

BIAS IN THE INVESTIGATION OF THE POST-COITAL PILL. FEMININE  
HORMONES IN THE MATURATION OF THE ADOLESCENT BRAIN.

## 1. Introduction

The emergency contraceptive pill or the day-after pill came out into the market in 2004 as an “emergency” solution for an undesired pregnancy after having had sexual intercourse without physical or pharmacological protection. The launching speech was striking, the doubts that the product generated were unravelled and the pill cleared its way with few restrictions: Age does not matter. Any fertile woman can consume it be she 30 or 12 years old. There is talk about it as a “form of contraception”, though one of immediacy, but not as an abortive method.

According to the leaflet, and the Health Ministry, the side effects are translated to gastrointestinal discomfort, and bleeding among others, but in general the product is “innocuous”.

The only requisite is to ask for a prescription. Guaranteeing in this way a “prudent” use of the product, really only for emergencies, and being subject to a prescription.

Five years later, in September 2009, the Spanish Health Ministry gave the green light to use this hormonal product. Any woman can dispose of the pill without a prescription, whenever she wants, and in the case of minors, without the parents’ permission. The pill doubled in sales that same year.

We are witnesses to an advocacy, very well orchestrated by the sexual liberation ideology and supported by strong economical interests, of the emergency pill. An advocacy that has achieved a very high intake in young people and in minors, but that has not contributed, however, in decreasing abortions or sexually transmitted diseases.

This Report is not directed to debate on the problems of conscience created for doctors or pharmacists who in the carrying out of the profession, are being legally obliged to prescribe the product, without the possibility of conducting the necessary medical history or of doing a follow-up on the user. They feel pressured by the law and the existing legal provisions that are in contradiction with the principles and values of such professions: rigour in the investigation and information, rationality, spirit of cooperation, sense of service, responsibility towards society, etc.

Here we try to contribute to the scientific knowledge that allows for truthful and complete information, without omitting data or relevant aspects on the actions of this brew. To this end, it is necessary to liberate truth from economical interests and the imposition of a political sexual partisan health model that is ideologized to an extreme.

It is precise to alert society on the bias of an investigation lacking rigour about whether the emergency pill is a contraceptive product (which impedes ovulation only because it acts before it occurs), or, on the contrary, it is also abortive since it has effects on the human embryo by obstructing its implantation in the uterus. The user, in the first place, has the right to know the answer, the reason for the assertions or contradictory negations in the name of scientific investigation, and to know what other effects that EC can have on her body and especially on her brain. The male who is part of the relationship also has a right to know. As well as do parents and educators in a special manner.

The neurosciences of the XXI century can shed some light, letting us know how our brain functions, on possible effects of EC in the development and maturation of the brain. The changes in the cyclical hormonal levels in the woman exercises a special function especially in a brain fully involved in reaching maturity such as the adolescent's is. Each person carves his own brain on the genetic base received and the hormone levels, depending on upbringing, experiences, personal decisions, etc. The brain is plastic and it is influenced by everything. That is why the consequences of EC consumed by very young people are worrying.

What guarantees are offered for health in the advocacy of a product where it is possible adverse effects on the brains of young users are silenced? What guarantees do the health and social policies that do not rule out the fact that with PDD human beings already conceived are being eliminated irresponsibly? How then something that is considered "an emergency" in itself has been turned into a habitual birth control method, due to the fact that some young girls have even used it several times in the same month?

Human nature gives us limits although we want to avoid them in an excessive eagerness to dominate life through biotechnology. It is precise to act in consequence retracting from imprudent decisions such as the one that permits, fosters or broadens the handing out of the day after pill without any other requisite than asking for it or buying it. The manipulation of the transmission of human life, so much so in its artificial reproduction dimension as in the contraception/abortion, is a priority and crucial realm where interests of profound human importance.

On the one hand, biotechnical absolutism imposes on us the choice between a technology that affirms what can be achieved can and should be done; and a technology oriented by human nature itself, that sets rational limits.

## **2. Interpretation of the results of how EC acts.**

José López Guzmán's article "Sesgos en la publicación sobre el mecanismo de acción de la píldora del día siguiente", published in issue 75 of Cuadernos de Bioética, emphasises, when it analyzes the publications about how PDS acts, that we are witnessing a great risk for the population's health. It is also a great gamble for the integrity of health care investigation, for using it without sufficient rigour and scientific data in order to achieve political, economical and ideological objectives.

So much so that the International Consortium for Emergency Contraception (ICEC) as well as the International Federation of Gynecology and Obstetrics (FIGO)<sup>1</sup> in 2008 issued a Declaration on EC, indicating strongly that it does not act in implantation. This text, coming from two scientific associations has been the benchmark and has had an enormous impact in the media.

In José López Guzmán's judgement this topic of special seriousness has to be evaluated much more; it is anti-scientific and not very honest the lack of vigour in taking from each study that what suits and is convenient and omitting what does not interest.

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<sup>1</sup> [www.cecinfo.org](http://www.cecinfo.org)

Definitely, “it can not be claimed that EC does not act impeding implantation” and contributes reasonably to the three following conclusions:

1 There is enough reason to sustain that the inhibition of ovulation is not the only mechanism of action of PDS. It will have to be elucidated that other mechanisms, and in what proportion, are activated so that EC can reach the degree of efficiency that it professes.

2. There is scientific evidence that EC acts, in some cases, and in certain days of the cycle, impeding or delaying ovulation. Nevertheless, there are many papers that prove that after the intake of EC there is ovulation.

There are reasons of common sense, supported by the statistical facts published, to not deny impeding ovulation is not the only effect, at least in many cases. On the one hand, taken on days when ovulation can not be impeded it still has an unexplainable effectiveness. On the other hand, if it did not have any other effect, effectiveness after 72 hours does not correspond with the lesser time, some 48 hours, in which the sperm remains in the women’s body with fertilizing capacity.

It is necessary to follow up on why it impedes ovulation, for which it would have to be demonstrated then that it only has an effect in the stage prior to ovulation.

3. And if it was true that PDS does not act after ovulation an act of bad praxis would be being committed on not informing in the uses that PDS is only effective the days before ovulation. That is to say that if all its effectiveness only depended on the pre-ovulation stage, to take it after ovulation would only be a placebo and it would not therefore explain the efficiency rate of this post-coital method.

### **3. Word Games**

A great part of the social and moral acceptance of EC depends on believing the statement that it has no effect on the human embryo. The supporters of PDD deny the possibility of its abortive effect, even without information, basing itself on a false definition of pregnancy and abortion.

The question is very easy. Abortion is legally defined as “voluntary interruption of pregnancy”. Pregnancy has always been the condition of a woman who has conceived a new human being when one of her ovules has been fertilised by a spermatozoid. This embryo, in its different stages of development: morula, blastocyst, etc., travels through the Fallopian tubes of its mother and nests in the uterus. Upon finishing this process, some 14 to 15 days later, it is fully implanted or dies.

What happens when the pregnancy is not produced in the woman but in the laboratory? The possibility of fertilizing in vitro and maintaining the embryo in culture changes its venue. Obviously if it is in the laboratory there is no woman pregnant of it. There will be pregnancy when the embryo is transferred and it is able to be nested. For this reason some call implantation pregnancy. Therefore, even with data to the contrary, they state that PDS is not abortive because since it avoids implantation “it does not voluntarily interrupt pregnancy”.

The anti-nesting action does not prevent that embryo forming itself and being alive, if there was fertilisation, the same as those that were generated *in vitro*. The fact that there are thousands of them that never will be implanted in a mother does not annul its condition of human embryo. No doubt exists either that life in each human being begins with the fertilisation of the gametes of its progenitors so much so if it is engendered naturally as if it is artificially generated *in vitro*.<sup>2</sup>

The pretension is to cover that in a natural pregnancy the PDS would have an abortive effect with any device that impedes the nesting of the embryo, either by modifying the receptivity of the endometrium, or because it hinders its passage through the tubes.

***Rejection of the conclusion that there is not enough data to deny the abortive effect of the day after pill is upheld by a false definition of pregnancy and abortion.***

#### **4. Conflict of interests v. Scientific Rigour**

The difficulty of clinically following up women who take the emergency pill, for being over the counter, is added on to the typical of these types of investigations: The results of animals to humans can not be extrapolated, nor the results unified because of the differences of samples and control studies. This problem would find solutions if it were investigated without prejudices joining forces in a team those who “wish” to defend its use and those that criticise it, as has been done in other cases.

But interests are very strong and they seem to cloud the subjectivity of the declarations of relevant associations such as the *International Consortium for Emergency Contraception* (ICEC) and the *International Federation of Gynecology and Obstetrics* (FIGO). Implicated in the promotion of contraception, including those of emergency, substitutes the conclusion “there are doubts that the mechanism of action should not also be anti-implantation” for “there is scientific certainty that it does not have such an effect”.

***A state of difficult definition of the “level of scientific certainty” and given that human lives are at stake, it is more than sufficient to withdraw a drug from the market. It does not happen with PDS because of interests not related to science.***

#### **5. Information and misleading advertising**

Of special seriousness are the activities of the Health, Social Policy and Equality Ministry of Spain that apart from imposing the sale without prescription, etc., disguises the Information which is not anything more than publicity besides being misleading.

In 2011, the Spanish Society of Contraception and the Chiesi España signed an official statement announcing *the start of the “Campaign of the Day Before Pill”* with the objective of “giving information and formation to the youth in sexual education so that they can deal with responsibility and without risks contributing in this way to decreasing unwanted pregnancies and sexually transmitted diseases”.

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<sup>2</sup> Cfr. El informe ACRE nº 1 <INICIO DE LA VIDA DE CADA SER HUMANO ¿QUÉ HACE HUMANO EL CUERPO HUMANO DEL HOMBRE?> Cuadernos de Bioética, 75, 2011.

They indicated that they were worried that “in Spain more than 100,000 unwanted pregnancies are produced” and in “a significant increase in the cases of sexually transmitted diseases among young people”.

The campaign of “the Day Before” would consist of distributing a box that contained a “fictitious pill” with a leaflet where all existing contraception methods would be taken into account.

The Medical College Organisation spoke up pointing out that information should differ from publicity and highlighting that surreptitious advertising harms the prestige of the medical and pharmaceutical profession.

1. The web of the firm Chiesi España states that its fundamental basis is to inform about emergency contraception and, consequently, promote the sale of their day-after-pill.
2. The advertising campaign on “the Day-after-Pill” boosts, by word association, the demand for it.
3. A doctor can not participate in promotional campaigns of medicines that are profit-seeking unless that be it their profession and that it is clearly known that they work for the pharmaceutical industry.
4. A scientific medical society does not act in the correct manner when it supports a campaign of a laboratory whose aim is to increase sales of the day-after-pill as is indicated in the aforementioned web; it would be punishable from Deontology if it was proven that a member of that Society or that said Society obtained economical benefits, without declaring them, as a result of the campaign.

In pharmacies the informative leaflet is massively distributed destined to the users of the “Day-after-Pill”, its content twists reality and denies the side effects and drawbacks of this drug. Misleading Advertising which incites its irresponsible consumption, with very negative effects on the users’ health, many of who are under-aged.

*When, as in this case, there is no certified scientific certainty, since it is not possible in this situation to obtain statistically significant data and adequate checks, the approach is ethics. Suffice that there is a reasonable doubt on the possibility that it has an anti-implantation effect to state in many cases that it has an abortive effect.*

## **6. Estrogens and the development of the female adolescent brain**

The brain is an extraordinarily flexible and plastic especially during infancy and in the adolescent stage that begins with puberty.

The architectural and functional structure of the brain depends in the first place on genetic endowment. Nevertheless, since foetal life is constantly influenced by hormonal actions and, throughout all of its life, is by the sensorial, emotional or cognitive exterior stimulus.

The neurons that constitute the circuits in diverse areas and that communicate them amongst themselves, have a great sensibility to sexual hormones so much so, that

towards those from the gonads (testicles and ovaries), which cyclically change their concentration in circulation, like those generated by the brain.

Estrogens control the menstrual cycle: without them a living being could not develop in the mother's womb. They make a woman a woman. Several cerebral areas, and not only those related to the reproductive ability have receptors for said hormones. The unions of estrogens to their specific receptors stimulate concrete actions that regulate diverse cognitive and affective functions.

Sexual hormones, apart from the neurons, have an effect on the glia cells- supporting cells of the nervous tissue-, and are related with the neuronal metabolism and its protection and defence. They have a neuro-protector effect that prevents the degeneration of the neurons.

In the period between puberty and maturity, adolescence, a cerebral maturation takes place that follows a natural developmental pattern of the nape to the forehead and bottom-up and that depends on the hormones. Cyclically in females, the hormones induce changes in the brain, in its structure and functions. The alteration of these hormonal levels can modify the natural pattern of maturity.

The article, "Estrógenos y desarrollo del cerebro femenino en la adolescencia. Anticoncepción de emergencia" ("Estrogens and the development of the female brain in adolescence. Emergency Contraception"), published in issue 75 of "Cuadernos de Bioética", gathers the data concerning the mechanisms of estrogen action in diverse areas of the female brain.

## 7. Puberty

Puberty initiates the transition from infancy to sexual maturity. It is characterised by corporal, psychological, affective and cognitive modifications that lead to the development of secondary sexual characteristics and the intellectual aptitudes and the behaviour needed to confront and unfold all its potentiality in the fertile stage of life.

These changes in the body are produced when certain cerebral factors are liberated that in turn activate the liberation of sexual hormones. These united to their receptors stimulate the mechanisms of cellular differentiation in the *target organs*.

This is how the first stage of puberty takes place, the maturation of the ovarian function: the hypothalamus sends a chemical substance (the LHRH) to the pituitary, which transmits two hormones called gonadotrophins to the ovaries, the luteinizing hormone (LH) and the follicle stimulating hormone (FSH). Continuing with the analogy of the *target*, the follicle stimulating hormone, which induces the liberation of estrogens, acts as an arrow and the target organ (where the hormone will exert its action) are the ovarian follicles. When the FSH unites with its receptor in the follicle its maturation is induced finalizing with ovulation and a subsequent menstruation. Around the ovulation period, the secretion of androgens reaches its highest level.

Estrogens and androgens are directly associated with the development of secondary sexual characteristics: mammary gland development and that of the external genitals

depend on the action of the estrogens, and also that of the pubic and axillary hair correspond to the action of androgens.

Many of the cycles after the first period, menstruation, are anovulatory and puberty finishes around 16 years of age without any predetermined moment having been established. Then the cycles are regular, with ovulation occurring habitually. Prior to ovulation the estrogens reach their highest peak, to decrease their concentration brusquely and to generate once again another peak to the beat of progesterone.

***In each cycle, the brain is literally invaded by elevated levels of estrogens and will experiment bursts of estrogen-progesterone that turn into repetitive monthly waves from the ovaries, waves that vary day by day and week to week.***

The estrogens modulate cognitive abilities, such as learning and memory, behaviour and affective life. They are all human capacities and which men and women process following different strategies to respond and reach the same actions. This difference in the processing is due to the specific genetic endowment of the pair of the sexual chromosomes XX, a chromosomal symmetry that in turn determines the structural symmetry of the feminine brain. Thus, some activities or capacities, like spatial orientation and the verbal fluidity, depends on the levels of estrogen in women and vary according to the cycle phase that they are in.

Indeed the ability of women for spatial orientation tasks, genuinely “masculine”, increases after menstruation when the level of the estrogens is minimum and the level of testosterone has increased. However, the performance worsens with the increase in estrogens. On the contrary, women have an advantage over men in verbal fluidity, an activity that requires the flow of information of one to the other cerebral hemisphere and that improves in them when the concentration of estrogens is high.

## **8. Female Brain Development Conducted by Hormones**

The human brain is constituted by three concentric layers connected in a precise and orderly way. A basal layer in the interior processes the visceral; another intermediate layer – the limbic system- processes the emotions and connects the other two between themselves. The cerebral cortex in the exterior, divided in four lobes and formed by two hemispheres, right and left, processes the greater functions, in clear linkage with the intermediate layer.

With the union of the cortex and the limbic system the affective and cognitive areas are joined, what is elaborated with one’s own life on what has been naturally received, consolidating in this way each person’s personality.

The development of the brain requires two types of phenomenon. One is the formation of cells-neurons-, their growth and localization of precise places and its maturation, following a genetically determined process and, thus, different according to gender. The other phenomenon is the formation and development of the connections between the neurons, forming neuronal circuits that conduct and process information. Experiences continuously remodel the connections between the neurons, on the basis of a natural inherited map inherent to women or to men.

Both processes-that entail an authentic sexual impregnation of the brain- begin during gestation and reach their peak in puberty, following a specific maturation pattern carried out by sexual hormones.

*Thus the global growth of the brain as the building-up of the diverse cortical zones reach their peak at puberty, and each one of the areas follow a maturation process specifically carried out by sexual hormones.*

## 9. Feminine Cerebral Strategies

The hormonal concentration also has a direct effect on female capacities and in the manner of processing the information.

The feminine brain has as a special peculiarity the symmetry of the distribution of the functional areas of both hemispheres. The bundles of nervous fibres that unite the left hemisphere-cognition- and the right -emotion- and constitute the denominated corpus collosum, are very robust and so the hemispheres interact among themselves with great intensity. In them the emotional and cognitive are always united.

The region of the temporal lobe that processes language is also the most extensive. However, the part of the parietal cortex of the right hemisphere implicated in the perception of space is smaller. Thus, statistically, males have more ability to resolve spatial problems and to orient themselves, and women have more verbal fluency.

Another characteristic is that the feminine brain cortex presents a pattern of very intense groves, that is to say they are say wider, in the temporal lobe where emotions are processed. The left hemisphere is more efficient in processing the warning signals and also the left frontal lobe the responses to emotions of fear and disgust. On the contrary, the left is more implicated in the control of motivation and rapprochement conduct.

The anterior cingulate cortex, that evaluates options and makes decisions and is the area that processes minor concerns, is very active.

In the feminine brain the left amygdale –that processes “negative” emotions –is more active than the right side. These areas are crucial in the social and emotional intelligence learning; and are implicated in the formation of the emotional memory. This explains the fact that women remember with more liveliness events, as well as being are more vulnerable to interpersonal conflict situations, and more susceptible to some psychiatric alterations such as depression anxiety disorders and eating disorders.

The hypothalamus-pituitary centres associated with sexuality have in the female brain a strong tie with the orbito-frontal cortex/amygdale, which means a high ability to handle reactions since the pre-frontal cortex controls emotions and restrains the processes of the brain amygdale.

Feminine strategies, therefore, allow for a higher participation of emotion –emotional intelligence-in the cognitive processes. The processing of information and the elaboration of the response, the strategies- the routes through the different areas implicated- are interconnected with strength in female brains.

The ability to “systematize” –more notably of the left hemisphere- and of “empathize”- more notably of the right hemisphere- are connected coherently in each person, although the centre of gravity of such balance is usually displaced, and innately, in males to the former and in women to the latter.

So, even if the female strategy supposes the integration between both parts, it suffers with the menstrual cycle a fluctuating movement of its centre of gravity by the action of hormones, which leads to changes in the intellectual skills. It is evidence of the effect of hormonal concentration in the abilities of women.

*A fact that allows us to comprehend the risk that it implies for an unstable brain such as the adolescent's in full acquisition of its anatomical and functional structure to mature, alters externally the levels of estrogens and the cyclical character of its usual changes of concentration, by ingesting the ECP.*

#### **10. Cerebral Maturation in adolescence/youth stage**

With the start of adolescence, with puberty, the biggest changes happen. The process of changing with age, with hormones and with the environment, modulates the structure of each person's brain. Life experiences, upbringing and behaviour play an essential role and have some positive and some negative effects.

Experiences change the gene expression of different proteins, hormones, receptors in brain cells, with which the activity of the skills finishes being “translated” to biological changes, and constituting, at the end of development, the basis of the mechanism of the brain itself and distinctive of each person. Some changes are permanent.

Several recent studies at micro and macroscopic level contribute knowledge to the pattern of architectural and functional development that follows a process in accordance with the chronological age and caused by the sexual hormones and their union with the specific receptors located in specific areas. In this way, the influx of estrogens becomes an activation signal of certain cerebral processes, which in turn, modifies the maturation rate.

This maturation rate goes from the nape to the forehead and from top to bottom. We know the temporal rhythm in which the diverse areas mature structurally and functionally. We know the pattern of connections between them, the neural circuits in action and the connections at the ultra structural level that form the matrix of the brain fibres.

The maturity rate consists in the conversion of grey matter to white matter. From the perinatal stage, neurons multiply and emit extensions searching for others with which to connect. Thereto the total brain volume and specifically the grey matter increases, in different areas and at different speeds.

Later on a pruning of the unused terminations by which the grey matter decreases and white matter begins to form, consistent in the coated axons of the myelin sheath and associated among themselves, that organized under the cortex, permits plenty of speed in the transmission of information. The myelin sheath that coats the neural extensions is

formed by cells, the oligodendrocytes, which roll up tightly around the axon and are charged with the proteins and lipids of a matrix. And finally it is gathered in fibres.

Thus adolescence is the stage of that reorganisation of the brain where the decisive structures are renewed: some areas grow, others are reduced and others are reorganised. Concurrently, the perfection of the cognitive skills, such as study skills, reading, memory, etc and of affective life occurs.

Hormones determine the speed at which that lobe reaches the different structures to exert its effects on them. Obviously, each hormone, released by the chronometer accentuated by puberty, finds its area of action in a state depending on the age, thus its action is modulated in a precise and controlled manner.

In 2011 it is at its inception the understanding of the atypical maturation patterns that favour the development of neuropsychiatric illnesses, depending on the moment that the maturation lobe is at and what areas are affected by that variation of the natural and precise sequence of the maturation is conducted by hormones.

### *10.1 The maturation lobe of the cerebral cortex*

It is known that the grey matter of the brain begins to mature since the beginning of infancy and the maturation lobe of the cerebral cortex reaches at a different speed to the different lobes.

The different regions of the cortex where the transformation appears are the parental lobes in charge of processing the motor system. Its maximum volume is reached at the age of ten years. This change is in perfect harmony with the change in the body proportions with the significant lengthening of the arms and legs. This sudden growth constitutes a challenge for the brain. This will have to adjust its cost by neuronal mapping to the changing somatic make-up that occurs until the age of fifteen.

After the areas that process the sensory stimuli mature, in the first place the visual cortex. Development continues in the temporal and frontal lobes responsible for the cognitive and emotional processes. The maximum volume is not reached until the age of sixteen or seventeen years. Then the adult stage of association is reached that integrates the primary functions and those of memory.

Finally, the prefrontal cortex implicated in the control of impulses, in judgment and in decision making, is the last of the cerebral areas to attain its definite structure and function, and only then, which sometimes may be delayed even up to the age of thirty, can it be stated that the brain has reached maturity.

### *10.2 The maturation of the limbic system*

In as much as how the cerebral cortex matures fundamentally in a linear manner from infancy to adulthood, the correlatives of motivation and emotion, the limbic system, has a changeable pattern of development according to experiences and hormone dependency. These modify the brain in different ways according to the age that the exposure occurs and they exert an important role in emotion processing, in personal knowledge and in relationships with others. These areas are activated during emotional-

cognitive tasks such as face or gesture recognition, the assessment of mental states-intentions, wishes and beliefs-feelings, willingness and actions of other people.

*Particularly, female hormones play an essential role in the consolidation of memories of one's own life that begin to form, at this stage of life, the autobiographical memory and to shape one's identity.*

### **11. The maturity of the strategies require a natural delicate instability**

Shaping the personality, attaining affective fullness and head and heart balance, requires a series of changes in the brain structures. Without this natural plasticity we would naturally be genetically and hormonally set in brain processes; and without the personal involvement of what is cognitive and emotional we would be due to our own history.

Diverse neuro-biological studies have shown that during puberty there is great emotional response and great influence of motivation on knowledge. In this period there exists a great temptation to pursue instant compensation. And precisely the ability to delay the reward in favour of long-term recompense is the key in the development of behaviour. This maturity, which is not mechanical, but depends on life experiences, upbringing and one's own decisions and life projects is the innermost self of a person.

The cognitive strategy has to go from an infantile mentality with “repetition of information” reasoning-based on gathered details of daily routine and the memorization of facts-to adult mentality. This second style of mature reasoning depending mainly on intuition allows to quickly enter into the heart of the matter to be able to make decisions on the basis of experience, stored memory, emotions and the perception of the world and upbringing. This mindset calls for cooperation between the analytical and emotional components of the human mind.

It is known that well into adolescence the maturity of the neuronal correlates that regulate emotions is not reached. Hence, the natural attractiveness towards risk behaviours giving more weight to benefits instead of to risks.

Multiple studies reveal that the areas of the limbic system, apart from the hypothalamus and the hippocampus, are shaped by the gonadal hormones.

This still poor cognitive control in adolescence coincides precisely at the time when the least level-headed decisions are made such as those dealing with premature sex and drug dependency. And such early atypical experiences have an impact on the normal efficient development of the functional circuits, leading to an equilibrium disorder in brain maturity.

### **12. Estrogens and memory**

Memory, one of the most notable aspects of human behaviour, is the ability to retain and store information of one's self, of the world that surrounds us and of others. It allows us to resolve everyday problems that we confront daily recalling various incidents simultaneously, tapping into our past, creating and imagining the future.

To memorize is to always create new connections between neurons or to increase the intensity of those connections, the synapses. Each cognizance and each experience establishes a pattern of activation on an existing network. Each neuronal network cooperates with others associating the diverse aspects of reminiscence in a dynamic form and goes through different structures of the brain.

Each activation profile of the synapses that reconfigures the network, contains information of the fact that we saw, heard, lived and knew. According to the subject matter, the network assumes a memory of perceptions, for example visual, of knowledge (semantic), events (episodic), feelings (emotional), spatial localization (cartography) of what happened. Memory settles itself in the same circuits that have processed the function of what has been dealt with.

Each of these activation patterns in the network, remains “lit” more or less during a small time span, are thus short term memories. Some memories will be lost when the lit ones are disconnected while others are consolidated and remain throughout life.

To store long-term it is necessary to change the anatomical configuration of the circuit by of the creation of new connections amongst the neurons, by means of the development of new endings in the hippocampus neurons.

In the hippocampus long-term memories are formed but they are not kept “forever”: a transfer of information to the centres of the cortex that stay connected among themselves with enough strength to attain a stable, explicit and conscious representation. Only after this process can they go on to form part of the past and participate in the construction of “I” and the memory of one's own life.

This consolidating process that puts together our own memories and creates the intellectual capital that we can dispose of and increment throughout all of our life, depends on the levels of estrogen in the brain and the amount of that hormone in circulation, coming from the ovaries.

In the hippocampus of females there is a great amount of receptors for estrogens; thus the consolidation of memories depends on the levels of these hormones. During adolescence there is a very active development of the hippocampus, which in girls increases in volume between the ages of four and eighteen.

The emotional memory is very active in women and is also dependent on sexual hormones. The consolidation of memories in the hippocampus is of great impact on emotions, which increase the amount of details memorized and the feeling of reality of a memory. In fact, emotional neutral memories are saved only a little. However, the positive ones resist better over time and participate intensely in the forming of the personality since we base ourselves on them to form our own identity, define the coherence of our decisions and aspirations. On the contrary, the emotional impact that traumatic events and disappointments have “fragment” the emotional memory. Sometimes, horrible memories persist and ruin life, such as what occurs in post traumatic stress, turmoil which affects people who directly suffered terrible shocks, especially in women. It has been observed that the hippocampus suffers a reduction in its volume, in that traumatic event, not by the creation of white substance but by the destruction of offshoots.

A lesion of this type of the hippocampus has been observed in adolescents that sporadically, either at the weekend or in celebrations, drink a great amount of alcohol- the culture of street drinking- and brings about serious neuro-psychological damage regarding memory and executive functions. The lack of memory is due to the decrease of activity in the hippocampus.

In conclusion, the make-up of emergency contraception-the morning after pill-with an elevated hormone dose, the lack of control in its dispensation and the lack of the young user being followed up, poses urgently the need for a profound knowledge about the effects that the disarray of the menstrual cycle, at a moment where the maturity of the brain is being strengthened, can bring about the design and the development of the brain circuits.

The great sensitivity to the concentration changes of sexual hormones, because of their high quantity of receptors for them, of the brain amygdale- that processes emotions- and the hippocampus- that consolidates memories- explains the labile nature of females to anxiety disorders and depression among others that have their origin in imbalances of brain maturation.

It therefore constitutes a primordial ethical duty, not only to inform of the mechanisms of action of a product -anovulatories and/or preventing implantation- but also of the possible risks for the psychological and psychiatric health of the woman, providing the known data concerning the influence of estrogens in the female brain.

**Available articles online with scientific bibliography of the topics dealt with:**

López Guzmán, J. “Sesgos en la publicación sobre el mecanismo de acción de la píldora del día siguiente”. *Cuadernos de Bioética*, 75 (2011) ([www.aebioetica.org](http://www.aebioetica.org))

López Moratalla, N., Errasti Alcalá, T., Santiago, E. “Estrógenos y desarrollo del cerebro femenino en la adolescencia. Anticoncepción de emergencia”. *Cuadernos de Bioética*, 75 (2011) ([www.aebiortica.org](http://www.aebiortica.org))

López Moratalla, N., “Neurobiología de la adolescencia. El control del circuito afectivo-cognitivo”. *Clínica y Analisis Grupal*, 1, (2011), 31-47 ([www.arvo.net](http://www.arvo.net))

**Available videos in [www.lossecretosdetucerebro.com](http://www.lossecretosdetucerebro.com):**

Cerebro adolescente, entre gustar y desaparecer.