Near Death Experiences and Transcendental Experiences. Neurophysiological correlates and hypotheses.

Dr. Jean-Pierre Jourdan

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Taking place at the approach of death, NDEs might suggest that they could be a good starting point for those who seek an answer to the question of survival. But this hides an essential fact: if NDEs take place in particular circumstances, usually characterized by a physiological stroke (classical NDE) and at least by a psychological stress (Fear Death Experiences), very similar experiences occur, either spontaneously or because they have been induced by various techniques which could be qualified as psychophysiological, usually in a mystic context. In fact, many aspects of NDEs and its long term effects resemble phenomena described since time immemorial but also contemporary experiences, in most cases with no relationship with imminent death.

These experiences could be compared on two levels:

-the manner in which they unfold (some, apart from the circumstances, are identical to NDEs);

-and also their long term effects. According to witnesses' reports, these long term effects exist, although they might be disturbing. No serious study can neglect them.

The question is therefore simple: either one solves the problem by deciding arbitrarily that all those who experienced such phenomena (including important spiritual personalities) have suffered near pathological hallucinations, or, with a little curiosity, admits that those accounts are sufficiently similar and consistent to merit further study.

As I think that everybody now knows well the NDE's unfolding, we shall see now only some excerpts of french reports concerning essentially impressions and after effects : the conception of life, the sense of values and the behavior of NDErs are deeply modified after such experiences. A few citations are more explicit than a long explanation:

A witness talks about "that divine part of man", she has the impression that "in this life we only half live, and reality is after death", which she defines as a rebirth, an awakening. Another says "in each human being exists a divine spark" and for her "earthly reality is an illusion because here on earth we cannot grasp the real sense of life"..."I had the impression that my body was an integral part of the soil, the water, the sky, stars and stones. I was both myself and everything at once, it's difficult to explain,..., I can't say that it was either joy or happiness, it was a sort of well being which I couldn’t compare with beatitude which I have never known"."I saw nobody at the end of the tunnel, it was the infinite..". Concerning human beings, "they are tiny but all encompassing, it is for each individual to work towards the essence, but can words express this?" Another speaks of the descent into infinite love, peace and the feeling of infinite love reaching the absolute and the extraordinary and warming light in which she bathed.

One should not forget that these experiences are difficult to explain to those who have never known anything similar, due to the lack of concepts and words, which are pale and insufficient. One witness, for example, admits: "for a long time, I spoke to nobody of my experience for different reasons. First of all, I didn't want to use words to describe it because I felt they would diminish the splendor, because it was impossible to

describe verbally. There was no point in talking about it, because anyway it would have been misunderstood.. It's very, very painful to keep it to myself.

Try to translate a symphony into words and describe the emotions listening to it.. what will remain?

During NDE, it seems that there is an opening into a different state of consciousness in which a vaster reality, transcending time, space and matter encompasses ordinary reality. Apparently this opening does not disappear completely after the experience. It appears , as Kenneth RING so aptly says, that a seed has been planted, free to germinate or not with time.

A few quotations will illustrate this concept: "my sensibility increased, sometimes I had premonitory dreams and often telepathic powers. I decide to call my mother or my daughter or else I think they will call me, and within five minutes I get a phone call. After this experience I left my body several times"."An acuter sensibility, telepathic powers, and ability to leave one's body as well as healing powers and the ability to help others". "Sensibility is greater, I learn quicker, I can concentrate better, I have a better memory and psychic gifts, but most important, I strike to incarn myself by trying to decrease OBEs. It is in and through the body that the experience of life is centered and nowhere else."

By loosening the ties between consciousness and body, NDE seem to be at the origin of many OBEs; in one instance a man who became bedridden after a serious accident (and a core NDE) experienced OBEs nearly every night. During these experiences, he had the sensation of complete identification with anything he fixed his attention on (by observing a tree, he became the tree, its leaves, its roots, he could feel the bird's nests in his branches..). Another left his body at night, during conscious sleep, an experience which enabled him to help diying people leave their bodies without fear.

These abilities are sometimes a burden, as it appears that precognition phenomena often involve highly emotionally charged events. The future is not always bright, and even if , for them, death is only the discarding of a worn out body, some would willingly do without foreseeing the death of close friends and family: "I quickly discovered in the month that followed my experience that I knew how long people had left to live .. Believe me, it's a very uncomfortable realization.."

There is another brighter, more common aspect: many discovered they had the power to help and heal others (altruism and compassion are leitmotivs in the testimonies)."I develop more and more my capacity as a healing channel, divine energy uses me as its channel". The techniques used are varied (laying on of hands, feeling of acting upon the subtle body, chamanic techniques and "wild" but effective psychotherapy, accompanying of the dying, etc..).

Many NDErs describe synchronicities after their experience (Jung defines the concept: "synchronicity means first of all, the simultaneity of a particular psychic state with one or several external events which appear to be parallel elements significant in relation to the subjective state of the moment and -possibly- vice-versa").

Whoever has studied mystic tradition will recognize many characteristics of transcendental experiences and their after effects, wether oriental and western, today or a thousand years ago.

Similar features are decribed in all mystic traditions (Tao, yoga, zen, sufism, gnosticism, chamanism, hesychasm, !Kung, etc..) and even outside of these traditions (university survey: 30 to 40% of students had at least one spontaneous OBE, some of which are very similar to NDEs).

We shall see now one of them which has particularly well described this awakening to a higher consciousness and the techniques employed to reach it.

In Hinduism exists a "force", an "evolutive power", symbolized by a snake coiled around the base of the spine, called Kundalini. Its awakening and ascension of the spine open up "centers" called chakras (they are between 6 or 7 along the bodie's axis). When it reaches the last and highest chakra at the top of the skull, it awakens consciousness to a superior reality. (Jung is again a forerunner, as he organized in 1932 a seminar on Kundalini!).

According to Lilian Silburn (29):"Kundalini, this vertical axis set up in the center of the individual and the universe, is the origin of man's power from which it drains and develops all energy. Rather than stressing the extraordinary powers it creates, its followers(...) draw attention to the peace and living harmony it confers. The mysterious energy awakened by Kundalini yoga can be of an extreme violence and cannot be manipulated without incuring danger."

For Tara Michael (19): "when Kundalini sleeps in the Muladhara (the first and lowest chakra center), man awakes to the world. But when it awakes and unites with Siva, man falls aslept to the world and becomes one with the infinite consciousness beyond matter."

It's easy to compare this peace described by Lilian Silburn and accounts of NDEs. This so called infinite consciousness is also a frequently reported sensation. Long term changes which affects those who have experienced NDEs are precisely the changes found in yoga, and the Siddhis (powers) that this awakening is supposed to confer (and in opposition to which exists many warnings) are precisely what many witnesses experience spontaneously, i.e. transcendence of time (precognition), space (telepathy, clairvoyance, OBEs) and matter (healing powers). Some experiences are physically and psychically disturbing.

The comparison between NDE and the kundalini awakening concept has already been described by Kenneth Ring in a fascinating book (27).

One of the characteristics of this phenomenon is that it is accompanied by many and various (physical, psychological and sensorial) symptoms, which have been studied by Lee Sannella (28), Itzhak Bentov (1) , who advances an explanation, and Hiroshi Motoyama (21).. Yoga has coded these characteristics, but it is worth noting that the same side effects exist in a number of experiences linked to transcendantalism around the world. It appears to be a universal phenomenon, at the origin of a set of experiences that man has always strived to in order to transcend his condition.

In order to conceive an idea of this kind of experiences, here are two examples, amongst the best known:

Gopi Krishna, a hindu brahman who had received a western education was in no way a mystic. His only tie with hinduism was regular meditation. One morning, while meditating on a bright lotus on his head, he perceived a strange but pleasant sensation at the base of the spine, which fluctuated according to the intensity of his attention. Concentrating again with determination, the sensation was renewed and it moved upwards. "Suddenly, with a roaring like a torrent, I felt a flow of liquid light invading my brain and spine. The illumination became brighter, the roaring louder. I felt an oscillating sensation, I was shaken and all of a sudden I felt myself slipping out of my body, completely surrounded by a halo of light, simultaneously conscious and omnipresent, bathed in light and in a state of exaltation impossible to describe." It was only the beginning of an experience which was to last years, moments of exaltation alternating with periods of doubt and depression.

A japanese scientist, Hiroshi Motoyama, relates what he experienced over a period of several months after practising pranayama yoga (breathing techniques). "...During continued practice, I began to notice some new sensations. I had an itchy feeling at the coccyx, a tingling feeling on the forehead and at the top of the head, and a feverish sensation in the lower abdomen. I could hear a sound something like the buzzing of bees around the coccyx. In ordinary life my sense of smell became so sensitive that I could not endure offensive odors."

"...These conditions continued for two or three months. One day, when I was meditating before the altar as usual, I felt particularly feverish in the lower abdomen and saw there a round blackish-red light like a ball of fire about to explode in the midst of a white vapor. Suddenly an incredible power rushed through my spine to the top of the head and, though it lasted only a second or two, my body levitated off the floor a few centimeters. I was terrified. My whole body was burning, and a severe headache prevented me from doing anything all day."

A few months later he started to have premonitory dreams, frequent ESP experiences (telepathy). His wishes seemed to be spontaneously fulfilled. Clairvoyance phenomena developed with the progressive awakening of the different chakras. Sometimes after, .. " I saw a kind of heat energy rising from my coccyx to my heart through the spine .(..) As the kundalini rose from my heart to the top of my head, I began shining white. I left my body through the top of my head and I rose with it into a much higher dimension". He acquired then a healing power. At the same time profound psychic changes took place, and he lost attachment to material things. The awakening of another chakra (Vissudha chakra, situated at the throat level) gave him the ability to see the past, the present and the future in the same dimension.

Similar concepts may be found in other traditions, implying the existence of a universal phenomenon:

In the Egyptian Book of the Dead we can find "a symbol of the vital fluid, of the fire snake in the spine. That fluid is the breath of life that the priest passes on by lying his hands on the deceased's nape of the neck to warm and cover him with Isis's heat". The snake in that tradition is the symbol of eternity and reincarnation and is supposed to help in acquiring magic powers.

For the chinese Taoists "Energy does not only flow in meridians: it also concentrates in certain areas linked by forces: the three "Fields of Cinnabar". The upper Cinnabar Field originates from the strange point Inn Trang (between the eyebrows)... The middle Cinnabar Field, or "Vermillion Palace", is situated on the chest with the heart as a center.. It circulates energies. The lower Cinnabar Field-the third energy center-(...) is two inches above the navel. The control of one's breath may allow the transmutation of mental energy into a golden elixir dripping the median canal to mix into ancestral energy and Ki. In a burst of sparks, the substance created by the fusion of the Ki, ancestral energy and mental energy, flowing up through the central canal to the upper crucible, bursts the universal orbit of Tao into a gold, silver, sun and moon blossoming.

Richard Katz, an anthropologist, has studied (12) the !Kung, a tribe living in the Kalahari desert. (! and / correspond to particular phonemes in their language). This tribe has a rite which seems to have a lot of common points with what has just been written: its aim is to wake up and set the "N/um" ablaze in order to reach a state called !Kia, in

which extraordinary possibilities appear, such as healing powers, remote viewing, walking on fire, etc..

The N/um is said to lie in the pit of the stomach. Once started, it flows up from the base of the spine to the skull, allowing people to reach the state of !Kia: "In your backbone you feel a pointed something, and it works its way up. Then the base of your spine is tingling, tingling, tingling, tingling,.... and then it makes your thoughts nothing in your head".

How is this phenomenon produced?: "You dance, dance, dance, then N/um lifts you in your belly and lifts you in your back and then you start to shiver. N/um makes you tremble; it's hot. Your eyes are open but you don't look around; you hold your eyes still and look straight ahead. But when you get into !Kia, you're looking around because you see everything, because you see what's troubling everybody... Rapid shallow breathing, that's what draws N/um up... then N/Um enters every part of your body, right to the tip of your feet and even your hair.

Lee Sannella, a psychiatrist, is well known as a specialist of these phenomena. He has collected (28) a number of similar contemporary testimonies in a book. People who had gone through a NDE describe identical symptoms followed by identical consequences (see for example Barbara Harris's experience (10)and the study of her case by Kenneth Ring (27)).

I. Bentov and L. Sannella have collected the symptoms occurring in the duration of those experiences under the name of physio-kundalini. They can be classified under three headings:

-sensory symptoms: ticklings, vibrations or feeling of "energy" in a particular spot, flowing up along the spine then going down to the chest and abdomen, orgasmic sensations (purely sexual or spreading in the whole body, sudden pain stopping just as suddenly, sensation of cold or heat in different parts of the body), various sounds, internal light sometimes illuminating the body.

-motor symptoms: spontaneous movements of hands and body, involuntary contractions (anus, abdomen, throat), changes in breathing rhythm, sudden locking or paralysis of certain parts of the body.

-psychological symptoms: sudden joy or ecstasy, anxiety or depression, acceleration of thought, expansion of consciousness beyond bodily limits.

Now, to try and understand what may happen, here is a first clue: most of the techniques used seem to aim at disconnecting the consciousness of external stimuli and feelings, either in concentrating it on a point: meditation on an object, a concept, a sound, a posture.., or reciting a mantra, a prayer, or deep relaxation or contemplation (several spontaneous experiences occurred in laymen in the western world, while contemplating a landscape, the sea, etc..). But a common fund does exist which can be found nearly everywhere and which is the use of breathing with, from the very start, a capital explicit notion: the equation.

mind<=>breath

Here follow a few examples:

First, here is a Taoist text, "The secret of the Golden Flower" (15). To understand it, one must know two things:

-the same chinese ideogram has simultaneously the significations of "heart" and "mind".

-this ideogram is itself incorporated in the one that means "breathing".

..."breathing comes from mind/heart. What comes out of that mind/heart is breathing... Since mind and breathing are interdependant, the revolution of light must be united to a rhythm given to breathing."..." The great saints, who were aware of how mind/heart and breathing energy influenced each other, made up a simplified method to help later generations..."

In Hatayoga PradŒpika: "when breath is set into action, so is the spirit; when breathing stops, so does the mind.."

In Tibetan yoga (7):"..in consequence, that thing called mind -so difficult to control because of its normal incapacity to function outside the process of breathing which is the cause of the continuous impulses from one thought to another- takes control and gets free from that dependance on breathing"..With that comment:"The length of a thought is equal to that of a respiration...these exercises aim at trainingthe mind to work independantly from breathing and therefore being no longer influenced by the process of thinking. Concepts grow up in the mind because of stimuli. Those stimulimust be neutralized and the process of thought disappears, then the mind reaches a natural state."

In Vijnanabhairavatantra (29): "..when the outflowing of sensorial activities is stopped by the energy of breath which grows little by little.."

A praying technique, the Hesychasm, could be found used by the monks of Mount Athos (5). It consisted in controlling their breathing while repeating the words"Kyrie Eleison".

In the !Kung tradition.." Rapid shallow breathing, that's what draws N/um up"...

Numerous shamanistic (6) techniques are built up on breathing, and the same observation can be made with famous mediums who seem to have found thereby a mechanism making their feats easier : Eileen Garret, for instance (9) : "In order to be clairvoyant it is possible for me by breath, and by breath alone, to lift myself above the normal everyday being. The moment I make contact with those who seek my help, I really, with animal understanding, "sniff" their atmosphere. Therefore, I think much of my clairvoyance could be a "leftover" primitive race faculty. I do exactly as a dog does when he catches the scent of a rabbit. I seize it and hold onto it until I know a good many needed facts about the personality of the inquirer".

In every case, one must set a rhythm to one's breathing, either slowing it down, sometimes to apnea, or speeding it up. The states reached by those techniques range from a more or less complete trance to a complet loss of contact with reality, leading then to -according to tradition- a state which might in its turn lead to a transcendant experience.

In order to sort out the main characteristics, I propose, to start with, to put together all those experiences, similar in their main features, without classifying them according to the circumstances in which they take place.

We could call N.O.E. (Non Ordinary Experience), those experiences containing :

*- persistance of consciousness and memory
*- feeling of reality

combined with at least one of the following points :

-feeling of beatitude
-feeling of leaving one's body
-transcendance of time and/or space
-perception by unusual channels, different from ordinary senses
-perception with a different form:
* panoramic vision
* melting/identification with the watched object or phenomenon
* non verbal perception and comprehension
-checked access to a piece of information impossible to get by ordinary means and in the specific circumstances of the experience
-perception or participation in a transcendental event of a spiritual or mystical nature
-long term effects:
* restructuring, therapeutic or evolutive
* attainment of "psi" or healing abilities

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But let's stop there for now and let's consider some bases to reflect upon..

Organization of perceptions : (26,16)

Olfactory informations must be dealt with separately because they are processed differently from the others. Actually, they are directly sent to the olfactory cortex. Belonging anatomically to the limbic system which appeared in the phylogenesis before the neocortex, these areas have been driven to the center of the brain during evolution.The primary olfactory area is the pre-piriform cortex,the parahippocampal gyrus or entorhinal cortex is considered as the secondary olfactory area.

The visual, auditory and tactile informations, issued by sensorial organs, must first go through the thalamic relay, which is responsible for a reaction of orientation and the focusing of the attention on the field corresponding to"what is new" in the environment (allowing the automatic passage from a diffuse attention to a focused attention). Those informations are then sent to the specific cortex of each sensorial organ where they are analyzed and where the connection between both brain hemispheres is made. Once processed, those informations are sent to the associative areas where they are integrated and linked together. Once there, the perceptions are modulated on the affective and emotional level by projections to the limbic cortex level.

For the time being, we are facing a series of global but instantaneous representations of the external world. The "instantaneous" perceptive bundles must be linked together in time to be understood in a temporal context (passage from a spatial to a space/time perception). The influx from the associative areas are then sent, via the entorhinal cortex, to the hippocampus where a "working memory" stocks the preceding informations and links them to the newest ones. The informations are linked temporally (we pass from the instant to the present) then sent back to the neocortex. Therefore there is a circuit on that level which has retroactive loops which permanently reprocess all the perceptions. For A. Remond, the hippocampus is "the place of conscient perception in the present".

The piece of information, thus processed, is then sent back to the structures of the neocortex (temporo-parietal cortex and fronto-temporal cortex) where semantic and cognitive integrations are made.

LTP, hippocampal theta rhythm and basic behavior for survival: (32,33)

In order to explain learning and development in the brain, Donald Hebb propounded in 1949 that neuronal activity should modify synaptic connections, i.e. when a neuron stimules constantly or frequently another one, metabolic or structural modifications of one or both cells should strengthen their connections. This hypothesis was unverifiable at that time, but in 1966, Terje Lomo, inOslo, discovered the "long-term potentiation"(LTP), a long lasting enhancement of synaptic efficacy by which a neuron, if it is put to a particular combination of nerve influx, is durably and sometimes definitively modified. This phenomenon appears above all in the hippocampus (in mammals). This area seems to participate in the memorization as well as in the learning through LTP. A particular electrical activity (about 4-7 Hz) called theta rhythm is at least one of the factors in this phenomenon since it can activate the NMDA receptors which are the originator sites of LTP. That was proved (23) by the fact that short trains of high frequency pulses, applied to certain parts of the hippocampus, induced LTP if they were synchronous with the peak of theta rhythm, whereas they produced a decrease of synaptic efficacy if applied at the through.

In 1977, Jonathan Winson published a first article where he studied the fact that neuronal transmission on the hippocampal level depends on behavior (he compared slow wave sleep, rapid eye movement sleep and alert but non moving state).

The hippocampal theta rhythm is linked in mammals to relations to the environment which are essential for their survival, unlike the genetically programmed behaviors such as mating or feeding, during which it can't be observed. It appears in the hunting behavior of the cat, in the exploration behavior of the rat, and in the rabbit when it feels the presence of a predator. An important fact is that its peaks are synchronous with the physical manifestations of that behavior, i.e. breathing movements (sniffing), movement of the vibrissae (whiskers). It seems to have a synchronizing role on the processing of sensorial informations during those basic behaviors: for instance in the rat exploring its environment, olfactory messages and those coming from the vibrissae, together with the other sensorial informations, converge simultaneously through the entorhinal cortex to the hippocampus where they are processed in bunches cut every 200 ms by the theta rhythm. For J.Winson (32) "One may speculate that in animals such as the rat which make great use of the sense of smell it is important that all sensory information, touch sensations from the vibrissae, vision and hearing are coordinated with the cyclic inhalations of odors. In this way the entorhinal cortex, hippocampus and the rest of the limbic system can process all sensory input along with smell -an event is linked to its odor-".

In my own opinion -little qualified may I be to say so- it could also well be the equivalent or the complement, for the olfaction, of the thalamic orientation reaction which, as we have seen, only deals with the auditory, visual and tactile perceptions. Since the olfactory messages deal vital information for the lower mammals, the theta rhythm would be a sort of priority signal, the information arriving synchronically with the positive peaks being considered as vital and therefore processed and memorized in consequence..

The hippocampal theta rhythm can also be influenced by a labyrinthine stimulation (Costin and al.) : "In the awake, non stimulated animal (a rabbit), angular acceleration evoked a hippocampal theta rythm, expressing itself in synchronization and in an increase in amplitude.."

Theta and dreams:

The theta rhythm appears not only during the behaviors we have just seen. It appears as well during the REM sleep, in spite of the lack of movement or information seeking. For J. Winson, the neocortex-hippocampus circuit, being again submitted to theta rhythm, could durably reshape the memory (a clever experiment described in "Science"(33) seems to show it in the rat). Although that rhythm is difficult to show in primates, and in man particularly, Winson supposes that this phenomenon is ours as well and is responsible at least for part of our dreams.

NMDA receptors:

The NMDA receptors which are found in the membranes of the dendrites of the granule cells, of hippocampal CA1 neurons and in various areas in the neocortex, are so called because they bind an artificial aminoacid, the N Methyl D Aspartate, which allow their characterization. It is through their activation that LTP is produced. Their neurotransmitter is glutamate, which is an excitatory aminoacid. Permitting a quick transmission and processing of sensory influx, its properties are unfortunately counterbalanced by what is called excitotoxicity: if too much glutamate is produced (which occurs for example in anoxia) it becomes toxic and brings about the death of the neuron where it has been released.

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After this interlude, we shall see that various experiences, phenomenologically similar to NOEs, can be produced by pharmaceutic products or physiological disturbances:

Ketamine is a dissociative anesthetic. It reduces the activity in the neocortex and sub cortical structures and increases it in the limbic system and the reticular activating system: the patient is disconnected on the sensory level(and therefore of the pain stimuli) but not really asleep. Of course, the effects depend upon the route (IM or IV) and on the dose. Ketamine acts in particular on the neocortex, thalamus and hippocampus by blocking NMDA receptors. Depending on the given dose, consciousness and memory are kept up while sensory perceptions are progressively disconnected.

Its effects seem to turn into a good experimental model for the study of NOEs: An experiment(3) on two groups, one receiving 40 to 60 mg of ketamine IV, the other a mixture 50/50 of nitrous oxide and oxygen gave the following results:

-In the first group, composed of eleven patients who were given ketamine:

-10 experienced a sensation of floating in space.

-9 felt the "spirit" or mind rise from the body.

-4 saw coloured or white patterns with their eyes closed.

-3 were able to "look down" on their bodies lying on the trolley and note the exact time the "spirit" re-entered it, i.e a few moments after the return of light pinprick.

-1 subject "became" one of a pile of boxes.

-2 experienced the "mind" moving very rapidly in one direction through a vacuous space with a loss of time and light concepts.

-In the second, who received nitrous oxide and oxygen:

-10 experienced distorted body awareness.
-5 experienced a sensation of floating upwards.
-2 suffered from a sense of claustrophobia.
-2 became dizzy.
-4 noted changes in auditory perception.

The author (M. Collier) compares the description given by the patients under ketamine with what is collected in the experiments with sensory deprivation (Lilly-Shurley, Hebb).

Ketamine has been used in psychiatry (13) as a pharmaceutic abreactive agent (abreaction could be defined as a reaction of externalization through which a subject can freed himself of an affective repression).The doses used were infra-anesthetic, most of them between 0.4 and 0.6 mg/kg. The patients treated had various pathologies (anxiety, dissociative, phobic, obsessive compulsive, depressive reactions, etc..). The effect seems to have been a revival of memories, and particularly those of the events which induced the psychiatric troubles... Six months after the experiment , 91 patients were thought cured.

Here are some samples of what the patients reported :"Heavy burden of sin is gone now", "I was in a different world and with flash backs I was seeing vividly events which led to my illness","I was talking to the Holy Family", "I was walking everywhere and seeing everything", "I was walking on an infinite piece of land and my life was marching in front of my eyes", "I was flying and chasing my own life", etc...

In the 50s, L.T. Meduna (17) tried treating various neuropsychiatric troubles by giving a mixture of 70% oxygen and 30% carbon dioxide to volunteers. He thus induced experiences certain aspects of which (feeling of getting out of one's body, vision of a bright light, ineffability of the experience, etc..) are similar to what is lived through a NDE, but accompanied with great neurological troubles and unpleasant hallucinations.

Some experimental functional disturbances in the temporal lobes seem to be the source of interesting phenomena too. In the 50s, Wilder Penfield, a neuro-surgeon from Montreal, described the results of experiments in electrical stimulation of various zones of the temporal lobes during surgery for temporal epilepsy (25). The patients, who had not been put to sleep could describe their perceptions. The zones bringing the most interesting responses were locatedon the right and left upper and lateral faces of the temporal lobes. The phenomena described were motor responses, sensory or somatic illusions, feelings of vertigo, of leaving one's body, but also more complex phenomena such as remembering whole blocks of memories, sensations of d,j…-vu , hearing pieces of music, reviviscence of certain moments of one's life, etc. Let us quote an example taken from Penfield's article about the feeling of getting out of the body: The stimulation was set on a point located 2 cm along the superior surface of the temporal lobe, within the fissure of Sylvius, causing the patient to say "that bitter-sweet taste on my tongue!". The stimulation was then cut off and a generalized slow rythm of 4 hz appeared as an after-discharge on the electro-corticogram. At that very moment the patient exclaimed:" Oh God! I am leaving my body."When the electro-corticogram was back to normal, the feeling stopped.

Penfield then voiced this hypothesis: superficial stimulation of the temporal lobe can in fact act on a deeper zone with which it is directly linked and which is among other things in charge of stocking memories. Hippocampus was for him a good guess.

Since then, strong monosynaptic connections have been discovered between the temporal cortex and the limbic structures, particularly with the hippocampus.

An interesting hypothesis :

K.L.R. Jansen, a New-Zealander author, proposes (11) a hypothesis based on the fact that ketamine acts by blocking NMDA receptors, especially in the hippocampus, thus preventing the LTP, which would amount to close the access canal to sensory informations. The author supposes them to be replaced by memories coming up to the front stage.

The discovery of endogenous ligands for those very receptors was grist to his mill and his hypothese: those ligands (4) called alpha- and beta-endopsychosins could be released in anoxia in order to block the acces of the glutamate to the NMDA receptors and thus prevent the death of the target neuron by excitotoxicity. The result would then be similar to what occurs with ketamine and would thus explain, at least, the phenomenon of panoramic memory and life review which is found at the beggining of many a NDE.

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Before proceeding further a clarification is necessary. This research deals with the spiritual, which is beyond words and beyond any common experience. There is no question of comparing, or even to try and explain an area where the experiences are always of an intimate nature well beyond the human capacity of analysis and understanding. All we can do for the moment is to try and catch a tangible clue and pull just to see what will come next.

This clue may reside in the various factors which are at the origin of the experiences. If we could isolate a common neuro and psychophysiological substrate, it would perhaps be possible to carry on an objective research and not only a study based on speculation and phenomenology.

We have seen that according to J. Winson (33), REM sleep would be for man as well as for animals linked to a reprocessing of the information received while in a state of wakefulness and a reshapening of the memory by application of a theta rhythm to the hippocampus during sleep.

That rhythm, which in animals has been shown to be closely related in fequency and phase to breathing movements under certain circumstances, seems to be able to modulate information processing during awakeness as well as during sleep. Perturbances induced by pharmacological means or other (ketamine, hypercapnia, electrical stimuli) aimed at those very formations (and the hippocampus particularly) seem to have the capacity to induce similar effects.

To start with, that fact might give a convenient explanation to the cathartic effect which appears just as well with ketamine as in the modified states of consciousness induced by using various breathing techniques or other, as after a NDE.

Actually, assuming that one of the factors of a memory reorganization during sleep it the apparition of a theta rhythm applied to the neocortex-hippocampus circuit, an artificial theta rhythm induced by a particular breathing rhythm or movements implying a labyrinthine stimulation applied during wakefulness to this very circuit could, under certain circumstances, produce that very operation too. If another characteristic of REM

sleep, sensory and motor disconnection , is also produced, then every condition which seems to be at the base of a number of NOEs is present.

The hippocampus is an archaic structure of the brain, which used to have a capital role in the sense of smell.That role has passed on to the entorhinal area which receives and processes the interoceptive informations too, but the circuits which modulate its functioning may still exist in man. As it has already been written the influx issued by the primary and associative areas reach the hippocampus through the entorhinal cortex which, since it still has a direct link to the sense of smell, might have its functioning modulated by a particular breathing rhythm. If we take into account the hypothesis that the theta rhythm could be, in fact, on the olfactory level, the equivalent of the thalamic orientation reaction for the other senses, one can understand that a breathing rhythm changed on purpose might deceive certain circuits, and give priority to olfactory and interoceptive information, thus inhibiting the transmission of other sensory information (see the report of Hiroshi Motoyama who complains about an olfactory oversensitivity...) But we are not a particularly gifted species on the olfactory level and if, what is more, there is no particular smell to perceive, that could in fact, in most cases, focus our consciousness on... nothing!, and, therefore end by a sensory disconnection. Since most of the techniques used in the traditions we have written about above imply a mastering of one's breathing or a labyrinth stimulation (rotating for the dancing dervish, dancing for many a chamanic technique) that seems able as well to start outbursts of hippocampal theta rhythm, we think we may be right. In fact it is most probable that any voluntary change in the breathing rhythm will have more or less effect on the processing of information on the brain level.

A first hypothesis can be deduced from all that: NDEs are part of a large number of experiences that I have called NOE, and which all have the same starting point: a sensory disconnection. Since there is an emotional detachment (particularly in the NDE), there seems to be a disconnection of certain parts of the limbic system as well which corroborate that hypothesis. Apart from the sensory deprivation experiments where environment does not give any stimulus, all the mechanisms we have describe may deal with the data processing in the hippocampus and its related structures.

That disconnection, during the NDEs, might be due to the release of neuroprotective substances blocking the NMDA receptors (so supposes Jansen, but for him that explains only the life review), while the voluntary launching of similar experiences by breathing exercises could be due to a progressive blockage of the hippocampal transmission, allowed by the persistance of archaic ways of modulating the perceptions on that level.

That disruption may be identical in the "Fear Death Experiences", when a parallel can be drawn with the Stress Induced Antinociception (SIA), which consists in a lesser response to the pain stimuli in case of stress. It involves a disturbance of serotoninergic systems (2, 30). Insofar as afferent ways of the hippocampus are serotoninergic (Melvin Morse proposes on that case a hypothesis (20) dealing with the NDE), the analgesy in the SIA may be produced by a modulation on that level, which could sometimes be enough to start a complete disconnection, thus creating the conditions allowing an NDE-equivalent to happen.

In the experiments in hypercapnia, the increase of carbon dioxyde could be thought as the beginning of an anoxia, releasing in the same way neuroprotective substances, the carbon dioxyde being responsible for side effects producing distortion and the

unpleasant aspect of the perceptions, maybe through a hyperexcitability on the temporal lobe level.

For the experiments using ketamine: action roughly similar to that of the endopsychosins, inducing at least a flux of memories, and for a larger dose a more complete disconnection starting OBE, etc..

For the Penfield experiments: since the sensation induced by the stimulation of the temporal lobe was gustatory, an area of the entorhinal cortex (piriform lobe) may have been indirectly stimulated. The OBE described happened after the stimulation had stopped, while a phenomenon of synchronization around 4 Hz was in process, which can have disrupted the hippocampus by imitating a theta rhythm, unless the recorded rhythm was itself an hippocampal after discharge having diffused to the temporal lobe.

As for the experiences lived during pure meditation, the link between hippocampal and cortical theta rhythm, apart for the same frequency range, is not clear. However, the EEG recordings (31) of experienced yogis showed during meditation slow rhythms, first alpha then theta becoming more important. A study by Palmer (22), in 1979, showed that out of 20 subjects, the three who had the most lively OBEs had more than 30% theta waves in their EEG, implying at least a certain disconnection with their environment.

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It is therefore possible to find a pure neurophysiological link which could take into account the start of the NOEs, a link concerning essentially a key formation, the hippocampus. Can we go any further? the hypothesis I propose according to which the hippocampus could see its functioning altered by external factors seems, if not to explain, at least to allow the proposal of an interpretation to some of the collateral phenomena described in the tradition and confirmed by contemporary experiences.

In every relation of experiences of that kind, a host of various sensations already described under the name of physio-kundalini can be found. Although those phenomena occur in a mystic context, they do have a reality nevertheless for those who lived through them. The question is then: what do they reflect?

To analyze that, let's see a few premises:

The Kundalini awakening is said to allow an evolution, a transcendance from the ordinary human condition. It must then be correlated to actual changes, both physiological and psychological.

Some techniques like biofeedback (8) are known to be susceptible to cause lasting modifications in vegetative functions, thus normally out of control from pure will. The nervous system is malleable enough as to allow us to imagine that the way we function is not fixed or set rigidly by strict laws, but can be altered either unwillingly by the mechanism of adaptability, or more or less willingly through certain techniques.

If the physio-kundalini phenomena that occur sporadically seem to affect all the cerebral systems (in the tradition, they match a work in progress), in the course of the experience which represents the peak of these phenomena there seems to be an actual explosion, a saturation of all transmitting channels into synesthesia: "with a roaring (auditory)..., I felt (somesthesic) a flow of liquid (tactile) light (visual) invading my brain and spine. I felt an oscillating (equilibrium) sensation, I was shaken and all of a sudden I felt myself slipping out of my body..."

That seems to be a general excitation, perhaps an unusual phenomenon that each sense tries to express in its own way.

A superficial survey of these perceptions can of course lead to feel they are but pathological brain troubles. Some people presenting those symptoms have rather quickly been stamped and treated as psychotics. G.Krishna and L.Sannella both estimate that about 30 per cent of the patients labelled as psychotics or schizophrenics are in fact victims of a pathological "awakening". G.Krishna gives as examples the characters called Avahoots in India and Mastanas in Persia, which combine extraordinary gifts of clairvoyance, schizophrenia and maniaco-depressive psychosis at different stages. This is not the proper place to discuss the relationship between madness and transcendance (nevertheless it should be noted that whatever the system, it is all the more apt to evolve since it is far from its balancing point, and there is no reason for the brain to be an exception...), but it is remarkable that a psychosis is shown particularly by identity troubles and by the loss of estimating reality, which cannot be found in the previously quoted experiences. If some symptoms look like epilepsy on account of their location and unfolding, it can be said that a comitial fit always means there is cerebral pain, due to an irritating seat (traumatic, tumoral or vascular). When the seizure is general, it is a short dramatic event leading to a loss of consciousness as well as a post-critical amnesia. No such pathology has been found to explain those phenomena.

Every mystic tradition appears to try and integrate the lower levels of psyche through control of the behaviors, instincts, feelings and perceptions, and of the mind... This control may be functional as well as psychological, that is to say the working of the nervous system may change too, since the deepest and most archaic structures (limbic and reptilian brain) might be mastered and therefore integrated by higher structures. This seem to be the case if we consider the long-term changes found in NDErs (altruism and empathy, which are the most important, appeared (16) with the prefrontal cortex) and those who lived a transcendental experience, generally speaking.

The hippocampus is a central processing area where meet sensory and associative cortex, wich are tuned outwards, limbic system which is turned both inwards and outwards and helps the perceptions to get an emotional value, memory, and the prefrontal neocortex which makes us human... Any phenomenon dealing with its functioning is, therefore, liable to modify all that.

Many facts lead us to think that what we have just seen might well be precisely the reflection of changes in its functioning:

- the hippocampus is particularly rich in NMDA receptors, which can also be found in the thalamus and neocortex.
- those receptors are now known ("Pour la Science", nø186, p.18) to be one of the main factors of the synaptic regression which is at the heart of cerebral development and plasticity.(As its name doesn't explain, synaptic regression is not a degenerative phenomenon. In fact, just in the same way as in sculpture, the most you want to give details, the most you have to remove substance...)
- they are also the site of LTP which may alter, sometimes for ever, the neuronal status.
- LTP can be influenced, again through NMDA receptors, by both endogenous and exogenous factors, and probably by voluntary changes in breathing rhythm.
- whereas most parts of the brain have only brief periods of plasticity, generally during their development, at the very beginning of the life, the hippocampus retains this capacity at full length of the life.

Now, let us make a few speculations: in the yogic tradition, the techniques of meditation and visualisation concern all the senses: meditation or concentration on a sound, a posture, a symbol, a concept, on various parts of the body (particularly by visualizing the various chakras at their own level), on the circulation of an "energy" or "prana"(which is said to be the subtle part of breathing...), etc. They are used together with the techniques controlling the breathing rhythm, which are of prime importance in every tradition.

We have seen that the interoceptive influx, along with the olfactory informations get directly to the entorhinal cortex, and I propose the hypothesis that what I suppose to be a priority signal given by theta rhythm may concern them as well under certain circumstances. If it is true that certain breathing techniques could modify the processing of sensory informations in the hippocampus, we may suppose that the exteroceptive informations could be inhibited, whereas the interoceptive informations, travelling through another channel, could in some cases be transmitted in priority.

An enhanced perception of a normally unconscious inner phenomenon is a necessary and sufficient condition to create a feedback loop which will in turn allow to act upon this phenomenon, and increase or decrease it.

Physio-kundalini phenomena could well be the consequence of an increased perception of interoceptive information (normally unconscious) and, why not, of the functioning of certain parts of the nervous system which would be understood differently according to each sensory system.

We may suppose that the various techniques in concentrating and visualizing could be the start of a real feedback, thanks to and reinforced by the usage of breathing techniques, perhaps creating durable modifications in the functioning of certain parts of the nervous system, probably through the phenomena responsible for the neuronal plasticity, just like the LTP and synaptic reinforcement or regression.

Since hippocampus has centrifugal connections with hypothalamus and the other structures dealt with in the somatovisceral, emotional and endocrinal functions, we can then understand the possibility of actual changes among all those functions (according to some reports, those changes are not always really right nor very well borne).

Indeed, an elegant explanation is found to what is called mystic physiology ("chakras" with their various functions, "nadis" which are the communication and circulation channels of "energy", etc), which is more like a projection or corporal interpretation of a functioning than any anatomic reality...

The fact that in some animal species, the hippocampal theta rhythm is linked to the breathing frequency, is not of course evidence there is the same thing in a human being. However, the usage by most mystic traditions of rhythm and breathing frequency changes with the aim of creating altered states of consciousness is a recognized fact and the persistance of an archaic circuit allowing the modulation of perceptions and states of consciousness in man cannot be set aside as a possibility.

The hippocampus is at a crossroads between perceptions, memory and the consciousness of those. If all the phenomena we have just seen are liable, in a way or another, to influence its functioning, the relationship of consciousness with the outside world will then be modified.

That world is usually perceived through the sensory organs which are filters as well as captors and the image, perhaps really hazy, that we have is but the one they give us.

In fact we are functioning with a representation of the world and not in an absolutely objective reality, even if it is consensual.

The proposed hypotheses are concerning certain characteristics in the working of the brain which could allow a NOE and could possibly help in understanding some of their long-term effects but don't claim they can give an explanation to the experience itself. Unusual perceptions, incapacity or difficulty to tell the others about one's experience, deep changes in the space and time notions during NOEs let us think they are perceived outside the usual cortical tools of perception and cognition. In numerous cases, the forwarding of information supposedly unobtainable dismiss any hypothesis of hallucinations or purely neurological phenomena.

Concerning NDEs, the same experience may occur either in an unharmed brain (Fear Death Experiences) as well as in an anesthetized person with in addition a cardiac arrest, therefore with a combination of anoxia, hypercapnia, anesthetic chemicals and metabolic refuses intoxication. This fact heads to ask some questions, the first being: how can an experience be lived and memorized exactly in the same way in such different conditions ?...

The deeply spiritual aspect of these experiences eludes for the moment any objective research, but does exist. I hope I have shown it is possible to draw a bridge, however frail it may be, between science and transcendence, and that what concerns the latter can be thought up, without necessarily making one of the opposite mistakes of a scientistic reductionism or a blind mysticism, which may be but various images of the same lack of curiosity.

Dr. Jean-Pierre JOURDAN

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