Rejoinder to Responses to "Could Pam Reynolds Hear?"

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ABSTRACT: In this article I provide a rejoinder to Stuart Hameroff's and Chris Carter's responses to my article, "Could Pam Reynolds Hear?" (2011, this issue). I address some specifics of anesthesiology and neurosurgical technique to maintain my contention that Reynolds could hear through normal physical processes during her near-death experience.

KEYWORDS: Pam Reynolds, anesthesia awareness, hearing, near-death experience, consciousness

The responses of Stuart Hameroff (2011, this issue) and Chris Carter (2011, this issue) to my article raising the question of whether Pam Reynolds could hear during her near-death experience (NDE) are well considered. Hameroff's response is formulated from a viewpoint of admitted unfamiliarity with the details of the Reynolds case, whereas Carter formulated his reply from the viewpoint of dualism. However, their main points of critique do overlap somewhat, which is why I will respond in this single counter-response. So what are their main points?

1) Both Carter and Hameroff ignored the basic construction of the Midas Rex® bone saw. I believe that details of the construction and use of this apparatus explain the differences in the first two veridical sounds that Reynolds reported.

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2) Both Carter and Hameroff ignored the fundamental differences between bone conduction of sounds and air conduction.
3) Carter made a correct point regarding the brainstem auditory evoked response (BAER). He stated that the fact that sounds register in the brainstem does not mean they are consciously perceived.
4) Hameroff stated incorrectly that the BAER is the gold standard to monitor depth of anesthesia and to detect consciousness during general anesthesia. BAER is also known as the brainstem auditory evoked potential (BAEP).
5) Carter cited an excellent large-scale prospective anesthetic awareness study to supposedly, and misleadingly, demonstrate that awareness experiences are very different from those that Reynolds reported.
6) Both Carter and Hameroff consider it possible for an immaterial conscious mind to perceive physical sounds and perceive physical light while separated from the physical body during an out-of-body experience.

These are the main points of their responses I discuss in this rejoinder.

1) The Midas Rex® Saw

I will begin this rejoinder with a discussion of the bone saw used during Reynolds' operation. Sabom's (1998) account, while generally very accurate, contained several inaccuracies overlooked by both him and others unfamiliar with neurosurgery. Carter's response revealed this same lack of familiarity. He and many others failed to realize the implications of the construction of the bone saw as illustrated and described by Sabom (1998, pp. 187–189). Examination of the illustration of the Midas Rex® bone saw reveals it to be a shielded reciprocating saw attachment. I say attachment, because the Midas Rex® is not just a bone saw; it is part of a pneumatically powered surgical system consisting of a small and powerful pneumatic motor contained in a hand-piece to which a large variety of different surgical saws, drills, burrs, etc, can be attached (Medtronic, 2009). Spetzler used this handpiece to drive at least two different instruments used to open Reynolds' skull: a burr, and the well-known saw.

How is such a saw used? The metal lip along the length of the saw, and folded over its tip, prevents it being used to make a hole in the skull of a patient undergoing a craniotomy (Mayfield, 2010). So the first step in using such a saw is to drill a hole in the skull through

which it can be inserted. Such a hole is never done with a drill bit. The use of a drill bit can cause unintended damage to the dura, the membrane covering the brain that lies close against the inner surface of the skull. Instead, a burr is attached to the hand-piece of the Midas Rex®. A burr is actually a round rotating rasp. Dentists also use burrs to drill cavities in teeth, and the Midas Rex® burr is a larger version of this. Using such an instrument enables the surgeon to carefully drill in a controlled manner through the skull. The surgeon stops the moment dura is seen at the bottom of the hole. A rotating burr makes a high-pitched whine similar to that made by a dental drill. Pam Reynolds described this sound as a "natural D" (Sabom, 1998, p. 41).

Subsequently, the surgeon uses a spatula-like instrument to gently push the dura away from the inner surface of the skull as well as to enlarge the hole. Once the hole is large enough, the saw attachment is coupled to the Midas Rex® handpiece. The saw attachment is inserted vertically into the hole and moved to the edge of the hole so that the folded lip is held flush against the inner surface of the skull, in between the dura and the inner surface of the skull. Because the folded lip is held against the inner surface of the skull, the reciprocating saw cuts through only the bone of the skull, and the lip ensures that the dura separates from the skull as the saw progresses. The saw blade is never continually in motion. Instead, after the motor is activated, the saw blade is engaged by a clutch and gear mechanism similar to the gearbox of an automobile. Furthermore, the sound it makes when cutting through bone is different to that when not cutting through bone. This two-step process explains the initial high pitched humming sound of the saw and the subsequent sudden "*Brrrrrrrrr!*" sound (Sabom, 1998, p. 41).

2) Bone Conduction of the Sounds of the Burr and Saw

Curiously, except for my website dealing with the Pam Reynolds case (Woerlee, 2008) and Charles Tart's (2009) book, *The End of Materialism*, no one seems to have realized the point of bone conduction of sound (Tart, 2009, p. 232). In common with all other writers on this unusual experience, Carter, in his response, failed to distinguish between the mechanisms by which the human ear may hear sounds.

I contend that the sounds of the burr and the saw were conducted through Reynolds' skull to her cochlea. An awake and aware Reynolds would have been able to hear these sounds even were her ears totally blocked and subjected to the sounds used to evoke auditory evoked

potentials. Fantasizing further: Reynolds would have heard these sounds even if her ears were filled with wax and covered with mounds of concrete. This is the reality of sounds heard by bone conduction—a process that any audiologist or ear, nose, and throat specialist will confirm.

3) A Measurable BAER Not Proof of Hearing

Chis Carter was correct when he stated that the BAER is a measure of only the response of the brainstem to the auditory stimuli applied to the ears. Conscious perception occurs only when these stimuli register in the cortical regions of the brain concerned with secondary processing of hearing. This point leads to a discussion of another inaccuracy in Sabom's (1998) account and Hameroff's response.

4) BAER Not a Measure of Consciousness

The BAER, or more correctly, the BAEP, is a measure of the response of the brainstem structures during the first 10–12 milliseconds after application of a sound stimulus. It is not a measure of anesthetic depth or level of consciousness, because the waveforms, amplitudes, and their latencies are relatively unaffected by anesthetic depth (Drummond, Todd, & Hoi, 1985). Instead, BAEP signals are used during neurosurgery to signal injury or damage to the auditory nerve during operations in the region of the brainstem—the region of Reynolds' operation.

During Reynolds' operation, the acoustic signal frequency used to elicit BAEP responses was 11.3 Hz, and the responses were recoded with "far field" techniques. This phrase means responses were derived from the processed signals from EEG electrodes placed far away from the ears. This stimulus frequency implies a $1/11.3 = 88.5$ milliseconds to analyze the BAEP and other longer latency signals. During 1991 people were studying and using the middle latency auditory evoked potential (MLAEP) as a measure of anesthetic depth or level of consciousness. So although it is not mentioned in the Spetzler group's article (Spetzler, Hadley, Rigamonti, Carter, Raduzens, Shedd, & Wilkinson, 1988), it is likely this group did use the MLAEP to determine the level of consciousness. This was very likely the auditory evoked potential misnamed by Sabom (1998) in his description of the Reynolds story. Like BAEP, the MLAEP is an averaged signal measured 10–100 milliseconds after a sound stimulus. But unlike

the BAEP, the MLAEP does correlate—though not perfectly—with the depth of anesthesia (Loveman, Hooff, & Smith, 2001; Schwender, Daunderer, Mulzer, Klasing, Finsterer, & Peter, 1997).

But during 1991, the use of MLAEPs was a technique in a development stage. This was also true for all other electronic measures of consciousness employed during 1991. Subsequent research revealed that the electronic depth of anesthesia monitoring techniques used during 1991 were unable to accurately to detect the presence of consciousness during the standard (for 1991) nitrous oxide and isoflurane anesthesia used for Reynolds' operation (Aceto, Valente, Gorgoglione, Adducci, & De Cosmo, 2003; Dwyer, Rampil, Eger, & Bennett, 1994; Loveman et al., 2001; Rundeshagen, Schnabel, & Schulte am Esch, 2002; Schneider, Nahm, Kochs, Bischoff, Kalkman, Kuppe, & Thornton, 2003; Schwender et al., 1997).

5) Reynolds Conscious and Aware?

Therefore, if Reynolds was conscious and aware, she would have been able to hear the sound of the burr, the sound of the bone saw, the sound of Murray's speech, and the sound of the music of "Hotel California." But was she awake when these verifiable sounds occurred? This question is the core of the whole argument of whether Reynolds heard these sounds with her physical hearing rather than by any other mechanism.

Many people express amazement that people can be awake and aware during general anesthesia, saying that this occurrence is a product of careless or irresponsible anesthesia. However, this belief is divorced from an understanding of the reality of anesthesiology practice. Anesthesiologists are guided by the advised doses of anesthetic drugs. These doses and concentrations are based upon averages, but not everyone is average. Some people require more and others require less. Interactions of medical conditions with the effects of anesthetic drugs, as well as the effects of surgery, all result in the anesthesiologist adjusting doses according to the clinical condition of each patient. So although the basis of anesthesiology practice is a science, its practice is a combination of science and art, and this is true even now during 2011. The fact that people do not always respond in a standard manner to an average standard dose or concentration of anesthetic drug is why people sometimes experience periods of awareness during general anesthesia.

Is it possible to detect moments of awareness during general anes-

thesia? Moerman and his colleagues (Moerman, Bonke, & Oosting, 1993) retrospectively studied persons with psychological distress resulting from awareness during general anesthesia. Anesthetic records of 12 of these patients revealed signs indicating possible awareness in only one of them (pp. 459–461). This study reveals the fact that awareness during anesthesia is seldom detected, a fact repeatedly demonstrated in modern studies (Avidan et al, 2008), as well from my personal experience.

A weakness of Moerman et al.'s study was its retrospective nature, so it gave no true indication of the incidence and long-term effects of the phenomenon. This weakness is corrected by prospective studies, so in Carter's response he quite correctly cited the excellent study by Sebel and colleagues (Sebel, Bowdle, Ghoneim, Rampil, Padilla, Gan, & Domino, 2004). He also cited the following statistics from the Sebel et al. study (p. 836), to which I have added the obvious conclusions.

- 48% of persons reported auditory perceptions. Therefore, 52% remembered no auditory perceptions.
- 36% of persons reported experiencing anxiety and stress while aware during general anesthesia. Therefore, 64% of persons experienced no anxiety or stress during awareness while under general anesthesia.
- 28% of persons reported experiencing pain during awareness while undergoing surgery under general anesthesia. Therefore, 72% of people reported experiencing no pain while aware during surgical procedures performed under general anesthesia.

So these statistics demonstrate that most people feel no pain and are not anxious during periods of awareness occurring during surgical procedures performed under general anesthesia. Moreover, the three different groups of drugs used to maintain general anesthesia explain the different categories of awareness experience (Woerlee, 2009) as well as Reynolds' mental state during the periods of consciousness when she made her veridical auditory perceptions.

6) The Immaterial Conscious Mind Able to "See" and "Hear"?

Carter and Hameroff considered it possible for a disembodied immaterial conscious mind to "see" light waves and to "hear" sound waves in air. I advanced reasons why this was impossible in my original article (2011, this issue). Both claim that because scientists have no idea how physical perceptions are converted into conscious perceptions, a

non-material explanation is as valid as a material explanation. Unfortunately, the logic of this argument ignores the fact that translation of nerve impulses from the organs of perception into a consciousness generated by a physical brain whose structure and organization is largely understood is very much more likely than transfer of information contained within physical nerve impulses to an immaterial conscious mind whose coupling with the physical body is as speculative as its structure and function. However, by ignoring these latter facts and using the logic of dualism as espoused by Carter and many others, the immaterial explanation is an alternative possibility.

Concluding Remarks

The veridical auditory perceptions Reynolds reported did occur. I believe I have clearly demonstrated the possibility that the four veridical auditory perceptions Reynolds reported were able to be heard by any conscious person; that the electronic monitoring used to determine her level of consciousness during 1991 was not 100% accurate; that people undergo undetected periods of awareness during anesthesia induced by nitrous oxide, isoflurane, and sufentanil; and that Reynolds' state of mind during these moments of consciousness were explained by the actions of these drugs.

In my view, this physical explanation for the veridical auditory perceptions Reynolds reported is provably possible, whereas the paradigm of perception of sounds by a separable immaterial conscious mind languishes in the situation of an unproven alternative. Nonetheless, the fact that the immaterial explanation is unproven does not exclude it, because the data available for the Pam Reynolds case are insufficient for this purpose. However, these data do mean that Reynolds' veridical auditory perceptions are not proof of the reality of a separable immaterial conscious mind. Reynolds' amazing NDE clearly demonstrates the necessity of examining every detail and aspect of apparently inexplicable experiences. I consider this to be the ultimate message implicit within experiences like Reynolds'.

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