86). But there must be some agency to mediate the antedating process: the accuracy of our awareness with the correct timing and somatic spatial location results from a single primary EP pulse. The referral backward in time is known to occur only when a primary cortical response is evoked by sensory input and can serve as a training signal for the referral. Electrical cortical stimulations with an electrode do not have such a timing signal available and no backward referral occurs.

Thus, there must be some agency that "holds together" both the time and specific sensation (location on the sensory cortex) while the sensation comes to awareness during the 500 msec period. No subsequent electrical activity can help to place the awareness in the specific sensory location and establish its subjective relative time, so this agency itself must be non-electrical in nature.

Large-scale neural synchrony

One proposal for the agency that must somehow induce our experience of consciousness is the large-scale synchronization of neural activity described by Francisco Varela et al. (2001). Assemblies of neurons in different regions of the cortex exhibit electrical activity at a particular frequency, at any given time. The frequencies are classified by range: for example, alpha neural rhythms are 8-12 Hz (cycles per second), beta neural rhythms are 12-30 Hz, and gamma neural rhythms are 30-70 Hz. Synchronization occurs when the two regions exhibit the *same phase* for a period of time at a given frequency. In other words, for a short period of time, the two regions oscillate in phase with one another. For example, the two regions might be said to be in phase-locked synchrony for 200 msec, say, in the gamma range at 40 Hz.

When the two regions are widely distant in the cortex, more than 2 cm, this is called *large-scale* phase-locked neural synchrony. The synchronous electrical activity can be measured either intracortically, with multiple electrodes implanted in a patient in preparation for epilepsy surgery, or on the scalp, measured at multiple electrode sites with electroencephalography (EEG) or magnetoencephalography (MEG).

A number of researchers have found that widely separated regions of the cortex can enter into synchrony during cognitive tasks. An experiment by Eugenio Rodriguez et al. (1999) had subjects view different black and white figures, either a high-contrast "Mooney" face or a similar face displayed upside-down. The subjects' EEG waves were recorded at 30 sites on the scalp. When a face was recognized, a characteristic pattern of transient phase-locked synchrony occurred among 13 electrodes, in the gamma range at 36 Hz, about 230 msec after the figure was presented. There was no phase synchrony if an upside-down figure was presented. The subject then pressed a button indicating whether a face was seen or not. In both the recognition and non-recognition cases, there was a second pattern of neural synchrony among 10 – 15 electrodes, at 40 Hz, about 700 msec after initial figure presentation. In the case of figure recognition, the initial neural synchrony corresponding to recognition was followed by a period of "active" phase scattering, where the regions that were previously in synchrony dropped below the baseline level of synchronization. The periods of synchronization were each about 150-250 msec in duration. This experiment showed that characteristic patterns of large-scale neural synchrony are associated with figure recognition and with motor responses to press a button.

An experiment described by Antoine Lutz et al. (2002) had subjects view an image (a three-dimensional autostereogram) as it gradually emerged on a display from a random dot background. The subjects were given a warning signal 5 seconds before the start of figure emerging and the subjects pressed a button when the image was recognized. The subjects' EEG waves were recorded at 62 electrodes on the scalp. The subjects were trained to give descriptions of their immediate mental processes. The different possible responses to the experiment were categorized into "phenomenological classes". In general, in a trial the subject was either prepared and expected the image to emerge, or the subject was engaged in other mental activities (e.g., memories, projects, fantasies, etc.) and was taken somewhat by surprise when the image emerged.

Characteristic patterns of neuronal synchrony were observed which corresponded closely to subjects' reports of the recognition of the image in the prepared case and in the unprepared case. When the subject was prepared, strong neural synchrony started about a second *before* the image began to emerge and continued through the period looking for the image, the recognition of the image and the motor response. The average response time was about 275 msec after the image started to appear. In the trials where the same subject was unprepared, there was no neural synchrony prior to start of the image appearance. As the image began to emerge, weaker, more "diffuse" neural synchrony developed, which then grew stronger, nearly matching the strength of synchrony in the prepared case. The average response time in the unprepared trials was about 520 msec after the image started to appear. In the unprepared trials, the subject was mentally engaged in something else, was taken by surprise by the image emergence and reacted more slowly, taking nearly twice the time to respond. This experiment also showed characteristic patterns of large-scale neural synchrony which correspond to particular cognitive factors such as recognition, attention, vigilance and expectation as indicated in the first-person accounts or by the motor response.

These are just two studies which demonstrate this phenomenon. Antoine Lutz and Evan Thompson (2003) summarized the research in both animal and human studies which demonstrate that neural synchrony occurs during arousal, sensorimotor integration, attentional selection, perception, and working memory, which are all crucial for consciousness.

A number of researchers have proposed that neural synchrony is the basis for the emergence of consciousness from neural electrical activity. For example, in the view of Varela and Thompson (2003), the unity of consciousness can be explained by the large-scale dynamic *integration* of neuronal activity that appears as transient phase-locking synchrony of widely distributed neuronal regions. Consciousness *emerges* from integrated neuronal activity via both "upward causation" where interactions at lower, local neuronal levels give rise to patterns at more global levels, and by "downward causation" where global characteristics of the neural regions govern or constrain local interactions at the lower levels.

Indeed, with the high correlation of mental states and neural phase-synchrony, one may be tempted to attribute the neural phenomena as the *cause* of the mental states. However, not all mental states occur with phase-locked synchronous neural activity. In the Rodriguez and colleagues experiment, the subject is watching the display screen and is shown a meaningless figure (an upside-down "Mooney" face). There is a small increase in overall "spectral power" corresponding to the subject's attempt to recognize and the subsequent non-recognition, but there is no neural synchrony. The synchrony occurs only when there is *recognition* of a face. Furthermore, when the subject has recognized a face, this is followed by a phase where there is a massive desynchronization. The desynchronization represents a transition between two cognitive acts (face recognition and motor response). The transition undoes the synchrony of the first act and allows a new synchrony for the second cognitive act.

Similarly in the Lutz and colleagues experiment, the subject can be engaged in all sorts of distracted mental thoughts (memories, projects, fantasies, etc.) and there is no neural synchrony. Only when there is *concentrated attention* without distraction, as reported by the subject, is there neural phase-synchrony. Thus, in both experiments, there are significant periods of no synchrony or of massive desynchronization, where the subject is still consciously engaged in looking, thinking, recalling memories or deciding which button to push as a response. (To be sure, there could be synchronous neural activity which is not being detected, but the experimental cases are nearly identical where there is synchrony and the absence of detected synchrony.) Thus, the presence of neural synchrony doesn't in fact explain the subject's experience of the continuity and unity of consciousness through those periods when the synchrony is absent or when there is massive desynchronization.

Moreover, the neural synchrony emerges and lasts only 100-300 msec before disappearing (Varela et al., 2001). The neural electrical coherence is transient and fragmentary, depending on the subject's specific mental states, with no apparent cohesion and continuity of the neural electrical activity.

The transient fragments of neural synchrony appear more to be reflections of specific kinds of mental activities that are only part of the subject's cohesive, continuous experience of consciousness. Specifically, all of the cases where neural synchrony has been found to occur (arousal, sensorimotor integration, expectation, attentional selection, recognitive perception and working memory) appear to involve some level of volitional activity, whereas with the other mental activities reported, a lower or zero level of volition is probably involved. We would suggest that neural synchrony is more closely associated with active volition: it is a cognitive volitional act that causes the synchrony, rather than the reverse. The subject's experience in these cases is one of preparation, concentration, attention, recognition or motor response, as opposed to distracted mental thoughts, looking at a blank screen or a meaningless figure, or reaching a mental decision (versus acting on that decision). Moreover, the neural synchrony appears to be highly correlated with increased brain energy levels, which would be consistent with an experience of higher or more concentrated mental effort.

Thus, we suggest that the phenomenon of neural synchrony better correlates with volitional mental acts rather than consciousness in general. The specific points of synchrony in the brain relate to the specific mental tasks (face recognition, preparation and stereogram recognition, motor movement). The observed energy levels probably correlate well with the subjects' experience of mental effort. In short, the phenomenon of neural synchrony is better viewed as the *effect* of a specific type of mental activity than as the cause of emergent consciousness.

This interpretation also suggests that there is some agency which interfaces in some way with the electrical activity of the brain, in this case to bring about the effect of neural phase-synchrony when we engage in volitional acts such as recognition, motor responses, and so on. Were this agency itself a type of electrical activity, that is, a "downward causation" governing or constraining lower level neural interactions, then external electrical stimulation should disrupt this sort of constraining synchrony and result in widespread disruptions to conscious experience. In fact, we find that electrical stimulation causes only localized inhibition of function, for example, interference with speech or verbal comprehension, vision in a portion of the visual field or a specific movement; the subject's normal awareness of surroundings continues. So the agency which induces the neural synchrony associated with volitional acts is not likely itself to be a form of electrical activity.

Independent self-conscious mind

The NDE OBE phenomenon strongly suggests that consciousness can operate completely independently of the operation of the body and brain, with a continuous sense of selfhood and memory through transitions out of the body and back to the body. The phenomena of electrical brain stimulation, backward referral of sensory experience, and large-scale neural synchrony all suggest that there is an agency that induces conscious experiences and self-consciousness but which is not itself a form of neural electrical activity. We propose that this non-electrical agency *is* the consciousness itself which can operate independently of the brain, namely, the independent self-conscious mind.

During the OBE, the self-conscious mind (SCM) appears as an independent "field of consciousness", that is, there is a particular locus of the experiencer's consciousness which is independent of the body. However, during ordinary consciousness in the body, the SCM is united with the body and brain. Consciousness within the body results from a form of induction between the brain (and probably other parts of the body) and the self-conscious mind. The SCM can potentially operate independently of the brain during the extraordinary experiences associated with NDE, but is ordinarily intimately united with the brain and body throughout a person's life. The following details can be inferred from phenomena associated with the self-conscious mind during NDE OBE:

1. During an OBE, the self-conscious mind carries with it the faculties of self-conscious awareness, perception, volition, feeling, thought and memory. Consequently, these faculties must also reside with the SCM while it is united with the brain. Clearly, the brain *mediates* all of these faculties: when the brain's normal electrical activity is significantly altered as in sleep, anesthesia, coma or trauma, we become unconscious; damage to sense organs or the sensory regions of the cortex results in a loss of perception; damage to other cortical areas similarly results in paralysis, ataxia, aphasia, loss of speech comprehension, disruption of memory formation or recall, and so on. However, NDErs experience a restoration of these disabilities, when they are present, during the OBE. Therefore, the SCM is an independent "field of consciousness" while out of the body. Since there is a seamless transition of consciousness in leaving the body and then returning, it is apparent that mediation by the brain does not alter the unity of the SCM field of consciousness. Through the mediation of the brain, the SCM carries these same mental faculties and attributes while united with the body.

2. The NDE OBE shows that the self-conscious mind, when it is out of the body, is non-material. The SCM is invisible to normal sight, its speech cannot be heard, and it has no ability to interact with physical objects, passing right through walls, people and so on. The SCM can generally be seen only by other OBErs. Still when the SCM is in the body, it appears to be held there strongly. Around 70% of the people who experience severe trauma, such that one would expect an NDE to occur, experience only loss of consciousness and do not experience a separation of the SCM from the body. Thus, the non-material self-conscious mind is ordinarily intimately united or integrated with the body and brain, and must therefore interface in some way through the brain's and body's mediation. The mediation with the body must take the form of some sort of induction. Since we are not ordinarily aware of the operation of our brains, the SCM works unconsciously and automatically within the brain and through the brain, not as in a so-called "Cartesian theater"; our consciousness is always directed outward to the world. We discuss in a later section the implications of the non-material aspects of the SCM.

3. During the initial stages of the NDE OBE, some experiencers feel tingling in the limbs and throughout the body prior to separation. When out of the body, most experiencers see that their non-material "body" has a shape: limbs, torso and so on, much like our ordinary body shape, while others experience their shape as spherical, about the same size as their physical body. While within our body, we feel that our physical body is ours and our sense of self extends throughout all parts of the body. When somatosensory areas of the cortex associated, for example, with the right arm are stimulated by an electrical electrode, we feel tingling in that arm, not in the brain, even though there is no involvement with the peripheral nerves. Thus, it appears that the self-conscious mind is united or integrated with the body, extending throughout the head, torso, and limbs, not just with the brain. We discuss in a later section the phenomenon of phantom limbs as it relates to the present view.

4. From the reports of some NDErs who had their NDE as infants, the self-conscious mind apparently already exists in fully developed form during infancy. During the NDE, the experiencers observed their non-material form to be as large as an adult. Perception, memory and thought were all fully functional during the infant NDE. Thus, it appears that the self-conscious mind is not developed during infancy as part of the physical development process, but rather is present already in a fully developed form at the time of birth. Thus, infants must go through numerous learning processes in their first several years, as they grow, not to develop the SCM per se, but rather to learn how to integrate their SCM with the brain and body. The interactions that the SCM has with the brain in these learning processes in infancy and early childhood also influence the development of the brain structures. The processes of

learning in infants and young children should give additional insights into how the SCM comes to be integrated with the brain and body, for example, the necessity for self-initiated movement in the development of perception.

5. During an NDE, memories of events that are perceived while out of the body are formed and integrated seamlessly with the experiencer's other memories, both before and after the NDE. For many NDErs, the memories of the NDE are more vivid than memories of ordinary events. Pim van Lommel et al. (2001) reported that patients could still recall their NDE almost exactly, even after 8 years, for example. Further, NDErs report that memories of their life prior to the NDE (e.g. memories of one's parents, children, or friends) are accessible for recall during the NDE. Thus, we must conclude first that the processes for memory formation within the body and out of the body must be equivalent, although memory formation and recall are clearly mediated by a number of brain structures and pathways while in the body (e.g., Popper and Eccles, 1977, ch. E8). Secondly, long-term memory appears to be part of the non-material self-conscious mind and thus resists destruction even with severe brain damage, such as bilateral hippocampectomy. Profound retrograde amnesia (loss of long-term memory), for example in dementia, is probably due to the destruction of brain structures that mediate memory recall, rather than destruction of the memories themselves.

6. Both during an NDE and in ordinary consciousness, the experiencer has a sense of self-conscious awareness. Indeed, the experiencer feels that it is the *same self* that experiences consciousness before, during and after the NDE. In the present view, it is the self-conscious mind that provides for this experience of continuity of self-consciousness and unity of conscious awareness. The SCM is the unitary field of our consciousness and the locus of self-conscious awareness, both within the body and out of the body.

In summary, all of our cognitive faculties, that is, self-conscious awareness, perception, volition, feeling, thought and memory, reside in a self-conscious mind (SCM), a non-material field of consciousness which is ordinarily united intimately with the brain and body. (A "field" in this sense is an area or region of space that has specific properties.) Ordinarily, the brain mediates the cognitive faculties with the SCM which enables us to be conscious; since the SCM is non-material, the mediation must work through some sort of induction with the brain. The non-material SCM has a shape or form which extends throughout our physical body. The SCM starts out in infancy as fully formed; the infant's and child's learning process involves learning to integrate the SCM with the brain and body. Long-term memory, in particular, is a non-material part of the SCM; thus, memories themselves cannot be destroyed by the destruction of brain structures but memory *recall* can be blocked by destruction of the structures or pathways that mediate recall. Finally, the SCM is the seat of our self-conscious awareness. Only during the extraordinary event of an NDE, does the SCM separate from the physical body and operate for a time independently of it.

One erroneous interpretation of the present view is that it proposes a "Cartesian theater" model of consciousness, either that the self-conscious mind sits within the brain and attends to the neuronal events and operates the requisite motor functions, or that the present view merely shifts the problem of the seat of consciousness to a different, non-material location instead of the brain. Both of these interpretations misunderstand the present view. The phenomenal evidence is that the SCM is integrated with the brain closely and intimately, and that the integration is strong, is very difficult to break, and ordinarily lasts one's entire lifetime. Normally people have no awareness of their brain's operation or any awareness of a separation of the mind from the brain and body. We do not attend to our brain processes and then react to them; rather, we normally attend only to what presents itself to our consciousness from the world, via the mediation of the brain. Further, when the brain stops supporting our ordinary consciousness, as with sleep, anesthesia, coma or trauma, we lose consciousness, because the SCM generally requires the mediation and support of the brain for consciousness. It is only under very extraordinary circumstances, such as an OBE associated with an NDE, that the self-conscious mind separates from the body and brain and shows its existence independent of the brain.

Comparisons with Eccles' self-conscious mind

The present view is very similar to the dualist interactionist model proposed by Karl Popper and John Eccles (1977) and further elaborated by Friedrich Beck and Eccles (1992) and Eccles (1989, 1994). For Popper and Eccles, the non-material self-conscious mind interacts with a liaison portion of the brain that is located in the ideational and linguistic structures of the dominant hemisphere. Eccles (1994) postulated that all mental events and experiences are a composite of unitary mental events called psychons. Each psychon is reciprocally linked one-to-one with an individual neural dendron. The psychons collectively form the interface between the non-material mind and the brain and *are* our mental experiences in all their diversity. A psychon interacts with its unique dendron and can affect the probability of release of chemical transmitter substances at synaptic junctions by means of quantum probability fields (Beck and Eccles, in Eccles, 1994, ch. 9).

Eccles' view is very similar to the present view of the non-material self-conscious mind that interacts with the brain to produce self-conscious awareness. The main differences between the present view and Eccles (1994) are:

1. Eccles' view is that the self-conscious mind arises from and is connected with the brain. In the present view, the SCM is ordinarily intimately integrated with the brain and body, but in fact is independent of them: under extraordinary circumstances, it can separate and later rejoin the brain and body, for example, in an OBE associated with NDE.

2. Eccles' view is that the self-conscious mind interfaces with the dominant hemisphere and other brain structures such as the supplementary motor area. In the present view, the SCM extends throughout the body to the limbs. Our sense of self permeates the body. For many people, the center of consciousness is located in the head. Nevertheless, our self-consciousness extends throughout the body through our proprioceptive or body sense. Furthermore, we do not have the sense that our consciousness is controlling our body as something that is separate or alien from ourselves.

3. Eccles proposes a specific mechanism for mind-brain interaction through unitary mental events called psychons which operate by means of quantum probability fields. The present view does not propose a hypothetical mechanism for mind-brain interactions but expects the mechanism to be discovered through the study of the phenomena.

4. Eccles' view is that memory storage is accomplished by imprinting in the brain through modification of synapses, in a kind of data bank, and recall occurs through the replay of spatiotemporal patterns in the brain (Popper and Eccles, 1977, ch. E8). In the present view, the brain facilitates formation and retrieval of long-term memories but the memories themselves are part of the SCM. The memories are encoded in some way in the SCM because, once formed, they are still available for recall even when extensive brain damage has occurred. Furthermore, during an NDE OBE, the sense of self with its prior life-memories is still very active, and the experiences which occur during the NDE generally produce vivid, life-long memories of them. Thus, memory acquisition, encoding or "storage" and recall are faculties of the SCM which are facilitated and mediated by the brain.

While the present view of the self-conscious mind is dualist interactionist and very similar to Eccles' self-conscious mind, the main differences derive from the *independent nature* of the SCM in the present view: the SCM and its cognitive faculties, particularly memory, are not always dependent on the brain and do not originate from the brain.

Comparisons with Libet's conscious mental field

The present view of the self-conscious mind has a number of similarities with Benjamin Libet's (2004) *conscious mental field* (CMF) because both views are based on the phenomena of neural activity in relation to subjective mental experience. However, there are also significant differences.

For Libet, the phenomenon of the unity of subjective conscious experience and the phenomenon that conscious mental function appears to influence nerve cell activity are the motivations for proposing the CMF. Regarding the unity of conscious experience, it is increasingly evident that many functions of the cortex are localized, even to a microscopic level in a region of the brain, and yet the conscious experiences related to these areas are integrated and unified. We do not experience an infinite array of individual events but rather a unitary integrated consciousness, for example, with no gaps in spatial and colored images. For Libet, some unifying process or phenomenon likely mediates the transformation of localized, particularized neuronal representations into our unified conscious experience. This process seems to be best accountable in a mental sphere that appears to *emerge* from the neural events.

Regarding the apparent causal ability of conscious mental function to affect or alter neuronal functions, Libet (2004, pp. 172-179) has proposed an experimental design, which would surgically isolate a slab of cerebral cortex (in a patient for whom such a procedure was therapeutically required). If electrical stimulation of the isolated cortex can elicit an introspective report by the subject, the CMF must be able to activate appropriate cerebral areas in order to produce the verbal report. This result would demonstrate directly that a conscious mental field could affect neuronal functions in a way that would account for the activity of the conscious will.

The present view is that the mind is a field of consciousness in its own right, one that is capable, under the extraordinary conditions of NDE OBE, of operating independently of the brain, rather than a mental field that emerges from neural events. The unifying process that results in our experience of unity and integration of consciousness *is* a conscious mental field, but one that can exist independent of the brain, namely the present self-conscious mind.

We suggest that Libet's proposed experiment to stimulate a surgically isolated portion of cortex may produce ambiguous results if the *neuronal* requirement for conscious awareness is affected by the surgical isolation. If the patient reports a subjective sensation, then the CMF is demonstrated. However, if the patient reports nothing, that result may indicate only that the requirement for bringing the sensation to conscious awareness (e.g. the requisite event related potentials) has not been met, not necessarily that the CMF (or SCM) does not exist. We suggest that a better experimental approach would be to study the correlations of conscious experience and neuronal activity in more detail in subjects who have severe brain damage, for example, commissurotomy, hemispherectomy, severe visual cortical damage resulting in blindsight, and so on.

Mind-brain Interactions

The strongest objection to a dualist interactionist view of the mind is that there is no reasonable explanation how the non-material mind can interact with the brain. The interaction must be magic, mysterious, or inaccessible to scientific study (e.g., Blackmore, 2004, p. 14). We contend that the phenomena of the mind, taken as a whole, including the experience of NDE OBE with its veridical elements in the absence of all cortical activity in the patient, indicate that the mind *is* non-material, and that the process of its interaction with the brain and body can be studied scientifically through the associated phenomena. Already numerous phenomena relating subjective first-person experiences to third-person observations have been described in the neuroscientific literature. These phenomena shed light on mind-brain interactions, as we discuss in this section. The mechanism for mind-brain interactions is discussed in a later section.

There is an inherent difficulty in studying mind-brain phenomena, namely in accurately correlating internal mental experiences, sensations and mental acts with observable neural and bodily events. Nevertheless, much progress has been made by a number of researchers. Benjamin Libet (2004) described several useful techniques he and others have used, such as subjective reports of felt sensations which are induced cortically in some way, the relative subjective times of two such induced sensations compared to the actual times of induction, subjective comparisons of the relative strength of induced sensations, forced choice in which the subject must make a choice even if nothing was consciously experienced, the accurate timing of subjective experiences via an oscilloscope clock display, response time measurements including forced subjective delays in the response, and conscious vetoing of a willed act.

A number of brain imaging techniques have been developed over the years, such as positron emission tomography (PET) which measures regional cerebral blood flow (rCBF) connected with mental activity, functional magnetic resonance imaging (fMRI) which measures changes in associated metabolic processes correlated to mental activity, electroencephalography (EEG) and magnetoencephalography (MEG) which measure electrical and magnetic potentials transcranially or intracortically (iEEG), direct intracranial electrical measurements via individual electrodes, and so on. These imaging techniques are a primary method for identifying the "neural correlates" of conscious mental activities.

Francisco Varela (1996) proposed a neurophenomenology which includes methods of relating subjective reports of experiences to observed neural data. Antoine Lutz et al. (2002) described the rigorous application of these methods in using dynamical neural signatures (DNS) of the neural phenomena and phenomenological classes (PhC) of first-person reports of the subject's cognitive context. From this work, Lutz and colleagues claimed that first-person data can be used effectively to detect and interpret neural processes according to the subject's specific mental activities.

In the present view, the neural correlates represent the actual *interface* of the SCM with the brain, rather than the *emergence* of the mind from the electrical brain activity. By studying the neural correlates of specific cognitive activities, the regions and properties of the interface of the SCM with the brain can be studied. For example, Eccles (1994) proposed that the supplementary motor area (SMA) regions specifically participate in intentional mental acts, and thus would be candidates for the interface location for intentional or volitional acts.

Other avenues for scientific investigation include the investigation of conscious functions in patients with brain damage (see next section) and the rehabilitative strategies that work to restore full or partial function, for example with stroke patients (Hallett, 2002). Finally, much more thorough study of electrical brain stimulation is needed, both the somatosensory cortex and regions involving volitional functions including stimulation of speech areas, the inhibition of willed function, and the experience of "imposed" willed function, such as the urge to move.

Therefore, scientific study of the mind is certainly possible, even though the mind is non-material. In the balance of this section and in the next, we explore how the present view of the non-material self-conscious mind could be applied to various phenomena in neuroscience.

Phenomenology of mind-brain interactions

Electrical activity in the brain is a complex physical and physiological phenomenon. Changes in localized neural electrical fields induce corresponding changes in localized magnetic fields in the brain. The electrical and magnetic fields are induced by chemical cell processes within and between the cortical neurons. These chemical processes in turn are supported by metabolic processes related to blood flow within the brain. For simplicity, we will refer to the complex of electromagnetic, cellular chemical and metabolic processes as electrical brain processes or electrical brain activity.

A number of phenomena of consciousness are correlated with electrical activity in the brain. Three of these, namely, electrical brain stimulation, backward referral of sense experiences, and large-scale neural synchrony, were discussed in the previous section. Given the correlation of consciousness phenomena and electrical activity, it is very likely that the non-material self-conscious mind works through the electrical activity of brain neurons, and possibly also body neurons and other structures, in order for conscious experience to occur while the mind is united with the body. The SCM must operate through some kind of mutual induction with the brain neurons involving electrical brain activity.

On the one hand, neuronal processes such as electrical, magnetic, or chemical processes induce effects in the SCM, which result in experiences in our consciousness, such as sensations and perceptions. External electrical stimulation of different cortical regions with an electrode, discussed earlier, also induce internal experiences of perceptions, intentions and memories, but which do not feel to us as *our* experiences. Thus, the *brain-to-mind induction* of conscious experience very likely results from neural electrical activity, and these experiences are felt to be ours when we have in some way been involved, for example, through our attention or volition, or from a stimulus to our body.

On the other hand, conscious mental activities such as thoughts, intentions and emotions, induce electrical neuronal effects such as large-scale neural phase-synchrony, discussed earlier. Part of the effect of this *mind-to-brain induction* appears to be that the level of intensity of preparation, concentration or intention results in an overall higher level of energy of electrical activity (Lutz et al., 2002). The widely distant points of synchrony in the brain also suggest that mind-to-brain induction works simultaneously on different regions of the brain. An equivalent result by P. Roland and L. Friburg (1985) showed that specific silent thought activities produce significantly increased levels of regional cortical blood flow (rCBF) in widely separated regions of the brain, with a different pattern for each type of thought task.

Libet's delayed awareness of willed action

One clear phenomenon relating conscious experience with neural electrical activity is the delay between a neural event and our conscious awareness of the sensation or other activity that induced the neural activity (Libet, 2004). One manifestation of this delay is the delay of about 0.5 seconds in our sensory awareness, which results in backward referral or antedating of sensory experience, discussed earlier. When a skin stimulus is applied, there is an initial "evoked potential" (EP) in the region of the somatosensory cortex associated with that part of the body. If the skin stimulus is strong enough, we become aware of it and accurately refer the sensation to the correct area of our body and back to the time of the primary EP. However, the sensation and its timing remain only subliminally "perceived" until at least 500 msec after the stimulus. During this time there are further neuronal responses called "event related potentials" (ERPs) which are broadly distributed across the cortex. The ERPs must continue for at least 500 msec in order for us to become consciously aware of the stimulus.

Thus, there is a delay in our *conscious* awareness of the stimulus. However, we are "aware" at some level, because we are able to react quickly in emergencies and in physical activities requiring a high degree of responsiveness and accuracy without time to deliberate (e.g., a skilled musician, baseball player or tennis player). These reactions occur well before the 500 msec delay, usually within 100-150 msec. Only after the 500 msec do we become consciously aware of the events and our reactions. Still we feel that we are the one who has reacted. Our reaction is not a simple, low-level reflex: our subconscious response in an emergency situation, for example, to avoid our car hitting a child running into the street, is fairly complex, involving recognition of the situation, a decision to act and the actual act of steering and braking.

For Libet (2004), conscious awareness is a phenomenon that is independent of content: we become aware after a certain duration of neural electrical responses, regardless of the specific type of sensation. If these neuronal responses do not last sufficiently long, we do not become consciously aware of the sensation. Nevertheless, there is strong evidence that subjects have a subliminal awareness of the sensation when they are required to guess what the stimulus was, even though the neuronal responses do not last long enough for conscious awareness.

This phenomenon of a required duration of neural activity, an inherent delay and an initial subliminal awareness applies to conscious awareness of sensations, in other words, to brain-to-mind induction. We would argue that a similar process with similar characteristics applies as well to mind-to-brain induction. Thus, we would expect that any endogenous mental event (produced from within), for example, a thought or a decision to act, would also require a characteristic duration of neural activity and thus there would be an inherent delay in conscious awareness with an initial subliminal awareness of the mental event. Because endogenous mental events occur without causing a primary evoked potential (EP), we would expect that one would have no ability to antedate the thought or decision to the actual time it occurred. We would expect that our awareness of a thought or intention to act is delayed because conscious awareness of *all* mental activity, including our own will, must operate through and be mediated by the brain.

Libet (2004, ch. 4) described a series of experiments to time a freely voluntary act (to flex the wrist at a time of the subject's choosing). Prior to any motor activity, a "readiness potential" (RP) appears. The RP is a slow rise in electrical negativity measured at the scalp at the top of the head, which indicates a preparation for the movement. In this experiment, Libet found that the RP neural response occurred typically 550 msec before the actual muscle movement. The subject's awareness of the wish to move was measured by reporting the position of a rotating spot of light on an oscilloscope, one rotation occurring every 2.56 seconds. The accuracy of these timings was confirmed by timing skin stimuli and the experimental results were adjusted for the slight (50 msec) observed delay. Ironically, the subject's *first awareness* of the intention to move was on the average 350 msec *after* the RP. This delay makes it appear that the brain has decided to move prior to the actual conscious intention to move by the subject.

This anomaly of the apparent decision by the brain to act prior to the actual conscious intention has been discussed extensively in the literature. If we accept the proposition that awareness of our own endogenous mental acts is delayed in the same way as sensations, Libet's results become less enigmatic. If we assume that the same delay occurs with endogenous mental activity as occurs with sensations, namely 500 msec, then our decision to "act now" is made, subconsciously, well prior (by some 150 msec) to the appearance of the RP. Only 500 msec later do we become aware of our decision. Table 2 summarizes this picture of the timings from Libet's experiments.

Table 2
Timing of events in Libet's self-initiated act experiment

Relative time	Event
-700 msec	Subconscious wish to move
-550 msec	Readiness potential begins (RP II, no pre-plans)
-200 msec	Awareness of wish to move (W)
0 msec	Muscle movement (EMG)

It appears still to be contradictory that we can subconsciously intend to do something and then half a second later become aware of our intention. However, our experience is that our decisions are purely our own and are made out of the conscious *context* we are in: we are never surprised that we have decided something that is contrary to that context. Furthermore, a delay in the conscious awareness of endogenous mental events (mind-to-brain) is consistent with the general observation made for conscious awareness of sensations (brain-to-mind), that is, that there must be a neuronal response of a certain duration for the event to reach conscious awareness. Therefore, it is reasonable to conclude that delays in conscious awareness, which are preceded by a level of subconscious or subliminal awareness, apply as a general rule to all mind-brain inductions.

Moreover, it is not unreasonable that non-material to material processes involve delays that require a specific duration of neural electrical activity. Even though the precise mechanism for mind-brain induction is not yet clear, such delays can be explained, in the present view, by the nature of our organization, namely, the self-conscious mind united with the brain and body. When our mind is united with the body, the brain mediates all conscious activity from the SCM. Without neural activity, we become unconscious. The SCM's activity needs to be "reflected" in the brain in order to achieve consciousness (Elsas, 2005). Our endogenous mental activity must first work through the brain's neural activity to reach consciousness. In contrast, when the SCM is free of the body, as in an NDE OBE, our endogenous mental activity appears to have a different character. For example, our will appears to work "instantly," that is, as soon as we wish something, it appears to be fulfilled, unencumbered by the brain or body.

Other mind-brain phenomena

A number of other brain phenomena are relevant in understanding how the self-conscious mind interacts with the brain. Popper and Eccles (1977, ch. E5-E6) cite investigations of global lesions of the cerebrum, including commissurotomy (cutting the nerves joining the two brain hemispheres, resulting in a "split brain") and hemispherectomy (removal of one of the brain hemispheres), as well as circumscribed cerebral lesions in the temporal, parietal, occipital and frontal lobes. In each case, the lesions give us an opportunity to discover the functions of the missing brain regions as well as provide insight into how the mind as a whole operates when united with the brain. For example, our awareness and sense of self appear to remain intact through very drastic damage to brain structures and function.

The present view of the self-conscious mind is that it is whole and complete in itself. When the SCM separates from the body in the NDE OBE, it recovers sensory functions such as sight, which may have been impaired, and is no longer constrained by physical disabilities. But when united with the body, the SCM must operate *through* the physical brain for us to be conscious and to have cognitive function. When the brain is dysfunctional or damaged in some way, the operation of the SCM is impaired and difficulties with cognitive functions result. Nevertheless, while in the body, the SCM appears to be able to overcome significant neural damage by transference of function to other brain regions. The appropriate perspective in these cases is not the *plasticity of neural function,* but rather the *adaptability of the SCM* to relearn cognitive functions, in the face of reduced or altered neural function. In the balance of this section we present several different cases of reduced or altered neural function and how they relate to the SCM.

Split-brain patients

Patients with advanced intractable epilepsy are sometimes treated by cutting the cerebral nerve fibers, the commissures, which connect the two hemispheres, in an effort to control epileptic convulsions that cannot be controlled by medication. The main connecting nerves that are sectioned are the corpus callosum, comprising some 200 million nerve connections. Additional, smaller commissures are also sectioned in the commissurotomy. In nearly all cases, the epileptic seizures are completely controlled and, in the balance of cases, are considerably diminished in severity and can be controlled by medication. Despite the evident severity of such an operation, the split-brain patient experiences no apparent serious effect from the operation in terms of ordinary everyday behavior. Split-brain patients do experience some initial short-term memory deficits which are diminished over time, as well as experience fatigue more quickly in reading and other mental tasks (Sperry, 1968, 1974).

However, with appropriate testing procedures, a wide variety of distinct impairments can be demonstrated in the cross-integration of cerebral functions. The left hemisphere is the dominant hemisphere in more than 90% of people, including many left-handed people, and includes the functions of speech and writing. The right hemisphere is the minor or non-dominant hemisphere and includes the functions of face recognition and spatial, musical and non-verbal ideation. The right visual field, the right hand and other parts of the right side of the body "project" neurally to the dominant left hemisphere. Similarly, the left visual field, the left hand and other parts of the left side of the body "project" neurally to the non-dominant right hemisphere.

In the split-brain patient, cognitive functions in the dominant left hemisphere operate essentially as in normal people. When words or images are flashed, for example, only in the *right* visual field, they are perceived via the contralateral *left* hemisphere and the subject can describe them normally in speech and writing. However, when words or images are flashed only in the *left* visual field, the subject insists she saw nothing, or possibly saw only a flash of light. The subject appears to be blind to the left half of the visual field. However, if the subject is asked to point with the left hand to a matching picture or object among a collection of pictures or objects, the subject can consistently point to the very object she just insisted she did not see.

Thus, objects in the *right* visual field (projecting to the dominant left hemisphere) can be recognized and identified verbally. In contrast, objects in the *left* visual field are in fact *seen* (via the non-dominant right hemisphere) and are recognized and remembered, but cannot be identified verbally or with writing. The non-dominant hemisphere in the split-brain patient has a substantial comprehension of language, but appears to be motor aphasic (unable to speak) and is mute as to what it has seen. In addition, the subject, using the dominant, verbal hemisphere, appears to be completely unaware of what she has experienced via the non-dominant hemisphere.

This same cross-hemispheric functional isolation is seen in a number of similar tests. For example, a blindfolded split-brain patient can readily verbally identify an object such as a pencil or a comb that is placed in her right hand. When the same object is placed in the left hand, the subject appears to recognize what it is and can demonstrate how it is used, but, when asked what it is, will make only guesses. The subject can later reliably retrieve the object with her left hand from among several other test items in a sack. Again, the subject, using the non-dominant hemisphere, is unable to name the object she has experienced but still has recognized the object and has remembered it by touch. And again, the subject, using the dominant, verbal hemisphere, appears to be completely unaware of and can only guess at what she has experienced via the non-dominant hemisphere.

Split-brain patients can nearly always compensate for these cross-integrational impairments under ordinary circumstances, such that their behavior appears normal. Left visual field information can be obtained in both visual fields by scanning eye movements, and simple verbal clues from the left hemisphere and non-verbal signals from the right hemisphere can be given to compensate for the lack of internal neural integration. Ordinary motor movements, such as buttoning a shirt, are generally also coordinated because either hemisphere can direct the movement of both sides of the body, including to some extent the movements of the ipsilateral hand (i.e., on the same side of the body).

The split-brain patients themselves claim that they do not feel different after the surgery than before. They claim they do not experience any "dual consciousness" that appears to be present (Gazzaniga, 2000). On the one hand, one can argue that this is the dominant, verbal left hemisphere's experience that is being reported. Any apparent anomalous experiences or gaps in understanding arising from experiences by the right hemisphere might have been explained away or ignored. On the other hand, the patient has utilized strategies which have compensated for the lack of internal cross-integration, so the patient's report of experiencing a single consciousness is probably accurate. Only under unusual circumstances, such as strict experimental procedures, are the experiences of the two hemispheres isolated and unknown to each other.

The phenomenon of split-brain patients was initially interpreted by some investigators as showing that the two hemispheres, each with its own private perceptions, memories and learning which are inaccessible to the other, have their own stream of consciousness. Each hemisphere appears to have a separate "mind of its own". In particular, the minor hemisphere appears to be a complete conscious system with its own characteristically human perceptions, memory, thinking, volition and emotions. If we discount its generally inferior linguistic abilities, the minor hemisphere has its own capabilities at which it excels, such as spatial and musical abilities, and thus is a separate conscious system in its own right (Sperry, 1974).

Such an interpretation is not universally held. Popper and Eccles (1977) used the phenomena of the split-brain consciousness, where only what is experienced by the dominant hemisphere reaches consciousness, as justification to place the primary interface of the conscious self in the dominant hemisphere. Michael Gazzaniga (2000) proposed that the dominant hemisphere harbors our "interpreter", that is, the part of our cognitive makeup that interprets our responses to what we encounter in our experience of the world. The interpreter verbalizes our experiences and provides the unity of our conscious experience through its narratives. The narratives of our past behavior give us an autobiography and create our sense of being a coherent, rational agent, thus providing the basis for the development of our sense of self.

Phenomenologically, the commissurotomy operation results in an extraordinary apparent splitting of conscious awareness. Under test conditions which prevent compensation, the dominant hemisphere is not aware of the experiences arising in the minor hemisphere. Nevertheless, consciousness is otherwise integrated by the patient by various compensating behaviors. The interpretation that there are two minds operating independently is not tenable because of the automatic compensation the patient adopts to overcome the cross-integrational impairments. The patient automatically works to integrate what the commissurotomy has blocked, namely the natural neural communication between the hemispheres.

So the split-brain phenomena are better viewed from the perspective that neural electrical activity has been blocked across the commissures, rather than there is now a splitting of consciousness. The patient's sense of self remains intact. The situations resulting from test conditions that prevent external compensation give indications of the effects of blocked neural electrical activity especially along pathways from the minor hemisphere to the dominant hemisphere. These test results indicate that significant cognitive functions can occur (perceptions, memory, thinking, volition and emotions), and yet remain unconscious when the neural activity along the necessary pathways is inadequate to achieve conscious awareness. Thus, all of the cognitive activity of the minor hemisphere remains subconscious or subliminal.

In the present view, a certain duration of electrical brain activity is needed to bring cognitive activity, including endogenous mental activity, to consciousness in the SCM. The sectioned commissures have blocked the neural pathways that ordinarily conduct the inter-hemisphere electrical activity that is necessary to reach consciousness. The experiences of the minor hemisphere thus are forced to remain subliminal to the SCM. A demonstration of the subliminal character of the minor hemisphere's experience is given in tests where the presentation of an embarrassing or a terrifying image will cause a strong emotional response in the patient (seen as blushing or giggling or a fearful reaction). The emotional reaction is felt consciously but the patient can't explain its cause consciously. The emotional reaction is thought to be spread across the hemispheres via intact neural routes that have not been divided, whereas the perceptual image has been blocked from conscious awareness.

From the present view, the split-brain phenomena give an indication of the neural process of "coming to consciousness", that electrical activity from cognitive functions in the minor hemisphere must traverse the corpus callosum in order to reach conscious awareness. Otherwise, the cognitive functions such as perceptions, motor responses, learning and emotions are able to be completed successfully but without coming to conscious awareness. The conscious awareness appears to be the final step in the process and, in a way, is superfluous to successful completion of long sequences of cognitive activities. This result is not completely surprising because there is strong evidence, for example, of people being able to react quickly to emergency situations without being fully aware of the situation (e.g., a child running into the street in front of one's car), or of people executing complex motor sequences without direct conscious control of every movement (e.g., a virtuoso piano performance).

The split-brain phenomena confirm the earlier conclusion that cognitive processes, including endogenous volitional acts, require a certain duration of neural activity to come to our conscious awareness. The severed corpus callosum prevents the neural activity from reaching that level. Nevertheless, the effects of subliminal experiences are still present in the SCM and show themselves to be present subliminally, such as with the patient's emotional reaction to an embarrassing image. We would expect that a forced choice experiment, wherein the subject is forced to make a response whether the subject was aware of a stimulus or not, would show that the subliminal awareness is present (cf. Libet, 2004, p. 116).

Hemispherectomy patients

Hemispherectomy or hemidecortication is the surgical removal of one cortical hemisphere. The procedure is used to treat intractable unihemispheric epilepsy and is usually performed on children. Two recent studies have shown that this procedure is very effective in eliminating or reducing seizures. Motor ability in general is already impaired preoperatively on the affected side of the body (i.e., hemiplegia), and the motor impairment is generally either improved or unchanged postoperatively. In addition, language ability and cognitive function are not significantly impaired, even though half of the brain has been removed.

E. H. Kossoff et al. (2003), summarizing the outcomes for 111 hemispherectomy patients, reported that 89% of patients are able to walk independently without the use of assistive devices. Indeed, several patients have shown such adaptation on their handicapped side that they can play piano, golf and ping-pong. Most patients are in school or have graduated and hold jobs. Similarly, Devlin et al. (2003), summarizing the outcomes of 33 hemispherectomy children, reported that no significant cognitive deterioration or loss of language occurred, and four children showed significant cognitive improvement. There was no significant loss of language function following either right-sided or left-sided hemispherectomy.

Thus, there is generally no deterioration of motor, language or cognitive function and sometimes there is significant improvement in one or more of these areas, even with the removal of the dominant hemisphere. From the results of split-brain patients, we would expect that removing the dominant hemisphere would result in the loss of the ability to speak. In the split-brain patient, the separated, non-dominant hemisphere shows severe motor aphasia. Indeed, left hemispherectomies *in adults* can result in severe motor aphasia (see Popper and Eccles, 1977, pp. 331-332). In contrast, motor aphasia is considerably less in children and is nearly absent when the hemispherectomy is done in infants. There is evidence that language ability in infants and young children is still not localized in one hemisphere and thus is readily transferred to the unaffected hemisphere.

Thus, self awareness, speech, motor ability, and cognitive functions, including memory and learning, are unimpaired and are sometimes improved despite the loss of half of the brain. Researchers speculate that part of the reason these operations do not result in significant dysfunction is that the speech and motor functions have already transferred prior to the operation from the partially or severely dysfunctional hemisphere, and thus reside completely in the healthy hemisphere. Even that is remarkable, that brain functions can gradually transfer from one hemisphere to the other through the restriction of normal neural function in one hemisphere due to disease.

Explanations that are offered for this apparent transference of function are "neural plasticity" or "neural reorganization". These phrases appear to lack explanatory force and simply acknowledge that such phenomena exist. In the present view, such transference of function is the result of the mind's activity to adapt to the reduced neural capacity. The SCM applies its independent agency on the brain and "learns" how to accomplish an equivalent function via other neural pathways, thereby providing a continuity of function. Indeed, part of the disease symptomatology in these cases probably results from just this adaptive activity of the mind and how successful or unsuccessful the adaptation is. A striking instance of this is the adaptation of motor and sensory functions to the ipsilateral hemisphere, when the contralateral hemisphere that normally supports them, with its supposedly hardwired neural pathways to the limbs, has been removed.

The fact that neural plasticity or reorganization occurs with hemispherectomy (and in many other cases) confirms the present view that a non-neural agency is involved in mental functions. The adaptation of the SCM to an altered neural environment appears to be most effective via gradual change, where the SCM can continue to operate and gradually learn a new mapping of neural pathways. A sudden change in neural structure, such as with brain trauma or stroke, probably leaves the SCM "isolated" from adaptive neural pathways.

Roger Sperry (1974) and others have noted that when functions appear to be transferred to another part of the brain, there is an apparent "crowding" of function. For example, when verbal functions have transferred to the minor hemisphere, language tends to develop at the expense of the competing non-verbal functions, resulting in deficits in the normal minor hemispheric (e.g., spatial, non-verbal) functions. The phenomenon of functional "crowding" implies that conscious functions require a certain degree of "neural capacity" in order to operate. In the present view, the phenomenon further implies that the SCM requires a minimum neural capacity to support cognitive functions, perhaps as an unambiguous dedication of neural pathways to provide the necessary mind-brain interfaces.

Hydrocephalus patients

Hydrocephalus is a condition involving an increase in cerebrospinal fluid volume in the brain. The increased fluid volume can raise intracranial pressure, increase the size of the cerebral cavities or ventricles, distort brain structures, and change the composition of the gray and white brain tissue. Generally the child is at a high risk of motor and cognitive impairment, and if untreated, of dying. About 50% of children who are treated with a shunt to release the intracranial pressure achieve a normal IQ. The cognitive impairments are generally thought to be a result of the anomalies in brain development, for example, selectively thin cortical structures (Chumas et al., 2001; Dennis et al., 1981).

What is striking about hydrocephalus is that some patients achieve normal cognitive function, indeed in some higher than normal IQ, with drastic deformations of brain structure, reduction of brain mass, degeneration of neural axons (white matter) and reduction of cerebral blood flow. John Lorber (1981; Lewin, 1980) reported an analysis of more than 600 CT scans of patients with hydrocephalus including a comparison of ventricular size with intellectual and physical function. In about 10% of the patients, there was a reduction in brain volume of 95%. Many of these patients were severely disabled, but about half of them had an IQ greater than 100. Lorber cited one mathematics student with an IQ of 126 and socially completely normal, who had a cerebral mantel about 1 mm thick, compared with the normal thickness of 45 mm. The balance of his cranial volume was cerebrospinal fluid. These cases of severe ventricle expansion with normal functioning and normal or above normal intelligence indicate that normal cognitive function can be achieved with a significant deviation from normal brain structure, brain mass and neural cell structure.

Op Heij et al. (1985) reported an analysis 50 cases of primary non-obstructive hydrocephalus in infants for factors predicting later intelligence. The most predictive factors were the age of speech development, the age of walking and general motor disability. Thus, a child who begins to speak and walk at the age of 12-17 months and who has normal motor ability or only slight disability will typically have normal IQ. Thus there appears to be a relationship between intellectual development and motor development, as seen in speech, walking and general motor ability. Consistent with Lorber’s (1981) results, this research found no relationship between intelligence and ventricular size or brain mass. However, there was a relationship between ventricular size and loss of skill in perceptual-motor tasks. The enlarged ventricles did affect certain motor tasks in some children. Thus, it is likely that cortical deformations, reflected in ventricular size, can result in the observed motor disabilities in some children, which in turn negatively affect intellectual development.

Both of these general results are relevant to the present view. The SCM can work within the brain even when it is affected by hydrocephalus. Milder hydrocephalic cases, with moderate and slow progressive hydrocephalus in infants, can be managed conservatively, without shunting to relieve intracranial pressure, and typically result in higher survival rates and higher IQ than with shunting (Lorber, 1981). When the abnormal brain structures develop slowly, the SCM can apply its independent agency on the developing brain and “learn” how to accomplish the necessary function via existing neural pathways, thereby enabling normal development. But if cortical deformations occur too quickly or to too large an extent, the SCM can become overwhelmed and can’t successfully adapt to operate via the existing neural pathways. There is then a cascading effect that interferes with the onset of speech or walking, or results in moderate or severe motor disability. The negative effects on motor abilities then interfere with intellectual development, because much of the intellectual development of the first several years comes through bodily movement.

As with hemispherectomy, hydrocephalus demonstrates that the non-neural agency of the SCM is involved in mental functions. The SCM can adapt to an altered neural environment particularly when the change comes about gradually, where the SCM can continue to operate and gradually learn a new mapping of neural pathways. A sudden change in neural structure can overwhelm the SCM. The learning of new neural pathways by the SCM appears to be facilitated by bodily movement in conjunction with acquiring cognitive skill. When motor ability is impaired, the SCM has difficulty integrating or reintegrating with the brain.

Decorticate patients

Children who are born without cerebral hemispheres, that is, who are “decorticate”, are usually thought to remain in a persistent developmental vegetative state, because the functions of the neocortex are thought to be required for consciousness. Alan Shewmon et al. (1999) reported the cases of four children aged 5 to 17, with congenital brain malformations involving complete or nearly complete absence of cerebral cortex. Nevertheless these children possessed numerous functions of ordinary consciousness including person recognition, social interaction (smiling when spoken to, giggling when played with, vocalization with music therapist), functional vision (object discrimination, fascination with own reflection), musical preferences, orienting toward and smiling at someone calling, appropriate affective responses, goal directed motor behavior (scooting on back to reach a goal) and associative learning (using limited receptive vocabulary to correctly look at an object).

Shewmon and colleagues argued that even though there is evidence of some cortical tissue in two of the subjects who thus were not absolutely decorticate, the children's neurologists' prediction was nonetheless of a vegetative outcome. Consciousness in all four subjects can be inferred to be mediated subcortically. Even though there were some neurons present, those few neurons could not plausibly support the range of their conscious behaviors. Still, the two subjects with rudimentary limbic structures were more affective, sociable and had more motor function than the other two subjects with the more classical decorticate condition of hydranencephaly. Clearly the presumptions that the cortex is necessary for consciousness and that a decorticate child will be in a "persistent vegetative state" need to be reexamined.

In the present view, the SCM operates within whatever brain structures are present. Certain subcortical structures appear to be an absolute prerequisite to consciousness: damage to the reticular formation of the brain stem results in permanent loss of consciousness (Eccles, 1994, p. 81). While the SCM is connected to the body, it must work through the brain. Nevertheless, the SCM is whole and complete in itself. Therefore, it is possible for a decorticate child to exhibit a wide variety of conscious functions with a minimal neural structures. Clearly, certain functions were severely limited: the subjects were all severely disabled in cognitive and motor function, vision was only marginally present (estimated at 20/600 to 20/200 in one subject), speech was absent, and so on. The reason these four decorticate subjects appear to be able to function at such a high level is that the SCM is able to adapt to the limited neural pathways present and operate to the extent that they allow.

The case of decorticate children is perhaps the clearest example of the non-neural agency of the SCM; in this instance the SCM operates in severely limited cortical structures. Since the SCM is whole and complete, even the decorticate child can be viewed as a complete person, despite the clearly evident physical disabilities that are present. The same principle of the integrity of personhood applies to numerous other instances of disability and physiological degeneration: despite the sometimes extremely severe physical limitations, there is a whole individual present.

Clearly the four decorticate children in this study are conscious individuals even though they were diagnosed to be in a persistent vegetative state (PVS). PVS is assumed to be a state in which the individual is awake but unaware, because the brain stem continues to function but there is a total loss of cerebral cortical functioning. Clearly these criteria do not apply when there is obvious conscious functioning as in these four subjects. But what about individuals who meet these criteria (brain stem function but no cortical function), but who do not exhibit any evidence of consciousness? A related question is how to determine the time of death, especially for individuals who meet these criteria.

The phenomenon of the NDE can be instructive here. Since the SCM separates from the body in the NDE, a reasonable hypothesis is that the same process occurs at death. Indeed, the NDEr can exhibit all of the signs of physical death and yet somehow revives. Furthermore, the accounts of anticipatory NDE, where an NDE has occurred but there has been no actual physical trauma, imply that the SCM can separate from the body even though the body continues to function. If this hypothesis is correct, the criterion for death then becomes the *permanent* separation of the SCM from the body. Even if the SCM has permanently separated, it may still be possible for the body to continue to function on life support, but the recovery of consciousness will not occur. If the hypothesis that death involves the separation of the SCM is correct, the question then is to determine unambiguously that permanent separation of the SCM has occurred. There are enough cases of NDEs of long duration, that is, where the individual was apparently dead on the order of days, which indicate that this is not an easy matter to determine. Further study of the phenomena is needed.

Phantom limbs

A phantom limb is the vivid experience that a limb that has been amputated is still present. Between 90% and 98% of all amputees experience a vivid phantom almost immediately after the loss, particularly if the loss was due to a sudden, traumatic event, as opposed to a planned amputation of a non-painful limb. Phantoms occur less often in early childhood, with a gradual increase in incidence from 20% in children less than 2 years old, increasing to 25% at ages 2-4, 61% at ages 4-6, 75% at ages 6-8, and 100% in children older than 8 years. The onset of phantom sensation is usually immediate, as soon as the anesthetic wears off, but may be delayed by a few days or weeks. The phantom limb is perceived to be an integral part of the body, with a distinct shape and occupying a habitual position or posture. If the limb was deformed or painful prior to amputation, the deformity or pain is often carried over into the phantom. Many patients are able to move the phantom limb at will, but in some the limb is stuck in a fixed posture (Ramachandran and Hirstein, 1998).

The phantom limb appears to the patient as subjectively very real, especially shortly after the amputation, and as part of their body. The patient can use the phantom to reach for a cup, extend to shake hands, gesticulate when talking or count on the phantom fingers. Such experiences occur even when the phantom appears in a limb that was congenitally absent

(Ramachandran, 1993; Poeck, 1964). Sensations in the phantom can be invoked by the sight of the phantom interacting with objects, such as a feeling of wetness when the phantom foot “steps” in a puddle (Melzack, 1992). V. S. Ramachandran (1998) described a patient who grasped a cup handle with his phantom fingers and felt strong pain when the cup was pulled away.

About 20% of people who were born without a limb experience a phantom (Melzack et al., 1997). The cases of phantoms in subjects with congenital limb deficiency can be striking: the use of the phantom fingers to count and solve simple arithmetic problems like other children, the use of the phantom arms to gesticulate during conversation, and the sprouting of phantom fingers to “assist” the stump in manipulating objects. The sensation of a phantom as an integral part of the body can be among the earliest memories of a subject (Brugger et al., 2000). On the other hand, in other subjects with congenital absence, no phantom sensations are felt initially for the missing limb, but may be awakened later in life by a blow to the stump or after minor surgery. Phantom limb pain occurs in relatively fewer congenitally limb-deficient subjects than in amputees.

Elizabeth Franz and V. S. Ramachandran (1998) described an experiment that demonstrated bimanual coupling between the phantom arm and the intact arm. Ordinarily a person cannot perform two “contradictory” actions with both hands simultaneously, such as twirling the finger of one hand and drawing a vertical line with the other, because the hand and arm movements are coupled together. When this experiment was performed on an amputee, the phantom arm and hand still showed bimanual coupling, as if phantom was actually present. Thus the operation of the phantom appears still to be integrated with the patient’s overall motor function.

The phantom limb can become paralyzed and stiff, or stuck in an awkward position. Because of the sense of the phantom’s reality, the patient usually acts to accommodate these sensations by moving so as not to interfere with the phantom’s position. Sensations in the limb prior to amputation can also be carried forward to the phantom, such as the presence of a ring that fits tightly on a finger (Melzack, 1992). These phenomena all imply that the phantom limb is integrated into the patient’s body as much as the intact limb was prior to amputation.

In many cases, the phantom is experienced vividly for a few days or weeks, but then gradually fades from consciousness. In other patients, the phantom persists for years or decades. Some patients can recall a faded phantom by focusing attention on it or by some form of stimulation to the stump. For about half of the patients in whom the phantom fades, it does so by the limb gradually growing shorter or “telescoping” in. This occurs especially for the upper limbs: only the experience of the phantom hand remains, extending from the end of the stump or the hand may disappear into the stump. Some patients can telescope their phantom arm out or in at will, for example, when they reach for an object.

More than 70% of amputees experience pain in their phantom. The pain appears in the form of cramping or a clenching spasm, or as a painful burning, tingling, shooting or tearing sensation. When pain is present, movement of the phantom is also painful. In the case of a clenching hand, the patient frequently also feels the fingernails digging into the palm. The pain does not result from the existing somatosensory neural pathways because cutting these pathways at every level from the stump to the spine to the thalamus and cortex has been attempted. The pain may be alleviated for a while in these cases, even for months or years, but usually returns. Moreover, the sense of the phantom limb itself persists even when these nerves are severed (Melzack, 1992). Phantom pain may lessen in the months following amputation, but in general, phantom pain that persists more than 6 months after the operation is very difficult to treat. Analgesic drug therapy is often used but is not very effective.

V. S. Ramachandran and D. Rogers-Ramachandran (1996) described a novel treatment for phantom pain using a “virtual reality box”. The patient inserts the intact arm and the phantom arm in the box which has a mirror installed lengthwise between the arms. The image of the intact arm is seen in a mirror so that it coincides visually with position of the missing arm behind the mirror. The amputated arm now appears to be present. The subject is usually surprised and pleased to see an image of his missing arm, now resurrected. The patient is asked to make mirror symmetric movements with both hands and generally experiences vivid sensations of movement in the muscles and joints of the phantom. When the eyes are closed or the mirror is removed, the patient’s arm remains frozen as before. The visual feedback of movement in response to volitional motor commands restores phantom limb movement and sensations. If the phantom hand has been clenched or frozen, it can be unclenched and the related pain is relieved. In general, the phantom pain is reduced or eliminated following a number of short mirror-box sessions and in some cases the phantom recedes completely.

The procedure of matching voluntary “movements” can also be done using computer generated images rather than a mirror (Giraux and Sirigu, 2003). With training in these movements, a dramatic increase in motor cortex (M1) activation was detected in some subjects, with a corresponding decrease in pain. Subjects not showing the increase in motor cortical activation had little or no pain relief. With these virtual reality therapies, pain is generally reduced in clenching, cramping and constriction, that is for proprioceptive motor related pain, but not burning, tingling, electric discharge or shooting pains, that is sensory nerve related pain.

Subjects frequently can feel sensations in their phantom when other parts of the body are stimulated. These sensations are thus referred sensations and are also called "dual percepts" or "mislocalizations". For example, gently stroking the ipsilateral (on the same side) cheek or lip with a cotton swab produces a touch sensation on the cheek, as one would expect, *and* a sensation of tingling on a finger or the palm of the phantom hand. In some patients, these referred sensations are "mapped", that is, the regions that show referred sensation on the face are contiguous and correspond to different fingers appearing on different parts of the cheek, lips and jaw. There may also be a similar mapping of the phantom hand on the regions surrounding the amputation such as on the arm stump or shoulder and occasionally also on the contralateral limb (Ramachandran and Rogers-Ramachandran, 1996). Also, in some subjects, the sensations are multi-modal, so the subject can distinguish touch, hot or cold, pain, and complex sensations such as water trickling (Ramachandran, 1993).

One reported subject (F.A.) had his right arm amputated 8 cm below the elbow after a boating accident. F.A. showed a striking ability to move his phantom at will. He experienced a referral of sensation on the face and at two different arm locations, on the stump and the biceps, which formed two complete "maps" of his phantom hand. When F.A. subjectively rotated his phantom hand to the left, the touch sensation of the biceps map shifted 1.5 cm to the left (toward the body) and shifted back on return to the original hand position. As a demonstration of this, if a drop of water was placed, say, on the pinkie finger region on the arm, when F.A. rotated the phantom hand, he felt the water moving from the pinkie to the ring finger (Ramachandran, 1993, p. 10419).

The referred sensations are not exactly like normal touch or temperature sensations, because there is a 2-3 second latency before the sensation is felt in the phantom hand, and when the stimulus is removed, an "echo" of the sensation persists for 8-10 seconds afterward in the phantom. The sensory latency and echo, of course, do not occur in the *direct* touch sensations from the direct stimulus to the face or arm (Ramachandran, 1993). Thus, the referral of ipsilateral sensory stimulation to the phantom hand appears to be an "invasion" of the phantom hand into the face and upper arm, with a phantom-like delay of the sensation and echo of sensation.

The referral of stimuli from the face and upper arm to the phantom limb was also studied with magnetoencephalography (MEG). The MEG image of the sensory cortex representing the amputation side showed that sensory information from stimulation of the face and upper arm had shifted in the brain toward or into the region of the hand; the hand region happens to fall between these two regions. In the other hemisphere, representing the intact side, the mapping of sensory stimulation appeared normal. The absence of the amputated arm and hand seems to allow the neural pathways from the adjacent regions of the face and upper arm to expand and "invade" the neural structures of the missing limb (Yang et al., 1994; Ramachandran and Hirstein, 1998). At the same time, of course, there is delayed referred sensation from stimulation of the face and upper arm to the phantom hand. Anke Karl et al. (2001) found that there is a similar reorganization of the motor cortex in upper limb amputees, where the motor neural areas for the lip and biceps muscles are similarly displaced toward the motor hand region.

This cortical reorganization happens within hours or days, so it is unlikely to be due to new neural synaptic growth. Furthermore, a very strong correlation was found between phantom limb pain and the observed cortical reorganization (Flor et al., 1995; Birbaumer et al., 1997; Karl et al., 2001). The greater the shifts were in cortical electrical activity from their expected neural pathways, the greater was the phantom limb pain experienced by the patient.

Thus, we have *outwardly* an apparent invasion, in some subjects, of delayed sensory feelings of the phantom hand into the face and upper arm and, at the same time, we can observe through *brain imaging* an apparent invasion and reorganization of the sensory and motor neural structures of the face and arm into the adjacent region of the missing limb. In at least one subject (F.A.), the sensory map of the hand on the arm can shift with the subjective movement of the phantom hand. Along with the cortical reorganization of neural pathways, the amputees experience both proprioceptive motor related pain (clenching, cramping or constriction) and sensory related pain (burning, tingling, electric discharge or shooting pains). The former types of pain, but not the latter, can be alleviated by phantom limb movements that are enabled when an image of the phantom limb's movements can be seen and copied by the patient.

In the present view, the non-material SCM has a shape similar to the physical body and this shape includes "mind-limbs", which are visible to many NDErs during the OBE (Moody and Perry, 1988, p. 10). The phantom limb is the continued conscious experience of the mind-limb when the body limb is not present. The SCM is whole and complete from birth even though it may be united with a physical body that has deformities. Thus we would expect that phantom limbs would be experienced by subjects with congenital limb deficiencies. However, because the deficient limb was never physically present, the mind-limb in many cases will not be engaged by the subject during infancy and childhood but will rather lie dormant. Similarly for young children who have limb amputation, the younger the age of the operation the more likely that the mind-limb will be dormant because the mind-limb will have had less time to unite and integrate with the physical limb through ordinary physical movement. This implies that during infancy and early childhood, the SCM becomes more and more intimately united with the physical body until the age of 7 or 8, through normal use of the limbs and body.

The mind-limb projects into and throughout the physical limb, probably via the limb's neural pathways. The cortical electrical activity that we observe in the motor and somatosensory cortex is a *reflection* of the mind-limb activity in the body rather than the cause. Thus, the activity of the phantom mind-limb, both sensory and motor, can result in measurable cortical electrical activity even though parts of the neural pathways are missing due to amputation. The phantom mind-limb must still be able to induce electrical activity, including sensory activity from purely mental constructs such as "seeing" one's phantom hand move in a mirror, "feeling" one's phantom finger nails digging into the palm, "feeling" one's phantom foot step in a puddle, or "seeing" the cup pulled away with the phantom fingers wrapped around the handle.

Note that these phantom limb sensations all result from *mind-to-brain* inductions, whereas we usually associate sensation with *brain-to-mind* induction via neural sensory stimulation. In the case of the phantom mind-limb, the SCM is inducing neural stimulation at some point in the neural sensory pathways. This kind of induction is not the normal sensory induction but involves both a long latency and a very long echo sensation. Thus the neural induction from the phantom mind-limb must be influencing the sensory neural pathways at unusual locations and via an unusual form of induction. However, the operation of the phantom mind-limb may provide insight into how mind-limbs normally operate when the neural pathways are intact.

Normally there are thresholds before neural electrical activity reaches conscious awareness: a certain minimum intensity of stimulation and a minimum duration of electrical activity (usually 500 msec) must occur before we become aware of the stimulus. Since the amputee's SCM is still united with the brain, these requirements must still hold. Thus, we can expect to see thresholds of phantom sensations, both non-painful and painful. Indeed, data from Sabine Grüsser et al. (2001, p. 269, lower right) suggest that there is a threshold of phantom limb pain associated with cortical reorganization >8 mm but not ≤8 mm. Similar thresholds may account for the variations reported in the literature in subjects who have or do not have phantom limb sensations, referred sensations, referred mappings, and so on.

In normal physical development, the mind-limb is usually well formed and coincident with the physical limb. However, when there is a loss of a limb, especially through a sudden traumatic event, the mind-limb becomes a phantom limb. The subject continues to experience of mind-limb even though the physical limb is not present. The subject experiences the phantom within hours or days of the amputation because the mind still works to project the mind-limb into the missing limb. The process of projection is not a neural process but a mind process. The subject will not experience a phantom if the mind-limb has retreated and isn't active. However, the phantom can be "called out", usually with a blow or other stimulation to the stump.

The patient can still feel the phantom and move it, but the non-material phantom does not interact with the physical environment. When a prosthesis is used, the patient usually experiences that the phantom fills the mechanical prosthesis as it would the physical limb. The phantom then interacts through the prosthesis with the environment much as a blind person uses a cane to sense the area in front of him. The prosthesis becomes integrated into the patient's body sense through movement of the prosthesis-embodied mind-limb. K. Poeck (1964) reported that a man with a leg amputation so well integrated his leg and foot that he could feel the unevenness of the ground through the prosthesis as well as he could through the shoe on the intact foot.

When there is the sudden loss of an arm, say, the mind-arm's projection into the body can become "diffuse", because there is no physical arm to project into. Then we observe the related phenomena of (1) an apparent invasion, in some subjects, of the sensory aspect of the mind-arm into other parts of the body, (2) an apparent invasion or reorganization, in all subjects, of neural sensory activity into the missing arm and hand's cortical region, and (3) sensory and motor related pain. The mind-arm seeks its normal neural pathways but they now reach only to the stump; the mind-arm becomes diffuse and disorganized. Indeed, the degree of neural reorganization and pain both appear to be related to the length of the remaining arm: the shorter the residual arm, the greater in general is both the motor neural reorganization and the phantom limb pain (Karl et al., 2004). With a greater length of limb loss, the mind-arm projection becomes ever more diffuse and disorganized.

In the cases where referred sensations are felt by the subject, for example from tactile stimulation to the lower face, the neural pathways leading from the sensory cortex to the hand become involved. Adjacent pathways, which are neurally close together to the hand at points along the path, for example in the thalamus (cf. Ramachandran, 1993, p. 10418; Grüsser et al., 2001, p. 270), are induced by the mind-arm in these subjects to project sensory receptivity to the face, upper arm and other areas. Sensory stimuli above the requisite threshold at these face and arm locations are then projected both to the primary face or arm area *and* to the referred phantom location. The induction across adjacent neural pathways is not the usual neural connection and so results in a 2-3 second latency and an 8-10 second echo of the referred sensation.

The projection of the mind-arm still carries the neural structural form of the hand, so the associated induction results in contiguous sensory maps of the fingers and arm forming on the face and upper arm. The limb projection is a dynamic mind process and thus we can occasionally see a movement in the sensory mapping when the subjective mind-arm changes position. Over time the cross-neural induction weakens in many subjects, probably because the projection of the mind-arm becomes less diffuse and more focused in its proper place, namely in the location where the arm was. The absence of referred sensations in many subjects is due both to the induced sensations failing to reach the requisite threshold, and, particularly in congenitally limb-deficient subjects, to the focused organization of the mind-arm.

The normal neural processes for the face and upper arm areas continue to function. However, additional neural activity from the mind-arm induction is superimposed on the normal neural electrical activity. This extra electrical activity would ordinarily project to the hand regions of the sensory and motor cortex. Thus we see an anomalous shift of the face and upper arm electrical activity toward the hand region because it is reflecting the combination of normal tactile sensations and motor activity of the face and upper arm as well as the induced sensory and motor activity of the mind-arm. The result is both a diffuse neural activity in the cortex and, frequently, subjective sensations of pain. We would expect the motor related pains of cramping, clenching or constriction to be associated with the anomalous shifts in the motor cortex (Karl et al., 2001), and are probably caused by anomalous induction of electrical activity in proprioceptive pathways. Similarly, we would expect the sensory related burning, tingling or shooting pains to be associated with the anomalous shifts in the somatosensory cortex, and are probably caused by anomalous induction of electrical activity in sensory pathways. The induction by the mind-arm is clearly demonstrated by the non-material, clenched fingers digging into the non-material palm and inducing the real sensation of pain via neural pathways.

Thus, the observed shifts of neural activity in the cortex is not a cortical "reorganization", but rather is the abnormal projection of mind-limb into the body via a neural induction which is then reflected back as a shift in neural electrical activity. The rule then appears to be that when the SCM cannot "connect" to a limb via ordinary neural pathways, the SCM will initially induce adjacent neural pathways using an abnormal induction which will cause phantom limb pain. Such pain will not be conducive to ordinary pain management via analgesic drug therapy because it involves an unusual kind of neural induction which the ordinary therapies do not affect. Similarly, severing the nerve pathway to the painful limb will also not help because the pain is occurring via the adjacent induced neural pathways leading to the referred areas.

Nevertheless, alternate therapies are possible, which can reorganize and "focus" the phantom mind-limb and reduce or eliminate the pain. In the virtual reality mirror box (or an equivalent computer generated display), when the subject sees a mirror image of his hand projected where amputated hand would be, the mind-arm projection immediately focuses from a diffuse projection into the hand image that is actually seen. This reduces the diffusion and focuses the mind-arm projection in the proper place in space. We would expect that this focusing would feel pleasant to the subject and this is what subjects report. With movements of the hand image and corresponding subjective movements of the mind-limb, the mind-limb can begin to follow the normal motor neural pathways. Some of the pain can be alleviated, especially pain that is related to the *spatial placement* and *proprioceptive sense* of the limb (i.e., clenching, cramping and unnatural posture or position). The mind-limb can now focus and project properly into the presented *image* of the limb. The practice of movement of the phantom reorganizes the placement and the motor function of the mind-limb.

However, we would expect that not all pain is reduced because this sort of focusing is only via an image and the subjective hand movement that follows and mimics the moving image. The process of refocusing the mind-limb is similar to the learning that an infant does to integrate her mind-limbs with the body in the first place. The infant does not learn to use her arm and hand by looking at an image of it, but rather by actually using it in the world. Therefore we would expect that a much more effective therapy would be to use a prosthesis, where the subject could work with the prosthetic arm and hand in the world. This would be much more effective in refocusing the mind-limb properly and should eliminate all diffuse neural activity, including pain that is related to the *sensory functions* of the limb (i.e., burning, tingling and shooting pains). The mind-limb can now focus and project properly into a physical representation of the limb (the prosthesis). The use of the prosthesis reorganizes the sensory function as well as the motor function of the mind-limb.

Thus, we would expect that projection of the phantom mind-limb into a functional prosthesis, where the patient can relearn to use her mind-limb actively to interact with the environment, would be very effective in reducing or eliminating phantom limb pain. Use of the prosthesis refocuses the mind-limb to its proper spatial position, eliminates the pain-inducing neural inductions in adjacent pathways, and thereby eliminates both the referral of sensation to other body areas and the anomalous cortical "reorganization". The use of a cosmetic prosthesis, on the other hand, would not involve movement and interaction of the mind-limb with the physical environment and would not result in reduction of pain. In fact, the active use of a functional prosthesis, such as a myoelectric or Sauerbruch prosthesis, has been found to be positively correlated with reduced "reorganization" and reduced phantom limb pain (Lotze et al., 1999; Karl et al., 2004; Weiss et al., 1999). The use of a cosmetic prosthesis did not result in reduced phantom limb pain.

Thus, the present view of the SCM provides a comprehensive explanation of phantom limb phenomena. Phantom limbs provide strong supporting evidence of the reality of the non-material mind and the adaptability of the SCM to altered body function. Phantom limb phenomena should also provide a good ground for scientific investigation of the SCM because the phantom mind-limb is a non-material reality that interacts semi-independently of the body and brain in unusual, counterintuitive ways which can be explored experimentally.

Mechanism for Mind-brain Interactions

The phenomenon of the NDE OBE strongly suggests that consciousness can operate completely independently of the body, with perception, volition, feelings, thought and memory. A number of neural electrical phenomena suggest that there is a non-material agency that induces conscious experiences and self-consciousness. In the present view, this agency is the non-material independent self-conscious mind (SCM), which ordinarily is intimately united with the brain and body. The SCM must interact with the brain in order for consciousness to occur. Thus, there must be some process or means whereby the mind induces electrical brain activity and is induced by electrical brain activity.

How can the non-material mind interact with the physical brain? In particular, how can the non-material mind interact with the physical brain when it doesn't interact with other physical things while out of the body (e.g., passing through physical objects)?

Brain-to-mind induction can be demonstrated with external electrical stimulation of the sensory cortical areas or the temporal lobes, which *simulates* natural neural electrical activity and produces conscious experiences (sensations, percepts, feelings and memory sequences). This phenomenon implies that naturally-occurring neural electrical activity from sensory brain processes induces conscious experience of actual percepts. *Mind-to-brain induction* can be demonstrated with particular mental states, such as a willed movement, concentrated attention or the recognition of an image, which cause identifiable electrical brain activity such as the readiness potential (RP) and characteristic patterns of large-scale neural synchrony.

In both cases of induction, brain-to-mind and mind-to-brain, it is reasonable to propose that the two kinds of induction are equivalent, perhaps symmetrical or complementary. The phenomena indicate that the induction operates from one aspect of reality (physical brain functions) to another aspect of reality (mind) and vice versa. The actual process of mutual induction between the two aspects of reality must be identified by considering agencies beyond ordinary physical processes, because the mind is non-material and not yet well understood.

Addressing the "hard problem"

David Chalmers (1995) asserted that the really "hard problem" of consciousness is the problem of *experience*, that is, how physical brain processes give rise to subjective experience, and why the performance of specific brain functions is accompanied by experience. Chalmers explained that, in physics, it occasionally happens that an entity may be encountered in a phenomenon that has to be taken as *fundamental*, that is, the entity cannot be explained in terms of anything simpler. He cited the example of the development of electromagnetic theory by Maxwell and others, where the fundamental entities of charge, electrical force and magnetic force were introduced in order to explain the phenomena of electromagnetism.

Chalmers proposed that *experience* could be taken as a fundamental entity. We propose that *mind* is a better choice to introduce as a fundamental entity, in order to develop a theory of consciousness from the phenomena. Chalmers' "hard problem", that is, how does experience arise from physical brain processes, can then be reformulated into two somewhat simpler problems: (1) how does the self-conscious mind, when *united* with the body, interact with physical brain processes to give rise to experience, and (2) how does the self-conscious mind, when *independent* of the body, interact with physical processes (and other mind processes) to give rise to experience? These two questions need to be studied phenomenologically: the externally observable physical aspects and their correlated subjective experiences need to be studied simultaneously, as independent categories, to understand both aspects and their relationship (cf. Libet, 2004, p. 153).

There are thus two classes of phenomena to be studied: (1) the neural correlates of conscious experiences, and (2) the experiences of the mind within physical environs, when it is independent of the body, that is, in a veridical OBE. The first class of phenomena, the neural correlates of conscious experiences, needs to be studied, not from the perspective of consciousness in some way emerging from brain activity, but rather as consciousness arising from the *interaction* of an independent self-conscious mind with the brain. It is clear from numerous phenomena that the brain mediates conscious experience while the mind is united with the brain and body. Consciousness arises in this case when the mind operates *through* the brain.

This first class of phenomena is the more tractable of the two, since it is part of the ordinary state of affairs of all human beings. And it is more tractable than the original "hard problem" because it becomes more like Chalmers' easy problems, that is, an explanation of cognitive *functions*. Thus, certain electrical brain activity interacts or interfaces with the self-conscious mind in a certain way to give rise to a specific subjective experience. Indeed, the SCM unites with the brain as a whole in particular ways which can be described, mapped out and explained. Exactly how the mind-brain interface works is also probably tractable because it can be studied via neural correlates of consciousness: a particular set of evoked and event related potentials give rise to the experience of a sensation; a particular volitional or attentional state in the mind gives rise to particular synchronous electrical brain activity.

Thus, the physiological and electromagnetic aspects of mind-brain induction can probably be found and described in detail. The non-material self-conscious mind will not be the first instance of a fundamental entity which cannot be detected directly. The existence and properties of certain subatomic particles, for example the neutron and the neutrino, cannot be detected directly because detection first involves an interaction with other types of particles. The results of these interactions are particles or electromagnetic radiation that produce detectible scintillations or other effects. Thus, the existence and properties of such particles can be inferred only indirectly. In the same way, the existence and properties of the non-material SCM can be inferred only indirectly from the interaction of the mind with the brain and body.

Understanding the properties of the SCM can also help elucidate functional placement, that is, what part of a function is embodied in brain structures and what part is actually "embodied" in the non-material mind. Memory is a good example because various brain phenomena indicate that memory acquisition and recall are dependent on certain brain structures and pathways. However, because existing memories are accessible during the OBE, it is quite reasonable to ascribe the "storage" of the memories themselves to the non-material SCM, rather than to any physiological brain structures. And because new memories can be acquired and existing ones recalled during the OBE, memory acquisition and recall are also in part a function of the SCM, which must also be mediated by the brain while we are in the body. Thus, memory brain functions would probably better be studied from the perspective of the physiological processes that support *acquisition* and *recall* of memories rather than the *storage* of memories. For example, with Alzheimer's patients we would expect that acquired memories are not destroyed with the deterioration of cortical structures but will return when even a slight reversal of cortical deterioration can be made. The long-term memories, once acquired, are not lost to brain deterioration, only our ability to recall them. Rather than *lose* our past in Alzheimer's disease, we become *blind* to it.

The second class of phenomena, namely the experiences of the SCM when it is out of the body but still within physical environs, needs to be studied from a number of perspectives, for example, the nature of the interaction of the out-of-body mind with physical phenomena such as light, sound, heat and physical surfaces, the shape and structure of the mind's "body", the relationship of thought and volition, the nature of memory in the out-of-body state, the interaction of the out-of-body mind with other minds, both embodied and out-of-body, and so on. This class of phenomena requires much more attention than it has hitherto been afforded. A detailed study of the veridical NDE OBE is needed, but to date it appears we have only tantalizing hints of the detailed OBE phenomenology. For example, the mind's "body" appears to have an intricate, luminous structure, at least in some NDErs (Moody and Perry, 1988); the NDEr's sight appears to be more complex than normal vision, having at times such qualities as enhanced clarity and focus, omnidirectional awareness and synesthesia, that is, sensations with more than one sensory quality such as tones and colors (Ring and Cooper, 1999, pp. 146-167).

How the out-of-body SCM interacts with physical processes is of particular interest because it can elucidate the aspects of the interface of the SCM with the brain. If the SCM can directly "perceive" electromagnetic radiation (i.e., light) when out of the body, then the SCM likely can "sense" in some way the electrical activity of the brain when it is united with the body. If the out-of-body SCM can be luminous in some way (i.e., giving off light of its own), it may similarly be able to induce electrical brain activity. We believe the study of this class of phenomena is also tractable but it will involve studying the phenomenology of the NDE OBE in much greater detail than has hitherto been done.

Mind is a fundamental entity, a new dimension of reality

The fundamental question of the present view is how the non-material mind can interact with physical processes in the brain. This is also the fundamental objection to interactionism in general, that such mind-body interactions cannot involve any known kind of interaction with matter, and would violate the laws of physics, in particular the law of conservation of energy (that the total amount of kinetic and potential energy in an isolated system remains constant). Thus, the present view will ultimately need to explain not only how the non-material mind interacts with the brain, but also how a non-material consciousness occupies a particular location in space with a particular cohesive "body" form, and how memories are formed, "stored" and recalled in a non-material field of consciousness. With the phenomenon of the veridical OBE, explanations are also needed of how out-of-body perception works with the apparent direct interaction of the non-material mind with light, and how communication works with the reported experience of telepathic transfer of thoughts.

In Goethean phenomenology, the phenomena *are* the theory, and in the present case, the fundamental phenomena are clear: the veridical OBE phase of the NDE suggests that consciousness can operate completely independently of the body, and a number of neural electrical phenomena suggest that a non-material agency induces conscious experiences and self-consciousness. The phenomena themselves are the theory of the non-material independent self-conscious mind which can have veridical perception of its physical surroundings separate from the body, and which interacts with electrical activity in the brain to produce conscious experience.

If the phenomena of the mind can't be explained by our known physical laws, then the mind must be a fundamental entity, a new, non-material dimension of reality, one that involves mental and consciousness phenomena. If there are *non-material* aspects of reality, it is entirely possible, and even to be expected, that the current laws of material physics need to be extended, in much the same way as they have been in the past. The laws of physics and chemistry, which currently deal with matter, time, space, energy and so on, will now also include "mind". And such an extension is not unreasonable. The natural laws of physics and chemistry were all derived from purely physical, material processes, not involving living, conscious organisms. It should not be a total surprise to find that they do not necessarily apply to all processes in living, conscious organisms.

Therefore, the fact that a non-material mind interacts with electrical brain processes means that there must be some sort of mind "force" which brings about this interaction, the effects of which appear objectively as the electrical brain activity that we observe and introspectively as the changes in our consciousness that we experience. The effects of these mind interactions are almost certainly small, because the observed interactions in the brain are physically small, on the order of milliamperes.

Thus, the law of conservation of energy is not, in fact, violated, because there is a new fundamental entity, mind, and a new "force" which describes the nature of its interaction in the world. The law of conservation of physical energy becomes the law of conservation of *energy-mind*. "All" that has been done here is to introduce a new concept which extends our conception of reality. The precise nature of mind and its interactions still need to be investigated, and whether mind interactions with physical processes are amenable to mathematical description still needs to be determined. Introducing the concept of mind into the scientific description of reality will not cause all physical science to collapse as some seem to fear (see Mohrhoff, 1999, p. 168).

David Wilson (1999), among others, has objected that mind-brain interactions cannot be explained using quantum mechanical processes. He cited two basic reasons: (1) the possible electrical and chemical brain processes that could support these interactions require a magnitude of disturbance by the mind that is significantly greater than is permitted by the limits of quantum mechanical uncertainty, and therefore (2) the laws of physics, such as energy conservation, would be violated. In the present view, the laws of physics need to be extended to include the reality of non-material mind, but we agree with Wilson's first point that the order of magnitude of mind-brain interactions, in terms of linear dimensions, frequencies, energy levels, and so on, is significantly greater compared to quantum interactions, especially interactions that are within the limits of quantum mechanical uncertainty. With an extended law of conservation of energy-mind, it is not necessary to confine mind-brain interactions to these lower magnitudes, although such a level of interaction may be what in fact is involved.

In summary, reality includes "mind" which interacts with the physical brain, so mind operates in the same "sphere of interaction" as matter and energy. The basic conservation law is thus the conservation of energy-mind. The effect of the self-conscious mind on electrical brain activity does not appear to be relatively very large, so the mind component of the conservation law is probably also very small and manifests only in subtle ways in ordinary physical reality. Indeed, proposed quantum mechanical processes, such as John Eccles' (1994) psychons or Pim van Lommel's (2004) fields of consciousness in phase space, are possible mechanisms for mind-brain interactions, but our sense is that, while we will find mind-brain effects to be relatively small in magnitude, nevertheless they are so fundamental that they are likely to be of a larger order of magnitude than atomic level quantum phenomena.

Summary

The present view is that the self-conscious mind (SCM) is an independent entity that is united with the brain and body in ordinary life and may separate from the body in the unusual circumstance of the near-death experience (NDE). The out-of-body phase of the NDE provides evidence to support this view in three ways:

- Consciousness continues in the NDE out-of-body experience (OBE) during cardiac arrest, even during periods of global cerebral isoelectricity (flatline EEG). Veridical perceptions during this time establish that lucid consciousness still functions. There is a continuity of self-conscious experience which spans the time the patient was in the body, then separated from it, and then reunited with the body. The experience is integrated by the patient in memory as a single, continuous experience, even though it occurred during periods of complete demonstrable cerebral incapacity.

- The NDEr experiences her consciousness as separate from the body, typically hovering near the ceiling, while the body is unconscious. Veridical perceptions during the NDE OBE, which could only have occurred if consciousness had operated in a location distant from the body, confirm this subjective experience. The details of purely visual veridical perceptions and their timing show that these perceptions could not have been constructed by the imagination from subliminal impressions received by the brain. Comparison of the NDE OBE with other types of OBEs (spontaneous, willed, induced by hypnosis, electrical brain stimulation or drugs, etc.) suggests that there is a relationship between the degree of apparent separation from the body in the NDE OBE and the veridical perceptions that are experienced, as compared with other types of OBEs.

- The phenomenology of the NDE OBE shows that the NDEr's consciousness operates with the same cognitive faculties of perception, thought, will, memory, feelings, and conscience as were present while in the body, but many of them are enhanced, having greater acuity and agility. There is a continuity of the NDEr's memory and the sense of self which continue from being in the body, to out of the body, and then back to the body. During the NDE OBE, the NDEr feels she is the same person as before, but is now freed of the constraints and limitations of the body. The return to the body brings back all of the characteristics of the body: weight, fatigue, physical pain and any pre-existing disabilities. The NDE OBE is thus a coherent, self-consistent experience, implying that separation of consciousness from the body in fact occurs.

If consciousness can separate from and operate completely independently of the body in the NDE OBE, then neurological phenomena should be evident that show there is a unified conscious self which operates *in the body* in ordinary consciousness. Three neurological phenomena are presented that are suggestive of an agency that induces conscious experience and self-consciousness but which itself is not a form of neural electrical activity. *Electrical brain stimulation* shows that electrical brain activity in itself is not sufficient to produce actual conscious awareness or intentional movements; some agency other than electrical activity must be involved that brings about our actual consciousness. *Subjective backward referral of sensory experiences* shows that there is no neural mechanism that can mediate the subjective backward spatial and temporal referral of sensations; some agency other than electrical activity must "hold together" both the time and location of the sensation while the sensation comes to awareness over a period of 500 msec. *Large-scale neural synchrony* shows that specific endogenous volitional tasks (recognition, decision, and movement preparation) give rise to phase-locked synchronized neural activity across widely separated cortical regions; some agency must interface in some way with the electrical activity of the brain to bring this about. The agency cannot itself be electrical activity because electrical brain stimulation, which should disrupt the agency, thereby causing widespread disruptions to consciousness, does not have that effect.

We propose that the non-electrical agency that induces conscious experiences and self-consciousness in these three neurological phenomena is the consciousness itself which can operate independently of the brain during the NDE OBE, namely the *independent self-conscious mind.* During the NDE OBE, the self-conscious mind (SCM) appears as an independent "field of consciousness". However, during ordinary consciousness in the body, the SCM is united with the body and brain. Consciousness within the body results from a form of induction between the brain and the SCM. The phenomena of the NDE OBE are consistent with this view and provide many details related to the SCM. The SCM carries all of our cognitive faculties during the NDE but these are restored to the body upon return to the body. The SCM is non-material, is invisible to ordinary sight, cannot interact with physical objects, and so on. In ordinary life, the SCM is strongly and intimately integrated with the body and brain; people will ordinarily lose consciousness when the brain ceases to function. In only about 30% of people who are near to death is the SCM able to separate from the body.

Because the SCM is perceived frequently in the NDE OBE with a bodily form, this form is likely extended and integrated throughout the body when the SCM is united with it. Since some NDErs who had their NDE as infants experienced themselves as fully developed adults with fully developed perception, memory and thought, the SCM apparently already exists in fully developed form during infancy, rather than developing during infancy as the body does. During early childhood, the child's development is a process of learning how to integrate the SCM with the brain and body. Long-term memory resides with the SCM, since memories during the NDE are formed and retained prior to the return to the body. Thus memories themselves cannot be destroyed by the destruction of brain structures. However, it is clear that memory acquisition and recall while within the body are mediated by brain structures and pathways. The SCM is the unitary field of our consciousness and the seat of our self-conscious awareness, both within the body and out of the body, which gives us the sense of the continuity of our self throughout our lives.

The present view of the non-material self-conscious mind is very similar in a number of respects to the dualist interactionist model of Karl Popper and John Eccles (1977). However, there are several differences. Likewise, the present view has similarities but also significant differences with Benjamin Libet's conscious mental field (2004).

The strongest objection to the present view is that there is no reasonable explanation how the non-material mind can interact with the brain. In response, we note that the phenomena of the mind, taken as a whole, including the phenomena of the NDE OBE, *do* indicate that the mind is non-material, and contend that the interactions of the SCM with the brain and body can be studied scientifically through the associated phenomena. The difficulty of correlating internal mental experiences with observable neural events has been successfully addressed by a number of researchers, although much more needs to be done. Another approach to scientific study is to investigate conscious functions in patients with brain damage. By looking at existing, well-known neural phenomena, the nature of the interaction between the mind and the brain can begin to be deduced. Evidence from electrical brain stimulation shows that *brain-to-mind induction* of conscious experience very likely results from neural electrical activity where in some way "we" have been involved. Evidence from large-scale neural synchrony shows that our conscious mental activities induce electrical neuronal effects through *mind-to-brain induction.* One such effect is observed where the subjective level of mental intensity results in an overall higher level energy of electrical activity.

Benjamin Libet's (2004) phenomenon of the delayed awareness of willed action, the famous paradox that brain activity appears to start before the subject's awareness of his decision to move, can be explained by assuming that there is a delay between making the decision within the SCM and that decision coming to our awareness, much the same as the delay that occurs in tactile sensations coming to awareness. Indeed, if the delay in awareness of the *endogenous* mental activity (deciding to "act now") is the same 500 msec as the delay in tactile sensations, then the paradox is removed: the decision to move is made some 150 msec prior to the brain's first response. Libet's paradox is now replaced by another paradox: we subconsciously decide to move before we are aware of the decision. This is not as difficult a contradiction, because we always decide to act out of a conscious context. When the SCM is united with the brain, all conscious awareness, including awareness of our own decisions and thoughts, must come through neural electrical activity in brain-to-mind induction.

A number of other brain phenomena are relevant to understanding how the SCM interacts with the brain. *Split-brain patients* who have had the connections between their two hemispheres severed, exhibit an apparent splitting of conscious awareness where the patient does not become aware of perceptions which were received only by the non-dominant hemisphere. These phenomena indicate a situation where the neural activity across the hemispheres has been blocked. The lack of neural activity in the dominant hemisphere prevents the perceptions from coming to consciousness, consistent with the prior observations that a certain duration of electrical brain activity is needed to bring both sensations and endogenous mental activity to consciousness.

Hemispherectomy, hydrocephalus and decorticate patients all exhibit brain structures which have been severely compromised and yet all exhibit remarkable motor, language and cognitive abilities given the degree of cerebral loss. In all three cases, the SCM is able to adapt to severely compromised neural pathways to achieve a high level of function. The SCM is thus shown to be whole and complete in itself and not the *product* of neural function. Evidently, the SCM can adapt most easily to gradual changes in neural structures, for example due to slow disease processes rather than sudden brain trauma or stroke. Sudden changes appear to overwhelm or "isolate" the SCM and inhibit adaptation. Even so, adaptation appears to be facilitated by bodily movement in conjunction with relearning cognitive skills. Also, there appears to be a certain level of "neural capacity" below which cognitive functions appear to become crowded, implying that the SCM requires a minimum neural capacity to support particular functions.

The phantom limb is the vivid experience of a limb that has been amputated but subjectively is still present. Phantom limb patients frequently experience pain in the non-existent limb and can sometimes feel delayed tactile sensations when another part of the body, for example near the point of amputation or on the face, is gently rubbed. There are electrical anomalies in the sensory and motor cortex which appear when there is phantom limb pain. The present view is that the non-material SCM has a shape similar to the physical body and the shape includes "mind-limbs" which are visible to many NDErs during their OBE. The phantom limb is the continued conscious experience of the mind-limb when the body limb is not present. A number of phenomena related to phantom limbs can thereby be explained which give insight into mind-to-brain and brain-to-mind induction. In particular, the experience of pain is the result of the mind still attempting project the mind-arm into a non-existent physical arm. The mind-arm seeks its normal bodily neural pathways but they now reach only to the stump and the mind-arm becomes "diffuse" and disorganized. If the disorganization is too great, certain cortical electrical anomalies appear and pain is experienced. However, when the patient uses a functional prosthesis, the mind-arm can now project into the prosthesis and becomes focused again into a physical "arm". The cortical electrical anomalies are reduced and the pain stops. Researchers have found that the active use of a functional prosthesis is positively correlated with reduced cortical electrical anomaly and reduced phantom pain. The present view of the SCM thus provides a comprehensive explanation of phantom limb phenomena.

The SCM must interact with the brain via some sort of mutual induction in order for consciousness to occur. The mechanism for mind-brain interactions can begin to be addressed from phenomena that have already been studied by neuroscience. *Brain-to-mind induction* can be addressed by considering external electrical stimulation which produces conscious experiences. This phenomenon implies that naturally-occurring neural electrical activity from sensory brain processes induces conscious experience of actual percepts. *Mind-to-brain induction* can be addressed by considering particular mental states such as willed movement or concentrated attention, which cause identifiable electrical brain activity. The two kinds of mind-brain induction are probably equivalent and perhaps symmetrical or complementary. How the *out-of-body* SCM interacts with physical processes may also give us clues to how the induction works. If the SCM can directly "perceive" light when out of the body, it can likely "sense" in some way the electrical activity of the brain when it is united with the body. If the out-of-body SCM can be luminous in some way, albeit not to our ordinary sight, it may similarly be able to induce electrical brain activity. The study of mind-brain interactions is thus potentially tractable but it will probably involve much closer examination of the NDE OBE phenomenology than has hitherto been done.

The "hard problem" of consciousness is the problem of *experience,* that is, how physical brain processes give rise to subjective experience. We propose that the mind should be taken as a *fundamental entity* in this regard. Subjective experience then arises when the self-conscious mind, which is the fundamental seat of consciousness, interacts with the brain and body. This is the usual case; but there is another case, namely, when the *independent* self-conscious mind interacts *directly* with the physical environs in the veridical NDE OBE. Thus there are two classes of phenomena to be studied: the neural correlates of consciousness and the processes of veridical perception in the NDE OBE. The neural correlates of consciousness need to be studied from the perspective of consciousness arising from the *interaction* of the independent self-conscious mind with the brain. It is clear from numerous phenomena that the brain mediates conscious experience while the mind is united with the brain and body. Consciousness arises in this case when the mind operates *through* the brain. The fact that the SCM is non-material should not deter such study because its effects can be inferred indirectly from observable neural phenomena.

The objection that the interaction of the non-material mind with physical brain processes is impossible because there is no known kind of interaction with matter which could explain it, and the further objection that such interactions would violate the laws of physics, can both be answered by stating that the phenomena are primary. If the phenomena of the mind can't be explained by our known physical laws, then the mind must be a fundamental entity, a new, non-material dimension of reality, one that involves mental and consciousness phenomena. Furthermore, if there are *non-material* aspects of reality, it is entirely possible, and even to be expected, that the current laws of material physics need to be extended, in much the same way as they have been in the past. The law of conservation of physical energy then becomes the law of conservation of *energy-mind*. "All" that has been done here is to introduce a new concept which extends our conception of reality.

Conclusions

The phenomenon of the near-death experiencer's veridical perceptions during the out-of-body experience demonstrates the existence of the self-conscious mind (SCM), separate from the physical body. In the out-of-body state, the mind is completely independent of the body and is non-material as far as can be ascertained. Ordinarily, though, the SCM is intimately united with the brain and body. In this united state, the SCM operates *through* the brain. This view is also supported by evidence from neurological phenomena which suggest that a non-material agency induces conscious experience and self-conscious awareness. These phenomena include electrical brain stimulation, subjective antedating of sensory experiences, large-scale neural synchrony, Libet's delayed awareness of willed action, split brain phenomena, hemispherectomy patients, hydrocephalus patients, decorticate patients, and phantom limbs. The non-material self-conscious mind and the brain interact in some way by mutual induction. Various phenomena of neurological processes can be reconsidered in detail in light of this view, and we believe such efforts will prove very useful, for example in explaining phantom limb phenomena.

In the present conception of mind and body, the highest cognitive functions of thought, memory, perception, feelings, and volition operate in the non-material mind. The brain has a supportive role, supporting all aspects of our consciousness so that we are conscious of our outer environs, our selves, and our inner mental activities of thought, feeling and volition. The brain's sensory functions help to give rise to perceptions. Memory is supported by the processes of the hippocampi and other structures. The brain's motor functions help to manifest the effects of volition in motor activity and speech, while the brain's higher motor areas carry out our preplanned or habitual actions, and the brain stem supports the processes of the body's autonomic systems. The necessity of understanding the function of the brain is not diminished by this view. The brain is the instrument and the mind is the operator.

The present view is applicable to both NDE research and neuroscience, but its value probably lies more with neuroscience. The present view offers a number of perspectives different from those currently taken by most neuroscience researchers:

- The self-conscious mind is an *entity* in its own right that *interfaces* with the brain, rather than an *effect* that *emerges* from the brain's operation. The big question of course remains how mutual induction between the mind and the brain actually works. We began to address this question in an earlier section, with some preliminary observations.
- When neurological functions become impaired, the mind exhibits *adaptability* in operating within the brain, rather than the brain exhibits *neural plasticity*.
- The mind is the *person per se*, rather than brain processes *determine the person*.

- Significant brain impairment may *impede* the mind from operating but the mind and the person *remain whole*, rather than brain impairment *diminishes mental function* and thereby *diminishes the person*.
- Memory resides *within the mind* and uses the brain for acquisition and recall, rather than memory is *encoded in the brain*.

The present view can also inform various practical realms, for which we present four possibilities:

- For education, the insight that early childhood development is a process of integrating the already fully developed mind with the infant's quickly developing body and brain, can direct educators to focus on the early stages of development of the senses, thinking, motor function, walking, and speech. Early childhood education can then work with these processes to assist the integration of the mind with the brain and body. In later years, education can focus on drawing out and enhancing the innate capabilities of the child's mind.

- For problem areas involving memory, for example memory loss, the insight that memory does not reside in the brain may be helpful in developing treatment strategies. The processes of laying down long term memories and recovering them are mediated by specific physical brain structures and processes. Understanding that these processes are really *interface* processes with the non-material mind may help focus research on the memory acquisition and recall processes as *interfaces* rather than on memory storage.

- For the broad problem of autistic spectrum disorders, observed differences in the autistic child's brain development may be due to differences in how the mind of the autistic child interacts differently with the brain. This insight could give clues for understanding how autism manifests and for developing strategies for treatment.

- For the problem of rehabilitation from stroke and brain trauma, the insight that the mind always seeks to work through the brain and will try to adapt when there are neurological impairments, may be helpful for treatment. Rehabilitation strategies to help transfer of mental, motor and speech functions can be developed that will shift cognitive functions to unaffected areas of the brain. Such strategies might include sensorimotor activities that gradually redirect the mind to use areas that are contralateral to the lesion.

In seeking the factors that influence individual human development, we generally look at two areas: *nature,* that is, heredity and genetics which bring about the structure of the body including the brain and nerve structures, and *nurture,* that is, the environmental and experiential influences during a person's life. The present view posits a third factor besides these two: *mind* or more specifically the independent self-conscious mind, that is, the individual non-material aspects of the person that are also operant in human development from birth. Where there is confusion over which factor has been determinative in a particular situation, nature or nurture, as in cases, for example, of genetically identical twins raised in the same environment but who are not identical in all respects, the factor of the individual self-conscious mind is probably the operant determinative factor. We suspect that *mind* plays a significant determinative role in human development.

In the present view, our *sense of self* is the self-conscious mind itself, rather than a conceptual self that emerges from the operation of the brain's neural circuits. To be sure, our *awareness* of our self and of much of the rest of our experience of the world is dependent on the operation of neural circuits while we are in our body. But because the self-conscious mind is fundamentally *independent* of our brain, our sense that our self is in charge of our destiny is, in fact, true.

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