

The death of neuroethics (as we once knew it)

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ABSTRACT

Introduction. With a view to reaching a more thorough understanding of individual and collective human life, we attempt to analyse the social sciences and humanities from the point of view of the neurosciences. The prototype of the neurohumanities is neurophilosophy. The key issue of this study is to determine whether neuroethics constitutes a single field of knowledge.

Development. Although the neologism 'neuroethics' was introduced by Anneliese Pontius in 1973, neuroethics is often believed to have emerged in 2002 at the conference held by the Dana Foundation. Between 1973 and 2002, neuroethics was understood to be a branch of bioethics referring specifically to the 'ethics of the neurosciences'. Adina Roskies highly influential proposal states that neuroethics also refers to the 'neuroscience of ethics'. The parallel development of these two concepts has sometimes resulted in confusion and ambiguity. This study proposes retiring the term 'neuroethics' and replacing it with more descriptive terms.

Conclusions. It would be more appropriate to refer to 'encephaloethics' instead of ethics of neuroscience and 'neuromorality' rather than neuroscience of ethics. Each field has its own problems and focus areas and will require different theoretical and methodological approaches.

KEYWORDS

Neurophilosophy, neuroethics, neuroscience, bioethics, encephaloethics, neuromorality

Introduction

Just over twenty years ago, a scholar wrote that "from now on, both disciplines will go hand in hand, interacting and mutually transforming each other".¹ He was in fact referring to the relationship between philosophy and the neurosciences. The author of this quote considered that the mind-body relationship, first addressed by a thousand years of philosophy and only recently by the emerging neurosciences, was the fundamental problem. His study was published at the beginning of the last decade of the twentieth century, a period known as the Decade of the Brain² according to a political initiative launched by the government of the United States on 17 July 1990. The neurosciences were developing at a rapid rate and advances in knowledge during that decade were impressive. Important studies designed to further our knowledge of the brain are still underway. On the one hand, we have BigBrain,³ a neuroanatomy-oriented study that has obtained 7404 slices of a human brain at a near-

cellular resolution of 20 μm and digitalised those images to create 3-D maps.³ On the other, we find the Human Connectome Project, a functional neuroanatomy project aimed at building a map of networks of anatomical and functional connectivity in the healthy human brain.⁴ Lastly, the Blue Brain Project focuses on molecular neurophysiology; its main focus is studying the structure of the human neocortex by generating a molecular-level simulation.⁵

In the middle years of the Decade of the Brain, Francis H. Crick published a book containing the following excerpt:

"You", your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules".⁶

On this basis many neuroscientists will consider, to a greater or a lesser extent, that the humanity of human

beings originates in the brain. This concept was already present in the Western medical tradition; 25 centuries earlier, Hippocrates had written:

Men ought to know that from nothing else but the brain come joys, delights, laughter and sports, and sorrows, griefs, despondency, and lamentations. And by this, in an especial manner, we acquire wisdom and knowledge, and see and hear, and know what are foul and what are fair, what are bad and what are good, what are sweet, and what unsavory; some we discriminate by habit, and some we perceive by their utility. By this we distinguish objects of relish and disrelish, according to the seasons; and the same things do not always please us.⁷

Crick's study made an impact on Patricia Smith-Churchland, a philosopher he met at the Salk Institute in La Jolla where they both worked. Churchland proposed a true synthesis of philosophy and neurosciences in a novel discipline: neurophilosophy.⁸ The disciplines now known as the neurosciences took shape during the latter part of the twentieth century. New research, paired with novel approaches to the typical problems shared by the emerging neurosciences and classical philosophy (definition and description of processes related to learning, decision-making, the self, social affection, emotions, etc.) have resulted in a new proposal. This proposal suggests that philosophical questions from many sub-fields should be reshaped in new directions,⁹ one of which would be the field of ethics. This new series of approaches has given rise to a discipline known today as neuroethics.

The original proposal by Anneliese Alma Pontius

Neuroethics, the basis of our study, is a neurological neologism – 'neurologism' according to some authors¹⁰ – first coined by Anneliese Alma Pontius, born on 19 May 1921 in Chemnitz, Germany. She studied medicine in Germany (Jena and Frankfurt) and worked in psychiatry and neurology units at university hospitals (Frankfurt, Munich and Hamburg), where she also completed her training in psychoanalysis. Pontius worked in the Department of Psychosomatic Medicine at the University of Hamburg before joining the Department of Psychiatry at McGill University. She later worked with children, adolescents, and adults in the USA. She opened a private practice in New York and provided consultancy services in the US federal courts. Pontius then moved to Rockville where she worked as guest researcher at the National Institute of Mental Health while spending her summers teaching at the University of Heidelberg as a visiting

professor. Dr Anneliese A Pontius worked in forensic neuropsychiatry at New York University, as an associate professor in the department of psychiatry at Harvard Medical School, and as associate clinical professor of psychiatry at McLean Hospital until 2001.¹¹

The article Pontius published in 1973 was the first in scientific literature to use the neologism 'neuroethics'. It directly criticised the work of a research group that proposed studying early physical exercises for newborns who did not yet possess the walking reflex.¹² Her censure was directed at this and other early interventions affecting the motor development process. Pontius's article "focused on a new and neglected area of ethical concern-neuro-ethics".¹³ She concluded that researchers should be aware of the implications of experimenting with motility in newborns. In their reply, the group that came under criticism mentioned the ethical aspects of interventions in neurodevelopment, but they did not repeat the new term.¹⁴ The article was well-regarded and widely cited in its time.¹⁵

Meanwhile, another neologism had arrived on the scene in the early 1970s: bioethics. This term first appeared in the literature in 1927 in an article by German author Fritz Jahr.^{16,17} However, this use of the term might be considered prehistoric since it did not catch on and would not appear again until the early 1970s, when bioethics began developing along two different lines. The first refers to Potter's use of the term,^{18,19} and the second refers to the founding of two centres dedicated to this field: the Hastings Center in 1969 (through the efforts of Daniel Callahan and others) and in 1971, the Joseph and Rose Kennedy Institute for the Study of Human Reproduction and Bioethics (currently the Kennedy Institute of Ethics, through the efforts of André Hellegers and colleagues). This demonstrates the interest in and need for an ethical platform for observing the life and health sciences.

Returning to Pontius's contributions, she also published a 1975 study addressing the attempts to control normal neurodevelopmental factors that are environment-resistant (in her opinion, calling them 'innate' is vulgar). She suggested that such interventions reflect a problem of neuro-ethics.²⁰

Twenty years after coining the term, Pontius stated that failure to provide an informed consent form explaining the neurophysiological and neuropsychological processes involved in neuroscientific research would constitute a violation of neuroethics (her new spelling).²¹

In 2000, Pontius proposed educational neuro-ethics (returning to her former spelling) as a branch of bioethics. Here, her purpose was to stress the neurobiology underlying the neurodevelopmental stages to avoid the false belief that the effects of environmental nurture are unlimited.²²

It is surprising that almost no mention is made of the fact that Pontius was the first to coin this increasingly popular term. In a response to one of the entries in the BrainWork section of the Dana Foundation's website, Pontius posted a comment clarifying that she was the first to coin the term 'neuroethics'²³ (supported by data from a columnist from the New York Times). Despite the above, only a couple of studies give Pontius the credit she deserves.^{24,25}

Studies contemporary to the Pontius articles

Apart from Pontius's studies, few articles mention the term 'neuroethics' before 2002. An article published in 1986 pays tribute to Franz Seitelberger, an Austrian neuropathologist, on his 70th birthday; it relates that part of his professional life was dedicated to neuroethics.²⁶ Nevertheless, it did not specify which activities would be covered by that term.

Another study published in 1998 reminds us that the Council of Europe adopted the Convention on Human Rights and Biomedicine in 1996. In that same year, a special interest group on neuroethics was also created within the European Federation of Neurological Sciences.²⁷ The president and secretary of the Special Interest Group on Ethics in Neurology published a joint study on diagnosing brain death in the absence of a neurologist.²⁸ The Federation's website presents information on educational activities related to neuroethics carried out between 2000 and 2002. These activities were coordinated by the president and the secretary of the same special interest group.

Meanwhile, the term 'neuroethics' appeared on the keyword list of an article published in 2000. This study researched the attitudes of Belgian doctors on the management of patients in persistent vegetative state.²⁹ The article made no attempt to define the concept of neuroethics.

The contribution by Ronald Eugene Cranford

Ronald Eugene Cranford³⁰⁻³³ was a neurologist and coma expert. He also worked with the families of patients who

attracted media attention, including Karen Ann Quinlan, Paul Brophy, Nancy Cruzan, and Terri Schiavo. He was academically and professionally outstanding and his opinions were held in high regard.

In a 1989 study, Carnford proposed 'neuroethicist'³⁴ as a term for a neurologist who works toward the resolution of ethical conflicts involving neurological cases that are presented to ethics committees. No more information is given and although the study does not specifically address neuroethics, we can presume that the term he proposes indicates a professional who works in the field of neuroethics.

The Dana Foundation's groundbreaking conference

Believing that neuroethics was born at the Dana Foundation conference would be both unfair and inaccurate. A series of specialised publications on ethics and the neurosciences began to appear in the 1980s.³⁵ The Bioethics Committee of the UNESCO has also shown an interest in these topics since the mid-1990s.³⁶

Nevertheless, neuroethics is generally believed to have originated in 2002, when the Dana Foundation organised the first international multidisciplinary conference to focus on addressing neuroethics and defining the discipline (and calling it by that very name). The conference proceedings were rapidly compiled and published. Furthermore, a journalist who participated in the conference used the term in a major international newspaper.³⁷ His actions lent considerable visibility to this supposedly new field of study.

The definition of neuroethics presented in the introduction to the conference proceedings appears below.

Neuroethics is the study of ethical, legal, and social questions that arise when scientific findings about the brain are carried into medical practice, legal interpretations and health and social policy. These findings are issued by such fields as genetics, neuroimaging, and the diagnosis and prevention of different diseases. Neuroethics must examine how doctors, lawyers, judges, insurance companies, and politicians, as well as society at large, make use of these facts.³⁸

We can find another definition in the proceedings, written this time by William Safire, the journalist mentioned above. He speaks of "the examination of what is right and wrong, good and bad about the treatment of, perfection of, and welcome invasion or worrisome manipulation of the human brain".³⁹

Defining neuroethics

Definitions and concepts can have at least two meanings: one for general use and another restricted to a specialised field. General meanings can be found in dictionaries, but this is not very helpful in the case of 'neuroethics'; the term has not yet been included in major English or Spanish-language dictionaries.

Other types of sources must be consulted to find specialised definitions. Firstly, the prefix 'neuro-' can refer to the subject of investigation, a research method, or a descriptive approach to exploring the mind-brain relationship⁴⁰ (recall that the brain is the only organ that provides both a topic for research and the means for completing an investigation). According to some specialists, the prefix has been overused,⁴¹ while others insist on adding 'neuro-' to indicate the new dimension of the theoretical and methodological approaches used to study other areas of human knowledge.⁴²

At the same time, we should highlight that every ethical system or moral philosophy has three key aims⁴³: 1) to clarify what is understood by morality, 2) to try to discover the basis of morality and the principles of what we think of as moral, and 3) to apply those principles to everyday life, whether in individual or collective spheres.

To devise a better approach, we must consult specialised texts defining and refining the concept of neuroethics. In their different ways, these texts refer to the following proposal which has been widely disseminated and explicitly or implicitly accepted by many.

Adina L. Roskies' proposal

A review of the texts dealing with neuroethics prior to the Dana Foundation conference, including that foundation's conference proceedings from 1973 to 2002, clearly shows that the discipline deals with ethical questions raised by advances in neuroscience. As such, the field would simply constitute a branch of bioethics (a more established term denoting a better analysed and consolidated discipline, as explicitly proposed by Pontius).

If the content of neuroethics were limited to the ethical issues posed by new technological advances in clinical neurology, it would include debates regarding brain death, vegetative state, minimally conscious state, etc.⁴⁴ Some have questioned the necessity of delimiting subdisciplines of bioethics⁴⁵; however, these subdisciplines, including

neuroethics, are still developing and are even making an impact on ethics committees.⁴⁶

But where are the novel ideas? Everything mentioned up to this point had clearly been expressed before. However, according to Adina L. Roskies, neuroethics should have two meanings. The first refers to the ethics of neurosciences (a branch of bioethics). The second meaning would refer to a neuroscience behind ethics. This presents a true paradigm shift, at least in ethics, as it draws the neurosciences into the search of the cerebral basis underlying the human trait known as ethics. While some rapidly concluded that the concept described a new discipline that was here to stay,^{47,48} others questioned its legitimacy.⁴⁹ Despite this criticism, neuroethics has continued to take shape as a discipline with a certain degree of autonomy, and one that relies greatly on non-invasive neuroimaging techniques such as functional magnetic resonance imaging (fMRI). Proof of the above can be seen in the results from bibliometric analyses of publications between 1991-2002,⁵⁰ 2002-2007,⁵¹ and 1999-2009.⁵²

The definitions that emerged in the first ten years of the development of neuroethics have assumed this contradiction, many times implicitly. Roskies' article came out the same year as the following definition:

From questions concerning new kinds of information about personality, decision-making and emotional judgement, to questions about whether we should grow or harvest stem cells for the benefit of prolonging life in the neurologically ill, a new discipline of neuroethics has been born.⁴⁷

In the most updated edition of the well-known *Encyclopedia of Bioethics*, we find another description:

Neuroethics involves the analysis of ethical challenges posed by chemical, organic, and electromechanical interventions in the brain.... Neurotechnologies have specific characteristics that raise unique concerns. However, the overall development of such powerful tools also has general implications for ethics and social policy.⁵³

One monograph written by a philosophy expert states that neuroethics "...is about the benefits and the potential risks of modern research techniques on the brain. It also questions conscience, the meaning of self and the values that the brain develops".⁵⁴

A different monograph, written by a neuroscientist, reads:

Neuroethics is more than just bioethics for the brain. I would define neuroethics as the

examination of how we want to deal with the social issues of disease, normality, mortality, lifestyle, and the philosophy of living *informed by our understanding of the underlying brain mechanisms*. It is not a discipline that seeks resources for medical cure, but one that rests personal responsibility in the broadest social context. It is—or should be—an effort to come up with a brain-based philosophy of life.⁵⁵

In an encyclopaedia of the neurosciences, we find the following:

Neuroethics is a newly identified field at the intersection of neuroscience and ethics, the area of philosophy that deals with the study of standards of conduct and moral judgment. Neuroscience intersects with other areas of philosophy as well, such as aesthetics, epistemology, metaphysics, and mind–body theory, but these are not directly relevant to neuroethics. Neuroethics includes both the ethics of neuroscience and the neuroscience of ethics; that is, it is concerned with ethical issues uniquely or primarily associated with the practice or application of neuroscience and also the neurobiology of moral and ethical thinking and decision making.⁵⁶

Another encyclopaedia on human behaviour defines neuroethics as “the body of work exploring the ethical, legal, and social implications of neuroscience”.⁵⁷

After analysing the content potentially falling under the scope of neuroethics, we glean that all topics involve terms that will require using different categories and reference frameworks in their respective analyses. At the same time, some believe that neuroethics and its goals have not yet been clearly defined.⁵⁸

The death of neuroethics

Given the variety of definitions appearing above, it is only natural that some would find the subject of this new discipline unclear. It may be particularly problematic to understand how one field might cover both the problem of the conscience and the issue of informed consent. Attempts at systematically organising neuroethics research have turned up texts that mention a moral mind,⁵⁹ moral brain,⁶⁰ or ethical brain.⁵⁵ What is being studied in each case? The brain or the mind? Ethics or morals?

This loss of focus was probably due to the initial confusion between these basic distinctions: morals and ethics, the brain and the mind. Whether the mind can be reduced to the brain is a question which, as we have seen, has been posed since the time of Hippocrates. It was even addressed by pre-Socratic philosophers, but we lack the

space to discuss this here. Functional neuroimaging shows images of the brain in action⁶¹; this should not be confused with ‘photographs of the brain’⁶² or ‘photographs of the mind’.⁶³ From an epistemological point of view, this is a different matter⁶⁴ requiring more detailed scientific and philosophical analysis. Although monism has many supporters, it cannot be declared the clear winner.

As this question remains unresolved, we will have to examine the difference between morals and ethics, and given the nature of these terms, we will have to draw from the field of philosophy. Adela Cortina⁴³ has stated that it is always wise to follow the Greek aphorism ‘know thyself’: it is best to know how the brain works and how to prevent, diagnose, treat, or recover from neurological or neuropsychiatric illnesses, etc. However, Cortina reminded us of a fundamental distinction by distinguishing between the concepts of ‘seat’ and ‘foundation’: one thing is the presence of a brain-based seat of morality (a brainless or brain-dead individual cannot be a moral agent as he lacks that seat). Another very different matter would be to speak of a brain-based foundation of ethics (establishing foundations is a task typical of philosophy, as it provides explanations as to why something exists). In philosophical terms, a necessary condition (the presence of a functional brain) is not the same as a sufficient condition (establishing the foundation of ethics, which belongs to the field of philosophy).

In line with this idea, we can say that neuroethics may have exceeded its limits by trying to cover the two fields mentioned above. Although they interact and are related, they work within different limits: the more traditional ethics of neuroscience and the very new neuroscience of ethics. If we do not make this distinction, what remains to be said? It is not possible, or so it seems, to suggest halting the work in neuroethics. It may be the right time, however, to divide the two fields indicated by that single term to gain a clearer view of their theoretical and methodological approaches. It is also necessary to fill this empty semantic gap.

In light of the above considerations, this study aims to re-frame two concepts that have already been proposed, but which have made little impact. Now is probably the time to present the following terms clearly: encephaloethics (instead of ethics of neuroscience), and

neuromorality (rather than neuroscience of ethics). The term ‘encephaloethics’ was proposed by Albert Jonsen.⁶⁵ When dividing up the field of bioethics, experts have typically used prefixes to indicate a field of life sciences (such as ecoethics⁶⁶) or a field of medicine (gen-ethics,⁶⁷ gynethics,⁶⁸ etc.). Jonsen’s neologism follows this tendency. His argument has two parts: 1) his term is more elegant and precise than ‘neuroethics’; and 2) different historical reasons would support using this new term. The elegance and precision of the term is explained by the fact that many clinical entities originate outside the cerebrum but within the encephalon. These entities would not be included in an analysis described as purely neuroethical (he cites cerebellar or brainstem disorders as examples). The historical reasons he mentions differ from those listed in our study, but we can reaffirm what we have already stated: from the emergence of neuroethics in 1973 in Pontius’s works to the conference held by the Dana Foundation, the concept being discussed was actually encephaloethics. Using this term, for example, would prevent us from making the epistemic leap between analysing the ethical problems related to the minimally conscious state and later changing the subject to free will.

Yet another neologism, neuromorality, was introduced by Adina L. Roskies.⁶⁹ It is clear that moral acts stem from the previously mentioned neurobiological basis: they require a complex sensory perceptual system, emotional circuits, circuits involved in decision-making processes, etc. All of these elements must be in place for a person to display moral behaviour. However, analysing such behaviour to distinguish ‘ethics’ from mere ‘morals’ is the province of philosophy, an entirely different field. There are no localisations inside the encephalon to indicate the correctness of one act or the goodness of another. The concepts of correctness and goodness require something more, an argumentative process that has no direct brain-based seat. What is more, those who have tried to make this kind of neuroethical claim have descended into pure biological reductionism and considered only the brain itself. In doing so, they have overlooked society, culture, interpersonal relationships, personal subjective assessments of specific situations, and so on. To illustrate the above, it is one thing to understand the neurobiological mechanisms that cause dreaming during sleep and an entirely different matter to know the reason why one individual dreamed of a white horse while another dreamed of a family gathering.

Being able to locate the basis of the processes that necessarily underlie moral behaviours is not the same as trying to determine ethics on that basis only. While we might say that morality can be innate,⁷⁰ it does not mean that the notions of correctness, fairness, goodness, and so on are pre-recorded in the brain. What is actually present is a biological basis that enables the process. To cite another illustrative example, there is a neurobiological basis for language, but this does not mean that a person could learn to speak unaided and isolated. The basis may be present in such cases, but the other elements are missing: stimulation, learning, interrelationships, etc. Without these elements, language acquisition is not possible, as we see in the cases of feral children.

It would seem that, with the death of neuroethics (to paraphrase Macklin⁷¹), the emergence of encephaloethics and neuromorality will, at the very least, let us demarcate each of the fields appropriately. It will also foster the development of better theoretical and methodological approaches for studies pertaining to each of the disciplines.

Conclusions

- 1) The term ‘neuroethics’ was coined as ‘neuro-ethics’ in 1973 by Anneliese Alma Pontius. Until 2002, it referred to ethics in neurosciences (and therefore constituted a branch of bioethics).
- 2) The first major attempt to classify the concepts covered by the term ‘neuroethics’ was made by Adina L. Roskies in 2002. She proposed an ‘ethics of neuroscience’ and a ‘neuroscience of ethics’.
- 3) We suggest that encephaloethics, the term proposed by Albert Jonsen, be used instead of the more ambiguous term ‘neuroethics’ when referring to an ethics of neuroscience. Likewise neuromorality (proposed by Roskies herself) should be used to refer to the neuroscience of ethics. This approach will allow us to be more descriptive and accurate when establishing correlations between the separate worlds of neurosciences and ethics.

Conflicts of interest

There were no conflicts of interest relating to this study.

References

1. Poblano A. Las neurociencias y la filosofía. *Salud Pública Mex.* 1991;33:88-93.
2. Martín-Rodríguez JF, Cardoso-Pereira N, Bonifacio V, Barroso, Martín JM. La Década del Cerebro (1990-2000): algunas aportaciones. *Revista Española de Neuropsicología.* 2004;6:131-70.
3. Amunts K, Lepage C, Borgeat L, Mohlberg H, Dickscheid T, Rousseau MÉ, et. al BigBrain: An ultrahigh-resolution 3D human brain model. *Science.* 2013;340:1472-5.
4. The Human Connectome Project [Internet] [cited 2013 Oct 7]. Available at: <http://www.humanconnectomeproject.org/>
5. The Blue Brain Project. Lausanne: EPFL [cited 2013 Oct 7]. Available at: <http://bluebrain.epfl.ch/>
6. Crick F. La búsqueda científica del alma. Una revolucionaria hipótesis para el siglo XXI. Madrid: Debate; 1994. [The Astonishing Hypothesis: The Scientific Search for the Soul. New York: Charles Scribner's Sons; 1994.]
7. Hipócrates. Sobre la enfermedad sagrada. In: *Tratados hipocráticos I.* Madrid: Gredos; 1990. [Hippocrates, trad. Charles Darwin Adams. *The Genuine Works of Hippocrates.* New York: Dover; 1868.]
8. Churchland PS. *Neurophilosophy. Toward a unified science of the mind/brain.* Cambridge MA: MIT Press; 1986.
9. Churchland PS. The impact of neuroscience on philosophy. *Neuron.* 2008;60:409-11.
10. Illes J. Neurologisms. *Am J Bioeth.* 2009;9:1.
11. Max Planck Institute for Human Cognitive and Brain Sciences [Internet]. Leipzig: Max Planck Institute for Human Cognitive and Brain Sciences; 2013. Dr. med. Anneliese & DSc Dieter Pontius Foundation. *Lebensläufe der Stifter* [cited 2013 Oct 7] Available at: <http://www.cbs.mpg.de/pontius-stiftung/cv>
12. Zelazo PR, Zelazo NA, Kolb S. "Walking" in the newborn. *Science.* 1972;176:314-15.
13. Pontius AA. Neuro-ethics of "walking" in the newborn. *Percept Mot Skills.* 1973;37:235-45.
14. Zelazo PR, Konner M, Kolb S, Zelazo NA. Newborn walking: A reply to Pontius. *Percept Mot Skills.* 1974;39:423-8.
15. Wachs TD. The optimal stimulation hypothesis and early development. In: Uzgiris IC, Weizmann F, editor. *The structuring of experience.* New York: Springer-Verlag; 1977. p. 153-77.
16. Jahr F. Bio-Ethik. Eine Umschau über die ethischen Beziehung des Menschen zu Tier und Pflanze. *Kosmos.* 1927;24:21-32.
17. Sass HM. Fritz Jahr's 1927 concept of bioethics. *Kennedy Inst Ethics J.* 2007;17:279-95.
18. Potter VR. Bioethics, the science of survival. *Perspect Biol Med.* 1970;14:127-53.
19. Potter VR. *Bioethics: Bridge to the future.* Englewood Cliffs NJ: Prentice Hall; 1971.
20. Pontius AA. New frontiers of ecological ethics — A balance between over- and under-control of outer and inner factors. *Experientia.* 1975;31:263-4.
21. Pontius AA. Neuroethics vs neurophysiologically and neuropsychologically uninformed influences in child-rearing, education, emerging hunter-gatherers, and artificial intelligence models of the brain. *Psychol Rep.* 1993;72:451-8.
22. Pontius AA. Educational neuro-ethics. *Med Health Care Philos.* 2000;3:368.
23. Mehta A. 'Neuroeducation' emerges as insights into brain development, learning abilities grow [Internet]. New York; The Dana Foundation; 2009 [cited 2013 Oct 7]. Available at: <http://www.dana.org/news/brainwork/detail.aspx?id=22372>
24. Racine E. *Pragmatic neuroethics.* Cambridge MA: MIT Press; 2010.
25. Fukushi T, Sakura O. Exploring the origin of neuroethics: From the viewpoints of expression and concepts. *Am J Bioeth.* 2008;8:56-7.
26. Jellinger K. Franz Seitelberger on the occasion of his seventieth birthday. *Acta Neuropathol.* 1986;72:1-2.
27. Paladin AV. Ethics and neurology in the Islamic world. Continuity and change. *Ital J Neurol Sci.* 1998;19:255-8.
28. Baumgartner H, Gerstenbrand F. Diagnosing brain death without a neurologist. *BMJ.* 2002;324:1471-2.
29. Dierickx K, Schotsmans P, Grubb A, Walsh P, Lambe N. Belgian doctors' attitudes on the management of patients in persistent vegetative state (PVS): Ethical and regulatory aspects. *Acta Neurochir (Wien).* 1998;140:481-9.
30. Miles SH. Ronald Cranford, MD, a leading neurologist on coma and unconsciousness, dies at 65. *MedGenMed.* 2006;8:81.
31. Oransky I. Ronald E. Cranford. *Lancet.* 2006;368:112.
32. Roberts J. Ronald E. Cranford. *BMJ.* 2006;333:203.
33. Ronald E. Cranford, MD (1940–2006). *Neurology.* 2006;67:1338-9.
34. Cranford RE. The neurologist as ethics consultant and as a member of the institutional ethics committee. *The neuroethicist. Neurol Clin.* 1989;7:697-713.
35. Pfaff DW, editor. *Ethical questions in brain and behavior: Problems and opportunities.* New York: Springer-Verlag; 1983.
36. Vincent JD. Ethics and neurosciences. In: *UNESCO. Proceedings. Third Session.* Paris: International Bioethics Committee of UNESCO; 1995. p. 1-8.
37. Safire W. The but-what-if factor. *The New York Times,* May 16, 2002.
38. Marcus SJ, editor. *Neuroethics: Mapping the field. Conference proceedings.* New York: The Dana Press; 2002.
39. Safire W. Visions for a new field of "neuroethics". In: Marcus SJ, editor. *Neuroethics: Mapping the field. Conference proceedings.* New York: The Dana Press; 2002. p. 3-9.
40. Cubelli R, Della Sala S. The multiple meanings of "neuro" in neuropsychology. *Cortex.* 2010;46:703-11.
41. García-Albea JE. Usos y abusos de lo 'neuro'. *Rev Neurol.* 2011;52:577-80.
42. Ruiz-Sánchez de León JM, Pedrero-Pérez EJ, Fernández-Blázquez MA, Llanero-Luque M. Neurología, neuropsicología y neurociencias: sobre usos y abusos de lo 'neuro'. *Rev Neurol.* 2011;53:320.
43. Cortina A. *Neuroética y neuropolítica. Sugerencias para la educación moral.* Madrid: Tecnos; 2011.
44. Bonete E. *Neuroética práctica.* Bilbao: Desclée de Brouwer; 2010.

45. Wilfond BS, Ravitsky V. On the proliferation of bioethics sub-disciplines: do we really need “genethics” and “neuroethics”? *Am J Bioeth.* 2005;5:20-1.
46. Ford PJ. Special section on clinical neuroethics consultation: Introduction. *HEC Forum.* 2008;20:311-4.
47. Illes J, Raffin TA. Neuroethics: An emerging new discipline in the study of brain and cognition. *Brain Cogn.* 2002;50:341-4.
48. Kennedy D. Neuroscience and neuroethics. *Science.* 2004;306:373.
49. Knoppers BM. Neuroethics, new ethics? *Am J Bioeth.* 2005;5:33.
50. Illes J, Kirschen MP, Gabrieli JD. From neuroimaging to neuroethics. *Nat Neurosci.* 2003;6:205.
51. Comerford K, Rasmussen E, Illes J. Evidence of a new and evolving discipline: Neuroethics literature, 2002–2007. *Proceedings of the American Society for Information Science and Technology.* 2009;46:1-5.
52. Garnett A, Whiteley L, Piwowar H, Rasmussen E, Illes J. Neuroethics and fMRI: Mapping a fledgling relationship. *PLoS One* 2011 Apr 22;6(4):e18537. doi: 10.1371/journal.pone.0018537.
53. Wolpe PR. Neuroethics. In: Post SG, editor. *Encyclopedia of bioethics.* 3rd Ed. Vol. 4. New York: Thomson-Gale; 2004. p. 1894-8.
54. Evers K. Neuroética. Cuando la materia se despierta. Buenos Aires: Katz; 2010. p. 13.
55. Gazzaniga M. El cerebro ético. Barcelona: Paidós; 2006. p. 14-5. [Italics in the quote reflect the original]
56. Bird SJ. Neuroethics. In: Squire L, editor. *Encyclopedia of neuroscience.* Oxford: Academic Press; 2009. p. 385-91.
57. Sifferd KL. Neuroethics. In: Ramachandran V, editor. *Encyclopedia of human behavior.* 2nd Ed. Elsevier; 2012. p. 694-700.
58. Northoff G, Witzel J, Bogerts B. Was ist „Neuroethik“ — eine Disziplin der Zukunft? *Nervenarzt.* 2006;77:5-11.
59. Hauser MD. La mente moral. Cómo la naturaleza ha desarrollado nuestro sentido del bien y del mal. Barcelona: Paidós; 2008.
60. Verplaetse J, De Schrijver J, Vanneste S, Braeckman J, editors. *The moral brain. Essays on the evolutionary and neuroscientific aspects of morality.* Dordrecht: Springer Netherlands; 2009.
61. Houdé O. Imágenes cerebrales funcionales. In: Houdé O, Kayser D, Koenig O, Proust J, Rastier F, editors. *Diccionario de ciencias cognitivas. Neurociencia, psicología, inteligencia artificial, lingüística y filosofía.* Buenos Aires: Amorrortu; 2003. p. 211-7.
62. Roskies AL. Are neuroimages like photographs of the brain? *Philos Sci.* 2007;74:860-72.
63. Illes J. Empirical neuroethics. Can brain imaging visualize human thought? Why is neuroethics interested in such a possibility? *EMBO Rep.* 2007;8:S57-60.
64. Huber CG, Huber J. Epistemological considerations on neuroimaging – A crucial prerequisite for neuroethics. *Bioethics.* 2009;23:340-8.
65. Jonsen AR. Encephaloethics: A history of the ethics of the brain. *Am J Bioeth.* 2008;8:37-42.
66. Polikarpov GG. The future of radioecology: In partnership with chemo-ecology and eco-ethics. *J Environ Radioact.* 2001;53:5-8.
67. Statland BE. Gen-ethics: More than just an academic exercise. *MLO Med Lab Obs.* 1996;28:29,32.
68. Canales-de la Fuente R. Gynética. *Perinatol Reprod Hum.* 2009;23:247-252.
69. Roskies A. Everyday neuromorality. *Cerebrum.* 2004;6:58-65.
70. Mendez MF. The neurobiology of moral behavior: Review and neuropsychiatric implications. *CNS Spectr.* 2009;14:608-20.
71. Macklin R. The death of bioethics (as we once knew it). *Bioethics.* 2010;24:211-7.