

MENTAL DISCONNECT:
'PHYSIOLOGICAL DECAPITATION' AS A HEURISTIC
FOR UNDERSTANDING 'BRAIN DEATH'^{*,1}

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1. STATEMENT OF THE PROBLEM

The important task entrusted to this Conference by Popes Benedict XVI and his predecessor John Paul II has been clearly articulated by Bishop Chancellor Sánchez Sorondo: 'The Academy is thus faced with the task of seeing whether the criterion of brain death (according to its full definition) indicates the biological state of death of an individual ...' (Conference Brochure, p. 4, 'The Purpose of the Meeting').

It is remarkable that in the last decade or so, the various position statements and official commentaries on brain death by neurological and other medical societies have failed to state *why* brain death should be regarded as death of the individual. The same can be said for many recent books and chapters by neurologists on the subject. The equivalence is simply taken for granted as common knowledge, and the discussions focus rather on such aspects as diagnostic criteria for determining that the brain is dead, controversies over how much of the brain must be destroyed for the brain as a whole to be dead, etc.

The American Academy of Neurology, for example, in its 'Practice Parameters for Determining Brain Death in Adults' (1995), which still remain the gold-standard diagnostic criteria in the United States, did not offer a single reason why it considers death of the brain to be death. Neither did fellow conferee Dr. Eelco Wijdicks in his accompanying commentary on the 'Practice Parameters' (Wijdicks, 1995) or in the chapter on brain death in his book on critical care neurology (Wijdicks, 2003, pp. 547-62). Nor, in his recent book on brain death (Wijdicks, 2001a), does he state why he him-

* The views expressed with absolute freedom in this paper should be understood as representing the views of the author and not necessarily those of the Pontifical Academy of Sciences.

¹ Although not publicly discussed, this paper was added because Professor Shewmon sent it in before the meeting and it was privately viewed and discussed by the participants.

self believes brain death to be death; rather, that apologetic task was delegated to co-conferee Dr. James Bernat, who has become somewhat of the unofficial brain-death-theory spokesperson for mainstream neurology (not without good reason), in whose chapter only a single paragraph is devoted to answering what he himself characterizes as ‘the most serious challenges thus far to the brain death concept’ (namely my publications as of that time) (Bernat, 2001, p. 180). Neither does fellow conferee Dr. Allan Ropper, in the sections on brain death in his two widely read textbooks, state why he considers brain death to be death (Ropper and Brown, 2005, pp. 306-7, 961-2; Ropper *et al.*, 2004, pp. 157-64). Along similar lines, in their introductory essay for the conference brochure entitled ‘Why the Concept of Brain Death is Still Valid as a Definition of Death’, Dr. Ropper and colleagues concern themselves with rebutting the weakest arguments against brain death, while ignoring or glibly dismissing the strongest arguments, without in the end offering a single reason ‘why the concept of brain death is still’ – or ever was – ‘valid as a definition of death’.

Discussions at this conference regarding the history of brain death, disorders that are not brain death, neuroimaging, apnea testing, determination of irreversibility, determination of totality of brain nonfunction or destruction, controversies over what constitutes a ‘critical’ function of the brain, etc., interesting and important though they may be, will not bring the Church any closer to an understanding of whether and why death of the brain, so diagnosed, ‘indicates the biological state of death of an individual’.

I daresay that doctors in general, and neurologists in particular, have come to an overwhelming consensus that brain death is death, not because they have examined the evidence and concluded it for themselves, but purely and simply from a professional herd mentality. When queried about it, few can give a coherent explanation why brain death is death itself, as opposed to deep coma in a dying patient. In a revealing survey of physicians and nurses involved in transplantation, who surely ought to have a solid understanding of brain death for the sake of their own consciences, 58% did not use a coherent concept of death consistently and 19% held a concept of death that would logically classify patients in a persistent vegetative state as dead (Youngner *et al.*, 1989). This is a serious mental disconnect in professionals who should have clear and coherent thoughts on the matter.

2. FOUR CANDIDATE RATIONALES FOR EQUATING BRAIN DEATH WITH DEATH

Across the half-century of brain-death history up to the present, the many proposed reasons for equating death of the brain with death of the

individual have fallen into four basic categories:

(1) *because* death is not an objective physical state but a relativistic legal definition or custom based on what seems most useful to a given society at a given time (societal relativism); or

(2) *because* the brain is the organ of the mind, which is the essence of the person; therefore, the irreversible cessation of mind is cessation of the person, i.e., 'death of the individual' (person/mind reductionism); or

(3) *because* the brain is the central integrating organ of the body, so that without brain function the body ceases to be a unified biological organism and begins the irrevocable process of disintegration, thereby indicating cessation of 'the corporal reality of the person' (to quote Pope John Paul II, 2000) (somatic integration rationale).

(4) *because* the permanent loss of *both* mental functions *and* bodily unity, attendant upon death of the brain, constitutes – again in the words of Pope John Paul II (2000) – 'the total disintegration of that unitary and integrated whole that is the personal self' (psychosomatic integration rationale).

A fifth rationale is not listed, because it is only a pseudo-rationale, namely the 'fatal lesion fallacy' (brain death is death because it will imminently lead to death). Remarkably, some experts still offer this as an implicit rationale for brain death (e.g., Dr. Wijdicks, 2001b, p. 76): 'In the United States, primary brainstem death does not fit into the concept of whole brain death, but it has been accepted in the United Kingdom and rightly so, because no survivor has been reported when all brainstem function has been lost'.

There are no other broad categories of proposed reasons why death of the brain as an organ should constitute death of the individual person. Let us now examine these four rationales in somewhat greater detail.

(1) *Societal relativism* was the rationale of, among others, Dr. Henry Beecher, chairman of the Harvard Committee, as made clear in some of his commentaries following the revolutionary Harvard Committee report of 1968, which marked the beginning of the general acceptance of brain death as death (Beecher *et al.*, 1968). 'At whatever level *we choose to call death*, it is an *arbitrary* decision. Death of the heart? The hair still grows. Death of the brain? The heart may still beat. The need is *to choose* an irreversible state where the brain no longer functions. It is best *to choose* a level where, although the brain is dead, usefulness of other organs is still present (p. 120). ... Here we *arbitrarily* accept as death, destruction of one part of the body; but it is the supreme part, the brain (p. 121). ... Can society afford to discard the tissues and organs of the *hopelessly unconscious patient* so greatly needed for study and experimental trial to help those who can be

salvaged? (p. 122)' (Beecher and Dorr, 1971) (emphasis mine). Needless to say, societal relativism is incompatible with any sort of objective metaphysics of life and death, and as such is incompatible with the fundamental tenets of many of the world's religions, including Catholicism.

(2) *Person/mind reductionism* declares the person to be dead when there is no longer a personal mind or consciousness, even in potency (e.g., excluding states of sleep or coma from which there is a potential to awaken; whether human embryos are excluded or not varies across authors). According to this view, truly *irreversible* coma, as well as permanent vegetative state (defined according to the American Academy of Neurology and many other professional societies in terms of unawareness of self and environment – cf. Shewmon, 2004a; Shewmon, 2004b) are therefore death of a person, regardless of the biological life/death status of the (former) person's body (also prescinding here from the subtle controversies surrounding the terms 'irreversible' and 'permanent' (Cole, 1992; Lizza, 2005; Lizza, 2006, pp. 102-7; Tomlinson, 1993). This rationale is frequently referred to in the literature as the 'higher brain' formulation of brain death. It has had and continues to have many advocates. Such equating of person with mind is patently Platonic/Cartesian and contrary to the Aristotelian/Thomistic notion, which the Church endorses, that the human person is a corporal/mental hybrid, so that the spiritual soul is at once both the center and source of intellectual and volitional powers of the mind, as well as substantial form (life-principle) of the body (Council of Vienne [1312], 1957).

This psychological rationale was most strikingly articulated by one of the participants of the Pontifical Academy of Sciences' Second Working Group on Brain Death: '[T]he Cartesian 'cogito ergo sum' principle is still applicable in our days. Life means that the individual has the right and/or the ability to think freely. Death steps in when the brain is no longer able to think ... death can only arise from the cessation [of] the ability to think' (Gerin, 1992, pp. 91-2).

It is no secret that the philosophical world-view of most scientists today is material monism: only matter-energy exists, and all talk of any sort of spiritual 'soul' is meaningless nonsense, a holdover from previous ages of unscientific religious credulity. The fact that the brain is the organ of the mind, in this world-view, therefore translates necessarily to the thesis that the human mind is totally the product of physical brain activity (mysterious as that may be). Thus, most scientists today, and especially neuroscientists, are not only person/mind reductionists, but person/mind/brain reductionists, so that permanent unconsciousness from a brain lesion con-

stitutes cessation of personal existence. Perhaps the most succinct statement of such reductionism is to be found in the chapter on brain death in the influential textbook *The Diagnosis of Stupor and Coma* by Drs. Fred Plum and fellow conferee Jerome Posner: 'Agreement that the brain and the person are one has essentially removed the ethical conflict that otherwise derives from the almost universal respect for the dignity of the individual human being' (Plum and Posner, 1983, p. 325).

By contrast, according to the philosophical anthropology endorsed by the Church, the fact that proper mental functioning depends on the instrumentality of the brain translates rather to an interpretation of permanent unconsciousness as a severe mental disability, a paralysis of a person's psychological functions, but not an annihilation of the person, so long as the human organism remains biologically unified and alive, which is a sign of the continuing presence of the human soul in its other capacity as substantial form of the body. Catholic neurologists and neuroscientists are not immune to assimilating material-reductionistic ideas from their professional environment, despite the incompatibility with their faith.

(3) *Somatic and* (4) *psychosomatic integration*. Both of these rationales stand or fall on whether a developed human body (embryos and fetuses excepted) requires somatically integrative brain function to remain a unified biological organism, totally apart from the brain's role in mental functioning. In the 1970s and '80s this presumed physiologically integrating role of the brain was almost universally cited as a well established medical 'fact' by brain-death apologists (e.g., the U.S. President's Commission [1981], the Swedish Committee [1984], and the two Working Groups of the Pontifical Academy of Sciences [Chagas, 1986; White *et al.*, 1992]). Despite increasing challenges by new clinical and theoretical counterevidence over the last 10 years, many still cling to the somatically integrating role of the brain as a fundamental reason why brain death is supposedly death (whether the *only* fundamental reason as in the somatic integration rationale, or one of two fundamental reasons – *both necessary* – as in the psychosomatic integration rationale). Since societal relativism and person/mind/brain reductionism are incompatible with Catholic anthropology, it goes without saying that all endorsements of brain death by expressly Catholic apologists or Catholic institutions rely critically on the supposed medical 'fact' that without brain function the human body is no longer a unified organism and is therefore dead (and the person whose body it was is dead).

It was precisely the emergence of impressive counterevidence to this supposed medical 'fact' that caused me in the early 1990s to reverse my ear-

lier position defending brain death as death (as presented at the Second Working Group of 1989 [Shewmon, 1992]). Over the last 10 years an increasing number of brain-death commentators, including both advocates and critics of brain death as death, have rejected the somatic-integration thesis as no longer tenable. The October 2001 issue of *Journal of Medicine and Philosophy* was devoted entirely to the topic of brain death. In the preface, the issue editor acknowledged being convinced by my lead article (Shewmon, 2001) that '[e]quating brain death with loss of somatic integrative function, while useful for clinical, transplant, and policy purposes, is physiologically inaccurate and theoretically incoherent' (Lustig, 2001, p. 448). Moreover, the other authors, spanning a broad spectrum of philosophical and ethical opinions surrounding brain death, acknowledged being convinced that the brain-dead body is after all a living human organism (Dagi and Kaufman, 2001; Halevy, 2001; Potts, 2001; Youngner and Arnold, 2001). The same conclusion is accepted by most 'higher brain death' advocates (Lizza, 2006, p. 14; Spittler, 2003, pp. 91-2; Veatch, 2005) and other thoughtful critics of brain-death orthodoxy (Potts *et al.*, 2000; Truog, 1997).

At the Third International Symposium on Coma and Death, in Havana, Cuba, February 22-25, 2000, I gave a keynote address (Shewmon, 2004c), which in philosopher John Lizza's opinion 'delivered on [my] claim to 'drive the nails into the coffin' of the idea that organic integration requires brain function' (Lizza, 2004, p. 52). During the question-and-answer session Dr. Fred Plum himself, brain-death expert and co-author with Dr. Posner of the important textbook *The Diagnosis of Stupor and Coma* (Plum and Posner, 1983), stood up and said in essence, 'OK, I'll grant you that the brain-dead body is a living human organism, but is it a human *person*?' At which he proceeded to propound person/mind/brain reductionism as the *real* reason why brain death is death, insisting that the biological life/death status of the body is philosophically and ethically irrelevant.

It is not mere carelessness when prominent neurologists and neurosurgeons drop 'Freudian slips' regarding the life/death status of the brain-dead body, implying agreement with Dr. Plum's comment at the Cuba symposium.

Dr. Albrecht Harders, neurosurgeon: 'Transcranial Doppler findings were obtained in 15 patients who fulfilled the clinical criteria for brain death ... All of the patients *died* within 24 hours or upon discontinuation of the mechanical ventilation' (Harders, 1986, p. 115) (emphasis mine).

Dr. Allan Ropper, neurologist and first author of this Conference brochure's introductory essay: 'Dr. Ropper added that it has been suggested that children who are brain dead *can be kept alive* by artificial means for a

long period of time, but this is not true in adults' (*Neurology Today*, March 2002, p. 7) (emphasis mine). (We may give Dr. Ropper the benefit of the doubt that this was a misquotation on the part of the medical reporter; it is nevertheless provocative that that was the impression the reporter came away with). Of greater interest are the words Dr. Ropper and colleagues themselves chose, in their popular textbook *Principles of Neurology*, to describe long-surviving cases of brain death: 'In exceptional cases, however, the provision of adequate fluid, vasopressor, and respiratory support allows *preservation of the somatic organism in a comatose state* for longer periods' (Ropper and Brown, 2005, p. 962) (emphasis mine). This is precisely my thesis, that these patients are indeed comatose human organisms.

Dr. Fred Plum, neurologist: In a book chapter published in 1999, Table 2.4 is entitled 'Prolonged Visceral Survival after Brain Death', the fifth column of which has the heading *Mode of Death* (Plum, 1999, p. 38). Included in this column are entries of either 'spontaneous cardiac arrest' or 'respirator discontinued', implying that these patients were *not* dead by virtue of the brain death, which had taken place from 26 to 201 days before, but by virtue of the circulatory-respiratory arrest. Later in the same chapter, regarding a series of 73 brain-dead patients, Plum wrote: 'half experienced asystole by the third day but the bodies of 2 *lived on* until the 10th and 16th day' (Plum, 1999, p. 53) (emphasis mine).

The late *Dr. Ronald Cranford*, long-time chairman of the Ethics Committee of the American Academy of Neurology and prominent expert on brain death, was more forthright in not only his own endorsement of person/mind/brain reductionism, but even in opining that this was the ultimate, though tacit, conceptual driving force behind the widespread acceptance of brain death in the 1970s: 'It seems then that permanently unconscious patients have characteristics of both the living and the dead. It would be tempting to *call them dead and then retrospectively apply the principles of death, as society has done with brain death*' (Cranford and Smith, 1987, p. 243) (emphasis mine). I am indebted to Dr. Cranford for his bringing to my attention certain cases of prolonged survival in brain death and for his candid editorial commentary to my 1998 article on 'chronic brain death' (Shewmon, 1998), in which he agreed with my conclusion that these bodies are biologically living organisms, although he opined that this is ethically irrelevant because they are still dead as human beings (Cranford, 1998).

My impression from many Socratic conversations with colleagues on this issue is that most neurologists and physicians in general, when probed and pressed for a coherent rationale why brain death is death, regardless

what rationale they may offer at the beginning of the conversation, will ultimately end up saying something like Dr. Plum did in Havana: 'OK, I'll grant you that the brain-dead body is a living human organism, but is it a human *person*?' Nevertheless, 'cessation of the organism as a whole' still remains the tacit, semi-official rationale for brain death in most countries as well as the explicit rationale in Catholic circles.

3. BRAIN DEATH AS 'PHYSIOLOGICAL DECAPITATION'

In the effort to explain why brain death is death, authors of all persuasions have often made use of an analogy with decapitation, according to seemingly straightforward syllogistic reasoning:

- (1) A decapitated person is dead.
- (2) Brain death is physiologically equivalent to decapitation.
- (3) Therefore, a brain-dead person is dead.

I must preface this discussion with an apology for the distastefulness of the topic at a time when beheading is no mere historical curiosity of the French revolution, but a current and barbaric form of terrorism carried out on innocent hostages, sometimes even slowly and piecemeal in order to maximize the agony and the horror of it. Out of respect for these victims and their loved ones, I would prefer not to deal with the topic here in writing. Nevertheless, a thorough re-evaluation of brain-death orthodoxy is now very timely and necessary, and it cannot be done without addressing in depth the validity and explanatory utility of this traditional and powerful analogy. Therefore, I shall proceed, trying to keep the discussion as hypothetical as possible, but with a reverent awareness that some aspects of the analogy are sadly all too real.

3.1. *Utilization of the Analogy by Advocates of Whole-Brain, Brainstem, and Higher Brain Death*

The analogy must get at something fundamental and important about the essence of brain death, since it has been utilized by all three of the major competing brain-death camps: 'whole brain', 'brainstem', and 'higher brain'.

Among whole-brain advocates, nothing less than the U.S. President's Commission itself wrote: 'Contrast such situations [heart or kidney transplants, dialysis, iron lung], however, with the hypothetical of a decapitated body treated so as to prevent the outpouring of blood and to generate respi-

ration: continuation of bodily functions in that case would not have restored the requisites of human life' (President's Commission, 1981, p. 36). In the Commission's critique of 'higher brain death', it also refers to the analogy: 'When the brain processes cease (whether due to decapitation or to 'brain death') the person's identity also lapses' (p. 39). Eighteen years later, the Commission's Executive Director, Alexander Capron, was still citing 'physiological decapitation' as '[p]erhaps the easiest way to think of' brain death (Capron, 1999, p. 125). Conferee Dr. James Bernat, one of the most prominent apologists for 'whole brain death', began his chapter on philosophical and ethical aspects in Dr. Wijdicks' book with a historical reference dating the *Anlage* of modern brain-death theory back to observations on decapitation: 'The idea that irreversible absence of brain function was the equivalent of death began in the 12th century with the writings of the famous Jewish physician and philosopher Moses Maimonides. Maimonides noticed that decapitated humans exhibited muscular twitches for a short time immediately following decapitation. He asserted that decapitated humans were dead instantly and that such muscle movements were not a sign of life because they lacked the central direction that was indicative of the soul' (Bernat, 2001, p. 171; cf. also Bernat, 2002, p. 244). Within Judaism the 'physiological decapitation' analogy of brain death was introduced by Rabbi Dr. Moshe Tendler, citing Talmudic support for it (Tendler, 1978, p. 395). The validity and consequences of the analogy remain controversial among Jewish authorities, but its importance as a heuristic device is clear (Rappaport and Rappaport, 2004, p. 135; Rosner, 1999, pp. 217-9).

'Brainstem-death' advocates in the United Kingdom make similar use of the analogy. As far back as 1975, the British medical literature cited decapitation by guillotine as a conceptual aid to understanding the new criterion of death (Thurston, 1975). A 1996 monograph by Pallis and Harley (Pallis and Harley, 1996), one of the most complete and vigorous defenses of 'brainstem death', goes so far as to include a photo of an actual execution by decapitation (date and place unidentified), showing a propped-up, sitting, headless body with distinct columns of blood spurting spectacularly into the air. (At least it is in black and white). The caption reads: 'Anatomical decapitation. Heart is still beating as shown by jets of blood from carotid and vertebral arteries'. The associated text reads: 'One type of event epitomizes the fact that death may precede cessation of the heart beat: decapitation. Once the head has been severed from the neck the heart continues to beat for up to an hour [citing here an 1870 French reference regarding execution by guillotine]. Is that person alive or dead? If those who hold that

a person can be truly dead only when the heart has stopped believe that a decapitated person is still alive simply because parts of the heart are still beating, they have a concept of life so different from ours that we doubt if bridges could be built. The example given is one of *anatomical* decapitation. Brain death is *physiological* decapitation and usually occurs when the intracranial pressure has lastingly exceeded the arterial pressure. Nevertheless, the implications of the two types of decapitation are similar. They are that the death of the brain is the necessary and sufficient condition for the death of the individual person' (Pallis and Harley, 1996, p. 4).

Advocates of 'higher-brain death' similarly make good heuristic use of the analogy and all sorts of hypothetical variations on it, such as surgical brain removal, head or brain transplants, partial brain transplants, isolated living brains floating in vats, replacement of parts of the brain with futuristic computer chips, etc. I based my own earlier defense of brain death largely on a thought experiment involving surgical decapitation and technological maintenance of both the isolated head and the headless body (Shewmon, 1985; Shewmon, 1988). Similar kinds of thought experiments have been used to support a consciousness-based 'higher-brain' notion of death by philosophers (Green and Wikler, 1980, pp. 123-5; Lizza, 2006, pp. 28, 107; Machado *et al.*, 1995, pp. 3-4; Wikler, 1988), ethicists (Youngner and Bartlett, 1983, p. 265), and neurologists (Machado, 1994, p. 214; Machado, 1995, p. 63-4; Machado, 2000, pp. 206-8; Spittler, 2003, p. 110).

Actual experimental decapitations of animals, with mechanical ventilation and prevention of exsanguination, have been performed to prove that such thought experiments in humans are in principle physiologically possible. In the Pallis and Harley monograph cited above, on the page facing the decapitation-execution photo, there is a photo of a decapitated chicken standing, with the head lying on the ground at its feet. The text reads: 'About 25 years ago a picture of an unsuccessfully decapitated chicken appeared in a leading magazine. The forebrain had been amputated and lay on the ground. The brainstem was still in situ. The animal, still breathing, was photographed some time after the decapitation. Was it alive or dead? In our opinion the animal must be considered alive so long as its brainstem is functioning' (Pallis and Harley, 1996, p. 5). A pregnant sheep was technologically maintained for 30 minutes following decapitation, when a healthy lamb was delivered by Cesarean section (Steinberg and Hersch, 1995). Neurosurgeon Robert White, consultant for the Pontifical Academy of Sciences' First and Second Working Groups on Brain Death and co-editor of the proceedings of the Second Working Group, performed experi-

mental head and brain transplants in monkeys to demonstrate the theoretical feasibility of such thought experiments in humans, and made use of these experiments in his arguments justifying brain death as death (White, 1968; White, 1986; White *et al.*, 1965; White *et al.*, 1963; White *et al.*, 1964; White *et al.*, 1971). Bernard Gert, co-author with Bernat on two important conceptual articles on brain-death (Bernat *et al.*, 1981; Bernat *et al.*, 1982), cited these experiments of White in his later independent defense of brain death (Gert, 1995, pp. 25-6).

What I intend to show in the remainder of this paper is that, when the 'physiological decapitation' analogy is properly dissected down to its essential features, it ironically proves just the opposite of what 'whole-brain' and 'brainstem' advocates have been using it for. Namely, I will show that the 'physiologically decapitated' brain-dead body is just as much a living 'organism as a whole' as a body with high spinal cord transection, the difference being that the former is comatose and the latter is conscious – but as far as the physiological equivalence goes, they are the same. If the focus of the analogy is on the headless body and its physiology, then the analogy completely backfires on the defenders of 'whole-brain' and 'brainstem death'. If, on the other hand, the focus is on the severed head, consciousness and personal identity, then the analogy has a powerful heuristic value for defenders of 'higher brain death'. I will argue, however, that the conclusions that can be drawn from thought experiments involving brain-body separation are highly speculative, depend in large part on one's basic philosophical world-view, and in the final analysis are irrelevant to understanding clinical brain death, in which no such separation is involved. Michael Reuter, in his recent monograph on brain death, comes to a similar conclusion about the lack of heuristic utility of the decapitation analogy (Reuter, 2001, pp. 54-5). Not only can such thought experiments not be taken as proof that brain death is death within the framework of a Catholic philosophical anthropology, but something much stronger can be said – that the somatic-physiology aspect of the analogy surprisingly proves that brain death cannot be death within a Catholic philosophical framework.

3.2. *Focus on the Body – Is it Still an Organism as a Whole?*

Let us begin by focusing on the headless body following decapitation, since, after all, that is the part where the 'physiology' occurs in 'physiological decapitation'.

3.2.1. *Irrelevance of Exsanguination and Esthetic Considerations*

First I want to quickly dismiss the relevance of references to actual decapitation-executions (such as mentioned historically by Bernat and sensationalized by Pallis and Harley). Everyone seems to take for granted that a person dies instantly upon execution by guillotine or swift sword swipe (the major premise in the syllogism at the beginning of section 3. above). I suggest that this assumption is essentially an unreasoned gut-reaction to the emotional shock effect: the extreme degree of mutilation (neither part *looks* like a human being 'as a whole') combined with the profuse and rapid exsanguination from both parts. True death no doubt occurs some seconds to minutes later after a critical degree of exsanguination and anoxia in whichever of the two severed parts (or both) is the person. One hardly needs guillotines to know that the heart has its own intrinsic pacemaker and can beat perfectly well without any influence from the brain (although unmodulated in rate [García *et al.*, 1995]). Hearts removed for transplantation will continue beating spontaneously for some time completely outside the body. Be that as it may, no one can seriously claim that the acutely exsanguinating, unventilated body shown in Pallis and Harley's execution-photo is physiologically equivalent to a brain-destroyed body with normal blood volume, no bleeding, and normal blood gases maintained by mechanical ventilation.

Since neither grotesque mutilation nor exsanguination characterizes clinical brain death, there must be something else about decapitation that provides the supposed physiological equivalence with brain death. Moreover, that 'something else' must also be a reason why decapitation is death; otherwise the purported physiological equivalence would prove that brain death is *not*, rather than *is*, death.

A more plausible case for physiological equivalence can be made only if the decapitation analogy is 'President's-Commission style', featuring the hypothetical details of immediate suturing of severed neck vessels and cauterization of tissues to prevent bleeding, plus mechanical ventilation through an endotracheal tube placed in the tracheal stump. The major premise in the decapitation-analogy syllogism is that such a headless body is dead. But this cannot simply be assumed without question. One possible reason for saying that it is dead is to draw attention to the mind/brain-body disconnection: to look over at the severed head and argue that the person is with the head, because the head contains the brain; therefore, what is left

of the person's true 'body' following decapitation is actually the head, while the rest (whatever it may be) is no longer the person's body. But note that this is not an argument that the headless body is biologically dead (not an 'organism as a whole'), but rather that it is not the original person's body. The question presently at hand is whether the headless body is a mutilated 'organism as a whole' or is a non-organism with the metaphysical status of a severed limb. If it is deemed to be an organism, the question *whose* body it is, if anyone's, is a completely separate issue that will be taken up below in section 3.3.

The question presently at hand is therefore: Is the ventilated, non-bleeding, headless body a mutilated and terminally ill 'organism as a whole' or a mere unintegrated collection of living organs and tissues? To answer *that* question, we must look directly at the biological properties of such a body. This is rendered difficult by the fact that, thankfully, no such preparation of a human body has ever been or (hopefully) will ever be carried out. Two approaches come to mind to investigate the physiological properties of such a hypothetically maintained headless human body: (1) its physiological equivalence with a brain-dead body, and (2) determining the 'essential' anatomical component of such decapitation (*vis a vis* brain-death theory) and examining the physiological properties of cases of 'critical' ('essential') partial decapitation.

3.2.2. *Somatic Physiology in Brain Death*

The first approach sounds strangely circular: to understand whether a brain-dead body is an 'organism as a whole', we investigate a decapitated, ventilated, non-bleeding body, which is physiologically equivalent. But there are none to investigate, so to understand whether such a hypothetically maintained body is an 'organism as a whole', we investigate brain-dead bodies, which are physiologically equivalent. There are plenty of the latter to investigate, and the amount of physiological data accumulated over the years is vast. The interpretation of such data has led to conflicting conclusions regarding whether such a body is a very sick organism or a non-organism (and consequently for our purposes, whether the hypothetically maintained headless body is a very sick organism or a non-organism).

3.2.2.1. *Acute Instabilities*

Those who conclude from the somatic physiology of brain death that

such a body is a mere collection of organs and tissues, not an 'organism as a whole', point to several aspects: multi-system dysfunction and corresponding difficulty maintaining such bodies for any extended period of time in ICUs (e.g., the maintenance of brain-dead pregnant women for weeks to bring the fetus to viability is always a technological *tour de force*), extreme cardiovascular instability, and the alleged imminence of cardiovascular collapse despite all technological means to prevent it. Such reasoning is faulty. If brain-dead bodies are in fact unintegrated collections of organs, then such physiological properties would surely follow. But the fact that such physiological properties occur with brain-dead bodies does not prove that therefore they are unintegrated collections of organs. 'If A, then B' is not equivalent to 'B, therefore A'.

Indeed, there are other explanations for the multiple physiological instabilities of acute brain death that have nothing to do with the putative explanation of the brain being the central integrating organ of the body, without which the body literally dis-integrates. In many cases of brain death the etiology that damaged the brain directly damages other vital organs as well (e.g., severe hypoxia-ischemia, massive trauma). In my meta-analysis of 56 cases of brain death with survival at least 1 week, one of the two factors that statistically significantly influenced survival potential was indeed etiology (multi-system damage had shorter survival potential on average than primary brain pathology) (Shewmon, 1998). Even in cases of primary brain pathology, the very process of brain herniation, prior to actual death of the brain, can produce a 'sympathetic storm' resulting in subendocardial microinfarcts and neurogenic pulmonary edema (Wijdicks and Atkinson, 2001, pp. 32-8).

Thus, there could be several reasons why these patients are often so unstable in the acute phase that have nothing to do with loss of integrating brain function. Moreover, there are many kinds of severe brain lesions short of brain death, as well as non-brain lesions (e.g., high spinal cord injury, severe Guillain-Barré syndrome, septic shock, etc.) that result in similar degrees of cardiovascular instability and multisystem dysfunction, but no one concludes from the requirement of a similar level of high-tech ICU care that such patients are already dead. No more does such acute somatic instability *per se* prove that brain-dead patients are already dead.

Another reason for the systemic instability in many cases of acute brain death is spinal shock. As far as the spinal cord is concerned, brainstem infarction down to the level of the foramen magnum has the same effect as transection of the spinal cord at the level of the foramen magnum

(Jørgensen, 1973; Jørgensen, 1995; Shewmon, 1999b; Shewmon, 2004c). Spinal shock lasts days to weeks and involves not only hypotonia and loss of tendon reflexes but also, and more importantly, autonomic areflexia, which exacerbates the instabilities already due to intrinsic or secondary multisystem damage.

3.2.2.2. *Some Brain-Dead Patients Are Dead, But Not Because Only Their Brains Are Dead*

I am quite sure that some brain-dead patients *are* in fact already dead by virtue of associated supracritical multisystem damage, and the mechanical ventilation merely masks this fact. (This ‘masking’ theory of brain death – that there is only one kind of death, and the only difference between traditional ‘cardio-pulmonary’ criteria and the new neurological criteria is that in the latter the death-state is ‘masked’ by the artificial ventilation – is one of the earliest proposed rationales in the history of brain death. It was originally popularized by lawyer-ethicist Alexander Capron (Capron, 1987; Capron, 1999, p. 125; Capron and Kass, 1972) and promoted by the President’s Commission (of which Mr. Capron was Executive Director) (1981, pp. 33, 35, 58) as applicable to *all* cases of brain death. This theory of brain death was obliquely alluded to by Pope John Paul II in his discourse to the Transplantation Society, when he described ‘the traditional cardio-respiratory signs’ and ‘the so-called ‘neurological’ criterion’ as alternative signs for the same physiological state (John Paul II, 2000). I suspect that such ‘masking’ of death by the ventilator is in fact the case with many brain-dead patients who experience rapid cardiovascular decompensation and cardiac arrest, from which they cannot be resuscitated by any means. If such patients (or some subset of them) are dead, it is not *because* their brains are dead, but because they suffered supracritical multiorgan damage, including the brain. The diagnostic problem with such cases is that one can’t know that they fall into this category until they actually undergo the cardiovascular collapse from which they can’t be resuscitated.

3.2.2.3. *Chronic Stability*

Contrary to an endlessly repeated dictum in the earlier brain-death literature, and parroted even as recently as 1996 by Pallis and Harley (Pallis and Harley, 1996, ‘Preface to the second edition’), *not all* brain-dead patients undergo imminent, irreversible cardiovascular collapse. The pro-

portion that could in principle survive longer than a few days with ICU care will never be known, since the huge majority either become organ donors or have the extraordinary-disproportionate life support ethically discontinued. What is known is that with therapeutic motivation (e.g., brain-dead pregnant women to bring the fetus to viability; cultural reasons – especially in Japan, for example, where many of the long-surviving cases have been reported; respect for family sensitivities and beliefs; etc.), some brain-dead patients have been maintained long enough for many of the acute instabilities to resolve: blood pressure stabilizes and pharmacological cardiovascular support is no longer needed; intestinal ileus resolves and nourishment can be maintained through enteral tube feedings; diabetes insipidus, if initially present, may spontaneously resolve.

As of 1998 I collected some 175 cases of brain death with survivals at least 1 week, not just 56 as is often stated about my article (Wijdicks and Atkinson, 2001, p. 39) by those who must not have examined the accompanying Tables 1 and 2, which detail all the cases and references (Shewmon, 1998). (These tables were too bulky for inclusion in the published article but were available to anyone interested). The 56 cases were a subset of the 175 with sufficient individual information available to include in a meta-analysis, which identified two factors that statistically predisposed to longer survival potential: primary brain pathology (as opposed to multisystem damage) and young age. The other 119 cases were from published series with aggregate, rather than individual data; many were from Japan.

This provocative research has been both praised and criticized. Most of the critics have expressed doubt regarding the reliability of brain-death diagnosis in all the cases, whether an apnea test was performed properly, etc. (Bernat, 2001, p. 180; Bernat, 2002, p. 257; Bernat, 2004, p. 161; Wijdicks and Bernat, 1999). All I can say is to repeat what I wrote in the article itself and quoted in my reply to letters to the editor: 'If patients were 'brain dead' enough to qualify as organ donors, they were surely 'brain dead' enough to qualify for this study' (Shewmon, 1998; Shewmon, 1999a). Even if, for the sake of argument, some of the 175 cases were misdiagnosed, surely the majority were not; and even more surely still, the *longest surviving* cases were not.

I will not repeat here the case history of the record survivor, 'TK', who at the time of my meta-analysis had been brain-dead for 14 years and on a ventilator at home. I presented a video of my complete neurological examination of TK at the Task Force on Brain Death of the Pontifical Academy for Life (1997-98), as well as at the Third International Symposium on

Coma and Death in Havana (Shewmon, 2000). Everyone who saw the video agreed that the patient met all the clinical criteria for brain death short of a formal apnea test, which could not be ethically performed because there would have been no benefit to outweigh the risks. (He had never been observed to breathe spontaneously for up to 1 minute off the ventilator during suctioning or tracheostomy changes). Confirmation of total brain destruction (including the entire brain stem) was obtained, however, by an MRI scan, which showed no identifiable brain or brain-stem structure, making the apnea test a moot point. TK finally expired after 20 years in the brain-dead state. A brain-only autopsy was performed, with singularly remarkable findings that confirmed still more definitively the totality of brain and brain-stem destruction (Repertinger *et al.*, 2006).

I am glad that the autopsy and publication were done by physicians with no relationship to me and with no previous special interest in brain death. It is clear from their multiple choices of words what all four co-authors consider TK's life/death status to have been. He 'died at age 24 years of complications of *H influenzae* type b meningitis acquired at age 4' (p. 591). 'During the rest of his life, he was ventilator dependent ... He required chronic care for most of his life ... In his final 2 months of life ... [H]e experienced a cardiac arrest in January 2004. Following his death, a brain-only autopsy was performed' (p. 592). 'Our pathologic findings at autopsy confirmed that his brain had been destroyed by the events associated with the episode of *H influenzae* type b meningitis, whereas his body remained alive (brain death with living body) for an additional two decades, a duration of survival following brain death that far exceeds that of any other reports' (p. 594). I have no doubt that anyone else who might have seen TK prior to his cardiac arrest would have used similar terms to describe his body: a clearly living human organism, deeply comatose, with vigorous spinal reflexes (both neuromuscular and autonomic) – in no way a disintegrated collection of organs and tissues, or a 'corpse' whose death was masked for 20 years by a mechanical ventilator.

It takes only a single property at the level of the 'organism as a whole' to prove that there is a 'whole'. But the bodies of TK and other long-term survivors in brain death demonstrate many holistic properties, such as, for example: complex homeostasis of hundreds if not thousands of interacting chemicals and enzymes, assimilation of nutrients and elimination of wastes, proportional growth, maintenance of body temperature (albeit subnormal and with the help of blankets), wound healing, overcoming of infections, ability to recover from illnesses serious enough to require hospital-

ization and be discharged home again, systemic stress responses to noxious stimuli, feedback balance of various endocrine functions, etc. (Shewmon, 2001). A 13-year-old boy in my series, whom I personally examined in a skilled nursing facility, began puberty while brain-dead (Shewmon, 1998, Table 1, 'BES').

These chronic cases, though rare, teach several important lessons about the nature of brain death. (1) The systemic instabilities associated with acute brain death are due to a combination of factors other than mere lack of brain control over the body: primary multisystem damage (depending on etiology), secondary cardiac and pulmonary damage from the process of brain herniation, and spinal shock. Therefore, these often transient instabilities cannot be cited as evidence that the body's integrative unity depends on brain function *per se*. (2) Whereas some brain-dead patients may in fact be dead by virtue of supracritical multisystem damage, some are clearly living organisms, albeit severely disabled and dependent on a mechanical ventilator, tube feeding and nursing care. (Again, the question of *whose body* such an organism is, if anyone's, is a separate issue, primarily philosophical rather than biological in nature, which will be taken up in section 3.3. below). (3) 'Chronic brain death' would no doubt be more common if not for the fact that in the huge majority of brain-death cases, either organs are harvested or the extraordinary/disproportionate care is terminated within hours of the diagnosis.

3.2.2.4. *The Body Has no 'Primary Integrating Organ'*

Why do so many people think that if there is somatic integration, there has to be a single, primary organ responsible for it? Plants and embryos have no central integrating organ; rather, the integration is clearly a non-localized emergent phenomenon involving the mutual interaction among all the parts.

Two kinds of distinction have to be made: on the one hand the distinction between a healthy, optimally functioning organism and a sick and/or disabled organism; and on the other hand the distinction between a very sick, marginally functioning organism and a dead one (a non-organism). For human organisms the brain is clearly the primary organ as regards the first distinction: it is the organ that gives humans superiority over all other earthly creatures, the organ most intimately involved in the human mind, personality, and spirit (cf. Aquinas: *Quaestiones Disputatae de Anima*, a.8 co; *Quaestiones Disputatae de Spiritualibus Creaturis*, a.2 ad 7). The human

brain is regarded by many as the most awesome structure in the entire physical universe, and it is the reason why most neurologists, like myself, chose neurology as a career.

But the distinction 'healthy vs. sick' (or 'optimally functioning vs. disabled') has little if anything, physiologically or philosophically, to do with the distinction 'marginally alive vs. dead'. Therefore, the primacy of the brain regarding human health and mental life in no way implies that the brain is also, and necessarily, the primary organ for life vs. death of the human organism, or even that there is a 'primary organ' for life vs. death.

3.2.3. *The Essential Component of 'Physiological Decapitation'*

We have already determined that exsanguination is not a component of 'physiological decapitation'. What aspect of decapitation, then, is the essential one that supposedly makes it death? A related but distinct question, to be taken up later, is: What aspect of decapitation is the essential one that supposedly makes it physiologically equivalent to brain death? We shall see that the answers are not the same, which is a major problem for the analogy.

Insight into the first question (What essential component of decapitation makes it death?) may be gained by considering two extremes of partial decapitation. If the guillotine blade got stuck after penetrating only 1 mm into the epidermis of the back of the neck, it is obvious that the intended victim is still alive. On the other hand, if the blade passed through almost the entire neck and got stuck 1 mm from the surface of the front of the neck, leaving the head attached to the rest of the body only by a small sliver of skin, it is obvious that for the heuristic purposes of the analogy, this would be just as much death as a 100% complete decapitation (if, in fact, it is death). Now we have a conceptual dilemma, because life and death are generally understood as mutually exclusive categories, whereas the degrees of partial decapitation are along a continuum from infinitesimal to 100% minus infinitesimal, and the possible anatomical patterns of each degree are infinite. Where along such continua does life pass to death (assuming the analogy's utility as an explanation of brain death), and what non-arbitrary explanation can be given for the answer?

3.2.3.1. *Candidate Components*

One consideration that may help is that the cross-sectional anatomy of the neck is not homogeneous, so the relevant question may not be in terms

of distance traversed by the blade, but rather what anatomical structures are or are not severed. It would be more meaningful and heuristically fruitful to forget about instantaneous decapitation from a large guillotine blade and imagine instead a slow-motion decapitation from precise serial cuts from a surgical scalpel. The question can then be rephrased, whether there is a critical structure or set of structures, severance of which is the 'essence', so to speak, of decapitation, insofar as that alone suffices to produce the death of decapitation, whereas severance of any or all 'non-critical' structures does not produce death. Let us consider the following most likely candidates for 'critical' structures: (1) the non-neural, non-vascular tissues of the neck (skin, fat, fascia, muscles, cartilage, ligaments, bone); (2) the major blood vessels passing through the neck; (3) the neural elements (spinal cord, phrenic and vagus nerves); (4) all of the above (i.e., the total separation of head from body). We now consider these one by one.

(1) Non-neural, non-vascular tissues are clearly not critical: selective severance of these, with preservation of blood vessels, spinal cord, phrenic and vagus nerves, would produce a severe mechanical instability, in essence a severe cervical vertebral fracture with extreme soft tissue injury. Such a patient would be perfectly conscious, able to breathe and move all extremities normally. If the patient were brought to an emergency room in such a condition, a neurosurgeon would place him or her in a metal 'halo' device to immobilize and stabilize the head to allow the cervical fracture to heal over ensuing weeks (the juxtaposed severed soft tissues would also gradually reconnect by scar formation, no doubt with the help of surgical sutures). Clearly such a patient is not dead by virtue of the structures severed, and this form of partial decapitation is not death.

(2) Severing of the major blood vessels in the neck is not death, but certainly will very quickly *produce* death from exsanguination, beginning with loss of consciousness within a few seconds from the sudden, total lack of blood flow to the brain, followed by progressive damage, at first reversible and soon irreversible, to all the organs and tissues of the body due to hypovolemic shock and complete exsanguination. The organs succumb not all at once but in a well known sequence, depending on their selective vulnerability to ischemia, beginning with the brain, then kidneys, liver and heart, then soft tissues, and much later skin and bone. When along this sequence of ischemic damage death actually occurs is not entirely clear, but it is certainly at least some minutes after the severing of the vessels. As pointed out above, such death from exsanguination has no resemblance to brain death, and in fact the most 'physiological' version of the 'physiological decapita-

tion' analogy has the vessels sutured closed as soon as they are severed, to prevent blood loss. A vessel-focused physiological analogy with brain death would be the simultaneous ligation (rather than severing) of all the major blood vessels to the brain, resulting in total brain infarction. But such ligation is not a physiological *analogy* of brain death; it would actually be a particular *cause* of brain death some minutes later. Blood vessels are not the essential core of the 'physiological decapitation' analogy.

(3) Selective sectioning of the neural elements produces apnea and quadriplegia. Such a patient brought to an emergency room would be placed on a mechanical ventilator and admitted to an ICU for stabilization of blood pressure, and management of a variety of systemic complications of acute spinal cord injury. After some days or weeks, the patient would be transferred to a rehabilitation unit. Clearly this form of partial decapitation is not death.

(4) Complete physical separation into two parts (abstracted from the exsanguination issue) seems the only possibility left. In other words, there is no essential core of partial decapitation that is *per se* death. If both head and headless body are technologically kept alive through attaching the body to a ventilator and keeping the head perfused with oxygenated blood by attaching its major vessels to a cardiopulmonary bypass machine, then we can legitimately question whether even complete physical separation is *per se* death or rather a condition that would quickly lead to death if heroic medical intervention had not taken place. Whether the original person is with the head-part, the body-part, both, or neither, is again a philosophical issue to be taken up later; here we are focusing on the biology of the body-part.

Surprisingly, when we search for the essential anatomical core of decapitation that makes it death, we find that, not only is it elusive, but not even complete decapitation may *per se* be death after all (as opposed to an injury that would ordinarily quickly lead to death).

3.2.3.2. *Brain-Body Disconnection in High Cervical Cord Transection*

That having been determined, we now address the second question posed above: What form of partial decapitation captures the essence of the physiological analogy with brain death (setting aside whether either is death or not)? The answer is clearly the sectioning of the nervous elements: spinal cord, vagus and phrenic nerves. If the sectioning is above the exit level of the phrenic nerves, then we need concern ourselves only with high spinal cord and vagus nerve. Theoretically, the somatic physiology of brain

death and that of high spinal cord transection plus vagotomy ought to be identical, apart from the influences of pituitary function, which are variable in brain death but intact in spinal cord transection. This comparison was astutely drawn by Youngner and Bartlett back in 1983 (1983, p. 254), and it still remains perfectly valid. To make the somatic analogy conservatively complete, we could compare brain death with the combination of high spinal cord transection plus vagotomy plus hypothalamic hypopituitarism. This is necessarily so in principle, because in both cases the body 'sees' only the parts of the nervous system distal to the foramen magnum: in the one case because the rostral parts are missing, and in the other case because they are disconnected.

The theory is also borne out by clinical data. A detailed point-by-point comparison of the pathophysiology of brain death and the pathophysiology of high spinal cord transection reveals that the two conditions are indeed clinically identical (particularly if the spinal cord lesion is combined with vagotomy and hypopituitarism, or if the brain death does not involve much pituitary dysfunction). The *only* difference is consciousness (by no means a minor difference, but we are focusing here strictly on the issue of somatic physiology). In fact, a typical textbook chapter on the ICU management of brain-dead organ donors and a typical textbook chapter on the ICU management of high spinal cord injury patients are so nearly identical that one could be transformed into the other simply by switching the terms 'brain death' and 'spinal cord injury'. This is the case not only in the acute phase, when spinal shock plays a major role in the instabilities of each condition, but also in the subacute and chronic phases, when spinal reflexes and spinally mediated integration return. (For a detailed itemization and discussion of these parallels, see Shewmon, 1999b; Shewmon, 2004c).

The essential core of the 'physiological decapitation' analogy with brain death is high cervical cord transection plus vagotomy. But patients with high spinal transection are clearly not dead – and *not only* because they are conscious. It is not that they are conscious mind/brains within a jumble of unintegrated organs and tissues; rather, they are clearly still living mental/corporeal beings, with biologically living bodies, although ventilator-dependent and severely disabled due to the brain's lack of influence over the rest of the body.

Two conclusions follow: (1) If high-cord-transected bodies are disabled 'organisms as a whole', then brain-dead bodies are equally disabled 'organisms as a whole', the former being conscious organisms and the latter being unconscious organisms. (2) Loss of somatic integrative unity is not a viable

rationale for either brain death or the decapitation analogy. If brain death is death, it can only be so by virtue of permanent loss of consciousness, as maintained all along by the 'higher brain death' advocates. This would imply that not only 'brain death' but any neurological lesion producing permanent unconsciousness (e.g., permanent vegetative state) is also death.

3.2.4. *Logical Disconnects Between Brain-Death Theory and Practice*

Brain-body disconnection, which is the essence of the 'physiological decapitation' analogy, brings to light a number of paradoxes or mental (logical) disconnects between mainstream brain-death theory and mainstream brain-death practice.

1. What is so magical about the cervicomedullary junction that brainstem mediated somatic integration 'counts' for life/death status, but spinal-cord-mediated somatic integration does not 'count'?

2. In the context of all other criteria for brain death having been met, why should the presence of a somatically irrelevant sluggish pupillary reflex mean the patient is alive, whereas the presence of a somatically integrative hypothalamic function (e.g., maintenance of water balance through regulated secretion of antidiuretic hormone) does *not* mean the patient is alive?

3. Some patients with all the clinical signs of brain death (on the basis of primary 'brainstem death') can have prominent electroencephalographic activity, including even patterns resembling physiological sleep (Esteban *et al.*, 1995; Grigg *et al.*, 1987). Therefore, when the American Academy of Neurology practice parameter states that brain death is a clinical diagnosis and that electroencephalographic confirmation is not necessary, it implies that it doesn't matter whether the cerebral cortex is functional or not so long as the brainstem is nonfunctional, thereby tacitly aligning itself with the British 'brainstem death' notion and disconnecting its brain-death diagnostic criteria from all U.S. statutory laws defining the neurological diagnosis of death in terms of the totality of brain nonfunction.

4. If the mainstream rationale for equating brain death with death is still integrative unity ('organism as a whole'), why do the mainstream diagnostic criteria for brain death not require a single somatically integrative function to be checked and why do they explicitly allow some integrative functions to be present without invalidating the diagnosis (e.g., absence of diabetes insipidus, cardiovascular stability, autonomic and endocrine stress responses to unanesthetized surgical incision)? When Ropper *et al.*, in their essay on page 5 of the Conference brochure, state that residual hypothalamic func-

tion is a 'spurious argument' (Ropper *et al.*, 2006), why should hypothalamic function be any more 'spurious' than a gag reflex, if what is supposedly to be diagnosed is total brain nonfunction? And why should such a somatically integrative function as secretion of antidiuretic hormone be more 'spurious' than a somatically non-integrative function such as a corneal reflex, if the rationale for equating brain death with death is supposedly the loss of the brain's integrating and unifying control over the body? (Cf. Brody, 1999, p. 73; Halevy and Brody, 1993; Truog and Fackler, 1992). Furthermore, it is not true, as claimed by Ropper *et al.*, that such hypothalamic function is always a 'transient phenomenon'. In the majority of the 56 cases in my meta-analysis no mention was made of diabetes insipidus. I'm sure that some of these patients had it and the case reports simply omitted mention of it; I'm equally sure that many did not have it. In the record case of 'TK', what was transient was the presence of diabetes insipidus at the beginning, not its absence. It then spontaneously resolved, so that during most of his 20 years in brain death, he did *not* have diabetes insipidus, despite having no residual hypothalamic tissue identifiable at autopsy. To dismiss such a somatically integrative function, which is generally considered a brain function, as 'spurious' amounts to dismissing the mainstream rationale of integrative unity itself as 'spurious'. And what can possibly be meant by asserting that such 'technical arguments can be dealt with on a practical level'? It seems to imply that, for the sake of practicality, we should disconnect our minds from (i.e., ignore) this serious logical disconnect between mainstream brain-death theory and mainstream brain-death diagnosis, and simply forge ahead with mainstream brain-death practice and organ harvesting despite the incoherencies at its theoretical basis.

5. Another mental disconnect has to do with the cardiovascular instability in acute brain death, which is often cited as supportive evidence that brain death is death – so much so that one unusually coherent brain-death defender went so far as to state that, if there is cardiovascular stability without pharmacologic support, then the patient cannot be truly brain dead even if all the other signs are present, and that in such a scenario the heart cannot be ethically harvested (Cervós, 1991, p. 13). On the other hand, the American Academy of Neurology diagnostic guidelines (1995) explicitly regard cardiovascular stability without pharmacologic support as *compatible* with the diagnosis of brain death, and cardiac surgeons regard the best hearts for transplant as coming specifically from brain-dead donors with cardiovascular stability without pharmacologic support (Darby *et al.*, 1989; Guerriero, 1996). Thus, the very physiological qualities of the best heart donors logically conflict with the theoretical reason why they are suppos-

edly dead in the first place in order to donate ethically.

6. Yet another mental disconnect is the fact that, although mainstream neurology still semi-officially endorses the integrative-unity rationale, many experts in their heart of hearts endorse the consciousness-based rationale (dead person despite a live body). (See above quotations from Drs. Plum and Cranford; also personal impression from many conversations with colleagues on this issue).

7. Finally, there is the mental disconnect surrounding the 'physiological decapitation' analogy itself. The thought-experiment analogy is supposed to help us understand why brain death is cessation of the organism as a whole. But in the final analysis, we need to examine the actual pathophysiology of brain death in order to determine what the pathophysiology of a headless, ventilated, non-bleeding body would be like – and when we do, we are forced to conclude, after overcoming the instinct of revulsion at the mutilated appearance, that the decapitated body is after all an organism as a whole, to the same extent that a high spinal cord-transected body is, to the same extent that a brain-dead body is. *Whose* body the headless living organism is, if anyone's, is a totally different question, to which we shall turn now.

3.3. *Focus on the Head – Who's there, if Anyone?*

In our thought experiment, let us arrange things so that not only the ventilated body does not exsanguinate, but also the severed head, which is kept alive by attaching the major vessels to a cardiopulmonary bypass machine. Since nothing has been done to interfere with the brain's mediation of consciousness, we can reasonably assume that the head is conscious, with the same personal consciousness as before the operation, and that it can communicate with us through facial and eye movements. In my first brain-death publication, I argued that, since bone and soft tissue do not contribute to consciousness, the thought experiment would be just the same, and produce a greater external resemblance to brain death, if only the brain were removed and kept alive floating in a vat, by means of attaching the major blood vessels to a cardiopulmonary bypass machine (Shewmon, 1985). Based on what we know about brain and consciousness, this would result in the same personal consciousness associated with the isolated brain as with the full head, except now the conscious mind is cut off from all communication with the rest of the world and remains alone in its thoughts and memories. The brainless body is phys-

iologically identical to a brain-dead body.

3.3.1. *The Challenge of the Thought Experiment*

Given that the headless (or brainless) body is a living organism, as established in the foregoing section, and that the head (or isolated brain) is the putative locus of the original conscious person, what conclusions can be drawn regarding the personal status and/or identity of the body? At first glance it would seem that the person's true 'body' is the brain plus whatever is physiologically integrated with the brain (the head, or the entire intact body pre-decapitation); conversely, whatever is physiologically and spatially disconnected from the brain is not that person's body, regardless whether it is a living organism or not. Therefore, if now the isolated brain were disconnected from its life-support and allowed to die, the still living brainless body would remain just the same: a living organism but not the body of the original person. This is exactly what obtains in brain death, except that the total brain infarction takes place *in situ* rather than following surgical removal and temporary maintenance in a vat. Thus, the analogy lends strong support to the consciousness-based rationale for brain death, namely that the brain-dead body is a living organism but no longer a living human person: the original person died when the brain died. This line of argumentation was very convincing to me in the decade of the 1980s, and it formed the core of my defense of brain death, initially of 'higher brain death' (Shewmon, 1985) and later of a modified version of 'whole brain death', which I presented at the Pontifical Academy of Sciences' Second Working Group in 1989 (Shewmon, 1988; Shewmon, 1992).

At the time I had not yet realized that the headless (or brainless) body was a living 'organism as a whole' in its own physiological right, although a severely disabled one. Since the isolated living head (or brain) was the original person, I assumed without much further consideration that therefore the rest of the 'body' could not possibly be a true body but rather something with the metaphysical status of a severed limb, only larger and more heterogeneously structured. In 1992 the physiological equivalence between brain death and high spinal cord transection first dawned on me, forcing a difficult re-interpretation of the thought experiment in the new light of the headless (or brainless) body being rather a permanently comatose, living human 'organism as a whole'. For several years I was not sure how to reconcile these two apparently conflicting theoretical arguments for and against brain death being death of the individual, but I was surer of the empirically demonstrable somatic equivalence with spinal cord transection

than of philosophical speculations on a hypothetical thought experiment.

After 5 years of laying low on the topic, I ventured forth again in the literature with my new, iconoclastic position against brain death as death. In the autobiographical narrative of my intellectual journey, I realized that the thought experiment had to be seriously dealt with, and I attempted a reinterpretation of it in keeping with my new attitude toward brain death (Shewmon, 1997, pp. 70-5). That attempt received various criticisms, largely from higher brain death advocates, and in retrospect I concede that certain criticisms were valid (Lizza, 2006, pp. 102-7). I was never fully satisfied with my own reinterpretation even at the time, but was simply unable to come up with a better reconciliation between what seemed an unassailable physiological conclusion of 'organism as a whole', on the one hand, and death of the person with death of the brain in the thought experiment, on the other hand. Since then, my writings have focused on the organism as a whole, showing that brain function is not after all necessary for integration of the body, and that somatic integration is not localized to a particular master-organ but is diffuse throughout the body in the mutual interactions among its parts. This paper represents my first dealing with the decapitation analogy since 1997; hopefully the intervening 9 years have occasioned some additional insights and perspectives on the matter.

3.3.2. *Reductionistic Interpretation*

I am now convinced that the interpretation of the thought experiment is highly dependent on one's basic philosophical world-view. For a material monist and person/mind/brain reductionist, the solution is clear. The person is with whatever part contains the functioning brain. In case the analogy is extended to separation of only part of the brain (as proposed in my original *Thomist* paper [Shewmon, 1985]), then the person is with whatever contains the part of the brain that is conscious. That is now the person's true 'body', severely mutilated and hardly recognizable as a human body, but one nonetheless; the rest is not the person's body, no matter how much it might look like a human body. Given that it is biologically an 'organism as a whole', it could be called a 'humanoid organism' (Lizza, 2004, p. 52; Lizza, 2006, p. 15; Shewmon, 1985). The person dies when the part with the conscious brain dies, not when respiration and circulation irreversibly stop in the headless (or brainless) body. Since this is exactly what obtains in brain death, except that the brain dies *in situ* rather than after separation from the body, it follows logically that clinical brain death is just as much personal death as is death

of the separated conscious brain in the thought experiment.

3.3.3. *Catholic-Compatible Interpretation*

From the basic philosophical world-view of the Catholic Church, however, the interpretation of the analogy becomes much more complicated, because the human soul must also, and primarily, be taken into account. Of the various notions of 'soul' proposed in the history of philosophy, the one most compatible with the Judaeo-Christian tradition and officially endorsed by the Catholic Magisterium is the Aristotelian-Thomistic concept of soul as 'substantial form' or life-principle of the body (Council of Vienne [1312], 1957). In distinction from plant and animal 'souls', the human soul has a spiritual dimension which is the ultimate basis for hybrid spiritual/physical mental acts (which necessarily involve brain activity but are intrinsically irreducible to physical brain activity alone), such as reflective self-awareness, abstract concept formation, and volition. The brain is necessary for the interaction between the spiritual ego-center and the rest of the body and the world, but the person and the person's mental activities are more than mere electrochemical brain activity and involve a whole immaterial/spiritual dimension of existence, which the reductionist does not recognize. It should be emphasized that the concept of soul endorsed by the Church is *not* that of Cartesian dualism, in which a purely spiritual soul/mind somehow interacts with an essentially mechanical body. Rather, the soul is at one and the same time the spiritual basis for the immaterial dimension of mental functions *and* the life-principle of the body, making it an 'organism as a whole'. Separated from the body at death, the human soul is incomplete; it is in some sort of conscious state but cannot perform properly human mental functions without the instrumentality of the brain (cf. Aquinas' thoughts on separated souls: *Summa Theologiae*, Ia, q. 89; *Quaestiones Disputatae De Anima*, a. 15). This emphasizes the importance of the doctrine of resurrection of the *body* for Catholicism. (Contrast this with the Platonic notion of the soul as a spirit imprisoned in the body, which is not its fully functioning self until released from the body at death into a purely spiritual realm of existence).

For Catholicism, then, the human soul: (1) has an immaterial dimension that allows it to persist after bodily death; (2) utilizes the brain as an instrument for properly human mental functions, but is itself the basis for those spiritual/immaterial aspects of mental functioning that are intrinsically irreducible to electrochemical or other physical brain activity; (3) is also by nature the life-principle ('substantial form') of the body; and (4) as such is

present throughout all parts of the body, not only in the brain (which would be a variation on Cartesianism, with the brain as a whole taking the place of Decartes' pineal gland). An important corollary is that brain lesions producing unconsciousness, even if permanent, *paralyze* the mental powers of the soul but do not annihilate them, no more than the cutting of all the strings of a piano would make the performer any less of a pianist. This is a key difference between Catholic anthropology and person/mind/brain reductionism: the former admits of such a notion as a 'permanently unconscious person', whereas the latter does not. For the Catholic, as long as there is evidence that the body is alive (an 'organism as a whole'), then the soul and person are present, even if rendered permanently unconscious by a brain lesion. For the reductionist, if such a body is alive, it is simply not the original person's body any longer (a nonpersonal 'humanoid organism'), and the person is still dead by virtue of the permanent unconsciousness. For the reductionist, the notion of a 'permanently unconscious person' is a contradiction in terms, whereas for the Catholic (and of course many others who share the Catholic view of soul) there is no contradiction at all.

Approaching the thought experiment from this Catholic world-view, we can make the following observations. Since mental functions (presumably) continue to be mediated by the isolated brain, the soul must be 'informing' the brain (or the head with the brain, depending on which version of the thought experiment). This seems clear enough. The difficulty has to do with what to make of the brainless (or headless) body, given its biological status as an 'organism as a whole'. Several theoretical possibilities present themselves: (1) The brainless (or headless) body has a new 'soul' or life-principle, but not a new spiritual human soul – rather, some kind of animal 'soul', albeit not that of any naturally occurring animal species. (2) The brainless (or headless) body has a new human, spiritual soul, something analogous to twinning during early human embryogenesis. (3) The one original soul, because of its immateriality, transcends the limitations of space and informs *both* the brain (head) and the brainless (headless) body, even though they are physically separated. (This would seem to invoke a somewhat unorthodox notion of Aristotelian hylomorphism and its Thomistic application to the human soul).

3.3.4. *Need for a Refinement of Aristotelian-Thomistic Anthropology*

Such a thought experiment falls into a class of related philosophical problems involving the splitting and fusing of biological organisms, such

as: planaria and other lower species that can regenerate a whole organism from a severed part, twinning of human or animal blastocysts, and Siamese twins. When a planarium is bisected and each part grows into a new whole planarium, how would Aristotle have answered the question which of the two resulting worms has the original substantial form and which has a new substantial form that was educed from the potency of matter at the moment of bisecting? (Or was the original form lost, and two new forms educed?) Probably he was not aware of this remarkable biological phenomenon, and his system of hylomorphism was developed based on the ordinary things of nature that he observed. Perhaps hylomorphism is not a fully adequate metaphysical system for explaining what happens when a planarium is bisected. The same dilemma applies to human twinning, only worse, because the human soul's spirituality cannot be simply 'educed from the potentiality of matter' as animal souls are, but each human soul is created *ex nihilo* by a special act of God when the material conditions are appropriate (Aquinas: *Summa Theologiae*, Ia, q. 90, a. 2&3). Thus, with human twinning, it remains mysterious and probably intrinsically unknowable whether there were two souls already present prior to the twinning – and that's precisely why the twinning happened – or only one soul prior and two afterwards, in which case it remains obscure which twin kept the original soul and which got a newly created soul. And in the case of Siamese twins that share many vital organs and blood circulation, there seem to be two human souls but only one body, which is hard to reconcile with hylomorphism; or else there are two bodies, each 'informed' by its respective soul, but with complex domains of overlap that seem to be informed by both souls.

Traditional Aristotelian hylomorphism and its Thomistic application to Christian anthropology do not seem philosophically adequate to account for such phenomena. Whether what is needed is a further development of hylomorphism, or a completely new philosophical framework that better accounts for such biological phenomena without conceptually sacrificing the spirituality of the human soul or its essential relationship with the human body – I do not know. I am not a philosopher, and I am not ashamed to admit that I have no definite, logically defensible answer for the thought experiment any more than I do for the related questions regarding planaria, twinning, and Siamese twins. In the end, especially regarding the human examples, we may have to be content simply remaining agnostic about one or two souls, which soul, etc., and sim-

ply stand in respectful awe of the mystery of human life.

3.3.5. *The Thought-Experiment is Actually Irrelevant to Clinical Brain Death*

This sounds like an intellectually rather weak alternative to the reductionists and 'higher brain death' advocates. But I would also assert that the inability to definitively, non-arbitrarily, solve the thought-experiment dilemma within the context of traditional Christian anthropology is actually *not* a problem at all for understanding brain death within the same philosophical framework – because in real brain-death cases, there is no separation into two parts, so the question never arises which part has which soul (or which kind of soul). Throughout the entire pathophysiological process of total brain infarction, there is only one 'part' (i.e., the entire body), and as long as it remains a living organism, then we can be sure that the soul is there as its life-principle, even if the soul's mental powers are suspended due to the destruction of the organ through which those powers are designed to operate.

Thus, when examined in depth, the decapitation analogy sheds no heuristic light at all on brain death, but only confuses things by diverting philosophical attention to interesting but tangential questions, the answers to which do not determine the ultimate understanding of brain death. The 'essential' *partial* decapitation analogy, on the other hand, does shed considerable light on the subject by highlighting the physiological equivalence between brain death and high spinal cord transection (plus vagotomy, plus-or-minus diabetes insipidus), which is the critical essence of 'physiological decapitation'.

In summary, for the reductionist, the brain-dead body is a living 'humanoid organism' but no longer the body of a person, who is dead by virtue of permanent unconsciousness. For those who accept an Aristotelian-Thomistic type of spiritual soul, some brain-dead bodies are indeed dead by virtue of supracritical multisystem damage, whereas others (with pathology relatively limited to the brain) are permanently comatose, severely disabled, still living human beings; in either case, death of the brain *per se* does not constitute human death.

4. BRAIN DEATH AND THE NEW CARTESIANISM

The brain-death literature is full of word-choices that juxtapose 'brain' and 'body' as though the brain were not part of the body but rather an entity unto itself that governs the body, which in turn is regarded as essentially a complex machine in need of external governance and coordination. An

illustrative example is the phrase, encountered frequently in the more recent brain-death literature, 'brain death with prolonged somatic survival', which clearly implies that the *soma* or body does not include the brain. Moreover, the mechanistic view of the body so permeates modern biology and medicine that one can hardly get a manuscript or a grant application accepted without some reference to 'basic mechanisms'.

There is much structural similarity between Descartes' mind-body dualism and the 'brain-body' dualism which is currently in vogue. An important difference is that Descartes' dualism involved a purely spiritual mind and a purely mechanical body, whereas the neo-Cartesian dualism is purely materialistic, with the brain operating on 'mechanical' principles just as much as the rest of the body. Another important difference is semantic, regarding the term 'body': for Cartesianism the 'body' includes the brain, whereas for the type of neo-Cartesianism under discussion, 'body' includes everything *except* the brain.

Keeping these differences in mind, the structural similarities are fascinating and illuminating. For both, there are two distinct entities in a hierarchical relationship, with the mental entity governing the mechanics of the non-mental entity. For Descartes, the anatomical locus of interaction between mind and body was the pineal gland; for neo-Cartesianism it is the cervicomedullary junction. Descartes could not comprehend that human mental functions are a spiritual-physical hybrid, neither reducible to nor separable from bodily (brain) functions. Neo-Cartesians cannot comprehend that the human body is a unified hybrid of neural and non-neural elements, and that the neural elements are continuous with each other, so that the brain is a separate entity from the spinal cord only in diagrams, not in reality (cf. the many white matter tracts passing through both, and the transition zone between upper cervical cord and lower medulla). Even if the brain is destroyed, there is still the rest of the nervous system: the spinal cord with its intrinsic integrative functions and its two-way communication with almost all other parts of the body via peripheral and autonomic nerves. Just because these parts of the nervous system are not associated directly with mental function, they should not be underestimated in terms of their role in the maintenance of an 'organism as a whole'.

The intellectual sin of both 'isms' is to reify and compartmentalize what are in reality two inextricable components of a single hybrid entity. No doubt the very language we use (with distinct words for these components: 'mind', 'brain', 'body'), plus our tendency to think with our imagination in simple diagrams and compartments, are strong temptations in the reifying

direction, but our intellects must overcome such conceptual laziness.

5. WHAT IS DEATH, IF NOT BRAIN DEATH?

So far, this paper has expounded on what I think is *not* death. It should not conclude without stating succinctly what I think death *is*. In keeping with the traditional tripartite distinction introduced by Bernat and colleagues between ‘definition’ (concept), ‘criterion’ (anatomical substrate), and ‘tests’ for death (Bernat, 2001; Bernat *et al.*, 1981), I would say that my *concept* of death of a human person is the same as expressed eloquently by the late Pope John Paul II, namely, ‘a single event, consisting in the total disintegration of that unitary and integrated whole that is the personal self. It results from the separation of the life-principle (or soul) from the corporal reality of the person’ (John Paul II, 2000, §4). I also agree with the Pope that the exact moment of this event cannot be precisely determined empirically, but that there can be ‘biological signs that a person has indeed died’ (John Paul II, 2000, §4).

Turning now to the level of *criterion* or anatomical substrate, there could be many possible valid criteria (‘biological signs’) that a person has already died. But the closer one tries to get to the unobservable moment of death itself, the more difficult it becomes to formulate a universally valid and certain criterion. Rigor mortis is a valid criterion far from the moment of death and therefore not a clinically very useful one. A probably valid criterion close to the moment of death might be something like: ‘cessation of circulation of blood for a sufficient time (depending on body temperature) to produce irreversible damage to a critical number of organs and tissues throughout the body, so that an irrevocable process of disintegration has begun’. At normothermia, the minimum sufficient time is probably somewhere around 20 minutes, although there are insufficient data to support a precise duration with certainty (Lynn and Cranford, 1999, p. 108). I do not believe that the critical number of organs and tissues can be universally specified, as it will no doubt vary from case to case; surely the brain is included, but not *only* the brain.

This is similar to the traditional ‘cardio-pulmonary’ criterion, but it is a refinement of it, because neither heart nor lung function is necessary for life (people with artificial hearts, on cardiopulmonary bypass, extracorporeal membrane oxygenation, etc. are most certainly alive). The above proposed criterion is better called ‘circulatory-respiratory’, emphasizing what is really critical for maintaining the integration of the organism as a whole. ‘Respiratory’ is to be understood in this context not as ‘breathing’ but in the biochemical sense of exchange of oxygen and carbon dioxide in the mito-

chondria of every cell throughout the body (the enzymes involved are often collectively called the 'respiratory chain'). Perhaps a still better term could be devised that avoids the ambiguity inherent in 'respiratory'.

The precise sequence of organ failure can be highly variable from one death to the next, depending on the cause and overall context of death. I also think that the moment death can be legitimately 'declared' and acted upon can vary, depending on the type and context of the death (Shewmon, 2004d; Shewmon and Shewmon, 2004).

6. CONCLUSION

As admitted by brain-death defenders and critics alike at the 3rd International Conference on Coma and Death and in the October 2001 issue of *Journal of Medicine and Philosophy*, the accumulation of clinical evidence and theoretical considerations have indeed undermined some of the sacred mantras of traditional brain-death theory and driven 'the nails into the coffin' (Lizza, 2004, p. 52) of a biological, organism-as-whole rationale for equating death of the brain with death of the individual. Whether official neurology acknowledges it or not, the active debate among experts in brain-death theory has shifted from the biological to the philosophical domain, where the key question is: Is a permanently unconscious living human being still a human person? The answer to that depends on one's fundamental philosophical world-view and cannot be further elucidated by scientific investigation. It is in this philosophical arena that material reductionists and the Catholic Church must respectfully part company, the former answering 'No' and the latter answering 'Yes'.

Such affirmation of the existence of human life in its most fragile, disabled and dependent state is by no means an implicit mandate to 'therapeutic obstinacy' or 'vitalism'. Intensive care in the context of 'brain death' is one of the clearest possible examples of ethically 'extraordinary' ('disproportionate') means, which can (and in most cases should) be legitimately foregone, in keeping with traditional Catholic moral principles (John Paul II, 1995, §65; Sacred Congregation, 1980, §IV). Cases where it could be appropriate to employ such 'extraordinary' means include brain-dead pregnant women to bring the fetus to viability, respect for cultural sensitivities (e.g., in Japan) or personal convictions (as with the mothers of 'TK' and other chronically brain-dead children, some orthodox Jews, etc.), empathy in allowing time for family members to arrive and come together to grieve,

etc. Issues surrounding justice (who pays for these very expensive treatments) are also important, extremely complex, vary according to each country's health-care structure, and are far beyond the scope of this paper.

That brain death *per se* is not death carries profound implications for the field of transplantation. Regardless of the early history of brain death, its post-1968 history has been driven largely by the demands of transplantation: the rapid development and implementation of diagnostic criteria without adequate validation, the precipitous revision of statutory death laws without a real consensus on the fundamental rationale why brain death should be death, and now the huge momentum of transplantation making everyone reluctant to face squarely the accumulated evidence that the semi-official integrative-unity rationale was all along based on faulty biological assumptions and can no longer serve as an intellectually viable basis for the death of brain-dead organ donors.

But the demise of brain death does not necessarily imply the death-knell to transplantation that so many of its defenders seem to fear. It does, however, imply going about the transplantation procedure in a different way, so that the removal of 'vital' organs neither kills nor harms the donor if the donor is not yet dead (ethically analogous to live donors of blood, bone marrow, a single kidney or lobe of liver). At face value this sounds self-contradictory, but it is not – for reasons beyond the scope of this paper and already developed elsewhere (Shewmon, 2004d; Shewmon and Shewmon, 2004). I emphasize this in conclusion, to dispel the fear that surrounds accepting solid counterevidence against a 38-year-old medico-legal sacred cow. To admit that many brain-dead patients are deeply comatose, severely disabled, living human beings is progress, not regress. It will force a refinement in our understanding and diagnosis of death, a clarification in our fundamental philosophical principles regarding human life, and a realignment between our understanding and our consciences in dealing with these most vulnerable human lives.

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The availability heuristic describes our tendency to think that whatever is easiest for us to recall should provide the best context for future predictions. The availability heuristic can lead to bad decision-making because memories that are easily recalled are frequently insufficient for figuring out how likely things are to happen again in the future. Ultimately, this leaves the decision-maker with low-quality information to form the basis of their decision.

Psychedelic Experience as a Heuristic Tool for Exploring the Mind and the Brain. Alexey Alyushin. V. Hallucinating as gaining access to the domain of mental imagery Taking into account the aforementioned explanations, I now present some additional suggestions as to the why hallucinations appear. I refer to the "pre-appearance" of hallucinations to stress that some aspect of the hallucination exists before its overt manifestation. In my understanding, what is critical in the appearance of hallucinations is neither the overproduction of mental imagery nor a deficiency in reality discrimination. This paper presents different definitions of brain death, as part of the process of sketching the construction of brain death as a medical fact. Since its publication at the end of the 1960s in the Journal of the American Medical Association, the definition of brain death has drawn both adherents and opponents.

Space does not permit elaborating, except to refer to my book chapter, "Mental Disconnect: 'Physiological Decapitation' as a Heuristic for Understanding 'Brain Death'" (in M. Sanchez Sorondo, ed., The Signs of Death, Vatican City: Pontificia Academia Scientiarum, Scripta Varia 110, 2007, 292-333). In essence, the thought experiment does not shed physiological light on brain death, but requires actual brain death to shed light on it. In the developing brain, a neuron depends on molecular signals from other cells, such as astrocytes, to determine its shape and location, the kind of transmitter it produces, and to which other neurons it will connect. These freshly born cells establish neural circuits - or information pathways connecting neuron to neuron - that will be in place throughout adulthood.

Scientists hope that by understanding more about the life and death of neurons they can develop new treatments, and possibly even cures, for brain diseases and disorders that affect the lives of millions of Americans. The most current research suggests that neural stem cells can generate many, if not all, of the different types of neurons found in the brain and the nervous system. Organic mental disorders are caused by illnesses that are not psychiatric in nature. Learn more about symptoms, complications, and treatment.

Organic mental disorders are disturbances that may be caused by injury or disease affecting brain tissues as well as by chemical or hormonal abnormalities. Exposure to toxic materials, neurological impairment, or abnormal changes associated with aging can also cause these disorders. Alcohol, or metabolic disorders such as liver, kidney, or thyroid disease, or vitamin deficiencies, may be factors too.

Concussions, blood clots, or bleeding in or around the brain from trauma may lead to organic brain syndrome.