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# Theory and physiology of meditation

## *Teoría y fisiología de la meditación*

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### *Summary*

*In Spain, meditation is generally considered to be one more relaxation method amongst many used in psychotherapy. Nevertheless, an extensive body of experimental findings affirms that meditation has cognitive, physiological and psychotherapeutic characteristics that clearly differentiate it from other relaxation methods insofar as its origin, generic and specific effects, forms and methods of application.*

*Meditation can produce distinctive effects on the nervous system, especially in the long run, thus providing opportunities for therapeutic use in clinical psychology. This 'clinical meditation' is the object of experimental investigation in biological psychology and is not to be confused with meditation as an exercise in mystic and religious disciplines.*

**Key words:** Meditation. Relaxation. Psychotherapy. Physiology.

### *Resumen*

*En España, generalmente se incluye la meditación entre las técnicas de relajación utilizadas en psicoterapia. Sin embargo, un cuerpo extenso de documentación experimental afirma que la meditación posee características cognitivas, fisiológicas y psicoterapéuticas propias, diferenciándose claramente de la relajación en cuanto a la procedencia, los efectos genéricos y específicos, las formas y los métodos de aplicación. La meditación puede producir efectos diferenciales en el sistema nervioso, sobre todo a largo plazo y, por tanto, ofrece posibilidades para aplicaciones terapéuticas en psicología clínica. Conviene distinguir esta "meditación clínica" que es objeto de investigación de la psicología biológica de la meditación, como ejercicio utilizado en diversas disciplinas místicas o religiosas.*

**Palabras clave:** Meditación. Relajación. Psicoterapia. Fisiología.

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## INTRODUCTION

Meditation is a technique, used in many cultural, religious and philosophical traditions and recently, in the Western world, in sports such as football training. In order to understand the concept, one must accept that meditation is not a relaxation technique, nor a method to achieve enlightenment or religious ecstasy, nor is it a form of training with which to obtain a greater tolerance of pain or suffering. Meditation may produce all of this, but its objective it is not. Although there is no consensus as to a definition of meditation, in order to offer a global description that may serve the reader as a starting point for the information this article will provide, let us accept that *meditation is a learned technique with which to change a state of being attentive to identified stimuli, to a state of unfocused attention*. We could also consider it a method to prevent repetitive thinking, or one of cognitive reorientation. One of the differences with popular relaxation techniques is that meditation is not about "control". It does not concern relaxing muscles at will, nor "sending a warm feeling" or concentrating oneself on noticing a group of muscles or a specific part of the body. Nevertheless, meditation may be used to obtain relaxation, just as any other method, serving to reach a state of calm.

Thus, the short term effects of meditation and relaxation may be similar in their consequences for the autonomous nervous system (ANS), as Gelhorn and Kiely's 1972 study confirms. It may produce a deceleration of physical parameters, therefore slowing the motor response, slowing breathing, reducing muscular tension, reducing heart rate, slowing gamma brain waves, and so on, although certain types of meditation may produce a different response (Peng et al.,1999). Nevertheless, many other neurophysiological effects of meditation have been registered that are not found, or are found in the opposite sense, in relaxation. Table 1 reflects only part of the, by now extensive, research on physiological effects of meditation as compared with the ones relaxation typically produces, and where noticeable differences were found, both short and long term.

Relaxation techniques make use of willpower (sometimes on the part of the patient and other times on the part of the therapist) and concentration in order to achieve peaceful harmony, the physiological effects of which can be measured and verified. When tension recedes, or distal temperature rises, we will have obtained relaxation.

Meditation also uses willpower not only to relax but to maintain alertness throughout the session and to train the concentration, not to relax but to "de-concentrate", that is, to lose all notion of content, of thinking, of oneself, without losing alertness or clarity of mind. Meditation, as research using the most sophisticated technical means demonstrates, increases several indicators of central nervous system activity instead of decreasing them as do relaxation techniques. There is an apparent contradiction in the co-existence of relaxing effects on the one hand and activating effects on the other, but the cited study of Ernst Gellhorn and William Kiely has already underlined that no habituation was observed in electroencephalogram (EEG) alpha waves during the meditative state, demonstrating that trophotropic dominance is compatible with total presence of mind. Moreover, a reduction of beta waves in the EEG is characteristic of relaxation. However, as we see in figure A, the EEG and electromyogram (EMG) registers of the spectral analysis done by Banquet, also in 1972, indicated that meditation combined the absence of muscular activity according to the EMG, with an increase of beta and theta activity, although a theta activity that differed from the one related to somnolence (Banquet, 1973; Banquet & Sailhan, 1974). In 2000 Lazar observed, with functional magnetic resonance imaging (fMRI), that meditation activated neuronal structures related to attention and to the control of the autonomous nervous system.

Relaxation techniques are useful for training to adequately respond to stressors, by controlling the negative effects stress provokes. Meditation produces training in responding to stressors by taking away their stressful character, but also has a direct influence on blood cortisol levels. Relaxation intends that the subject concentrates on relaxing. Meditation aims at the subject having complete consciousness without focus on any specific action or aspect, with which unwanted interferences in mental processing will be reduced.

## ROOTS AND FORMS OF MEDITATION

A fair part of what we nowadays understand to be mediation comes from techniques used in Buddhism. It is relevant to briefly review some aspects of meditation practice in order to avoid mistaken interpretations by readers who are not familiar with the technique. Nothing is more important in Buddhist tradition than mind and consciousness as primary objects of introspective investigation. Its first task is to refine attention and to balance the nervous system with which to make the mind properly functional, free from the negative influences of excitation and laxity. Attention is trained with a discipline called Samatha or Samadhi, meaning tranquility in the sense of absorbed concentration. This is not a religious or philosophical discipline but merely a "contemplative technique". The objects of Samatha are to develop both the stability and the intensity of attention. Usually this type of meditation commences by focusing on a specific mental image, such as a flower. Two mental faculties are required: mindfulness and introspection, of which mindfulness is first and foremost in terms of importance. Introspection does not observe the mind but polices the process and is a type of "quality control".

Samatha develops in nine stages. When commencing meditation, the attention is purposefully and without hesitation maintained on the object chosen, instead of being permitted to dwell freely wherever. One concentrates on the image, but usually the beginner loses attention almost immediately. William James already said: "No one can possibly attend continuously to an object that does not change" (James, 1950, I, p.420). The well-known work of Posner established that the initial and limited capacity of sustained attention lasts between one and three seconds (Posner, 1978). Even so, Buddhism maintains that this ability of sustained attention can be increased by cultivated insistence. It is not a matter of increasing strength or power of concentration, but of the motivation to remain with the chosen image. Therefore in the beginning attention is practiced in several sessions of fifteen minutes during the day, until it can be maintained on the same object up to a minute. In other words, from now and during one minute, the attention does not at all lose contact with the chosen mental image. However, the mind is still vulnerable to interference: peripheral noise or mental "monkey chatter". By reducing the number of daily sessions and increasing their duration one gets to the point where the intensity of attention varies but contact is not lost during the entire session. With the help of introspection one achieves complete mental quietness and reaches the singular attention where the mind can be focused on the chosen object with complete stability and clarity for hours on end. The ninth and last stage of Samatha is attained when a dramatic change comes over the mental state, characterized by a brief and not disagreeable sensation of heaviness or numbness on the top of the head, followed by experiences of physical and mental enjoyment, which disappear rapidly whilst leaving the attention firmly and tranquilly sustained on the object of meditation but gradually uncoupling from the same and leaving the person with an absence of objects in the mind, a sense of clarity and a sensation of understanding. This sensation is also described as "pure positive affect" (*mahasukha*; pure joy; pure consciousness; beauty; and so forth) and is independent of any discursive thinking or specific phenomenal content (Shear, 1999, Alexander et al., 1990).

I repeat that meditation is just a contemplative technique, without religious or philosophical aspects, although many religions and especially mystical schools use it in one form or another. The mystification of meditation has been ridiculed and criticized by Buddhism itself. One of its best known representatives in the Western world, Chögyam Trungpa, says: "We sit and meditate. Once we begin to realize that we are actually one-hundred-percent fools for doing such a thing, then we begin to see how the techniques function as a crutch… Meditation practice is not a matter of trying to produce a hypnotic state of mind or create a sense of restfulness (…). Instead, meditation should reflect a mentality of richness in the sense of using everything that occurs in the state of mind (…). Acknowledging restlessness, identifying with it, requires mindfulness, whereas providing a luscious meadow, a big space for the restless cow requires awareness or alertness. So

mindfulness and awareness always complement each other (…). In mindfulness practice there is no goal, no journey; you are just mindful of what is happening there. There is no promise of love and light or visions of any kind – no angels, no devils. Nothing happens: it is absolutely boring. Sometimes you feel silly. (…) Boredom is important because boredom is anti-credential (…) it increases the psychological sophistication of the practitioners. They begin to appreciate boredom and they develop their sophistication until the boredom begins to become cool boredom, like a mountain river. (…) Mountains never get tired of being mountains and waterfalls never get tired of being waterfalls. Because of their patience we begin to appreciate them.(…) It is a good feeling to be bored, constantly sitting and sitting.(…) We have to work hard at it." (Trungpa, 1988, pp.44-54).

There are alternative techniques within Buddhism which center from the beginning on non conceptual attention and mentally cut all thoughts of the past, future and present from the mind. The technique of "adjusting the mind to its natural state" was developed within the Buddhist Indo-Tibetan tradition. It is promoted by the Dalai Lama (1997) although it was already described in the eighth century by the philosopher Padma Sambhava, and comes with the warning that there is nothing with which to meditate and, without any modification or adulteration, the attention must simply and without hesitation be focused on its own natural state, its natural blandness, its own character as it is. One must have clarity and relax the mind in such a way that it is loose and free.

There are simpler meditation techniques that may produce quicker results. A good example is Benson and his Harvard team's Relaxation Response, which greatly condenses meditative practice (Benson, 1975). Another well known example is Transcendental Meditation (TM), a standardized contemplative method made popular in the 1960's by the Maharishi, who gained followers among known artists and musicians. TM does not require any "conversion" to Buddhism or similar philosophy. It is based upon the wish to enter in states of mind that help to find answers to essential questions, to better understand oneself, the world, life itself. One is taught to use a mantra[1], in this case a sound without an assigned significance, and to repeat it without effort until the mind is absorbed and the maelstrom of thought is silenced. The repeated mantra acts as a "resonance" which obliges the mind to relax and, maintaining alertness, to enter "profound levels" of interior consciousness. All one does is effortlessly think the mantra. The training is based on the simplicity of the technique and the importance of the absence of effort. The mantra in TM is personal: each person is assigned a lifelong mantra. This way it is meant to acquire a special relationship with the meditator and his particular experiences.

Understanding the descriptions of the experiences that are produced in a meditative state is often complicated by the use of unknown and untranslatable terms. For the desired scientific approach in English of the fascinating subject of consciousness it is necessary that we forego as much as possible the use of words in Sanskrit, Chinese, Japanese and other languages of cultures which differ substantially from the occidental culture, and that we try to capture as much as possible the significance of these more or less transcendental terms in operative and consensual definitions.

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[1]Mantra: invocation based upon a sound repeated many times. It may consist of just a vocalization such as "Oúmmm"; a single word such as "One" in the Relaxation Response; or have a text as in the Gayathri Mantra:

Om Bhur Bhuva Swaha
Tat Savitur Varenyam
Bhargo Devasya Dheemahi
Dhiyo Yo Nah Prachodayat

Mother who subsists as all three Kalas (Lapses of time: past, present and future), in all three Lokas (worlds or realms of experience), and all three Gunas (Universal Attributes: harmony, agitation and inertness), I pray to you to illuminate my intellect and dispel my ignorance, just as the splendorous sunlight dispels all darkness. I pray to you to make my intellect serene and bright.

## MEDITATION AND SCIENTIFIC RESEARCH

Consciousness is a subject for controlled scientific study, for which meditation has proven to be fundamental (Shear & Jevning, 1999). In view of the subjective character of the subject of study, some combination of objective and subjective approximations is necessary. Psychophysiological studies examine the correlations between mental tasks and phenomena on the one hand, and different types of brain images and other physiological measures on the other. But those studies suffer from a significant asymmetry. Although their objective side employs sophisticated scientific methodology capable of identifying and evaluating variables which are entirely outside of ordinary sensorial perception, their subjective side typically uses ordinary introspection and is thus able to identify ordinary internal phenomena such as sensorial perception, imagination and verbal thought. As a consequence, whilst the objective side of consciousness is supported by sophisticated scientific methodology, the subjective seems somewhat more Aristotelian and in need of new "first hand" systematic methodologies, that is, bridging techniques between introspection and physiological measurement, or between cognition and observable reply, with guarantees as to reliability and validity. This asymmetry is sought by integrating meditative procedures with modern objective scientific methodologies such as EEG, EMG, PET and FMRI. There are many studies on meditation, of which the references cited here are just a small sample and which confirm that the variety of meditative procedures are useful components for neurophysiology and psychology.

## OBJECTIVE: REDUCE INTERFERENCE

Asiatic meditation traditions (Vedanta, Yoga, Buddhism, Taoism, Zen, and so on) affirm that it is possible to learn how to transcend the surface of human consciousness and gain systematic experience of the matter, structure and dynamics of consciousness under every human experience. They say that the direction of attention should be "inverted" and changed from its habitual orientation towards the exterior (towards sensations, thoughts, perceptions, and interior objects) to consciousness itself. We usually consider sensations and thoughts to be "internal occurrences" as opposed to "external" consciousness of the physical world in general, a fundamental distinction for learning to distinguish the public physical reality from the private mental reality. But in meditation the notion "internal" is used in a much more radical way. Here, even being aware of one's most private and internal thoughts and sensations is still external for consciousness itself because they still appear in one's consciousness, before one's "mind's eye" so to speak, and therefore the "internal" meditation referred to implies a complete inversion of attention, away from thoughts and sensations and external objects and backwards and inwards to consciousness itself, a perception "without objects", a mental "Ganzfeld".

Of course these explanations carry serious conceptual problems. In the first place, it is not easy to understand how one can redirect attention outside of any thinking, perception and mental content whilst practicing what really is a procedure like meditation, which one must conceive and learn. In the second place, the experiences produced with this technique are supposedly completely un-imaginable; in effect, this absolute unreachable description is a recurrent theme in the literature on the matter. In the third place, doubts exist as to the possibility of extrapolating a general use from this type of experience, product of other cultures. As Jung warned, any serious attempt to integrate traditional meditation procedures and experiences into contemporary scientific studies on consciousness, must find a solution for these questions (Jung, 1943). But, in essence, there is nothing paradoxical in the notion of a procedure that could, in the first place, bring one's total attention to a single point, to then transcend this focus –out of tiredness, through relaxation or by maintained stimulation (sic)– thus causing a halt not only in conceptual attention but in all conceptual activity, demonstrating that it is possible to arrive at non-conceptual mental presence. Training of both attention and de-concentration produces better control of the constant interferences that are not cognitively controllable and of a visceral origin, and that make the mind a noisy place where thinking with

clarity is difficult as is distinguishing the essential from the casual.

## EXPERIMENTAL INVESTIGATION AND MEDITATION

A search in Pubmed with the term "meditation" produces some 2,500 references of publications in listed medical journals since the beginning of the 1970's. Also, a sizeable number of books have been published on the subject. Although many studies can be criticized as to the methodology used, others are of acceptable design. A review of the most relevant described results of the effects of meditation –in several formats– on health in general and some pathologies in particular, identified some 40 fields of possible influence (Andresen, 2000). See examples in Table 1.

**Table 1**
**Some effects attributed to meditation**

| Field of action | Results | Reference |
|---|---|---|
| 1. Blood pressure/heart rate | Reduction | Benson, Rosner & Marzetta, 1973; Taylor & Farquher, 1977 Hafner, 1982; Delmonte 1984b, Muskatel & Woolfolk, 1984 Lukoff et al., 1995; Wenneberg 1997 Barnes et al., 2001 Vyas y Dikshit, 2002 |
| 2. Blood pressure – compared to progressive relaxation | More reduction | Kinsman & Staudenmayer,1978 Warrenburg et al.,1980; Kamen, 1978; Schneider et al., 1995 |
| 3. Myocardial ischemia | Reduction | Zamarra et al., 1996 |
| 4. Cerebral blood flow | Increase | Jevning,Wilson et al.,1978 Jevning et al., 1996 |
| 5. Left forearm blood flow | Increase | Levander et al., 1972 |
| 6. Electrodermal response | Increase | Allison 1971; Elson e al., 1977; Janby 1977; Laurie 1977; Curtis & Wessberg, 1975 |
| 7. Changes autonomous nervous system | Yes | Orme-Johnson 1973 Orme-Johnson et al., 1977 Parker et al., 1978; Corby 1978 Lazar et al., 2000 |
| 8. Heart rate variability | Improvement | Sun et al., 1986 |
| 9. Arousal reduction | | Fenwick, 1983 |
| 10. Depression reduction | | Carlin & Lee, 1997 |
| 11. Promotion of rehabilitation | | Poulet, 1996 |
| 12. Improvement asthma | | Honsberger & Wilson, 1973; Wilson, 1975 Davis et al.1998; Manocha et al 2002 |
| 13. Stuttering improvement | | McIntyre & Silverman,1974 |

| | | |
|---|---|---|
| 14. Insomnia improvement | | Miskiman 1977 a,b;<br>Jacobs, Benson &<br>Friedman, 1993<br>Jacobs, Rosenberg<br>et al., 1993 |
| 15. Plasma prolactin and growth hormone | Increase | Jevning, Wilson &<br>Vanderlaan, 1978 |
| 16. Palliative care | Support | Cole, 1997 |
| 17. Cancer, convalescence | Support | Gross, 1994; Simon, 1999 |
| 18. Mourning processes | Support | Edwards, 1997 |
| 19. Psychological health | Improvement | Linden, 1971;<br>Hjelle, 1974;<br>Ferguson, 1980 (review) |
| 20. Anxiety reduction | | Girodo, 1974; Otis, 1974;<br>Daniels, 1975; Dillbeck,<br>1977; Puryear & Cayce,<br>1976; Lazar et al., 1977;<br>Schwartz et al.,1978,1984<br>Bahrke & Morgan, 1978<br>Boswell & Murray, 1979<br>Goleman et al., 1979<br>Lintel, 1980;<br>Delmonte, 1985<br>Eppley et al.,1989;<br>Sakairi,1992<br>Miller et al.,1995<br>Barnes et al., 2001 |
| 21. Fear of public speaking | Reduction | Kirsch & Henry, 1979 |
| 21. Fear of Magnetic Resonance Tests | Reduction | Thompson & Coppens,<br>1994; Lukins et al., 1997<br>Quirk et al.,1989 |
| 22. Dominant tendency | Reduction | Fehr, 1996 |
| 23. Inflammation | Reduction | Klemons, 1977 |
| 24. Physiologic variables of age | Improvement | Wallace et al., 1982 |
| 25. Effect of stress on immune system | Modification | Solberg et al.,1995 |
| 26. Chronic pain | Reduction | Kabat-Zinn, 1982, 1990<br>Kabat-Zinn et al,1985<br>Collura y Kabat-Zinn, 1997 |
| 27. Substance abuse | Reduction | Robins, 1969; Marzetta et<br>al., 1972; Wallace, 1972;<br>Shafii 1974, 1975<br>Lazar et al., 1977; Klajner<br>1984; Marlatt & Pagano,<br>984; Alexander, Robinson<br>& Rainforth 1994 |
| 28. Alcohol consumption | Reduction | Benson, 1974; Brautigam,<br>1977; Alexander, Robinson<br>& Rainforth 1994 |

| | | |
|---|---|---|
| 29. Tension, guiltiness, addiction | Reduction | Carrington 1977, 1978, 1979, 1984a,b, 1987 |
| 30. Violent deaths in communities | Reduction | Assimakis & Dillbeck, 1995 |
| 31. Retarded ejaculation | Improvement | Delmonte, 1984a |
| 32. Basal and medial cortisol | Reduction | Maclean et al., 1997<br>Michaels et al., 1979 |
| 33. Affect disorders | Relapse prevention | Austin, 1997<br>Johnson y White, 1971 |
| 34. Sympathetic nervous system | Activity reduction | Brown et al., 1984 a,b;<br>Delmonte, 1989 |
| 35. Metabolism | Changes | Wallace, todos; Benson, todos;<br>Fenwick et al.1977 |
| 36. Distal temperature | Increase up to 8,3º C. | Benson, 1982;<br>Benson et al., 1982 |

## OTHER MEDITATION-PHISIOLOGY CORRELATIONS

Apart from the effects reflected in Table 1, there are several significant special correlations that we shall comment on as follows.

### 1. Respiration

The extensive scientific research on meditation of the past 30 years started with the evaluation of some of the traditional revindications of specific physiologic correlates of the "pure consciousness experience". One persistent transcultural revindication, encountered in Yoga, Vedanta, Taoism, Zen and other texts, is that the experience is not only accompanied by a significant reduction of metabolic activity but also by the cessation of a normal respiratory activity of inhaling and exhaling. Early Zen meditation studies showed a decrease in the respiration rate and oxygen consumption (Sugi & Akutsu, 1968). Results obtained with TM led Austin to the conclusion that respiration is the most significant variable to study "meditation from the viewpoint of its basic physiologic mechanisms" (Austin, 1998, p.XX).

Contemporary studies reveal a significant correlation between periods of complete respiratory suspension and episodes of "pure consciousness" as informed by subjects that practiced TM techniques (Badawi et al., 1984). Some biochemical indicators of metabolic activity were significantly lowered to cellular, tissue and corporal levels during entire periods of meditation by experimented meditators. These studies also reflected a correlation between episodes of experiences of "pure consciousness" and physiologic parameters that differ from the ones mentioned or proposed by traditional literature, such as a commonly elevated inter-hemispheric EEG coherence (Travis y Wallace, 1997). This "respiration suspension" refers to episodes of a respiration with predominantly vertical pneumotachygraphic traces, signs of an in principle normal respiration, although slightly slower than normal, which is suddenly interrupted by a suspension of normal respiration with straight horizontal traces for periods of approximately half a minute (Farrow & Herbert, 1982). Thus, what is called suspension of respiration indicates here the absence of detectable normal inhalation and exhalation; nevertheless, the airflow does not stop completely but continues thanks to a fibrillation of the lungs with ordinarily undetectable low amplitude of 2-7 Hz, which can be registered by Fourier analysis. The neurophysiologist James Austin concluded that these studies with subjects that practice TM connect the transparent consciousness, free of thought, with two very different groups of physiologic evidence. The fact which impresses most is the suspension of the respiratory impulse which causes a relative hypoventilation (with "respiratory

arrests" with posterior non-compensating extra breathing). The second group of associated findings is more subtle and variable. It includes autonomous peripheral changes and tendencies towards an increased EEG coherence. Austin observed also that short moments, transparent and silently conscious like these, are not merely indicative of sleepiness before falling asleep. On the contrary, when we are sleepy, the signs are a superficial abdominal respiration, slow times of cognition and reaction, and flatter Alpha waves in our EEG (none of these characterize the experience referred to here). Neither can anyone voluntarily produce similar moments of mental clarity, whilst withholding respiration (Austin, 1998, p.97). The respiration studies with TM meditators could avoid certain specific methodological problems. The technique is standardized, memorized in a few hours, and does not imply attention to physiological processes. The result is an ample availability of adequate experimental subjects. In general, the studies performed with other types of meditation confirm the results reflected here (Vyas & Dikshit, 2002).

Another type of study, carried out with TM subjects, serves to better understand these results. Wallace (Wallace et al, 1971) noted a decrease in oxygen consumption ($O_2$) and in the elimination of carbon dioxide ($CO_2$) without a change in the respiration coefficient during meditation periods of thirty minutes. A decrease in oxygen consumption in the absence of a change in the breathing coefficient is a sign of having reached a state of relaxation without manipulation of the respiration. When more "long-term" meditators (at least 5 years of practice) became available, more sophisticated respiration studies were performed. For example, Farrow & Herbert (1982), report a 40-50% decrease in respiration as well as a high correlation of breathing suspensions with the subjective experience of "pure consciousness", referred to earlier. The same authors also compared breathing rates with ordinary relaxation with the eyes closed, and with TM meditation. They found significant slowing in respiration during TM and no significant changes during ordinary relaxation, results that were confirmed by Wolkove et al (1984).

## 2. Metabolism

The mentioned studies as to entire-body level are complemented with studies as to organ levels. Meditation produces changes, both increases and decreases, in the metabolism (Benson et al, 1990). Blood flow studies measured greater changes in the dependent values of respiration and $O_2$ consumption in organs and metabolism, than in the whole body. With diluted coloring and measures of radioactive separation of blood flow, a general relaxation of blood vessels was identified, as well as specific circulatory changes such as a reduced blood flow in liver and kidneys (Jevning et al., 1978 a). A later study by the same authors showed that a lot of the decrease in $O_2$ consumption of the whole body in meditation was due to a reduced metabolism of the skeletal muscles and also revealed a direct relaxation of individual tissues (Jevning et al., 1983a). Significant differences were found with the effects of common relaxation, for instance in a study that found an increase in blood flow of 15-20% in the frontal and occipital brain regions during meditation (Jevning et al., 1996). These studies on the level of the whole body and of the organs have been complemented with in-depth studies at tissue and cellular levels. One of these reports reveals the cessation of $CO_2$ generation by the skeletal muscle of the forearm (Wilson et al., 1987). The metabolism of red blood cells decreases, an effect that implies that during meditation circulating chemical compounds are produced which modulate cellular activity (Jevning et al., 1983b). A decrease was also seen in the thyroid stimulating hormone (TSH), another sign of a lesser metabolic excitation (Jevning et al., 1987). Plasma cortisol, an indicator of stress, decreased with long-term practice of meditation but not with short-term meditation and neither during ordinary relaxation (Jevning et al., 1978b).

## 3. Brain activity

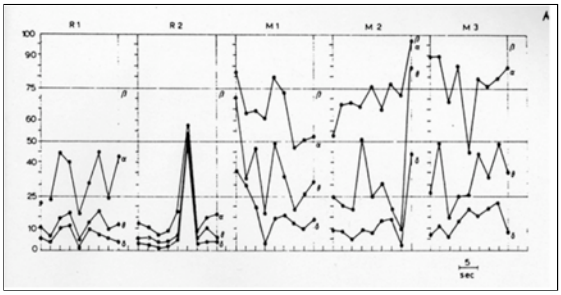
Although the majority of the mentioned physiological processes experience a decrease, the central nervous activity increases with meditation, as shown by EEG, the sensorimotor response, brain blood flow data and magnetic resonance images (Banquet & Sailhan, 1974; Jevning et al., 1987; Lang et al., 1979, Travis & Orme-Johnson 1990, Lazar et al., 2000) as well as by the subjective reports of "pure consciousness" as

a level of increased instead of decreased alertness (Jevning, 1988; Jevning et al., 1996), with which the meditative state distinguishes itself clearly from a state of relaxation or sleep. Effectively, the main part of the changes in hormonal and neurotransmitter concentration, cellular metabolism and in organs, and the respiratory function that accompany TM, differ from their levels during sleep or common relaxation. In a study of the effects of certain drugs with central activity (diazepam, naloxone and flumazenil) on the EEG during meditation, it was observed that the changes observed in the EEG during meditation were not causally related to the changes on account of the presence of endogenous opioids or substances similar to benzodiazepines, produced by the brain (Sim & Tsoi, 1992). Some measures, such as the respiration rate or EEG coherence, are directly correlated with self-informed experiences of "pure consciousness". Others are not sufficiently sensitive in time to be correlated with the episodes of "pure consciousness" as typically informed (of up to a minute, approximately) but still indicate that the meditative procedure generates a physiology that is characteristic at cellular, tissue, organ or entire body level. As a whole, these experimental data prove that both physiological and cognitive effects of a meditation technique are to be considered significantly distinguishable from the effects of relaxation techniques.

## CONCLUSION. CLINICAL USE OF MEDITATION

Experimental data indicate that meditation produces a relaxation of the body and a particular activation of the mind. Practicing this contemplative technique may reduce the levels of stress, more than habitual relaxation techniques. Moreover, it appears to be an efficient technique to control chaotic repetitive thinking –"monkey chatter"– so apt at diminishing both cognitive capacity and emotional balance. With meditation one can learn to not pay attention to these uncontrolled and noxious stimuli, and gain mental clarity but also –and probably more importantly– gain the confidence to be able to handle those interferences. Automatic thoughts, even when not negative by themselves but simply unsettling or un-coordinating, absorb much emotional energy and induce mood changes by giving a sensation of lack of control or even chaos, a sensation of being at the mercy of this invasion of "mental noise".

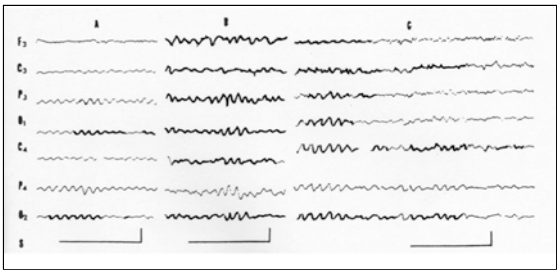
Apart from supplying us with specific data as to physiological characteristics of the human mind, studies on meditation indicate one or several base-lines of utility in psychiatry and clinical psychology, as well as in certain medical problems. They guide us towards new and non-pharmacological methods with which to promote fundamental changes in the unbalances that underlie those manifestations we clinically qualify as "disorders". Modern medication helps to control those symptoms and ever-more –specific psychotherapies improve basic problems but, on top of these, disciplines are needed to improve the relationship of a person with him– or herself. Ample experimental evidence shows that meditation is one such discipline and, thus, we may ask why its use is not more extended. Since 1996, the National Institute of Health of the United States recommends doctors to accept meditation as an efficacious treatment for chronic pain, anxiety, panic attacks, insomnia, premenstrual syndrome and infertility (Carlin & Lee, 1997). In Spain meditation may be labeled as something "mystic" or related to religions other than the Christian faith, therewith resulting in a limited acceptance of this non-religious and non-mystic technique that, moreover, has been practiced in Christian faith for hundreds of years. It is time to accept the evidence that meditation may be clinically useful in determined psychopathologies, as well as being an instrument for improving psychological health.




**Graph 1**

**EEG IN MEDITATION (J.P. BANQUET, 1973) GRAPH 1**

Plots of EEG amplitude integrals in 4 different frequency ranges: delta 0-3, theta 4-7, alpha 8-14, beta and rapid frequencies 15-50 c/sec. X= time in units of 2,5 seconds. Y= relative abundance of each frequency range in total percentage. Each line is an upper limit to the surface thereunder and moreover a lower limit to the surface above. The delta and beta ranges have a horizontal axis for exterior limits. The areas between lines (but not between lines and the X axis) represent the integration surfaces of each frequency range in proportion of its abundance. R1: Control subject in relaxation. The presence of alpha activity localizes him in the alpha plus group. R2: Control subject with hardly any alpha activity. The isolated delta peak in the middle of the figure is more an artifact or a movement than a somnolence period. M1: meditator in state of relaxation just before meditation. Note the superior quantity of alpha and theta compared to controls. M2: the same subject during the first phase of meditation. First the alpha range widens, then the slow activity increases dramatically and its beta range decreases. M3: the same subject after meditation in a period of concentration. There is an important remainder of alpha and a beta peak in the middle of the figure. The relative quantities of the different frequencies in meditators maintain certain stability during the changes from meditation to other states of consciousness.



**Graph 2**

**GRAPH 2**

A and B are the same recording at different moments of meditation. In B one can observe the increase in alpha amplitude in all channels and the appearance of alpha waves in F3. C represents the change from alpha to a disorganized pattern dominated by beta. The change is successively seen in F3, C3, and O1 at the left and later at the right.

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