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Lucky Triune Brain. Chronicles of Paul D. MacLean's Neuro-Catchword

“One cannot say anything about such a complicated structure as the brain without indulging in oversimplification.”

Paul D. MacLean, *A triune concept of the brain and behaviour* (Toronto: University of Toronto Press, 1973), p. 5.

Abstract

The triune brain idea has been rated as the most influential in postwar neuroscience. The first part of this article seeks to retrace its genesis and development through the vicissitudes of the research conducted by Paul D. MacLean (1913-2007). Ten years have passed since his death: despite the loss of scientific credit, the apparent simplicity of his tripartite theory continues to exert a certain popular appeal. In the second part of the article an attempt is made to figure out how the transfer from the laboratory to public fruition could happen. Initially responsible for the operation was MacLean himself, then aided by a few followers who had the means to spread his saving message. Against the background of the Cold War, and while the Western culture started to realize the threat posed by overpopulation, pollution, exhaustion of critical resources, they deluded themselves that “knowing the brain” might suggest new and more effective approaches to the troubles of the oncoming end of the century. Consulting MacLean’s papers in the archives at the National Library of Medicine (Bethesda, MD) has been essential to this historical reconstruction.

Keywords

Triune Brain – Paul D. MacLean – circulation of knowledge

Introduction

In 1990 John Durant was working at the Science Museum in London, just appointed by the Imperial College to the first professorship of Public Understanding of Science in the world and destined to become soon the founding editor of a new quarterly journal which exhibited that new expression as its title. During a workshop at the Woods Hole Marine Biological Laboratory and sponsored by the newly established Dibner Institute, Durant called into question and criticized something which he considered “more a *metaphor* than a theory”:

The triune-brain concept is enormously attractive. We should address it because I would judge it to be probably the single, most influential idea in brain science in the postwar period, at least in terms of public or popular perceptions of what brain science has to say about the human condition.

The ‘inventor’ of the triune brain, Paul MacLean, who participated in the workshop, replied by expressing first of all his doubts as to the appropriateness of becoming famous:

One of the worst things in this world is to be “discovered” by the popular media. I remember that when Carl Sagan raised the question of my appearing on his program, I said, “When people see me on television, then they’ll know I’ve gone over the hill.”¹

¹ John Durant, “Knowledge and Values in Neurobiology: The Case of the Triune Brain”, in Anne Harrington (ed.), *So Human a Brain. Knowledge and Values in the Neurosciences* (Boston-Basel-Berlin: Birkhäuser, 1990), pp. 268-269.

An attempt will be made here to figure out how the extrapolations from a particular line of neuroscientific research could have generated that “most influential idea”, apt to feed the lay public. Responsible for the operation was MacLean himself, initially, then aided by a succession of followers who had the means to spread his message everywhere. Even today, half a century after the beginning of the story, when the validity of the theory has waned, a search on the Internet using *triune brain* as a keyword gives an impressive amount of results, and videos on YouTube abound, of different quality and in various languages. The case in question shows how the echo of a scientific voice can last well beyond its actual life cycle.

In January 2008 *The New York Times* announced MacLean’s death, occurred a week before, saying that his concept of the limbic system as the center of emotions had been broadly accepted in neuroscience, while the triune brain theory still remained controversial. A theory “now discredited”, “abandoned but still compelling”, according to a medical journalist, who wrote that same year a short article about it: in fact, subsequent research had revealed that brain systems had not added by accretion in the course of evolution.² Recently Terrence W. Deacon, whose opinion was then mentioned to prove the groundlessness of MacLean’s theory, thus explains it:

I was lucky enough to have met and chatted with Paul a number of times. He was an inspiration to me as a young neuroscientist. His conception of the limbic system influenced some of my earliest neuroanatomical studies. [...] I particularly remember his warmth and humor and his infectious laugh even when speaking to otherwise too somber and self-serious audiences. Even then, though, I realized that his hierarchic additive characterization of the “triune” brain was based on a long-abandoned progressivist view of evolution and a too-limited view of comparative neuroanatomy, and I was troubled by the way this misleading simplification has found its ways into books about human evolution, psychology, and education. Nevertheless, theories don’t have to be right to be useful. They just need to lead to useful research. His did.³

Some of those who had been MacLean’s students and co-workers – like Thomas Insel, who directed the National Institutes of Mental Health from 2002 to 2015 – granted him an extraordinary ability to communicate his holistic perspective on brain evolution and behavior, although remembering that MacLean did have a career as an experimentalist in the 40s and 50s, but that later on “he was mostly a philosopher of science and someone who provided the framework”.⁴ Already in 1983, Antonio Damasio and G. W. Van Hoesen reminded that after MacLean had baptized *limbic system* a group of brain structures strongly linked to emotion and affect, it had become clear not only that multiple complex functions – like memory and attention – are subserved by key elements of it, but also that brain areas outside the limbic system have a decisive emotional role to play.⁵ When in 1990, after a long incubation, MacLean finally managed to enclose in a large book the results of his lifework, some reviewers criticized them as outdated.⁶ Afterwards, criticism has not

² Jeremy Pearce, “Paul MacLean, 94, Theorized a ‘Triune Brain’”, *The New York Times*, January 10, 2008, A28; Peter Farley, “A theory abandoned but still compelling”, *Yale Medicine*, 2008, 43: 16-17.

³ Terrence W. Deacon (Professor of Anthropology, University of California at Berkeley), personal communication, April 9, 2016.

⁴ *OMR Conversations. Thomas Insel and the Science Network’s Roger Bingham*, pp. 11, transcript in the sciencenetwork.org, undated.

⁵ Antonio R. Damasio and G. W. Van Hoesen, “Emotional Disturbances Associated with Focal Lesions of the Limbic Frontal Lobe”, in Kenneth M. Heilman and Paul Satz (eds.), *Neuropsychology of Human Emotion* (New York-London: The Guilford Press, 1983), pp. 85-110, p. 87. A similar remark will also be brought up by Joseph LeDoux, who admitted that MacLean’s synthesis was an “amazing achievement” – broad in its scope, wide ranging in its implications, long-lived – but unfortunately not acceptable because of the little evidence for the existence of the limbic system or for its involvement in emotion. As survival functions, emotions are manifold and each may well involve different brain systems: see Joseph LeDoux, “Emotion and the limbic system concept”, *Concepts in Neuroscience*, 1991, 2: 169-199; Id., *The Emotional Brain. The Mysterious Underpinnings of Emotional Life* (London: Weidenfeld & Nicolson, 1998), pp. 92-103.

⁶ Anton Reiner, “An Explanation of Behavior”, *Science*, 1990, 250: 303-305; C. B. G. Campbell, review of Paul MacLean, *The Triune Brain in Evolution: Role in Paleocerebral Functions* (New York-London: Plenum Press, 1990),

ceased to strike his vision of a linear and additive process that would preside phylogenetically to the development of the central nervous system, culminating in the superior cognitive powers of humans; as well as his hierarchical view of mental functions that would inspire a ‘backward’ attempt to separate and privilege reason over emotion.⁷ More generally, it has often been noted that the triune brain theory is far too simplistic to explain the amazingly complex evolution of the nervous system, and does not hold up under scrutiny. Natural selection does not act by simple overlapping of parts but constantly remodels them, therefore brains might virtually be more than three. Why then the long lasting appeal of the tripartite scene conceived by MacLean? Perhaps because “the idea makes a weird kind of intuitive sense”.⁸

On the opposite side, a special satellite symposium was organized in 2002 at the annual meeting of the International Behavioral Neuroscience Society in Capri, “to preserve his ideas” and to promote studies focused on neurobiological aspects of social behavior. The coeditors of the resulting papers, published in the year of MacLean’s 90th birthday, were sure that “his accomplishments are perhaps more relevant today than ever before”. In that occasion Detlef Ploog – a German psychiatrist and ethologist who had been working with him in Bethesda during the late 50s – said that MacLean, “a scientific thinker well ahead of his time”, had unified two seemingly opposed views of mental illness: Wernicke’s view, based on neuroanatomy, and Freud’s one, based on unconscious subjective experiences. In this way, the concept of triune brain was the most useful for linking evolutionary psychiatry, neuroscience, and the social sciences.⁹

It should also be briefly remembered that the evolutionistic tendency to identify successive stages in the development of the central nervous system had had proselytes since the days of Thomas Laycock, Herbert Spencer, and John Hughlings Jackson. All of them, and other supporters of a hierarchic brain model represent the somewhat remote roots of the curious story that took fully place in the second half of the 20th century.

1. *The child within us, or the evolutionary appearance of two brains*

Third son of a Presbyterian minister, born on May 1, 1913 in Phelps (N.Y) – where his father ran a parish – Paul MacLean seems to have performed his first experiment something between the age of three and four. Doubtful about the Decalogue’s threat that taking the Lord’s name in vain might result in being struck dead, he locked himself in a closet, shouted “Jesus Christ” and waited for lightning to strike. Nothing happened then, but his short autobiography (1998) adds that, as the sacred prescription does not qualify whether the shot would occur immediately or

American Scientist, 80, n. 5: 497-498. For a reply to critics, see Gerald A. Cory, Jr., “Reappraising MacLean’s Triune Brain Concept”, in Gerald A. Cory, Jr. and Russell Gardner, *The Evolutionary Neuroethology of Paul MacLean. Convergences and Frontiers* (Westport, CT-London: Praeger, 2002), pp. 9-27, which contains twenty contributions by various authors, 400 pages of positive evaluation. According to the book coeditors, MacLean had been trying to address the larger questions of human behavior, while other researchers were much more interested in the fine-grained technical questions: whence the roots of the tension (pp. 21-23).

⁷ See for instance Walter J. Freeman, *Societies of Brains. A Study in the Neuroscience of Love and Hate* (New York-London: Psychology Press), pp. 168-169; Ann B. Butler and William Hodos, *Comparative Vertebrate Neuroanatomy. Evolution and Adaptation* (New York: Wiley-Liss, 1995), p. 86; Arnold H. Modell, “Are Mental Functions Hierarchical?”, *The Annual of Psychoanalysis*, 2000, 28: 127-135; Paul Patton, “Many Minds: Intelligence in the Animal Kingdom”, *Scientific American*, 2008, 19: 72-79, who asserts that, according to recent findings of comparative neuroanatomy, complex brains evolved independently in multiple phyla and times among various groups of vertebrates. Therefore, no sequential line would be plausible.

⁸ Ben Thomas, “Revenge of the Lizard Brain”, *Scientific American*, Guest Blog, September 7, 2012.

⁹ Kelly G. Lambert and Robert Gerlai, “The neurobiological relevance of social behavior: Paul MacLean’s legacy”, in *Physiology and Behavior*, 2003, 79: 341-342; Detlef W. Ploog, “The place of the Triune Brain in Psychiatry”, *ibid.*, 487-493, p. 492.

sometime in the future, he had been waiting ever since. In another retrospective anecdote related to his child behavior during one of his father's sermons in church, MacLean delights in stressing his own perseverance on the question raised by Spinoza's statement to the effect that all people are driven by emotions.¹⁰ Nor can be neglected his declared cultivation of painting, triggered by a gift of oil colors and brushes.

The first two years as an undergraduate at Yale were "rather humdrum", but the discovery of F.S.C. Northrop's course of Philosophy of science captured his imagination to the point that MacLean decided to pursue a career in philosophy – under the Plato scholar A.E. Taylor in Edinburgh – which not even began due to a wise rethinking: "How, by reading and rereading what philosophers had already said, could I derive any substantial new ideas about the 'why' of life?".¹¹ A heart attack that seemed to hit his mother but turned out to be a simple passage of a stone in her gall bladder drove him toward science and medicine at Yale. A thesis about producing cardiovascular disease with antisera completed his medical studies. Soon the years of war came, and also his marriage in 1942 with Alison Stokes, a Quaker girl who was studying for a degree in nursing. Enlisted as a volunteer in the Yale Unit, MacLean sailed to Auckland, New Zealand, where a 1000-bed hospital was being built for soldiers evacuated from the Solomon Islands. Every patient there, together with wounds and malaria, suffered from a psychoneurosis; MacLean was put in charge of the psychotic ward, where his experience taught him that "the mind must be in the head, not just an epiphenomenon".¹² It follows that his first two short articles, published and coauthored in 1944-45, dealt with mentally disturbed soldiers and tropical psychiatry.

Dismissed from the Army in 1946, his subsequent private medical practice in Seattle lasted only one year, as in 1947 MacLean's research career started at the Massachusetts General Hospital, by reason of a fellowship offered by the neurologist Stanley Cobb. Nasopharyngeal electrodes devised by himself were slipped through the nostrils of epileptic patients in order to record the bioelectrical activity at the base of brain that possibly fed in the hypothalamus, considered important for the expression of emotions. Looking for some answer to questions posed by their symptomatology, MacLean happened to read a paper published in 1937 by James Papez, neuroanatomist at Cornell University. In those nearly twenty pages anatomic, clinical, experimental data were presented, dealing with the hypothalamus, the gyrus cinguli, the hippocampus, and their interconnections: "taken as a whole, this ensemble of structures is proposed as representing theoretically the anatomic basis of the emotions", and also schematically shown in a medial view of the right cerebral hemisphere (**Fig. 1 here**). The *Papez circuit*, as it is called, was largely speculative, only supported by data available in the literature, but undoubtedly played a seminal and heuristic role:

¹⁰ Larry R. Squire (ed.), *The History of Neuroscience in Autobiography* (San Diego: Academic Press, 1998), vol. 2, pp. 245-275 (for the anecdotes see pp. 248-249).

¹¹ Squire, *The History of Neuroscience* (cit. note 10), p. 251.

¹² Squire, *The History of Neuroscience* (cit. note 10), p. 255.

Is emotion a magic product, or is it a physiologic process which depends on an anatomic mechanism? [...] This is an attempt to allocate specific organic units to a larger organization dealing with a complex regulatory process. The evidence presented is mostly concordant and suggestive of such a mechanism as a unit within the larger architectural mosaic of the brain. Negative and contradictory evidence has not been presented. [...] It is evident that any such doctrine will have to stand the test of experimental and clinical experience if it is to be useful in science. Emotion is such an important function that its mechanism, whatever it is, should be placed on a structural basis.¹³

“One of the most influential theories of the emotional brain” – to use Le Doux’s definition¹⁴ – turned out to be the foundation myth of MacLean’s scientific path, thousand times recalled in his writings and speeches. Here, however, mythical and factual extensively overlap, as demonstrated by the letters exchanged with Papez for a decade. The first one is dated November 2, 1948, when MacLean proposed to visit the neuroanatomist, thirty years his senior:

You may possibly remember me as the young man who had the exhibit opposite yours at the last meeting of the American Neurological Association, demonstrating the use of two nasopharyngeal leads in electroencephalography. Since then we have developed two more basal leads which we place on the tympanic membrane. My studies with the basal leads were prompted by the desire to get nearer electrically to those circuits you have enumerated as being important in your proposed mechanism of emotion. Last June I talked to you about the possibility of coming to Ithaca in order to get a clearer picture of the neuroanatomy of the rhinencephalon, cingular gyrus, amygdala, and other related structures. Dr. Cobb has often said to me: “Why don’t you go up to see Dr. Papez?”¹⁵

With great cordiality Papez replied inviting MacLean, who in turn clarified what he had in mind:

I am particularly interested in the problem of scanning and its possible bearing on some of the more primitive systems in the brain – the same systems you have indicated may be tied up with emotional experience and emotional expression. A system of scanning is apparently necessary for the comprehension of universals. [...] It will be a great privilege to talk over some of these problems with you.¹⁶

After they met at Cornell, MacLean expressed his enthusiasm: “this was the nicest thing that was ever done for me professionally and I shall remember the occasion of my visit to your laboratory as one of the very high points of my life”; he was already in the process of preparing a talk for his group at the MGH, tentatively titled *Psychosomatics and the Papez mechanism of emotion*.¹⁷ In February 1949 Maclean “timidly” sent a copy of it to Papez, apologizing for the naivety of his own knowledge, and also for having had to water down much of the anatomy in front of a bunch of psychiatrists “who, as you know, get restive at the mere mention of a nerve cell”. Speaking to them he had used several more illustrations than those included in the paper, and now, expecting to publish it, he asked for a “honest criticism”, from disciple to master. Anyway, it was the first time – he was pleased to say – that an effort had been made to tie in Papez’s mechanism of emotion with psychosomatic medicine.¹⁸ His mentor and interlocutor answered approvingly, also giving many insights and suggesting some slight changes to the figures:

¹³ James W. Papez, “A Proposed Mechanism of Emotion”, *Archives of Neurology and Psychiatry*, 1937, 38: 725-743, p. 743.

¹⁴ Joseph LeDoux, *The Emotional Brain* (cit. note 5), p. 85.

¹⁵ MacLean to Papez, November 2, 1948, MacLean Papers (MLP from now on), Box 2 – *Correspondence*, folder 32.

¹⁶ MacLean to Papez, November 15, 1948, *ivi*. The envelope contained also a review of Wiener’s *Cybernetics*, that had just come out, with MacLean’s comment: “This book will be of tremendous interest to you because it introduces the concept of scanning and negative feed-back mechanisms which are implicit in your paper *Structures and mechanisms underlying the cerebral functions*. It is Professor Wiener’s thesis that the brain and the computing machine, as well as other servomechanisms, have much in common. I shall bring along a copy of Wiener’s books which I’ll present to you.”

¹⁷ MacLean to Papez, November 30, 1948, *ivi*.

¹⁸ MacLean to Papez, February 17, 1949, *ivi*.

Your paper [...] reads so well that I am happily surprised with the good integrations you were able to make. I am sure it will be interesting to any one who has to consider how the emotional components of experience and expression are integrated in the brain. [...] I am glad that you pointed out the ease with which one can demonstrate connections between the various regions of the neopallium and the hippocampal formations: and in turn connections of the hippocampal formations with the hypothalamus.¹⁹

With a slightly different title, MacLean's paper was published in *Psychosomatic Medicine*, periodical organ of the American Psychosomatic Society since 1939. Its first part is a review of certain neuroanatomical and neurophysiological evidence that contributes to the understanding of emotional mechanisms: there would be indications that the phylogenetically "old brain" – classically known as the rhinencephalon and "arbitrarily referred to in this paper as the *visceral brain*" – is largely connected with visceral and emotional functions:

Though our intellectual functions are carried on in the newest and most highly developed part of the brain, our affective behavior continues to be dominated by a relatively crude and primitive system. This situation provides a clue to understanding the difference between what we "feel" and what we "know". [...] In view of recent developments in electronics and cybernetics and the light these sciences have shed on neurophysiology, one can no longer be content to think of dynamic psychologic phenomena as existing apart from the restrictions of ordered neural mechanisms.²⁰

In this statement lies the original, embryonic nucleus of the indefatigable work conducted by MacLean during the following decades. The problem pertaining to emotional mechanisms – he had told his audience of psychiatrists, in cybernetic language – is basically one of communication in the central nervous system: messages from without and within the organism are relayed to the brain by nervous impulses. The landscape he described is made of neurons capable of sorting, selecting, and acting upon various patterns of bioelectrical activity, although his honesty forced him to confess that "the manner in which these impulses can give rise to the subjective feeling of emotion remains a complete mystery".²¹ The head ganglion of the autonomic nervous system and the effector mechanism of emotional expression would be the hypothalamus, but only the cerebral cortex seems capable of appreciating the various affective qualities of experience and combining them into states of feeling.

Of course Papez is the highly praised hero of this paper because of his 1937 contribution, "a considerable *tour de force*" given the scarcity of experimental data then available. Since then a number of reports had appeared, which would lend support to Papez's thesis; among them, most striking – according to MacLean – were the observations of Heinrich Klüver and Paul Bucy on rhesus monkeys that, deprived of both temporal lobes, presented a dramatic picture, being no longer able to discriminate between objects dangerous or useful, furthermore displaying a hypersexed and hyperoral behavior.²² Other researchers had produced results likewise supporting the recognition that the cerebrum is an outgrowth of the rhinencephalon, and that the visceral sense of smell played an important part in the evolutionary development of the vertebrate. In primitive forms the *visceral brain* – term preferred by him as a means of reducing the previous accent on olfactory functions – would provide the correlation center for ordering the affective animal behavior in such basic drives as getting food, fleeing from or orally disposing of an enemy, reproducing etc. MacLean was certain that even in higher forms, including man, such functions continue to be subserved by the same cerebral portion. He included four figures (**Fig. 2 and 3 here**) to convince of the validity of

¹⁹ Papez to MacLean, February 25, 1949, ivi. "You will be remembered – MacLean emphasized in his reply – as the man who localized the id!" (MacLean to Papez, March 8, 1949, ivi).

²⁰ Paul D. MacLean, "Psychosomatic Disease and the Visceral Brain. Recent Developments Bearing on the Papez Theory of Emotion", *Psychosomatic Medicine*, 1949, 11: 338-353, p. 351.

²¹ MacLean, "Psychosomatic Disease" (cit. note 20), p. 338.

²² Cfr. Heinrich Klüver and Paul C. Bucy, "Preliminary analysis of functions of the temporal lobes in monkeys", *Archives of Neurology and Psychiatry*, 1939, 42: 979-1000.

his view, which came up to hazard that, in the light of Freudian psychology, the visceral brain would have “many of the attributes of the unconscious id”:

One might argue, however, *that the visceral brain is not at all unconscious (possibly not even in certain stages of sleep), but rather eludes the grasp of the intellect because its animalistic and primitive structures makes it impossible to communicate in verbal terms.*²³

Already in this seminal paper, MacLean hypothesized that, given the particular role of the visceral brain in the realm of emotion, certain puzzling aspects of psychosomatic diseases would be more understandable. Patients who suffer from them show an intellectual inability to verbalize their emotions; if the visceral brain is an illiterate brain, then one would not expect, at the onset of psychotherapy, to accomplish a great deal by verbal methods. Rather, such a situation would recommend a “disalarming” attitude of the doctor – kindly manner, tone of voice and so forth.

Since the beginning, therefore, MacLean’s work aimed to foster improvements in individual and collective life quality, so all his subsequent lines of research would obey this pattern. His 1949 paper drew the attention of John Fulton, neurophysiologist at Yale, who had been doing comparative studies on functional localization in monkeys’ brain, and opened the way to the practice of lobotomy. The two men knew each other from the time of MacLean’s studentship in New Haven, so Fulton appointed him assistant professor to work on the physiology of the rhinencephalon as part of the lobotomy project.²⁴ Shortly after his transfer, the *visceral brain* changed name and became the *limbic lobe*, more neutral: in 1878 Paul Broca had written a long, comparative description of the “grand lobe limbique” that surrounded the brainstem and was referred to as the “cerveau brutal”, unlike the rest of the cortex – “cerveau intellectuel” – responsible for higher functions.²⁵ Inspired by the 19th century French clinician and anatomist, in 1952 MacLean put forth the term *limbic system* – generally adopted – in a paper presented to a symposium of the American EEG Society.²⁶

Seventeen pages dated 1952-53 contain a *Prospectus of Contemplated Research* that MacLean submitted at Yale in view of the following five years, for the purpose of elucidating by physiological methods the functional relationships of the limbic system with the rest of the nervous system. There was accumulating evidence that in all mammals the limbic system represents a “common denominator” involved in emotional behavior. Moreover, its constancy of gross and microscopic structures throughout phylogeny would contrast strikingly with the mushrooming and surrounding neopallium that could be likened to the “expanding numerator” of intellectual functions: a true “physiological dichotomy”, accompanied by distinctive differences in the

²³ MacLean, “Psychosomatic Disease” (cit. note 20), p. 348 (italics in text). For a history of the terms see Régis Olbry and Duane E. Haines, “Rhinencephalon: a Brain for the Nose?”, *Journal of the History of the Neurosciences*, 1997: 6: 217-218; Id., “From Dante Alighieri’s circle to Paul Donald MacLean’s Limbic System”, *ibid.*, 2005, 14: 368-370.

²⁴ In an obituary MacLean also mentioned frontal leucotomy on two chimpanzees, reported by Fulton at the International Neurological Congress in 1935, which led Egas Moniz to the practice of psychosurgery: “Although the operation no longer finds favor for this purpose, the clinical and experimental findings that grew out of it have greatly broadened knowledge of the functions of the brain in intellectual and emotional behavior.” (Paul D. MacLean, “John F. Fulton (1899-1960). A Midsummer Reminiscence”, *The Yale Journal of Biology and Medicine*, 1960, 33: 86-93, p. 90. His position on the controversial subject is much clearer in a page written for a panel discussion on psychosurgery held at the NIH in January 1973: “brain tissue is like an elephant; it never forgets an injury. [...] anywhere you enter the brain you risk damage [...] provided we are not talking about damaged brain, we need as much brain as possible to assure redundancy [...] I feel certain that the medical profession itself will call an end to it.” (MLP, Box 11, folder 2).

²⁵ See Paul Broca, “Anatomie comparée des circonvolutions cérébrales. Le grand lobe limbique et la scissure limbique dans la série des mammifères”, *Revue d’Anthropologie*, 1878, 7: 385-498.

²⁶ Paul D. MacLean, “Some psychiatric implications of physiological studies on frontotemporal portion of limbic system (visceral brain)”, *Electroencephalography and Clinical Neurophysiology*, 1952, 4: 407-428. In a letter to Stanley Cobb MacLean explained how he had come to introduce the term, which would avoid any preconception as regards function (January 18, 1956, MLP, Box 1 – *Answered Letters*, folder 18). See also Id., “The Limbic System and its Hippocampal Formation. Studies in Animals and their Possible Applications to Man”, *Journal of Neurosurgery*, 1954, 11: 29-44.

respective chemical properties. Four categories of studies to be done were described – ablation, stimulation, bioelectrical, clinical. It was expected that the Department of Physiology would continue to provide cage space and surgical facilities for the animal experimentation. In MacLean’s laboratory at the Psychiatric Department there was most of the essential equipment. Except for a histology technician, an animal lab man (both part time), and a secretary the contemplated research could be conducted without the hiring of other personnel, as up to that time a number of workers – colleagues or students – had desired to volunteer in collaborating in the experiments.²⁷ As soon as these started at Yale, he published with Karl Pribram a strychnine neuronographic study about association pathways from sensorial cortical areas to the hippocampal gyrus, and with José Delgado a description of emotions and behaviors elicited by stimulating the lower parts of the limbic ring fed by the amygdala. In both cases cats and monkeys were used as test subjects.²⁸

MacLean’s project emphasized its psychiatric implications. The limbic system seemed to be not only accountable for the psychomotor epilepsy, but also for alterations accompanying schizophrenia, the hysterias, and a number of psychosomatic disorders with focal or diffuse lesions. Further studies promised to contribute to a better understanding of normal and abnormal sexual behavior. To the President of the American Psychosomatic Society, who had invited him to the annual meeting scheduled for March 1954, MacLean pointed to other people to contact, “who have both physiological and psychiatric interests, try to tie things together”. For his part, he would obviously talk about the bearing of the physiology of limbic system on psychosomatic phenomena.²⁹ The incipit of his paper draft does not abstain from something reminiscent of natural theology:

Those of us who make a study of the brain have the satisfaction of realizing that we have within ourselves a microcosm, a little world, that seems to be as marvelous in its structure and workings as the whole universe. [...] In the brain of man we find over ten billion nerve cells that are related to one another in more combinations than there are atoms in the entire universe. It is the function of these constellations that accounts for the mind of man. To be an astronomer of these constellations very early leads one to exclaim with the Psalmist, “For thou hast made him a little lower than the angels, and has crowned him with glory and honor”.³⁰

Research over the past fifteen years had proved the evolutionary appearance of *two brains*, the first having to do with emotions and the second with intellectualization. The old brain looks like a relatively crude mechanism – analogous to an early TV set with a nine inch screen – that gives to both man and the animal a rather blurry picture of the internal and external environment, nonetheless essential to the preservation of the self and the species. Not satisfied with this mechanism, Nature began to work on a new brain – comparable with modern TV large screens ensuring images with little distortion – which in man is so refined as to generate an abstract picture in terms of word symbols. According to MacLean, this gives a clue to explain the difference between what we feel and what we know. A child speaks as a child, while a man puts away childish things, Paul says in first *Corinthians*, 13, but he could not realize “that even as adults we have the child within us, and will continue to have him with us until we die”, a child always wanting this and that, never ceasing to nag or cry until his wants are met. A misinterpretation of Freudian psychology had led to assume that the best way of dealing with the child within us is in indulging

²⁷ *Prospectus of Contemplated Research*, MLP, Box 6 – *Series II: Yale Medical School*, folder 37.

²⁸ Paul D. MacLean and Karl H. Pribram, “Neuronographic analysis of medial and basal cerebral cortex. I. Cat; II. Monkey”, *Journal of Neurophysiology*, 1953, 16: 312-323, 324-340; Paul D. MacLean and José M. R. Delgado, “Electrical and chemical stimulation of frontotemporal portion of limbic system in the waking animal”, *Electroencephalography and Clinical Neurophysiology*, 1953, 5: 91-100.

²⁹ MacLean to George L. Engel, November 10, 1953, MLP, Box 9 – *Series IV: Professional Activities*, folder 23.

³⁰ Paul D. MacLean, *Recent Concepts of Central Neurophysiology. Their Bearing on Psychosomatic Phenomena: The Limbic System. Draft of paper to be presented to the Meeting of the American Psychosomatic Society, New Orleans, March 28, 1954*, MLP, ivi.

and pampering him, but this would have only tended to aggravate the disorderly and conflictual domestic scene of individual and collective psychology. In having cracked the atom before cracking the brain MacLean sees the tragedy of contemporary man. It would only be sheer ignorance that forces him to focus so much attention on the productions of his primitive brain, but as he has learned to domesticate the animal, so there is now a scientific justification for the hope that he will someday learn to domesticate his emotions. MacLean's paper concludes with another quote from Paul the Apostle: "For now we see through a glass darkly; but then face to face...", and the life of Christ would be the breathing assurance that even now faith, hope, and charity are attainable by man.

"How can man be so bright and so dumb" – MacLean had asked before the audience of the 21st meeting of the Harvey Cushing Society in April 1953 –, thereby revealing an eminently paradoxical nature?³¹ This kind of dualistic belief was also submitted in a couple of talks (1954 and 1956) in the Dwight Chapel at Yale; at the Sixth Annual Meeting of the Veterans Administration, the image of a "schizophysisiology" was proposed, arising from the coexistence of those two brains, the old and the new, the "animalistic" and the properly "human". Perhaps the time had come for the second to husbandry (or to tame and harness) the first.³² In starting the campaign that would last for decades, MacLean received a strong encouragement from the man he considered his master. Papez appreciated and minutely discussed, by long and handwritten letters, what was being done at Yale on the limbic system, the importance of which had been recognized for the first time by Santiago Ramon y Cajal half a century before. Not for nothing the English translation of his writings on the cerebral cortex was promoted and came out in 1955, with an introduction by MacLean.³³ Drawing inspiration from that book "of inestimable value", one of Papez's letters has almost prophetic tones:

I dimly see the time ahead when we will be able to do some of this kind of interpretation. From detailed anatomy → to histological organization → to conduction processes → to experimental physiology → to dynamic interpretations → to behavioral functions.³⁴

In the same letter Papez congratulated for the NSF fellowship that was going to bring MacLean – newly promoted associate professor of physiology – to Europe: a year's leave of absence, affiliated with the Institute of Physiology at the University of Zurich. There Walter Rudolf Hess, already retired but still active with his coworkers, used electrodes in cats to stimulate and map out areas in the hypothalamus and other parts of the diencephalon.³⁵ Part of the sabbatical year was also spent in the library, reading ancient and modern books and taking notes that show the breadth of his gaze³⁶, as well as traveling with his large family. MacLean received information and advice about Italian and German researchers to contact from Valentin Breitenberg, who at that time was doing an internship at the psychiatric clinic in Rome. A visit to Giuseppe Moruzzi in Pisa is documented by

³¹ Paul D. MacLean, *Some Physiological Observations on the Limbic System (Visceral Brain)*, MLP, ivi, folder 19.

³² MLP, ivi, folders 24, 38 and 39.

³³ Santiago Ramon y Cajal, *Studies on the Cerebral Cortex*, translated by Lisbeth M. Kraft (London: Lloyd-Luke Medical Books Ltd., 1955). "A precise knowledge of anatomy – MacLean wrote in his introduction – is essential to a through elucidation of function": in that timely translation one of the world's greatest anatomists had given the most comprehensive anatomical account of the limbic system. MLP, Box 4, folder 32 contains materials relating to the translation.

³⁴ Papez to MacLean, May 15, 1956, MLP, Box 2 – *Correspondence*, folder 32.

³⁵ Hess had shared with Egas Moniz the Nobel Prize in 1949, for mapping the areas of the brain involved in control of internal organs.

³⁶ His notes cover the works of classical authors such as Arantius, Malpighi, Vieussens, Santorini, Lancisi, Ridley, Haller; many 19th century German titles are reported, with other more wandering readings of 20th century texts, also of historical character (MLP, Box 4 – *Zurich Notes*, folder 35 and 36).

an exchange of letters. He also accepted an invitation to participate as a discussant at a symposium of Ciba Foundation on the *Neurological Basis of Behaviour* to be held in London, July 1957.³⁷

After the European break, MacLean's activity restarted not at Yale, as expected, but at the National Institutes of Health in Bethesda, Maryland, where he had been asked to establish a new section on Limbic Integration and Behavior in the laboratory of neurophysiology. His decision of moving is understandable, since the new setting would give him the opportunity to fully pursue the type of research begun in the previous years. Squirrel monkeys – small primates with a well developed visual system – substituted cats as experimental animals, and for obtaining a satisfying description of their behavior, Detlev Ploog was employed as a visiting scientist, a German ethologist met in Zurich. MacLean wanted the animals to be housed across the hall from his office, and always insisted that in neurobehavioral studies their health and care were essential. One of the main purposes of his lab section consisted in obtaining information about the connections of the limbic system with the sensorial functions. Another field of investigation concerned brain structures and pathways involved in primal sexual acts. In September-October 1959 MacLean spent three weeks overseas, visiting, first of all, the Max Planck Institut für Verhaltensphysiologie in Seewiesen (Oberbayern), welcomed and guided by Konrad Lorenz's collaborators. He could not be received by the director, who was attending a meeting in Stuttgart, but immediately after returning he expressed his enthusiasm for what he had seen there and informed Lorenz "that we have had under consideration at the NIH a reserve for carrying out comparative behavioral, neuroanatomical, and neurophysiological studies in a quasi-natural setting".³⁸

2. A neuro-architectural dream and the emergence of a third brain

That was his purpose and commitment in the following decade. A long letter of 1958 to Robert B. Livingston – director of Basic Research at NIH – contains a meticulous explanation of what would be desirable for a National Institute of the Brain and Comparative Behavior, so tentatively named. It should be located near a cultural and educational center, to allow cross-fertilization of ideas among different disciplines, in a tract of land wide enough for expansion and growth, with an appropriate equipment of facilities:

I would, myself, visualize a central building built in the form of a hexagon, with buildings for each of the main subdivisions of the animal kingdom radiating from five to six sides. In other words, there would be individual wings, respectively, for (1) insects and other invertebrates, (2) fishes, (3) amphibians and reptiles, (4) birds, and (5) mammals. The spoke-like arrangements of these buildings would allow for adding extensions when needed, and the land for field work could be divided up into sectors to go with each building. [...] The sixth side of the hexagon would be left as an open space for an approach to the institute, and one might imagine a mall with formal gardens and fountains leading up to the entrance. The second floor of the hexagon would lend itself naturally to the administrative section of the library together with the connecting five wings for each of the libraries concerned with the five main subdivisions of the animal kingdom.³⁹

MacLean's architectural dream continues by dwelling on other equipments designed to provide a perfect structure. There was, underneath, the belief that a comparative approach would help to

³⁷ Breitenberg to MacLean, August 9, 1956, MLP, Box 3 – *General Correspondence*, folder 1. MacLean to Moruzzi, April 4, 1957; Moruzzi to MacLean, April 8, 1957 and May 8, 1957, *ivi*, folder 2. Wolstenholme to MacLean, November 28, 1956; MacLean to Wolstenholme, January 10, 1957; Wolstenholme to MacLean, March 20, 1957, MLP, Box 9 – *Series IV: Professional Activities*, folder 42.

³⁸ MacLean to Lorenz, October 20, 1959, MLP, Box 8 – *Comparative Behavior Research Center*, folder 1. MacLean's itinerary in Europe included a visit to Nikolaas Tinbergen at the Department of Zoology, Oxford.

³⁹ MacLean to Livingston, November 14, 1958, MLP, Box 6 – *Series III: National Institute of Health, Brain and Behavior Reserve*, folder 40.

understand the neural mechanisms which loom so large in psychopathology and in day-to-day social behavior: “depression, elation, passivity, aggressiveness, communal and non-communal living, wildness and domesticity, parental behavior, leadership, and the like”. Much potential it would also reveal in the study of the processes of aging and in psychopharmacology.

A few months later, Livingston informed MacLean about a recent meeting of the NIH Laboratory Chiefs where it had been agreed that he would be the “ideal person” to lead the planning and development on studies relative to the farm. Of course his fanciful project should come to terms with reality and be resized. The ethologist John B. Calhoun was already doing similar research at the NIH and had to be part of the new enterprise. Congress would predictably appropriate money for use during the next fiscal year (1960).⁴⁰ However, archival documents exhibit both the obstacles which slowed for many years the implementation of the plan, and MacLean’s perseverance in wanting to achieve his dream. Reacting to the opinion expressed by James A. Shannon – director of the NIH – about its “prematurity”, MacLean listed a number of reasons that made it indispensable. Through the use and extension of usual neurophysiological techniques in a simulated natural setting, it would be possible to get a clearer understanding of brain mechanisms underlying such important functions as mating, brooding, foraging, hunting, leadership, domestication and wildness etc. These matters might at first seem remote from medical and public health problems; further reflection, nevertheless, would point out how closely related many of them are to basic human functions, from individual moods to disturbances of the whole population:

Take for example the question of herding. Man is not a herd animal. Yet the conditions of population increase and city crowdings have in many respects been forcing him more and more into the unnatural condition of the herd during the past century. With improved medical measures for prolonging life, this promises to become an increasing, if not an alarming acute, problem in the foreseeable future. Ecological studies on animals have shown that conditions of crowding in non-herd animals may result in failure of mothers to nurse and tend to their young, homosexuality among males, and warring (with endocrine changes) between parents and offsprings. How do these findings possibly relate to rising juvenile delinquency in our modern cities, homosexuality in certain social settings, and warring among nations? It is possible that through a better understanding of the brain and behavioral mechanisms we might develop the insight to forestall and circumvent some of the hazards of overpopulation.⁴¹

Ten pages of a report were written again by MacLean in November 1959, to expand and reiterate his arguments. There currently existed many observers who were exceedingly familiar with the natural behavior of animals, but who had little concern with the brain. On the other hand, the highly skilled in neurophysiological techniques had poor knowledge of behavior. The aim was precisely to encourage the combination of the efforts of these two groups at a research reserve with a quasi-natural setting. From their cooperation some insight might come into the functions of such large enigmatic structures as the corpus striatum, “which for over fifty years had defied all experimental assaults within the confines of the laboratory”.⁴² Be that as it may, in 1964 the daring enterprise was still a “master site plan” (**Fig. 4 here**), and in 1968 MacLean recognized that “times were not ripe ten years ago for launching such a program”, although by no means discouraged that his desired kind of laboratory did not materialize. Alternative solutions should be proposed and discussed.⁴³ Only in 1971 the new research center would be opened at Poolesville, MD.

⁴⁰ Livingston to MacLean, March 12, 1959, *ivi*, folder 41.

⁴¹ *Meeting with Dr. Livingston and Dr. Jack Calhoun on May 11, 1959, regarding the behavioral farm*, *ivi*. From the mid-forties Calhoun had worked on a Rodent Ecology Project at Johns Hopkins University, continuing to study colonies of rats when he moved to the NIH in 1954. Evidently from him MacLean borrowed the alarm on crowding.

⁴² Paul MacLean, *Intellectual domain and program planning at NIH*, *ivi*.

⁴³ MacLean to John C. Eberhart (Director Intramural Research Program), April 22, 1968, *ivi*, folder 45.

In the meantime some remarkable changes had occurred. MacLean had been invited by Horace W. Magoun to join the second Macy Conference on the *Central Nervous System and Behavior* in Princeton, February 1959. Overcoming some doubts on the previous sessions of the famous series of conferences, he decided to accept and talk about *The limbic system with respect to two basic life principles*. During the discussion with the neurologist and psychoanalyst Lawrence Kubie he came up with a new picture:

Man finds himself in the predicament that Nature has endowed him essentially with three types of brains, all of which, despite great dissimilarities, must function together. One of these brains is basically reptilian; the second has been inherited from lower mammals; and the third is a late evolutionary development that has made man peculiarly man. [...] What engineer would ever think of combining an old fashioned radio with today's television? Yet this is what Nature has attempted to do in fashioning man. The amazing thing is that we work at all. Less amazing is the fact that so many people go to the psychiatrist to find out why the horse within them keeps throwing them. In therapy it has been traditional to try to get the animal within us to talk. But the probable fact of the matter is that, like our house pets, it is simply incapable of communicating in verbal terms.⁴⁴

So a third, "reptilian" brain had manifested itself, the most basic of all: a particular group of ganglionic structures located at the base of the forebrain in reptiles, birds, and mammals, also referred to as the "striatal complex" or R-complex. Recent observations of ethologists were leading to a situation where "we can no longer postpone a frontal experimental attack" on this cerebral part which is able to perform very complex behaviors required by daily routines. Psychiatry could benefit in the future: by instance, individual frustration and depression might arise from the failure to recognize and satisfy a particular ancestral longing.

Soon after, the same and new concept was reaffirmed in a couple of lectures given by MacLean (September and December 1960) at the Sheppard-Pratt psychiatric hospital (Maryland) and at a meeting of the AAAS in New York. Again, nature is said to have endowed man with three different brains compelled to live and work together: allegorically, one may imagine that when the psychiatrist bid the patient to line on the couch, he is asking him to stretch out alongside a horse and a crocodile, deep and powerful agents but unable to express themselves linguistically. Both lectures reported recent experiments focused on the lower mammalian brain (limbic system), attesting close organization of oral and sexual functions, as well as their link with anxiety, fear, and aggression. Their results could hopefully shed light on the evolutionary social structure of animals and acculturation on man. Behaviorally observed, the male squirrel monkey assumes the same posture of penile display in courtship as it does in the act of asserting dominance or expressing aggression toward another male. MacLean lamented that, although every part of the brain had probably been stimulated during the past eighty years, there was a surprising lack of information about the localization of central structures involved in penile erection. For the foregoing reasons he had undertaken a systematic exploration of them in the squirrel monkey and found positive loci distributed along three major pathways of the limbic system, in close proximity to neural structures involved in feeding and combative behavior. When the electrode passes through the transitional regions, both erection and fearful-like or angry-like manifestations appear simultaneously elicited.

⁴⁴ The quote is taken from a few typed and untitled pages: *Kubie discussion, 27 November 1959*, MLP, Box 9 – *Series IV: Professional activities*, folder 52. See Paul D. MacLean, "The Limbic System with respect to Two Basic Life Principles", in Mary A. B. Brazier, *The Central Nervous System and Behavior: Transactions of the Second Conference, February 22-25, 1959* (New York: Josiah Macy, 1959), pp. 31-118. In the section of the book containing the "Background and Interests of the Participants", MacLean thus presents himself: "My primary interest and curiosity are to get at an explanation of how man came to be the feeling, thinking, behaving creature that he is. To tackle this problem without at first trying to understand the nature of the mechanisms that account for man's psychic life and behavior, is, in my estimation, not likely to lead to any fundamentally new concepts." (p. 24).

This neurophysiological finding could explain the psychiatric and psychoanalytic awareness that the acts of destroying, devouring, and procreating all seem inextricably tied to one another.⁴⁵

In 1964 Leonard Carmichael – psychologist, secretary of the Smithsonian Institution – thanked MacLean for the copy of an article on “Man and His Animal Brains”, read with great satisfaction, and recalled that Kurt Koffka had already emphasized the importance of different brains in psychological understanding, “but he did not know as much as you do nor were his interpretation as clear”. As Stanley Finger points out, this was hardly a new theme, considered that the battle between the passions and reason had been a major concern of 19th physicians, but unlike his predecessors MacLean was seeking to ascertain the neuroanatomical basis of the conflict.⁴⁶

The first visualization of the three brains seems to date back to 1965, a color drawing attached to the typescript of a Brady lecture given on January 7 at the School of Medicine of the Johns Hopkins University. It is an image undoubtedly very effective in its schematic simplicity, continually resubmitted by its inventor and easily imposed (**FIG. 5 here**). For the occasion MacLean talked about *New Findings about the Brain and Sexual Functions*, and began – as he would do in dozens of subsequent speeches – by commenting his first shown slide:

In evolution one might say that the nervous system develops like a house to which wings and superstructure are added. In an evolutionary sense man has inherited the basic structure and organization of three types of brains. As the brain of oldest heritage conforms to a pattern of organization typical of reptiles, one might refer to it as man’s reptilian brain. It forms the matrix of the brain and comprises much of the so-called reticular system, the midbrain, and the basal ganglia. A cerebral mantle is present but it has not yet differentiated into a true cortex.⁴⁷

Some months after MacLean received a letter from Arthur Koestler, whose adventurous life, at age sixty, had relatively stabilized with a new, third wife (Cynthia Jefferies) and a running succession of editorial and lecturing projects. They had already met at the Bicentennial Celebration of the

⁴⁵ Paul MacLean, *Sheppard-Pratt Hospital Lecture*, October 8, 1960, MLP, Box 9 – *Series IV: Professional activities*, folder 54; *Expression of the Emotions in Man: Phylogenetic and Neurophysiologic Aspects* (abstract of paper), December 29, 1960, ivi, folder 57. MacLean dedicated many years of work to the small New World primate, also publishing (with John A. Gergen) a *Stereotaxic Atlas of the Squirrel Monkey’s Brain (Saimiri sciureus)* (Bethesda, MD: National Institutes of Health, 1962). Its brain, comparable to cat’s in weight and size, was suitable for combined neurophysiological and neuroanatomical investigations, with the added advantage that its small body made it easy to handle and economic to maintain. In a letter MacLean explained to James W. Ward of the Vanderbilt University, who had asked about its diet in captivity, why it had been chosen as laboratory animal: “The squirrel monkey withstands acute experiments requiring prolonged anesthesia and extensive exposure of the brain. We have also found it very useful for chronic experimentation involving cerebral stimulation and electroencephalography without the use of anesthesia.” (MacLean to Ward, August 9, 1960, MLP, Box 1 – *Series I: Correspondence*, folder 5). Moreover, in 1964 he described two varieties, one of which would constantly display to its reflection in the mirror, whereas the other showed no interest: see Paul D. MacLean, “Mirror display in the squirrel monkey, *Saimiri sciureus*”, *Science*, 1964: 146, pp. 950-952. It is worthwhile to add that in 1963 MacLean was appointed by the American Physiological Society on the Committee for Use and Care of Animals for a 3-year term: see Mayerson to MacLean, May 7, and response May 14, 1963. He said to feel a “natural inclination” for the assignment and to agree with the high standards prescribed by a recent *Guide for Laboratory Animal Facilities and Care*: see Cohen to MacLean, May 23, and response June 5, 1963, MLP, Box 7, folder 43 – Committee on Animals.

⁴⁶ Carmichael to MacLean, May 12, 1964, MLP, ivi, folder 13; Paul D. MacLean, “Man and his Animal Brain”, *Modern Medicine*, 1964: 32, pp. 95-106; Stanley Finger, *Origins of Neuroscience. A History of Explorations into Brain Function*, Oxford: OUP, 1994, p. 290. Others have noticed that a hierarchical, tripartite organization is inherent to Freud’s structure of the mental apparatus, or that similar models based on the ‘magic’ number three occur not infrequently during the 20th century: see Luciano Gallino, *Il contributo di Paul D. MacLean a una scienza unitaria del comportamento umano*, in Paul D. MacLean, *Evoluzione del cervello e comportamento umano* (Torino: Einaudi, 1984), pp. VII-LV; Gerald Wiest, “Neural and mental hierarchies”, *Frontiers in Psychology*, 2012: 3, pp. 1-8; Lazaros C. Triarhou, “Tripartite Concepts of Mind and Brain”, in Stella P. Weingarten and Helena O. Penat, *Cognitive Psychology Research Developments* (New York: Nova Science, 2009), pp. 183-108.

⁴⁷ Brady Lecture, Johns Hopkins Hospital, January 7, 1965, MLP, Box 10, folder 1.

Smithsonian Institution in Washington, and a strong drive led that “homeless mind” – as the best of his biographers called him – to “extract more information” from the scientist:

I am not motivated by eclectic curiosity but by a specific interest in this particular domain; as I mentioned, the book I am working on is about the various applications of the hierarchy concept in general, but in particular about the “disordered hierarchy” in which the part asserts itself to the detriment of the whole, and emotion tends to become dissociated from reason.⁴⁸

Thus a long friendship and collaboration started, in which a stimulating role was mostly played by Koestler, always prone to involve MacLean, sometimes reluctant, in several initiatives. The first one saw a group of people convened at the NIH in May 1966 “to discuss the concept of hierarchic organization in biological and mental evolution”. The seminar was “great fun”, according to Koestler who was then working at a book, in which MacLean’s theory of the three brain “looms large”, and would form the core of its final part.⁴⁹ His writing was constantly slowed by other commitments, as in the case of the epilogue he had to draft for the Norbert Wiener Memorial Symposium in 1967, where

I would like to bring in the Papez-MacLean theory as indicating that owing to the explosive growing of the brain, evolution slipped up and did not provide sufficient feedback circuits between the old and new structures. If you feel commenting on this, please do.⁵⁰

When, with some fear of being disapproved, Koestler submitted him the third part of his forthcoming book, he first received a provisional praise (“I have peeked through it and it looks fascinating”), and a couple of weeks later a more reasoned judgement:

I think you have accomplished a remarkable synthesis of a diversity of difficult subjects [...] Your book shows the brilliance of what happens when an author’s irresistible ideas meet with formerly immovable subjects. I was especially taken by your insightful discussions of such topics as the “inherent paranoid streak” in man, the “collective delusions of the crowd”, and “man’s inability to accept death”. [...] It is impossible to say how deeply affected I was to see how much you have quoted from my various papers.⁵¹

With a title borrowed from the expression used by the philosopher Gilbert Ryle to criticize the Cartesian, dualistic view of the mind-body relationship, *The Ghost in the Machine* highlighted with an impressive firework of examples the urge to self-destruction that would represent the dark side of human nature. Third of a cycle, Koestler’s book, with great public impact completed a long argument started with *The Sleepwalkers* (1959) – about scientific discovery – and followed by *The Act of Creation* (1964) – artistic inspiration under scrutiny. The creativity and the pathology of the human mind were considered by the hyperactive author just as two sides of the same medal coined in the evolutionary mint. A “streak of insanity” would run through the history of the species, due to something wrong that happened along the line of its ascent to prominence.

The Ghost in the Machine devotes thirty pages of its third part to *The Three Brains*, a chapter opened by a Freudian quote about the need of psychology to avoid “floating as if it were in the air, without any organic foundation”. The first part of the book tries to demonstrate that *Homo sapiens* is a “biological freak”, the result of some remarkable mistake in the evolutionary process.

⁴⁸ Koestler to MacLean, October 13, 1965, MLP, Box 3 – *General Correspondence*, folder 37. See David Cesarani, *Arthur Koestler: The Homeless Mind*, New York: Free Press, 1998. According to the testimony of Koestler’s third wife, “MacLean’s work came at the right moment when a number of ideas on this theme were in chrysalis form”: Cynthia Koestler, “Twenty-five Writing Years”, in Harold Harris (ed.), *Astride the Two Cultures. Arthur Koestler at 70* (New York: Random House, 1975), pp. 136-148, p. 143.

⁴⁹ Paul D. MacLean, *Memorandum to the Participants in an informal seminar etc.* (with a list of them), April 22, 1966, ivi. Koestler to MacLean, May 16; July 8; August 30, 1966, ivi.

⁵⁰ Koestler to MacLean, November 30, 1966, ivi.

⁵¹ Koestler to MacLean, January 31, 1967; MacLean to Koestler, February 7 and February 24, 1967, ivi.

The responsibility for that mistake is then imputed to some fault in the circuitry of the most precious and delicate instrument, the central nervous system. Not only the enlargement of the human brain has gone too fast and far, but also the insufficient co-ordination between the phylogenetically old areas, and the new, specifically human, can account for differences between emotional and intellectual behavior. Koestler reminds that the distinction between knowing and feeling goes back to the ancient Greeks, rapidly mentions historical steps – Xavier Bichat’s “little brains”, the James-Lange peripheral theory of emotions, the Cannon-Bard central theory – to arrive finally at MacLean’s experimental work and hierarchic view of brain functioning. The coexistence of the reptilian, the primitive mammalian, and the neo-mammalian brains – with their problematic relationships – would be responsible for the innate “schizophysiology” of man.

Koestler hoped that MacLean would not regard his approach as “diletantic or crankish”. The strict ethics of a neuroscientist did not prevent him to welcome the wide echo that a kind of bestseller, soon translated in other languages, would offer. Hospitalized in New York after surgery, MacLean rejoiced to see such a recognition of his own work⁵², and when Koestler organized a famous Symposium in Alpbach he, unable to attend, sent a paper which was read, accompanied by brain cross-sections drawn on the blackboard, and received “in a sort of awed silence”: “The reason people kept silent was the emotional impact of the paper. It was a kind of moment of truth – a direct hit in the solar plexus.” The flattering narration of the event was followed by the proposal to write a joint Koestler-MacLean book on *Cosmic Anxiety*, “the first attempt at a concrete collaboration of two authors representing the two cultures in tackling a vital problem”, which however never materialized, in spite of Koestler’s insistence. Moreover, he had just read a paper by Warren McCulloch for the Wenner-Gren Foundation Symposium that came to the same conclusion as he did in *The Ghost* and praised the exemplary work done on the squirrel monkey by MacLean, “who has taught us its anatomy and its role in instinctive acts and in social behaviour”.⁵³

MacLean began to feel surprised at “being videotaped for broadcast to an overflow audience” – it happened in February 1969 during a tour through Canadian universities – and after a few months the “rather naïve assertions” in a seminar by Gordon Allen entitled *Is the human brain an evolutionary mistake?* could not help but worry him.⁵⁴ Nevertheless this extrascientific resonance, still at an embryonic stage, hastened him to invent the catchword that would increase enormously his fame in the following decades. He took the opportunity of three Clarence M. Hincks Memorial Lectures given at Queen’s University (Kingston, Ontario) to repeat that the human forebrain evolved to its size while retaining features of ancestral formations, and that the three neural assemblies were radically different in structure and chemistry. His first slide was taken from the last chapter (*The Age of Climax*) of Koestler’s book, “with the curve depicting the population

⁵² Koestler to MacLean, March 2, 1967; MacLean to Koestler, September 8, 1967, *ivi*. *The Ghost in the Machine* was published by Hutchinson in London (1967) and the following year by Macmillan in New York. There were soon French, German, and Italian translations. All over the Western world it was reviewed by magazines as an influential and provocative essay. Strongly critical reactions were not lacking: an example for all is offered by Robert Jay Lifton, known for his studies of the psychological effects of war and political violence. He found the dichotomy of the bad old brain and the good new one – or of *instinct* versus *reason* – “a misrepresentation of the way man’s brain works and a neurological retreat from his psychology and history”. The erratic combination of unfocused and over-focused argument rendered Koestler’s book “tedious” (“Man as Mistake”, *The New York Times*, 1968, April 7).

⁵³ Koestler to MacLean, July 7, 1968, *ivi*. The European Forum Alpbach (Tyrol) was founded in 1945 by the federalist Otto Molden as an interdisciplinary venue for a peacefully united Europe. Since 1959 Koestler had owned a house for summer vacation there, and helped organize several symposia. His toiling in view of the 1968 conference is documented by the correspondence with MacLean, whose paper *The paranoid streak in man* was afterwards included in Arthur Koestler and John R. Smythies, *Beyond reductionism. New perspectives in the life sciences The Alpbach Symposium 1968* (London: Hutchinson, 1969), pp. 258-278. The Wenner-Gren Foundation Symposium had been organized by Gregory Bateson and held in Burg Wartenstein Castle (July 16 through 25, 1968): see Mary Catherine Bateson, *Our Own Metaphor. A Personal Account of a Conference on the Effects of Conscious Purpose on Human Adaptation* (New York: Alfred A. Knopf, 1972).

⁵⁴ MacLean to Koestler, February 28 and October 17, 1969, *ivi*.

explosion”.⁵⁵ The original title of the lectures – *The Brain and Behavior* – changed in the printed version, and for a good reason:

If you speak publicly in Canada, the communication ties within the British Commonwealth are such that there may be a period when the sun will never set on what you say. The underlying theme of my lectures – the three-brain concept – gained rather wide circulation, but in the abbreviated reports, one got the impression that we behaved as though under the direction of three separate brains. I realized that what I needed was a word so definably tight that there could be no possible confusion on that score. Despite its other connotations, I liked the word “triune” because its letter by letter spelling was so close to the Greek [*sic*] term meaning, literally, three-in-one. If the three main evolutionary assemblies were pictured as intermeshing and functioning together as a triune brain, they could hardly be completely autonomous, but would be able to operate somewhat independently. Moreover, the word triune also implies that the whole is greater than the sum of its parts because, with the exchange of information among the three main assemblies, each derives a greater amount of information than if it were acting alone.⁵⁶

Regardless of the misplaced etymology, a first trace of the new term is in a letter to Koestler, dated July 8th, 1970, and since then it found a permanent place in the titles and content of MacLean’s public speeches, before having an ultimate affirmation when the Hincks Memorial Lectures were published (1973). In the popular language of those years the three brains might be thought of as “biological computers, each with its own peculiar form of subjectivity and its own intelligence, its own sense of time and space and its own memory, motor, and other functions”. The caption of the usual image showing the superimposed brains – it is worth noting – adds that, “in Koestler’s terminology”, with their extensive interconnections they represent, a ‘holonarchy’.

Given the results of ethological observation, MacLean was certain that the reptilian brain programs stereotyped behaviors with instructions based on ancestral learning and memories, as shown by the tendency to follow roundabout, but proven, pathways, or operating according to some rigid schedules. In *Beyond the Pleasure Principles*, Freud had dwelt on man’s compulsion to repetition: obeisance to precedent is the first step to obsessive-compulsive behavior; but several other aspects of reptilian behavior induced to speculate about the functions of man’s counterpart of his primitive brain. The second Canadian lecture deals with “nature’s attempt to provide a ‘thinking cap’ for the reptilian brain and emancipate it from the ancestral superego”: the primitive cortex of the old mammalian brain – otherwise known as the limbic system – for the zoological class is a common denominator largely connected with emotional feeling and behavior that assure self-preservation, or are conducive to sociability, procreation, and the preservation of the species.⁵⁷ In his final lecture MacLean inquired “how the brain gets out from under the domination of the narcissistic, existential olfactory sense to be altruistically guided by the futuristic, visual sense”, and ends quoting an article he contributed to a book of 1968. Neuroscience seemed to offer the intimation that the neo-mammalian brain has a mechanism fully capable of coping with the medical and social problems of the time:

The most explosive issue, of course, is the problem of controlling man’s reptilian intolerance and reptilian struggle for territory, while at the same time finding a means of regulating our soaring population. [...] With the increasing insights that are being obtained from the brain and behavioral

⁵⁵ MacLean to Koestler, February 7, 1969, *ivi*.

⁵⁶ Squire, *The History of Neuroscience* (cit. note 10), p. 264. For an afterthought about the term, see the personal communication reported by Kelly G. Lambert, “The life and career of Paul MacLean: A journey toward neurobiological and social harmony”, *Physiology and Behavior*, 2003, 79: 343-349, p. 345: “Considering that MacLean’s father was a Presbyterian minister, this term seemed perfect for his theory at the time, but he later regretted this choice due to its religious connotations”.

⁵⁷ Paul D. MacLean, *A triune concept of the brain and behaviour, including Psychology of memory, and sleep and dreaming, papers presented at Queen’s University, Kingston, Ontario, February 1969, by V. A. Kral (and others)*, (Toronto: University of Toronto Press, 1973), pp. 8-9, 24, 43.

sciences, man should be able to continue to harness his emotions for progressively constructive purposes. If, through education, we could only apply what the brain already knows, the year 2000 might see the beginning of a truly golden age.⁵⁸

In November 1971 MacLean informed Koestler that he was having a busy autumn organizing his new laboratory, and enjoying the new surroundings, with a joke about the stages of brain development:

Today I am performing my second operation on a turkey. You can see how I am regressing in my old age! Next it will be a reptile, and I will be just that much closer to returning to mother earth. I refer of course to the reptilian homing instinct or what Freud would call the death instinct!⁵⁹

It took a very long gestation, but the Laboratory of Brain Evolution and Behavior had been finally inaugurated in Poolesville on May 28, 1971, with a morning ceremony and two afternoon scientific sessions, during which MacLean illustrated the tasks of the Section on Comparative Neurophysiology and Behavior, entrusted to him. There were 40 acres of woods and meadows, three laboratory buildings, staff and visiting scientists to toil in research on squirrel monkeys, dogs, rats and mice, turkeys, lizards, hamsters. Its primary purpose was to investigate the functions of an old and massive part of the forebrain that had been a painful stumbling block to investigators for more than 150 years. A handwritten note that accompanies the typewritten text of his discourse reads:

After 14 years, it is exciting to be with so many of our friends under this tent. I say this despite our still being on the plains of Moab and far, far away from the top of Mt. Pisgah and a view of the promised land and how the brain works.⁶⁰

For the time ahead, MacLean's activity at the Laboratory and his steadfast spreading the Good News inherent in the Triune Brain theory went hand in hand. Judging from some unpublished documents, the internal atmosphere seems that of a cohesive, family community. Birthday or Christmas songs were composed, one of them amusingly dedicated in 1978 by Michael R. Murphy – who was then working on the behavior of decorticated hamsters – to *The Three Brains*:

The three brains of crania are, / Ne-o-cor-tex, limbic and “R”. / So much fun, three minds in one. / What could be more bizarre.

Ooohhh, brain so triune, brain of three. / Where can primal memories be? / In the vortex of the cortex, / Hiding surreptitiously.

Here is how we study these brains, / Take out one and see what remains. / Tests are formal. All is normal. / What does it all explain?

Ooohhh, brain of beas-ti-al-i-ties. Brain of whim-si-cal-i-ties. / How exciting to be writing/ On your three mentalities.⁶¹

⁵⁸ MacLean, *A triune concept* (cit. note 57), p. 59. Also in Id., “Alternative neural pathways to violence”, in Larry Ng (ed.), *Alternatives to Violence. A Stimulus to Dialogue* (New York: Time-Life Books, 1968), pp. 33-34.

⁵⁹ MacLean to Koestler, November 8, 1971, MLP, Box 3 – *General Correspondence*, folder 37.

⁶⁰ *Dedication Program. NIMH – Laboratory of Brain Evolution and Behavior. National Institutes of Health, Animal Center. Poolesville, Maryland, May 28, 1971*, MLP Box 7, folder 1 (*Building Dedication*). “We intended – MacLean writes about the Poolesville facility in his autobiography – to focus on the anatomy and functions of cerebral commonalities of animals belonging to the three classes of terrestrial vertebrates: reptiles, birds, and mammals. All land vertebrates derive from the stem-reptiles. Continuing fossil discoveries are adding to the evidence that birds evolved from dinosaurs. The fossil record, on the contrary, provides numerous examples linking the lineage of human beings and other mammals to the mammal-like reptiles (therapsids) that lived in Permian times.”: Squire, *The History of Neuroscience* (cit. note 10), p. 265. The other two sections of the Laboratory were led by Walter B. Stanley (Comparative Biopsychology) and John B. Calhoun (Behavioral Systems).

⁶¹ Michael R. Murphy, *Lab Lieder for Christmas 1978: The Three Brains*, MLP, Box 8, folder 32.

At the Laboratory, researches were soon conducted on lizards, as distant relatives of the long extinct mammal-like reptiles, and antecedents of mammals. With a geological metaphor, the so-called R-complex – basal ganglia, and related deep structures – looked like “as much the bedrock of the forebrain as the Laurentian shield is to the North American continent”. Twenty-four types of behavior seen among reptiles, which involve self- and species-preservation, were listed in a table.⁶² Reptilian behavior raised many intriguing questions, for instance how its proneness to imitation is related, in human affairs, to mass hysteria, mob violence, world-wide adoptions of fads and fashions. The agenda of a meeting of the Board of scientific counselors, in October 1978, illustrates the activities carried out until then. MacLean talked about the *Striatal Complex*, assuring that their facility for research would not exist “had it not been for the recognition that a basic part of our forebrain reflects a reptilian ancestry”. When planning and designing the laboratory twenty years earlier, it was a main purpose to test the hypothesis that the striatal complex plays a fundamental role in organizing the expression of species-typical behavior employed in “prosematic” (nonverbal) behavior essential for conspecific survival.⁶³

3. *Doomsday or Dawnsday*

The following year an article published in *Science* by Constance Holden, who had interviewed MacLean at the animal center on his 65th birthday, described his “temptation” to look for the reptile embedded in human behavior. The journalist, destined to become one of the biggest names in public understanding of science, mentioned his being a neuroscientist inclined “to feel philosophical”, to coin neologisms, and to admit that “we have hardly begun learning our ABC’s”. Man’s rational perceptions of truth are merely cortical rationalizations for feelings welling up from the limbic pool – he told the interviewer – and looking at things from the inside out, deeper than the neocortex, would give a different appreciation of the self and the world. Consequently the human sciences could confidently develop some new and more effective approaches to the many troubles of the oncoming end of the century. Despite the unveiling of neural structures which are very powerful, mute and preprogrammed forces do not govern human behavior altogether; MacLean became upset if one inferred from his talk such a conclusion, perhaps risking an evident contradiction:

On the contrary, he is optimistic for the race if we can learn to make use of the latest equipment evolution has provided, namely the prefrontal lobe of the neocortex, which appears to contain the uniquely human capacities for foresight and insight that make possible empathy and altruism – a conscious linking of inward well-being with the well-being of others.⁶⁴

Those were the years in which ethology and sociobiology boomed and triggered strong reactions. MacLean might have wanted to remain foreign to the dispute, although he was entertaining a friendly correspondence with Robert Ardrey – prolific writer of theater and film texts, ‘self made’ anthropologist – who had achieved great popularity thanks to his endorsement of the killer ape theory: behind human evolution there would be nothing but aggression and war. In 1970 Mac Lean had reviewed Ardrey’s new book – *The Social Contract: a Personal Inquiry into the Evolutionary Sources of Order and Disorder*, and the following year welcomed him at the just opened Poolesville Laboratory, also asking his advice about an “experimental ethologist” for a position in

⁶² Paul D. MacLean, “Why Brain Research on Lizards?”, in Neil Greenberg and Paul D. MacLean, *Behavior and Neurology of Lizards. An interdisciplinary Colloquium*, Rockville: DHEW, 1978, pp. 3 and 8.

⁶³ Meeting of the Board of scientific counselors, 27-28 October, 1978, Agenda and MacLean’s presentation on *The Striatal Complex*, MLP, Box 8, folder 12 – LOBEB-NIHM.

⁶⁴ Constance Holden, “Paul MacLean and the Triune Brain”, *Science*, 1979: 204, 1066-1068, p. 1068.

the staff.⁶⁵ Ardrey repeatedly complained about “a left-wing attack from certain areas of the social sciences spread rapidly into the ‘intellectual’ gossip”, directed against Konrad Lorenz and others, included himself. MacLean’s sympathetic reply was unusually bold: “Arguing with a paranoid is like beating an angry penis; it only intensifies the swelling and redness and holds everyone transfixed, wondering what will happen next”. In retrospect – he added – how boring and time wasting was the feuding of scientists!⁶⁶ A few years later, Ardrey felt highly flattered by the review of *The Hunting Hypothesis* written for the *Saturday Review* by Edward O. Wilson: by the way, his explosive *Sociobiology. The New Synthesis* had recently come out, and he was “Harvard’s superstar of biology these days”, with a great influence.⁶⁷

No wonder that MacLean was eager, at this stage of his intellectual journey, to establish and maintain connections with paleoanthropologists, too. In the processing of his theory, he needed to collect information on how the human brain had evolved. This explains why he participated, between 1975 and 1979, to three symposia organized by the Leakey Foundation, formed in 1968 to support Louis and Mary Leakey’s fieldwork and the groundbreaking studies of young researchers. Louis Leakey died in 1972, but the Foundation’s activities intensified thereafter. In November 1975, at the Symposium held in Washington, the central theme was *In Search of Man*, discuss by ten speakers. Invited for the first time, MacLean accepted and promised “to concoct a vehicle to make the medicine go down easier for an interdisciplinary and lay audience”. He focused his talk *On the Evolution of Three Mentalities of the Brain*, starting with the alarmist tones that characterized each of its interventions in the 70s and over: exploding population, devastating power of the atom, potentially catastrophic forces within man. Then came the usual tale of the three brains, underlying neural mechanisms of what he referred to as “protomentation, emotomentation, and ratiomentation”, with the hope that precious insights might be gained from an investigation of those mechanisms. In September 1977, again he proposed his diagnosis and treatment – with some variations due to the topic (*Reflections on the evolution of hearing, vocalization, handedness, and speech*) – to the Symposium organized by the Leakey Foundation in London. A third time in October 1979 at Santa Fe (NM) – where the Leakey Symposium changed title to *The Roots of Human Behavior* – he happened to speak about *The triune brain in evolution*, with the following question in subtitle: *Does the reptile brain hold clues to the nature of the human mentality?*⁶⁸ Socializing with anthropologists meant to MacLean to befriend Leakey’s pupils like Diane Fossey and Jane Goodall, or to meet Raymond A. Dart, who had been involved in the 1924 discovery of the first fossil of *Australopithecus africanus* at Taung, South Africa. Anatomist before becoming paleoanthropologist, in a letter of 1976 he revealed that the real source of Papez’s article of 1937 – “A Proposed Mechanism of Emotion”, which MacLean had placed at the origin of his own brain research – was a paper published in 1934 by Dart himself about the dual structure of the neopallium and its “reptilian

⁶⁵ MacLean to Ardrey, December 20, 1971, MLP, Box 1 – *Answered letters*, folder 3. Published by Atheneum (NY), *The Social Contract* was the third part of a tetralogy started in 1961 with *African Genesis. A Personal Inquiry into the Animal Origins and Nature of Man* (1961) – a long time bestseller –, passed through *The Territorial Imperative. A Personal Inquiry into the Animal Origins of Property and Nations* (1966) and ended by *The Hunting Hypothesis. A Personal Inquiry Concerning the Evolutionary Nature of Man* (1976).

⁶⁶ Ardrey to MacLean, August 6 and September 13, 1972; MacLean to Ardrey, September 29, 1972, MLP, ivi.

⁶⁷ Ardrey to MacLean, March 13, 1976, MLP, ivi. In a letter of February 22nd, 1978 he exultantly believed to see around a “new pro-Ardrey gang headed by E. O. Wilson”. Ardrey died in 1980, and its folder of MLP contains a message by the psychologist John Paul Scott to the Senior Editor of the *Readers Digest* (probably forwarded to MacLean) with a merciless judgment on him: “You should place no faith in Robert Ardrey as a scientist. He had a little training as an anthropologist in his youth, but his primary career was as a dramatist and later as a publicist. While he liked to portray himself as a scientist, his actual method of thought was that of an advocate; that is he was concerned with making a case for his preconceived ideas.” (Scott to Methvin, September 11, 1982, MLP, ivi).

⁶⁸ Travis (Leakey Foundation) to MacLean, April 7, 1975; MacLean to Travis, April 18, 1975, MLP, Box 11, folder 21 (with the printed program of the Symposium). His contribution (*On the Evolution of Three Mentalities of the Brain*) was published in *Man-Environment-Systems*, 1975, 5: 213-224. The typescript of his second paper presented in 1979 is in MLP, ivi, folder 32. His third one is documented in MLP, ivi, folder 37.

primordia”. “Delighted to hear your reminiscences”, MacLean intended to report them during the special symposium honoring the memory of Papez – who had died in 1958 – convened for the following November at the University of Toronto. However, he did not stick to his own intention, perhaps not to belittle his old mentor.⁶⁹

Thus the 1970s were for MacLean a period of experiments, but even more of writing and travelling aimed to proclaim his diagnosis and treatment of the ills that afflicted humanity. On January 1, 1971 he entertained the *New York Times* readers on the need “to put on our thinking caps”: “We tend to blame the worldwide power struggle for our direst problems. But is it realized that this struggle reflects the established organization of man’s brain?”. To understand this organization, reasoning in evolutionary terms was essential, which meant describing – as he quickly did in the newspaper – the bizarre cohabitation of three biological computers within the human skull. The moral of the tale was already known: in the Space Age, “no matter what speed man attains with his new mammalian brain, he faces discontent unless he learns to accommodate to the horse and buggy pace of his animal brains”. The most explosive issue was restraining man’s reptilian intolerance and struggle for territory while putting the damper on soaring population. If language barriers among nations represented great obstacles, the greatest language barrier laid between man and his animal brains, incapable of intercommunication in verbal terms. For millions affected by mental illness, research in the field promised to yield increasing dividends; for mankind in general, there was ample potential for further “domesticating and harnessing” emotions.⁷⁰

Depending on the audience, which heard or read him, MacLean tried to modulate in different ways his message. It was his own faith – he had said in 1969 at Queen’s University during his first Hincks Memorial Lecture, published in 1973 – that a wide dissemination of available knowledge about basic brain mechanisms and behavior would do much “to help man live in greater contentment with himself and his society”. Perhaps his colleague and friend at NIH John B. Calhoun’s was right in predicting that just about the time of “Doomsday” there would in fact be “Dawnsday”. Anyway, some reason of hope came from clinical indications that the prefrontal cortex provides foresight in planning for the community and that it also helps to gain empathy.⁷¹ The triune brain contained, as it were, the devices to correct its own defects.

A map of MacLean’s lecturing would show a dense network of locations, both in the United States and abroad. A few examples will suffice, also because his topic was repetitive although with some adaptive variation. Invited by Edgar Morin, he participated in a famous symposium of the Fondation Royaumont (September 1972) on *Unity and Diversity of Man*, an interdisciplinary topic addressed by more than thirty natural and social scientists, big names like Salvador Luria, Jacques

⁶⁹ Dart to MacLean, February 12, 1976, MLP Papers – *Answered Letters*, folder 27: see Raymond A. Dart, “The Dual Structure of the Neopallium: its History and Significance”, *Journal of Anatomy*, 1934, 69: 3-19. MacLean to Dart, March 25, 1976, *ivi*. The proceedings of the Papez Symposium held at the University of Toronto (November 5-6, 1976), as a satellite to the Sixth annual Meeting of the Society of Neuroscience, were edited by Kenneth E. Livingston and Oleh Hornykiewicz, *Limbic Mechanisms. The Continuing Evolution of the Limbic System Concept*, New York, Springer, 1978. MacLean had been invited “as the one who picked up Papez’s torch and carried it, and saw the implications before anyone else” (Livingston to MacLean, October 2nd, 1975, MLP, Box 11 – Papez Symposium, folder 26). His discourse opened the Symposium (*Challenges of the Papez Heritage*, pp. 1-15). Dart continued to correspond with MacLean, before dying in 1988 at the age of 95. His letters express admiration for the work done at the Poolesville Laboratory which he had visited in 1976: “Let me also congratulate you on your magnificent effort in correlating the current data in cerebral evolution, ethology, animal behaviour, experimental neurology with human speech, memory and learning in such a way to be understood and appreciated [...] You are the first medically-qualified and experimental neurologist, as far as my antiquated knowledge goes, to have directed your primate experimental studies specifically to the evolutionary significance of their past.” (Dart to MacLean, July 19, 1978, MLP, Box 1 – *Answered Letters*, folder 27).

⁷⁰ Paul D. MacLean, “Putting On Our Thinking Caps”, *New York Times*, 1971: Jan. 1, p. 23.

⁷¹ Paul D. MacLean, *A triune concept of the brain and behaviour* (cit. note 57), p. 7; Id., “The Brain’s Generation Gap: Some Human Implications”, *Zygon*, 1973, 8: 113-127, p. 125.

Monod, Jean-Pierre Changeux, Alain Touraine, Irenäus Eibl-Eibesfeldt etc. Talking about his cherished topic, MacLean reminded first of all that the facts of science, even the colder and harder, “are all derivative of a soft brain”: no measurement or computation obtained by the hardware of the exact sciences enters human comprehension without undergoing subjective transformations by the software of the brain.⁷² The following June he flew to Stockholm, where an International Interdisciplinary Symposium of the Karolinska Institutet dealt with *Parameters of Emotion*, and his contribution illustrated *Sensory and Perceptive Factors in Emotional Functions of the Triune Brain*.⁷³ Moreover, in December of that year, he functioned as a Plenary Speaker at the annual meeting of the American Psychoanalytic Association in New York. In front of more than 500 listeners, he talked about *Psychoanalyzing the Triune Brain* and tried to reconsider Freud’s concepts of the unconscious and of the primary and secondary processes in the light of developing knowledge of the brain and behavior. In each individual case – he said – the analyst is not dealing with just a single person, but rather a mixture of three, or with a combination of three mentalities, two of which lack the power of speech. Their pathogenetic conflicts were especially highlighted by MacLean in a speech at the 11th European Conference on Psychosomatic Research, in Heidelberg, September 1976.⁷⁴

Even newspapers began to make room for the wider consequences of MacLean’s theory, as it happened to the *Washington Post* when a young Henri Allen – a future Pulitzer Prize – synthesized his views in February 1974. Sometimes a certain mistrust emerges from his scientific ethics towards the excess of public exposure. Both his talks at the University of Florida, Gainesville and at the University of Virginia, Charlottesville, in March and May 1973, paradoxically end with the same reflection: “For the scientist, I would suggest that there is still the need for the retreat into the ivory tower and the desirability of avoiding endless workshops, symposia, and scientific meetings”.⁷⁵

The Royaumont Symposium of September 1972 was also attended by an astronomer turned communicator, perhaps the first American specimen of a new type. Carl Sagan had already heard one of MacLean’s lectures, on December 27, 1971, at a Philadelphia meeting of the AAAS, and he sent his congratulations:

Permit me to say that I was enthralled by the content of your presentation. The tripartite brain is very reminiscent not only of the id, ego, super-ego distinction of Freud, but also of the white horse/black horse/charioteer image in Plato’s *Phaedo* [sic]. It seems to me that if the tripartite brain is an evolutionary fact, it should be possible to demonstrate it by introspection, or perhaps by the use of psychotropic drug. In any case I would be most grateful for a set of your recent reprints on the subject, both popular and technical if available. Enclosed are a few recent pictures of Mars which you might find interesting.

Prompt was MacLean’s response, with an invitation to visit the Poolesville Laboratory:

I only wish I had a picture comparable to the Martian chandelier to send you in return. I am mailing you a number of reprints under separate cover. Your allusion to Plato’s charioteer leads me to say

⁷² MLP, Box 10 – *Royaumont Abbey, September 6-9, 1972*, folder 43. See Paul D. MacLean, “Evolutionary Trends of the Triune Brain: from Imitation to Creativity”, in Edgar Morin, Massimo Piattelli Palmarini (eds.), *L’unité de l’homme: invariants biologique et universaux culturels: essais et discussions* (Paris: Éditions du Seuil, 1974).

⁷³ MLP, Box 11 – *Karolinska Symposium, June 4-6, 1973*, folder 8. MacLean’s paper is printed in Lennart Levi (ed.), *Emotions: their parameters and measurement* (New York: Raven Press, 1975), pp. 71-92.

⁷⁴ The text (with the related correspondence) is in MLP, Box 11 – *Psychoanalytic Lecture, 14th Dec. 1973*, folder 10; Paul D. MacLean, “The Triune Brain in Conflict”, *Proceedings of the 11th European Conference on Psychosomatic Research, Heidelberg, September 14-17, 1976*, in *Psychotherapy and Psychosomatics*, 1977, 28: 207-220.

⁷⁵ Henry Allen, “Beastliness. The three brains of Dr. Paul MacLean”, *Washington Post*, February 10, 1974, pp. 10-11. The title of both MacLean’s talks is *Brain Mechanisms of Ancestral Behavior*: MLP, Box 11 – *Gainesville, March 17, 1973* and *Charlottesville, May 11, 1973*, folders 4 and 6.

that in 1935 I was about to leave for Edinburgh to study Plato under A. E. Taylor, when I decided to go into medicine instead. You will find that one of the reprints begins with a quotation from Plato's "Republic".⁷⁶

Since some time Carl Sagan was already seeking for a broader role than the one typical of an academic researcher, also forced in 1968 by the denial of tenure at Harvard to move to Cornell, where his tendency to stardom was better received. So the public understanding of science became his main occupation, while his fame grew everywhere up to build a sort of myth. After Sagan's visit to the Animal Center in Fall 1975, writing to Koestler MacLean defined him "quite a literary person", not knowing yet that Sagan – some twenty years younger than him – would soon play the amplifier role played ten years before by the ineffable Hungarian-British polymath with the chapter on the three brains in *The Ghost in the Machine*.⁷⁷

As a matter of fact, on May 1977 that new Sagan's book with a strange title and an equally odd cover designed by the artist Don Davis was published, including a third chapter (*The Brain and the Chariot*) avowedly indebted to the triune brain theory. If he had previously focused on the possibility of extraterrestrial intelligence, its distribution in the galaxy and in the universe, human mind – a consequence of brain anatomy and physiology "and nothing more" – was under close scrutiny in *The Dragons of Eden*, which expanded the first Jacob Bronowski Memorial Lecture in Natural Philosophy he had given at the University of Toronto in November 1975. MacLean had developed "a captivating model of brain structures and evolution", which Sagan carefully described, finding it reminiscent of Freud's divisions of the human psyche, and of Plato's metaphor of the chariot, now (properly) placed in the *Phaedrus*. After having explained how *Homo sapiens* had evolved, who his ancestors and competitors were, the peculiar tripartite portrait of the brain did fit well with the frame and mediated the passage to the speculations on what the next steps in human evolution might be. Later in the book, Sagan also reported diffusely the experiments performed by Roger Sperry and his collaborators at the California Institute of Technology on the so called *split brain*: a dual entity where the two hemispheres coexist not without frictions, but basically in a non-hierarchical relationship.⁷⁸

Helping to prevent human civilization from destruction was one of Sagan's aims, widely shared with MacLean: the military and nuclear weapons establishment as well as Reagan Administration would become his polemic targets. Being its author a cult guru by then, *The Dragons of Eden* was brilliantly written under the influence of marijuana and resounded with special effects: its "neurological whimsies" irritated specialists but also received a few favorable reviews. *Newsweek* featured Sagan in a cover story on August 15, while John Updike wrote a bittersweet piece for the *New Yorker* and someone criticized his overdependence on MacLean's theory. Many complained about the display of mishmash, even though it might be a lot of fun. Certainly its fantastic naivety was pleasing to the jury which awarded the book with the 1978 Pulitzer Prize for general nonfiction.⁷⁹

⁷⁶ Sagan to MacLean, February 8, 1972 and MacLean to Sagan, February 17, 1972, MLP, Box 10 – AAAS, Philadelphia, December 27, 1971, folder 38.

⁷⁷ MacLean to Koestler, November 20, 1975, MLP, Box 3 – General Correspondence, folder 37. A *Festschrift* for Koestler had just come out, thirteen essays dealing with his multifaceted activity. MacLean's one closed the collection writing on "The Imitative-Creative Interplay of Our Three Mentalities": see Harold Harris, *Astride the Two Cultures. Arthur Koestler at 70* (London: Hutchinson, 1975, pp. 187-213). To the editor, MacLean sent his "infinite praise for having created this beautiful testimonial to a man whose writings will stand out as unique in the history of letters" (MacLean to Harris, September 15, 1975, ivi).

⁷⁸ Carl Sagan, *The Dragons of Eden. Speculations on the Evolution of Human Intelligence* (New York: Random House, 1977), pp. 49-79.

⁷⁹ For a brief review of reviews see Keay Davidson, *Carl Sagan. A Life* (New York: John Wiley & Sons, 1999), pp. 297-299, for whom scientists would react badly to *The Dragons of Eden*, "a moneymaking, best-selling, prize-winning book of neurological whimsies" (p. 292).

No particular, documented MacLean's reaction is available to the exploitation that Sagan had done of the triune brain. Their relationship continued in a very friendly way, with the neuroscientist who appreciated the lecturing astronomer ("nothing transports me more than being transported by you into interstellar space!") or commenting with him Reagan's candidature ("As Plato says, cities will never have rest from their evils – nor the human race – until philosophers be kings!")⁸⁰ In November 1982 he congratulated again for the humanitarian value of Sagan's initiatives: "In these times when the evolving wheel seems to be spinning forwards and backwards at the same time, it gives meaning to life and restores purpose to be aware of people like you who are striving for our future".⁸¹ On the other hand, giving a lecture on freedom at the Military Academy (West Point) in May 1981, the prince of popularizers had found himself "gravitating to the triune brain and finding the enemy of freedom in the R-complex, whose functions turn out to be pretty well expressed in the authoritarian personality" described by Eric Fromm.⁸² That kind of "gravitation" often inspired his reasoning:

We have been able in the last few centuries to eliminate cannibalism and slavery and to make spectacular changes in the status of women and the extent of sexual repression. If these are examples of limbic system control, I'm not sure it's a bad thing. But I think it's very clear that all these issues involve a mix of the three components of the triune brain, each contributing something useful. (Well...the R-complex tends to be less helpful in most situations).⁸³

In October 1983 Sagan sent a clip to MacLean, with an article appeared in *Good Life* magazine, just "another illustration of how your idea of the triune brain is propagating through popular culture".⁸⁴ The tempter was still in action. At that time a 29-minute film, *Les trois cerveaux*, was shot in 1983 by Gilles Thérien, professor at the Université du Québec, tending to stress the importance of their "maîtrise harmonieuse". Three years later MacLean was one of the scientists interviewed by the neuropharmacologist Gian Luigi Gessa for the Italian TV trilogy *La Fabbrica del Pensiero*.

In 1990, finally came to fruition the project to gather in a book the results of a lifetime of work. For a long period, in his correspondence MacLean had often mentioned the difficulties and the hope of writing a summa. Numbers count: at seventy-seven years of age, he published 680 pages in 29 chapters which describe the researches conducted and the issues addressed in the previous four decades: an impressive mosaic where all the tiles are located in their place. Significantly, the long introduction begins with a philosophical statement: in the human quest for a cosmic view of life, it would be of primary importance a better understanding of the brain. Two questions follow: "might not certain problems be resolved if we were more conversant with the limitational workings of the subjective brain?" and is it possible that further knowledge of it "might give insights into the meaning of life and the justification for the perpetuation of life with the untold

⁸⁰ MacLean's letters and postcards are in the Carl Sagan Papers (CSP from now on) archived at the Library of Congress. The two quotes come from MacLean to Sagan, April 4, 1978 and undated postcard (1979?). As for the public perception of MacLean's profile, it is symptomatic the title of the following article: Kate Callen, "Dr. Paul MacLean: Scientist, or Philosopher in Disguise?", *ADAMHA*, 1979, 5 (n. 3): p. 3.

⁸¹ MacLean to Sagan, November 24, 1982, CSP.

⁸² Sagan to MacLean, October 20, 1981, CSP. After having read Sagan's West Point lecture, MacLean hyperbolically eulogized him: "With its eloquent development, it is easy to see why your audience was so enthusiastic. You are making a neo-Carlylian out of me! By that I mean that I am again beginning to believe in heroes and hero-worship! (MacLean to Sagan, June 17, 1982, CSP).

⁸³ Sagan to MacLean, May 25, 1982, CSP.

⁸⁴ Sagan to MacLean, October 16, 1983, CSP. As for the amusing column see Sarah Overstreet, "Man's slithery nature alive, well in the brain", *Good Life*, August 15, 1983, inspired by a David Bottoms' poem ("Crawling Out at Parties") with the following incipit: "My old reptile loves the Scotch / The way it drugs the cells that keep him caged in the ancient swamps of the brain...". However, in the interview of 1979 already mentioned, Constance Holden had noticed that, despite Sagan's amplification, "MacLean is not one of those scientists whose work has captured the popular imagination" because of his virtually unique ethological approach to human brain: see Holden, "Paul MacLean and the Triune Brain" (cit. note 64), p. 1066.

suffering that afflicts so many forms of life?” The fate of humankind was at stake, threatened by overpopulation, pollution, exhaustion of critical resources. His aptitude for linguistic innovation led him to re-propose some thoughts on the twin domains of *epistemics* and *epistemology*: the first to deal with an explanation “from the inside out” of the subjective self and its relation to the internal and external environment, drawing from every field of knowledge reflecting on the human condition; the second representing the public view and the scientific approach “from outside in”. Notwithstanding all his efforts to explain it, the content of that pair of terms was to remain rather obscure and seemingly did not catch on.⁸⁵

If man learned to make use of the latest equipment provided by evolution, namely the prefrontal lobe of the neocortex – but without neglecting his two underlying brains – his predicament could be much improved. The neomammalian formation is like an expanding numerator ballooning out progressively, primarily oriented toward the external world, problem solving, learning, memory of details, language. Through the agency of these ‘newer’ parts of the brain a parental concern for family generalized in the distant past not only to other members of the species but to the entire biosphere, a psychological development that amounts to the evolution of responsibility and conscience. Neocortical capabilities of the psychencephalon would be able to govern man’s old-mammalian emotions and reptilian habits. This leitmotif ran through MacLean’s production during the last two decades of the century, gradually less frequent after the comprehensive 1990 book. Another leitmotif had to do with mammals: three forms of behavior seemed to separate them from the lower vertebrates: nursing and maternal care, audiovocal mother-infant communication, play. The “separation call” might represent the most primitive and basic mammalian vocalization, serving originally to maintain maternal-offspring contact: MacLean found that the core gray matter and the segmental white matter at the junction of the thalamus and midbrain were involved both in its production and structuring. Other researchers had given evidence that the rostral cingulate cortex in monkeys was the only cortical area where electrical stimulation would elicit vocalization. Experiments on hamsters raised from birth without the neocortex had shown their normal growth and all species-typical forms of behavior: playing, mating, breeding, and rearing their young. If in addition to the neocortex a large part of the cingulate convolution was destroyed, there were notable deficits in maternal behavior.⁸⁶

As a biological institution, family had survived 180 million years, originated with the earliest mammals living in late Triassic times. Accordingly, MacLean believed that in the class evolution the female element had been playing a crucial role. Commenting what James B. Ashbrook – a pioneer in neurotheology – had written in the late 80s, he quoted recent neuroanatomical and brain imaging studies supporting the idea of certain disparities in structure and function of the brain of men and women, whose brain would be “more balanced” than the masculine.⁸⁷ Speculation – so to speak – was indeed prevailing in the later phase of MacLean’s activity. Neurobehavioral investigations of the triune brain – he wrote in 1983 – reveal the source of the hierarchical development of three forms of power: ruthless, merciful, and transcendental.⁸⁸ An editorial of 1985 had even ventured the following hypothesis:

⁸⁵ Paul D. MacLean, *The Triune Brain* (cit. note 57), pp. 3-6. The couple epistemics/epistemology had appeared for the first time in Id., *On the Evolution of Three Mentalities* (cit. note 68).

⁸⁶ Paul D. MacLean, “Brain Evolution Relating to Family, Play, and the Separation Call”, *Archives of General Psychiatry*, 1985, 42: 405-417.

⁸⁷ Paul D. MacLean, “Women: a More Balanced Brain?”, *Zygon. Journal of Religion and Science*, 1996, 31: 421-439. Since 1973 MacLean had collaborated occasionally to *Zygon* and exchanged correspondence with its founder and editor, Ralph W. Burhoe, who once expressed his pleasure for having MacLean’s support “in the fact that our best wisdom and logic does not match the unconscious and unknown wisdom that men have.” (Burhoe to MacLean, July 7, 1973, MLP, Box 13 – Professional activities, folder 13).

⁸⁸ Paul D. MacLean, “Brain Roots of the Will-To-Power”, *Zygon*, 1983, 18: 359-374.

Human beings and their antecedents are the only creatures known to have used fire. In the course of millions of years did there arise some connection between smoke and tears and activities surrounding fire, including ceremonies involved in disposing of departed loved ones?⁸⁹

Even the style of old MacLean increased that taste for metaphor which had accompanied him since the 60s. In 1992, discussing a book of Phillip E. Johnson – the champion of the intelligent design movement – he appeared to condense into a sentence the ultimate meaning of all his work:

Since we can never learn more about ourselves and our environment than is provided by the brain's algorithms, it is important to create an intellectual atmosphere that is conducive to our listening to the *silent play* of the brain's algorithms. In this manner, we become somewhat like those mathematicians who can hear the melody of their equations.⁹⁰

⁸⁹ Paul D. MacLean, "Evolutionary psychiatry and the triune brain", 1985, *15*: 219-221, p. 221. The same question is in Id., "Brain Evolution" (cit. note 86), p. 415.

⁹⁰ Paul D. MacLean, review of Phillip E. Johnson, *Darwin on Trial* (Washington, DC: Regnery Gateway, 1991) in *Zygon*, 1992, *27*: 466-469, p. 469.