



Written by Margaret Sykes Former Guide at About Com

'Brain Waves' When???

Have you heard the common claim that "fetal brain waves" have been measured *very* early in pregnancy? Ever wondered how exactly that was done, and if it's true?

Good question, and no, it's not true. Instead, as with many "pro-life" assertions, it's based on very old research that has been taken out of context or misreported. It also depends on an incorrect, misleading definition of "brain waves," which is a nontechnical term anyway. Here's the real story.

The assertion is made over and over again that "fetal brain activity" has been observed or "fetal brain waves" have been measured at 40, 43, or 45 days, or at 6 weeks after fertilization. You can find the claim in "pro-life" and sometimes even nonmedical pro-choice literature. Sometimes a reference is cited, but most often not. This false information has passed into the general understanding about fetal development and is simply stated as fact. It is however a factoid instead, which is the name for a statement repeated often enough that people accept it as truth, though it's not.

One original source for the claim is Dr. Hannibal Hamlin's "Life or Death by EEG." This is a speech that was read before the Section on Nervous and Mental Diseases at the 113th Annual Convention of the American Medical Association in June 1964, and was printed in the *Journal of the American Medical Association*, October 12, 1964 (Vol 190, No 2, pages 112-114). Many claims reference it, for example this one from "Jack Dean" at a Compuserve address, cited by "The Pro-Life Advocate" on AOL:

At only 40 days after fertilization electrical waves as measured by the EEG can be recorded from the baby's brain, indicating brain functioning^{47, 48}.

47. Hamlin, H. (1964), "Life or Death by EEG," *Journal of the American Medical Association*, October 12, 113.

As is typical of "pro-life" writings and websites, however, it's doubtful whether "Jack Dean" or anyone else has actually read Hamlin's speech, which makes citing it dishonest. Rather, the claim is coming from "Dr. Jack" Willke's *Abortion: Questions and Answers*:

When is the brain functioning?

Brain waves have been recorded at 40 days on the Electroencephalogram (EEG).
H. Hamlin, "Life or Death by EEG," *JAMA*, Oct. 12, 1964, p. 120

What does the speech really say? I've looked it up in an actual 1964 *JAMA*, and it's amazing that this antiquated document is still being used in ways that must have Hannibal Hamlin turning in his grave. For one thing, it's misleading and deceptive for people to quote it as if it were original research rather than a personal essay or opinion piece from one physician, and for another, the research Hamlin cited is ancient and long superseded.

Not surprisingly for 1964, Dr. Hamlin had nothing to say about abortion. Instead, the speech is a plea that "competent application and interpretation of the EEG should gain medical approval for legal pronouncement of human death." This was not medical or legal practice in 1964, when only the lack of a heartbeat and breathing determined death.

As part of the speech, which is largely a consideration of the brain and not the heart in defining human life and which includes quotes from Pope Pius XII and the poet Pindar, Hamlin said:

The electrophysiologic rhythm of the brain develops early. Detailed EEG tracings have been taken directly from the headend of 16 mm (crown-rump) human

embryos at 40-odd days gestation, recovered from termination of pregnancies (Japan) ⁶ which revealed irregular slow waves, 0.2-2.0 per second at 10-90 mv with superimposed fine waves of 30-40 per second at 1-5mv. Recordings from embryos of 45 to 120 days gestation through surface and depth electrodes have shown responses to sedative and stimulant drugs, normal sleep spindles, and the effect of lack of oxygen by paroxysmal high voltage slow waves and ultimate electrical silence.⁷ The intra-uterine fetal brain responds to biochemical changes associated with oxygen deprivation by abnormal EEG activity similar to that produced in the adult brain.⁷ Thus at an early prenatal stage of life, the EEG reflects a distinctly individual pattern that soon becomes truly personalized. This is not so the ECG in producing its various types of records at all ages, many specimens of each type being identical and lacking any individual quality.

This is the entire text regarding fetal "brain activity." Let's look at the footnotes.

⁶ is Okamoto and Kirikae's "Electroencephalographic Studies on Brain of Foetus of Children of Premature Birth and New-Born, Together With Note on Reactions of Foetus Brain Upon Drugs" (*Folia Psychiat Neurol Jap* 1951;5:135-146).

These researchers studied fetuses obtained through hysterotomy abortions (Cesarean sections), a procedure which is no longer used. They used electrodes on the surface of the fetal cortex or buried within it to obtain some of the activity mentioned (the technical details are incorrectly quoted by Hamlin) at 3 months of pregnancy, or more than 90 days, not at "40-odd days" as Hamlin said.

The first ⁷ actually also refers to this article. Contrary to what Okamoto and Kirikae found, however, in modern EEG studies "normal sleep spindles" are not seen in premature babies before 32-35 weeks, according to the medical textbook *Electroencephalography: Basic Principles, Clinical Applications, and Related Fields*, and no activity in the cerebral cortex, drug-stimulated or not, has been observed by anyone else as early as 120 days. This makes it likely that Okamoto and Kirikae's readings were mostly artifacts (electroencephalographic waves that arise from a source other than the brain). In partial corroboration, though, R. Engel (1964, 1975) is said in *Electroencephalography* to have obtained high-voltage medium (neither fast nor slow) waves from a 19-week (133 day) premature newborn as it died from lack of oxygen. In short, the Japanese research is either largely obsolete and uncorroborated, or incorrectly quoted by Hamlin, or both.

The second ⁷ refers to R.L. Bernstine's 1961 book, *Fetal Electrocardiography and Electroencephalography*. At this point Hamlin is talking about late-term fetuses, but the things he says are still questionable. No one was penetrating women's bodies to install electrodes on fetal scalps in 1961, or doing external fetal monitoring during labor, and the claim that the readings were done through a woman's abdominal wall or vagina and "the mother's brain waves subtracted out" is preposterous, given the susceptibility of an EEG to interference. Bernstine's work is not mentioned in any neurology or electroencephalography text I've searched (though Okamoto and Kirikae are). In any case, this reference isn't relevant to the "40 days" claim.

'Brain Waves' When??? (2)

Another source for the "40 days" claim is John R. Goldenring's "Development of the Fetal Brain," a letter published in the *New England Journal of Medicine* in 1982. "The Pro-Life Advocate" website quotes it along with Hamlin:

48. Goldenring, J. (1982), "Development of the Fetal Brain," *New England Journal of Medicine*, August 26, 1982, 564.

And so does *Abortion: Questions and Answers*:

Brain function, as measured on the Electroencephalogram, "appears to be reliably present in the fetus at about eight weeks gestation," or six weeks after conception.

J. Goldenring, "Development of the Fetal Brain," *New England Jour. of Med.*, Aug. 26, 1982, p. 564

It's important to note that, like Hamlin's speech, letters published in medical journals are not subjected to the rigorous peer-review process that research is, and Goldenring's letter simply

expresses his personal opinion that abortion might be banned after 8 weeks based on brain development:

...[P]hysicians have always determined when a person is alive by measuring for the presence of certain "vital signs." ...[W]hen it became possible to replace both cardiac and pulmonary functions with machines, physicians turned to measuring the function of the only truly unique and irreplaceable organ — the brain. I submit that from this effort, the following principle has clearly emerged: The presence of a functioning human brain means that a patient, a person if you will, is alive. This is the medical definition of human life. We use it daily.

Historically, physicians have approached fetuses in the same way as any other patient, seeking vital signs to determine the patient's status — hence the emphasis on quickening in legal and medical thinking before this century. If we consider the fetus with the more sophisticated modern definition in mind, we find that brain function, as measured by an electroencephalograph, appears to be reliably present in the fetus at about eight weeks' gestation.^{6,7,8}

6. Hellegers A. Fetal development. In: Beauchamp, TL, ed. Contemporary issues in bioethics. Encino, Calif.: Dickenson, 1978:194-9.

7. Bergstrom RM. Development of EEG and unit electrical activity of the brain during ontogeny. In: Jilke LJ, Stanislav T, eds. Ontogenesis of the brain. Praha, Czech: University of Karlova Press, 1968:61-71.

8. Ellingson RJ, Guenter HR. Ontogenesis of the electroencephalogram. In: Himwich WA, ed. Developmental neurology. Springfield Ill.: Charles C. Thomas, 1970:441-74.

As with Hamlin's speech, no original research is being described here, which makes it dishonest and misleading to quote it as the source of a claim. But what did the sources Goldenring used have to say?

Andre Hellegers' "Fetal Development" was first published in *Theological Studies*, March 1970, and has often been republished in collections of writings on abortion. Hellegers was a professor of obstetrics and gynecology at Georgetown University Hospital and first director of its Kennedy Institute of Ethics who wrote about biomedical ethics. As with the other scientists and physicians quoted here, he never used the term "brain waves," but did write that

By the end of seven weeks tickling of the mouth and nose of the developing embryo with a hair will cause it to flex its neck, while at the end of eight weeks there will be readable electrical activity coming from the brain.⁹ The meaning of the activity cannot be interpreted.

Hellegers was talking about eight weeks from fertilization, not "at eight weeks' gestation" or "six weeks after conception" as Goldenring and Willke incorrectly claim, which makes it 56 days, not 40. But a bigger problem is that Hellegers was writing another personal essay, not reporting his own research. His source was D. Goldblatt's "Nervous System and Sensory Organs" in *Intrauterine Development*, a 1968 textbook which wasn't original research either.

On the other hand, Bergstrom's "Development of EEG and unit electrical activity of the brain during ontogeny" is original research. Only two courses of study on still-living aborted human embryos and fetuses have ever been done: Okamoto and Kirikae in Japan in the 1940s, and Bergstrom and Bergstrom in Finland in the 1960s. Like the Japanese researches, the Bergstroms obtained live fetuses "immediately after separation from the maternal circulation" from hysterotomy abortions, which are no longer done, so for practical and ethical reasons this kind of research will not be repeated. But the Bergstroms, who also studied rat, guinea pig, cat, and chicken embryos, did not find anything that substantiates a claim of "brain function, as measured on an electroencephalograph" at six weeks of development, as Goldenring claims.

What they did find was published in various obscure Scandinavian journals or 30-year-old medical books that are hard to find. It's also very well described in *The Facts of Life: Science and the Abortion Controversy*, a book that's easily available in paperback.

They found "electrical activity" in fetal brainstem cells from 10 weeks of pregnancy (56 days after fertilization) on, but that doesn't mean much. An EEG involves measuring varying electrical potentials across a dipole, or separated positive and negative charges. Any living cell has an electrical potential across its membrane, and any living structure is a dipole, which explains why

people have been able to put electrodes on plants, hook them up to EEG machines, and get "evidence" that plants have feelings. But this has nothing to do with "brain waves," which are a nontechnical term for a particular kind of varying potentials produced by certain brain structures that don't even exist in an embryo and associated with consciousness and dreaming as well as the regulation of bodily functions.

The Bergstroms did not find electrical activity of a kind that had anything to do with "brain function" until 84 days (12 weeks) of gestation, or 70 days after conception. The activity then recorded was not in any way similar to what is seen on a normal EEG, which includes what people call "brain waves." Rather, the Bergstroms stimulated the fetal brain stem and were able to record random bursts of electrical activity which looked exactly like the bursts they got from the fetal leg muscles when they were stimulated.

'Brain Waves' When??? (3)

At 17 weeks of pregnancy (119 days after fertilization) R.M. Bergstrom also reported finding "primitive wave patterns of irregular frequency or intermittent complexes from the oral portion of the brain stem and from the hippocampus" in the midbrain, according to *Electroencephalography*. Even the oldest fetuses that were studied, however, had no "brain waves" or other kind of signal from the cortex up to 150 or so days.

So all that this research showed, and reported, about the brain development of 56-to-70-day embryos and fetuses is that they have live nerve cells present in their brainstems. This is *not* the same as "brain waves" (Willke), or "electrical waves as measured by the EEG, indicating brain functioning" ("The Pro-Life Advocate"), or "coordinating and individuating brain function" (Goldenring).

In fact, of all the personal essays cited, only Hellegers got it right when he said that "readable electrical activity" is present at 56 days, but even he was wrong in saying that "The meaning of the activity cannot be interpreted." It can be interpreted: it means that fetal brain-stem cells are alive, interconnected, and react to stimulation, just the way fetal leg-muscle cells do.

Why has this subject not been researched since the 1960s? Apart from the fact that live aborted embryos and fetuses are no longer available, researchers now know more about the structure and development of the cortex, the highest part of the brain and the part that makes us who we are.

When people, including physicians, talk about "brain waves" and "brain activity" they are referring to organized activity in the cortex. While no embryo or fetus has ever been found to have "brain waves," extensive EEG studies have been done on premature babies. A very good summary of their findings can be found in „Pain and its effects in the human neonate and fetus," a review article (often cited by "pro-lifers" writing about fetal pain, but not about brain development) by K.J.S. Anand, a leading researcher on pain in newborns, and P.R. Hickey, published in *NEJM*:

Functional maturity of the cerebral cortex is suggested by fetal and neonatal electroencephalographic patterns...First, intermittent electroencephalographic bursts in both cerebral hemispheres are first seen at 20 weeks gestation; they become sustained at 22 weeks and bilaterally synchronous at 26 to 27 weeks.

There are reasons, based on the physics of the EEG, why this has to be so. Remember, an EEG involves measuring varying electrical potential across a dipole, or separated charges. To get scalp or surface potentials from the cortex requires three things: neurons, dendrites, and axons, with synapses between them. Since these requirements are not present in the human cortex before 20-24 weeks of gestation, it is not possible to record "brain waves" prior to 20-24 weeks. Period. End of story. Scientists do not attempt to find electrocortical activity in embryos and fetuses because they know more about the physical structure of the developing human brain than they did in 1963.

The irony is that Dr. Hannibal Hamlin himself would have been astounded at the use of his article to defend the personhood of embryos. The point of his speech, which only casually (and incorrectly) references fetal brain development, is to point out that

The sanctity of life must not depend upon cardiologic signs alone, with the brain excluded...Certainly the human spirit that emerges in man's unique individuality is the product of his brain, not his heart.

Willke, in *Abortion: Questions and Answers*, seems to agree:

Since all authorities accept that the end of an individual's life is measured by the ending of his brain function (as measured by brain waves on the EEG), would it not be logical for them to at least agree that individual's life began with the onset of that same human brain function as measured by brain waves recorded on that same instrument?

And Goldenring's discussion of "brain birth" as opposed to "brain death" makes the same suggestion:

I suggest that as physicians we should view human existence as a continuum from the first cell division of the fertilized ovum until the death of the last cell in the organism. When the coordinating and individuating function of a living brain is demonstrably present, the full human organism exists. Before full brain differentiation, only cells, organs, and organ systems exist, which may potentially be integrated into a full human organism if the brain develops. After brain death what is left of the organism is once again only a collection of organs, all available to us for use in transplantation, since the full human being no longer exists.

But the human part of the brain—the cortex—is not fully developed, as shown by "brain waves" on an EEG, until very late in gestation; in fact the EEG continues to change and mature into childhood. Indeed, the "individuating" function of a person's brain doesn't start to come into existence until the outer surface of the cortex begins to develop those deep furrows, grooves, and convolutions (sulci and gyri) that make a human brain look like a walnut, unlike the smooth brains of other animals. The furrows and grooves are what enable our brains to have millions more cells and connections between them than other animals, and so create our humanity. And the precise configuration of the grooves and convolutions are part of what determines our individuality; why, for instance, identical twins have different personalities, and even, perhaps, why Einstein was a genius. However, these structures don't begin to form until the last 2 months of pregnancy.

So I have no objection to saying that "a human life" or "human personhood" begins when brain waves are measured on an EEG. That is well into the second half of pregnancy, however, no matter how many times the "40 days" factoid is repeated.

FAIR USE NOTICE:

This site contains copyrighted material the use of which has not always been specifically authorized by the copyright owner. Such material is made available in an efforts to advance the understanding of environmental, political, human rights, economic, democratic, scientific, and social justice issues, etc. It is believed this constitutes a 'fair use' of any such copyrighted material as provided for in section 107 of the US Copyright Law. In accordance with Title 17 U.S.C. Section 107, the material on this site is distributed without profit to those who have expressed a prior interest in receiving the included information for research and or educational purposes. Each copyrighted piece posted here contains a link to the original owner of the copyright. If you wish to use copyrighted material from this site for purposes of your own that go beyond 'fair use' then you must obtain permission from the copyright owner.

I am, as owner, paid NO remuneration of any type from this site.