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Evolutionary aspects of affective disorders, critical review and proposal of a new model

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Evolutionary psychopathology incorporates psychiatry into biology via theory of evolution, generating new etiological hypothesis for mental disorders. For evolutionary psychopathology emotions are a response system or a genetically programmed, specialized state of functioning, formed by natural selection, that allows us to adapt to the environment, increasing the ability to cope with threats and opportunities. Emotions exert their function by coordinated physiological, psychological and behavioral changes. Many functions have been suggested for low mood or depression, including communicating a need for help, signaling yielding in a hierarchy conflict, fostering disengagement for commitments to unreachable goals, regulating patterns of investment, parallelism with despair phase of separation from mother situation in monkeys, hibernation, etc.

Despite other evolutionary models, our model not only tries to explain depression but mania, hypomania and other affective disorders as well. For us, most affective disorders are pathological states (and not adaptive ones), due to dysfunction of an innate precipitating mechanism (IPM). IPM function is to regulate energy and activity levels according to intensity and duration of light (namely IPM-A). This IPM-A is responsible for vegetative, endocrine and behavioral responses that are present in humans and more ancient phylogenetic animals. More recently in the phylogeny, other mechanisms (IPM-AA) have coupled to this IPM-A. In the human being, the precipitating factors of IPM-AA are predominately social. IPM-AA add new responses (such as mood) to the older responses of IPM-A.

Key words:
Psychopathology. Evolution. Affective disorders. Mood.

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Aspectos evolucionistas de los trastornos afectivos, revisión clínica y propuesta de un nuevo modelo

La psicopatología evolucionista enfoca la psicopatología bajo el prisma de la teoría de la evolución, generando nuevas hipótesis etiológicas de los trastornos mentales. Para la psicopatología evolucionista las emociones son sistemas de respuesta o formas especiales de funcionamiento prefijados genéticamente, producto de la evolución, que nos permiten adaptarnos al ambiente, a sus amenazas y oportunidades y que ejercen su función mediante una serie de cambios coordinados a nivel fisiológico, cognitivo y conductual. Existen varios modelos evolucionistas que intentan explicar la función adaptativa de la depresión: reacción ante la pérdida de jerarquía en la lucha social, escenificación de la sumisión o rendición, forma de lograr el cambio de motivación al no lograr un objetivo, función de búsqueda de apoyo social, paralelismos con la fase de desesperación del experimento de separación de crías de monos de sus madres, hibernación, etc.

Nuestro modelo intenta explicar la depresión, los estados maníacos, hipomaníacos y otros estados afectivos. A nuestro juicio la mayoría de los trastornos afectivos son procesos patológicos (y no adaptativos) que surgen de un mecanismo desencadenante innato (MDI) que inicialmente sí es adaptativo, pero se ha alterado, y cuya función es regular el nivel de energía y actividad a partir de la intensidad y duración de luz (MDI-A). Este MDI-A desencadena respuestas vegetativas, endocrinas y conductuales presentes tanto en humanos como en animales filogenéticamente más antiguos. Más recientemente en la filogenia se han acoplado a este MDI-A otros mecanismos (MDI-AA). En el hombre los desencadenantes de los MDI-AA son de índole social y se han añadido nuevas respuestas (como el humor) a las respuestas más antiguas del MDI-A.

Palabras clave:
Psicopatología. Evolucionismo. Teoría de la evolución. Trastornos afectivos. Humor.

INTEREST OF EVOLUTIONISM FOR PSYCHIATRY

The theory of evolution has a dominant position among the rest of the laws and models of the biology branches. Paraphrasing the eminent evolutionist Thedosius Dobzhansky «nothing in biology makes sense but is under the prism of evolution.»

However, within the scope of psychopathology, psychiatry, and to a lesser degree than of psychology, a sufficient effort has not been made to up-date our laws, explanations and models. Thus, they are integrated within the theory of evolution. This effort is not a whimsical exercise. Our discipline has significant gaps. For example, there is no agreement on the etiology of most of the disorders beyond proposals as «multifactoriality,» or «interaction genes and setting.» What is worse, there is an abundance of theories with philosophic aspects (if not sociological or political ones) that divide psychiatrists into irreconcilable schools.

A reflection of these problems is our atheorical classifications oriented at the merely descriptive that describe, but do not define, and obviously require corrections having better etiological orientation. This approach generates problems of excessive comorbidity in the first place and to a lesser degree, creates problems of stability in diagnosis, lack of reliability, etc.

Our knowledge on the etiology of the disorders includes knowing what functions or mechanisms are being altered in each condition. Precisely, the evolutionary explanations, due to their phylogenetic approach, can help us to understand what has been altered more clearly than other theories focused on the alteration of ontogenic development. Thus, the evolutionary concept of the «ultimate cause» tries to explain why some traits were selected versus others (e.g., depression as defense mechanism) and thus why our species is more vulnerable to a certain disease. On the contrary, the evolutionary concept of the «proximate cause» includes the physiopathological and etiological explanations without evolutionary base (e.g. depression as genetic failure, problems of education or learning, etc.). Finally, «proximate explanation» refers to the biological character structure, its ontogeny and how it functions. A final explanation refers to the function of the character, its evolutive history and the explanation of its existence.

In the following, we will explain some basic concepts of the evolutionary theory. We will then review the evolutionary explanations of emotions and affective disease differently from that done up to now in our setting[1-3]. Finally, we will propose a new evolutionary model on affective disorders.

EVOLUTIONARY THEORIES

One evolutionary explanation involves seeking universal aspects on a study subject and giving an interpretation of their adaptive function from the evolution theory point of view.

Evolution is defined as the change in the genetic resources of a population over time. This process is achieved through two steps: creation of diversity and selection of the characteristics that best adapt to the setting because they increase survival and reproduction possibilities either of an individual (direct fitness or direct adaptation) or of those genetically related with (indirect fitness or indirect adaptation). The sum of direct and indirect adaptation receives the name of inclusive fitness.

Thus, following this theory, when we speak of a specific biological characteristic, an attempt must be made to explain why it has developed and been maintained over the evolution, that is, it must be explained how total adaptive capacity increases. This does not mean that all character has an adaptive function. Some are a product of chance, failures in ontogenic development, have a pleiotropic function, etc.

The application of the evolutionary theory to mental functions and to psychiatric disorders gives rise, respectively, to evolutionary psychology and psychopathology[4-9].

EVOLUTIONARY EXPLANATIONS OF EMOTIONS

Timbergen[10] defends that explanations must be made on several levels to explain an emotion (table 1).

Responses to questions «c» and «d» are purely evolutionary (explanations on ultimate aspects). However, to postulate

Table 1 **Levels of explanation of emotions from an evolutionary point of view according to Timbergen**

a) Give an explanation on proximate emotions that measure or regulate emotions physiologically or psychologically
   - Stimuli that precipitate emotion
   - Mechanisms that regulate emotion based on stimuli
   - Cognitive, physiological and psychological aspects of emotional state

b) Explain the ontogeny of the proximate mechanisms

c) Explain in an evolutionary way how the emotional response has been generated and how adaptation is increased, which would help explain
   - In what situations it is adaptive. That is, the associated opportunities and threats
   - The adaptive aspects on cognitive, physiological and behavioral level of emotions (facial expression, changes in motivation, in sensorial capacity, etc.)

d) Explain the phylogeny of emotion

them, data on proximate aspects must be considered. Furthermore, but to a lesser degree, obtaining answers to questions «a» and «b» may be oriented by evolutionary explanations.

Up to now, research in psychology, but above all in psychiatry, has been and is focused on proximate explanations (type «a» and «b»). This helps to explain why we still cannot respond to such questions as: how many basic emotions there are, if there is an opposite one for each emotion, which aspect is primary (cognitive, physiological, behavioral, etc.), what do emotions serve for (to change motivation, to communicate, etc.).

Evolutionary and etiological approaches to emotions have tried to answer these responses. From the evolutionary point of view, that contributed by Ekman (1982)[11], Emde and Goensbauer (1981)[12], Hamburg (1968)[13], Hinde (1972)[14], Konner (1982)[15], Öhman (1987)[16], Panksepp (1982)[17], Plutchick (1980)[18], Scott (1980)[19] must be stressed. From the etiological point of view, the most outstanding contributions are those of Eilb-Eibesfeldt (1980)[20], Gilbert (1989)[21] and Scott (1980)[15].

Thus, at present, the evolutionary point of view considers that emotions and the brain from which they come from have a function shaped by natural selection. Emotions are response systems or special forms of functioning that permit us to adapt to the environment, to its threats and opportunities, and that exercise their function by a series of changes coordinated on the physiological, cognitive and behavior level[22-29]. We would add that these response patterns, which are emotions, are genetically pre-programmed, although shaped by experience to this definition. The best test of their adaptive function is that those persons who have problems in their emotions (e.g., affective disorders, autism) are seriously incapacitated.

EVOLUTIONARY EXPLANATIONS OF THE DISEASES

Table 2 summarizes the evolutionary models commonly used to explain vulnerability to diseases, including mental ones.

Table 2 | **Evolutionary explanations of vulnerability to the disease**

What we think is a disease is really the product of:
- The functioning of a defense
- Adaptive fight with other agents that co-evolve as pathogens
- Maladaptation between our adaptations and new aspects of the environment for which we are not prepared
- Silent mutations that are only harmful in a new environment:
  - Design agreements on gene or trait level
  - Evolutive legacy that cannot modify the design
  - Random product affecting the genes and development process

REVIEW OF THE EVOLUTIONARY MODELS ON DEPRESSION

Classification of evolutionary models on depression

Following McGuire[30] and trying to make a classification of the evolutionary theories based on proximate and ultimate explanations, we could use this classification:

Models based on explanations on ultimate causes

Depression as adaptive character

Depression is an evolutive strategy to respond to a loss of objectives (negative cost benefit). Thus, there is a precipitating factor that is generally external. Its specificity may vary according to gender. Depressive condition informs on the situation of negative cost-benefit, psychological slow-down avoids behaviors that generate more costs, emotional expression informs others of the internal psychological situation. Natural selection supposes that it has favored the selection of those who know how to recognize the depressive condition of the other (coevolution). If the precipitating factor improves, depression may improve. In this model, it is assumed that capacity to process data and express behavioral signals are intact. This model explains moderate depressions precipitated by environment factors well. It is the model that has generated the most hypotheses and these are shown in greater detail further on in the critical review of the evolutionary models on depression.

Depression as a pleiotropic trait

A gene or groups of genes control the expression of several genotypes, so that the same genes permit the development of a pathological phenotype and others that are not only pathological but also very adaptive. Thus, these genes will not be eliminated in spite of generating disease. In the case of depression, for example, it would be somewhat linked to gender, as depression is more frequent in women. Thus, it is predicted that depression would have to be more frequent after the fertile period to avoid adverse selection. This model well explains the bipolar disorder (supposing that it is associated to creativity), postmenopausal depression and perhaps dysthymia.

Depression as a product of variability in trait expression

Interindividual variation of trait clusters and different efficacy of the different clusters essentially related with social exchange and sociability influence the likelihood of depression, its subtypes, intensity and course. There are limitations for the onset of the disorder as an expression of vulnerability. This model well explains chronic (including dysthymia) and refractory depressions.

Models based on explanations due to proximate causes

There is a failure in the ontogenic development of maturing programs. These generate depression directly or increased vulnerability to suffer it.

Models based on interaction between proximate-ultimate causes

It requires that an external event (proximate cause) involves the achievement of the objective (ultimate cause). The proximate causes explain how the episodes are precipitated and the ultimate ones how the persons persistently respond in a certain way. McGuire gives three examples: the model of loss of social status, that of failures to resolve conflicts, or response to loss. For us, the fact that an adaptive function in the past is no longer one at present because the setting has changed should also be included.

These models do not contradict the vulnerability-stress model. Thus, vulnerability would include from ultimate to proximate causes, and stress exclusively the proximate ones. In our opinion, interaction between proximate and ultimate causes is the pathway to choose. However we will propose other ultimate causes different from those which have been formulated up to now, which we review in the subsequent lines. We must warn that when evolutionary literature is read, the expression depression may well be changed to sadness, the same being true for mania and euphoria.

Critical review of evolutionary models on depression

Role of hierarchy

Several authors have defended the role of hierarchy in the regulation of mood[31-35].

Based on animal models, Price and his team[36-38] postulated that depression occurs in persons who do not want to give up in the fight for the hierarchy when faced with a more powerful adversary. When these persons finally give up (dramatize submission), this serves as a signal that one is no longer a threat. Then, the conflict ends and depression is resolved. Thus this theory makes it possible to provide a role in the fight of social hierarchy to the low or elevated mood state[30]. It is a known fact that many depressive episodes are precipitated by hierarchical competence and that they are resolved after reconciliation[31,39].

In our opinion, depression is also involved with the loss of hierarchy. However, we consider that the phases are different from those proposed by Price. For us, while the subject fights for the hierarchy, depression does not appear, but rather rage, irritability and anxiety regarding the future result. Depression appears when the negative result is already perceived. When submission is dramatized, depression is not resolved, but rather it appears in all its intensity. After some time, depression is resolved with the internal acceptance of the new status.

Submission is a reaction that is very similar to depression and it could be questioned if it is not its phylogenetic background. Thus, for us, following this model or mechanism of generation of depression, this is an adaptive response to loss of rank in hierarchy and considering oneself as a loser. That is, depression makes it possible to adapt to the new situation of acceptance of the role of subordinate and loss or resources. Thus, the loser is also prevented from suffering more harm by the winner in the hierarchical fight and stabilizes the group, since we are speaking about animals that need to live in the group they belong to. According to this theory, depression and mania are the two components that dramatize, confirm and indicate that one gives in (depression) or that one is victorious (mania) in social conflict situations. These subroutine calls rapidly resolve the social change with little disruption, avoiding more harm to the loser and preserving the winner's status. That the subroutine of giving up has been selected by evolution as a response that appears easier than mania could be explained by the fact that there are potential losers in the social conflicts. Mania and depressive disorder are conditions derived from an inappropriate activation of these mechanisms.

Unreachable goals

A more general situation that would include the situations mentioned of not being successful in the competence for the hierarchy is that of having unreachable goals. When success is not reached, low mood appears and produces malaise and lack of motivation. This may help either to rectify or to use a psychological mechanism of avoidance or can even lead to suicide[40-43].

Klinger is the author who has best explained the role of depression in loss of motivation to reach an unreachable objective[44,45], a position also defended by other authors such as Janoff-Bulman[46] and Brickman[47]. According to this theory, the process is: first an attempt is made to reach an objective. Second, if an obstacle is found, efforts increase and aggressive attitudes appear. Third, if the obstacle finally cannot be overcome, low mood appears and helps to abandon the unreachable objective.

This situation, which conceptually includes the previous one, nonetheless entails a difference mechanism on the phylogenetic level.

Control theory (cost benefit regulation)

A more cognitivist frame, that tries to include the previous explanations, is the control theory. This theory sug-

gests that when the objective is not reached at the rate expected, low mood appears. This tries to induce a change in motivation so that there is an orientation to alternative strategie[48-40]. There are many similar theories that stress the appearance of low mood when there is a disparity between achievements and expectations[31,51,52].

Other theories stress the role of low mood in predicting more realistic and systematic solutions on the cognitive level[53-55].

Nesse[56,57] proposes that the function of low mood is to regulate the use of strategies in which resources of the body are inverted, depending on changes in anticipated payments. Thus, in a favorable situation, the body wins if the risk level assumed and effort increase. In an unfavorable situation, the contrary is adequate. This idea of Nesse connects with the theory of foraging in animals: at a certain time, the search effort does not compensate the calories that would be obtained, so that it is best to quit[58,59].

Function of depression in communication request for help

Low mood and depression have also been considered as signals[60]. For Lewis[61], depression in adults is a request for help, a way of obtaining resources or at least making someone feel sorry for you. It is true that the capacity of making someone feel sorry for you may be beneficial in the short run, however if the situation becomes chronic, it produces rejection[62]. A similar phenomenon occurs in children with crying, which has been shaped by natural selection to request help[63,64]. However, that which does not seem so beneficial in children is to withdraw instead of asking for help[65]. For these authors, depression (we would say low mood) is adaptive, and if help does not arrive, depressive disorder occurs.

Attachment theory

A strong theoretical trend that tries to explain depression is that which does so based on the attachment theory. Bowlby and his followers consider depression, grief and mourning as a primary response to a threatened or loss attachment[66].

In humans, depression has also been interpreted as a phenomenon similar to the despair phase of an infant monkey when faced with a maternal loss situation described by Kaufman & Rosemblaum[67]. In this experience, a monkey is separated from its mother and, by order, there is a first phase of protest, followed by despair and finally a third phase of detachment.

James Robertson has collected data summarized by Bowlby[68] of responses similar to those of these monkeys in children between 15 and 30 months, left under custody in institutions. If this experience of attachments and ruptures is repeated with the substitute mothers, over time, the child does not want to establish affective attachments and only shows interest in obtaining material goods. Besides considering the similarities of depression with the despair phase in which the subject appears to accept the loss, Wenegrat[69] suggests that agitated depressions are similar to the primary phase of protest and the late ones to the second phase of despair. The despair phase in monkeys has also been called conservation-withdrawal phase to describe it better[70,71]. Thus, some authors suggest that there would be a conservation of resources in depression[72].

Conservation of resources

A phenomenon in the animal world in which this conservation of resources occurs is hibernation. Atypical subtype of major depression (this occurs more in the bipolar disorder and children) and seasonal affective disorder have some similarities with hibernation, such as the presence of hypersomnia, hyperphagia with weight gain, spontaneous remission with change of season, intense psychomotor inhibition. Most depressions (above all in bipolar disorder) tend to worsen in fall and spring, and the manic phases appear more in summer, also reminding us of the link between affective disorders and biological rhythms. Approximately 15 % of depressions are atypical, having symptoms contrary to typical ones, thus presenting psychomotor agitation instead of inhibition, insomnia instead of hypersomnia, anorexia instead of hyperphagia and weight loss instead of weight gain.

Risk clusters

McGuire et al.[5] consider the individuals as clusters of traits or semi-independent or independent characteristics, many of which vary independently among themselves and the persons. The persons differ in the degree of optimum functioning on the baseline of specific traits. Causes of depressions are presence of certain trait clusters that are influenced by many causes.

OUR MODEL

Our model is based on joining the vulnerability-stress model with evolutionary hypotheses and etology concepts. First we approach the problem of depressions. When it is resolved, the same model will serve to explain other affective disorders such as dysthymias, manic or hypomanic phases.

We consider that the evolutionary debate has made inadequate questions or that these have been too simplifying. In general, an attempt has been made to answer the question of whether depression is adaptive and what circumstances of our phylogenetic history were the mechanism that generates depression created for[26]. In fact, the question is not if depression is adaptive but rather «which de-

pressions are? and, what is more important, what is depression and what adaptive mechanisms does it depend on? These mechanisms are those that really require an evolutionary explanation.

When speaking of «mechanisms», we must clarify that we are speaking, in fact, of the so-called innate precipitating mechanisms (IPM) described by the etology[73]. These are genetically pre-programmed patterns of response that are activated when there are specific signal configurations. This concept is similar to that of «trigger mechanism» although the IPMs make reference to the specific case of neuronal receptors and neural networks having an innate origin (genetically pre-programmed) responsible for the processing of a certain type of information of the generation of a specific response. The fact that the IPMs are genetically pre-programmed does not mean that they appear from birth. For example: adolescence or programmed cell death appears at a certain age, but are genetically programmed. The development of some of these IPMs require certain environment stimulus at a certain age (imprinting concept). Its ontogenic development may be upset by pathological conditions. For these IPMs, a series of properties that may help to understand the pathology associated to them, have been described. These properties are defined by the concepts of decoy (minimum schematic configuration of stimuli that produce response), overstimulus (amplification of some characteristics of the configuration of stimuli that more easily precipitate the response), the possibility of confusion, error or deception (precipitate the response to an incorrect stimulus), generalization (generation of response due to configuration of stimuli that have similarities with the real configuration), change in sensitivity and specificity of the trigger mechanism, etc.[73].

The functions performed by the IPMs cannot be explained by learning alone. It must be remembered that these concepts cannot be explained by learning alone since this is facilitated for some stimuli, which shows the genetic base of the predisposition and that learning is a tool that tunes or puts out of tune the IPMs, but does not substitute them.

What depressions are adaptive from the evolutionary point of view?

Returning to the question made by evolutionary psychopathology, for us, the answer to whether depression is adaptive from the evolutionary point of view involves knowing if depression is precipitated by any change in the internal setting (cognitive) or external one (setting) to the individual. It is difficult for it to be an adaptive response if there is no change in the setting that must be adapted to. Obviously, in the latter case, we would be faced with a pathological phenomenon from the evolutionary point of view. The existence of these depressions without a precipitating factor and a clinical picture that cannot be distinguished most of the times from depressions with a precipitating factor is a test of the existence of a mechanism prepared to activate depressive response with changes in the cognitive, vegetative and motor level.

Discussion on the existence of depressive responses without cause leads us to have to accept that there may be a cause, but that we ignore it. This, being possible, cannot explain all the cases in which the cause is sought. In any event, the patient experiences the depressive reaction in these cases as an unexplainable reaction. It is more common that our questioning leads us to suspect that an accumulation of minor circumstances or minimum factors may have generated the depressive reaction. In these cases, it seems clear that the IPM that activates the depressive reaction has, at least, sensitivity failures (or low triggering threshold), since it is activated with minimum stimuli. This may be due to genetic cause and/or previous sensitizations.

The clinical experience not only makes it possible to check failures of trigger control due to excessive IMP sensitivity, but that this, as occurs in bipolar disorder, may generate the incorrect response (qualitative alteration). Thus, an adverse event may generate a paradoxical manic phase in bipolar patients, instead of depression which would be that expected[74]. Clinical experience also shows us how depression and manic phases are precipitated due to certain stimuli that can only be explained based on the generalization, decoy, and overstimulus phenomena, which once again speaks in favor of the existence of an IPM. Regarding the ontogenic development of IPM related with affective disorders, the epidemiological data suggest that when there is a subcortical base that activates the IPM due to certain basic stimuli (e.g., light) and that gives certain responses (vegetative, etc.), corticalization is necessary for the IPM to activate against different stimuli (e.g., social) and give added responses to the previous ones (e.g. sadness). Thus, there are examples of incomplete clinical pictures in childhood (as not all the IPM that require specific corticalization have developed) and in dementias or in the elderly (in which there is corticalization loss)[74].

Depression of bipolar, childhood and seasonal affective disorder as well as the manic phases are generally generated without cause or with minimum precipitating factors and have more genetic load in first degree family members. The depressive pictures are generally atypical (increase instead of decrease of intake, tiredness, heavy fatigue, etc.)[74]. The genetic load in these disorders may be related with vulnerability to IPM dysfunction or with vulnerability to generate situations which, in turn, alter this IPM.

However, both in these pictures as in the rest of depressions (typical, adaptive disorders, etc.), what we generally see is that there is a continuum among low mood, adaptive depressive disorder and major depression. This continuum is also valid for elevated mood, hypomania and mania[74]. These pictures generally have a restitutio ad integrum in symptoms[75]. However, if these symptoms repeat often, we see that sooner or later (the time depends on interaction

between genetic and setting load), at least the sensitivity of the IPM alters progressively (sometimes also its specificity as we have seen for the onset of some manic phases). Furthermore, major depression appears due to an event which would only have generated an adaptive disorders years before. The patients describe this situation as a «burn out» or «the effects of age».

Major depression not only appears after previous adaptive pictures. It may also appear directly without a significant precipitating factor. In any event, once there is a major depression (independently of whether there has been a background of another psychopathology or clinical pictures), the high recurrence rate and evolution to chronicity[74] indicates that after this picture, sensitivity of the triggering mechanism (IPM) of the depressive response alters significantly.

To complete this description, we could include the dysthymia picture. This can be both a precedent as well as a consequence of the major depressive disorder or successive adaptive pictures[74]. It appears that the mechanism that precipitates low mood in this picture is being triggered almost continuously with a limited response, in severity.

In summary, as in emotions and attachments, mood (high or low) is phylogenetically adaptive and is the product of an IPM prepared to produce this response. Adaptive disorders, hypomanic phases and some major depressions (those that appear due to obvious precipitating factors such as mourning reaction) are also adaptive (from the point of view of the DSM IV and phylogenetically). However, most typical or atypical major depressions and manic pictures are the product of an IPM that regulates mood, but that no longer functions correctly. This has also altered at least quantitatively (sensitivity) and sometimes qualitatively, either due to genetic alteration or, in most of the cases, due to successive sensitizations (table 3).

Therefore, we should focus our attention on the mechanism that regulates mood and we must analyze if it really only regulates mood.

Table 3 | **What depressions are adaptive from the evolutionary point of view?**

The following are adaptative
Adaptative disorders
Hypomanic phases
Some major depressions with obvious and severe precipitating factors such as mourning
The following are not adaptative
Most of typical or atypical depressions
Manic pictures

What does the mechanism that generates the depressive response consist in?

To answer this question, we must speak of the possible phylogeny of the mechanism. This task requires analyzing which are the precipitating factors of the affective disorders since these may be the ones in the evolutive history which have been the selective pressure that has generated the present emotions[26].

Nature of the IPM on which mood depends

The IPMs of animals are designed by evolution to adapt to night and day[73]. Within the IPMs prepared for daytime, we propose that there are very varied ones. For example, the function of some IPMs is to face specific dangers, activating responses such as escape, fighting or surrender. However, the function of other IPMs is to monitor the oscillations of more general functions such as activity level, motivation for action and therefore the inversion of energy. We call the mechanism that performs these general functions IPM-A.

Triggering of IPM-A depends on a calculation of opportunities versus threats-contrarieties (past and future). For such calculation, (depending on the animal), we can use from simple precipitating factors such as light intensity or the level of calorie intake to complicated ones, such as the result of certain cognitive processes. These precipitating factors activate, deactivate and regulate the motivation level for the IPM-A action. The IPM-A, by defect, tends to act on a moderate level and is accelerated, but above all stopped, by different precipitating factors.

In the case of humans, the tendency to psychological action is accompanied by a certain mood (moderate optimism). However, in our opinion, the final objective of IPM-A is not to generate good or bad mood. This is an epiphenomenona, one more response of the IPM-A. That is, mood and its changes are one more manifestation of a global response. This includes changes in the attention level, motivation, tendency to action, underevaluation of risk, optimism, endocrine and vegetative changes, etc. We are aware of the changes in the IPM-A by their psychological manifestations (mood) and this could lead us to believe that mood is the central response of this IPM. However, in this case, we could not explain its binding to similar mechanisms in other animals that show similar responses to ours to similar stimuli, but without the affective response. That which makes the IPM-A mechanism more complicated, at least in humans, is that the perception itself of the mood state and its changes in an initial moment are data entry for the next moment of IPM-A evaluation. Thus, there is a certain tendency to maintain the present state, an inertia of the system due to this positive feedback. Furthermore, good mood not only has the function of contributing information but also motivates to action due to its pleasant effects. Thus, we seek to provoke situations that have generated good mood in the past. This model that we propose for this IPM makes us consider that the IPM-A is altered in affective disorders.

Precipitating factors of the IPM-A

Focusing on the precipitating factors of low mood and therefore on the activity level, we see that these are varied. Furthermore, from the perspective of the human beings, it may seem that all are social. However, if we think in animals and in certain moments of the course of affective disorders, we see that one of the most important is the intensity and time of light associated to the seasonal changes. In fact, beginning with a certain time in the evolution of depressive or bipolar disorder, light is the only apparent precipitating fact for many patients[74]. The importance of light should not surprise us. Outside of the animals that always remain in a level of constant light such as half-light or permanent darkness, animals regulate their activity level according to light, and some physiological changes that occur in them remedy symptoms or even groups of symptoms of the affective disorders, going from hibernation with previous hyperphagia to the simple decrease or increase in energy level. We will find analogies to the connection between the IPMs we propose, light, affective disorders, in certain findings of the chronobiology that we will analyze later on.

It seems obvious that the mechanism that regulates the activity level based on light levels (IPMs) is more primitive than any one that we could propose. It is a plausible hypothesis that other mechanisms along evolution will couple with this primitive mechanism to modify the activity levels (motivation for action), adding new behavioral, cognitive, affective, and even vegetative responses. We will call them IMP coupled to IPM-A (IPM-AA).

The first selective pressures that generated the appearance of IPM-AA must have essentially been the need to satisfy basic biologic needs: obtaining food or resources, reproductive success, social dominance, etc. More recently in phylogeny, IMP-AAs that detect signals of social setting that indicate success or greater likelihood of success in the fulfillment of basic needs may have been added. An IPM-AA that stands out in some animals (including humans) is that of calculation on the perception of adaptation to the environment. Ratio of successes and failures up to a certain time greatly stand out in this calculation, although there are other data entries for this calculation, such as perception of previous mood state. In our opinion, some of these IMP-AA submechanisms coupled to the primitive one IMP-A depending on the light, may be some of those presented in the review of the evolutionary models to explain depressions in relationship with: hierarchy, request for help, hibernation, despair phase, etc. Many of the IPM-AAs stop the tendency to activity of IPM-A. Thus, due to the scarcity of food, some animals detain their activity. One example of this is that some animals stop foraging in the snow to look for grass just when the effort does not compensate the calories obtained. It is as if they calculate that the effort is not worth it (forage theory)[57-60]. As we have already mentioned, this mechanism of calculating opportunities versus threats to regulate activity level is important in the regulation of the activity level and thus may have an important role in depression in humans.

Some of the IPM-AA models associated to the appearance of affective disorders require some corticalization, as shown by ontogenic development (no appearance of complete or typical depression picture until a certain age) and loss of precipitating factors and reactions associated in dementia[74].

Those that are precipitated by social interactions among all the IPM-AAs stand out. Thus, it is not surprising that the social type responses are the most outstanding among the behavioral responses that these submechanisms have introduced (for example, in the case of depression: sad expressions or low tone of voice, depressed aspect, etc.). On the other hand, there has been a co-evolution in the individual receptors, so that humans are capable of detecting these signals that indicate mood change and generate an appropriate response (in the case of depression, an empathic response that gives rise to help).

The responses initially coupled to the primitive IPM-A are physiological, behavioral and psychological. Essentially: metabolic changes, regulation of hormone level, ultra- and circadian rhythms, subjective experiences of energy sensation, motivation, etc. Other responses related with the new IPM-AA were subsequently added, as sensation of guilt, anhedonia, low mood, etc.

In summary, from an evolutionary point of view (which also considers the phylogenetic development), it can be proposed that the mechanism that regulates mood and therefore that which fails in affective disorders (IPM-A) is among the most primitive (regulation of energy-activity level) and its precipitating factors also are primitive (light duration and intensity). Other submechanisms (IPM-AA) for different stimuli (social, etc.) that add new responses to the basic reaction of IPM-A have been coupled to this primitive mechanism in the phyogenetic development. Good examples of the coupled mechanisms may be those proposed in the review of the evolutionary models that we have previously made. The triggering direction of these mechanisms, as has already been commented on, is generally to stop the activity, which is the functioning by defect. However, the triggering direction may also be towards elevated mood. This explains that the same mechanism may generate depression or mania, but depressions with greater frequency. Considering the different expression of affective disorders in the elderly and children, the ontogenic development suggests that corticalization is necessary for the IPMs that we propose to respond to certain stimuli (above all, social) and also to give certain responses related with these precipitating factors (table 4).

Neurobiological data that support the relationship between IPM, light, biological rhythms and affective disorders

Some of the clinical and epidemiological data that support our model have been included or will be included dur-

Table 4 Our evolutionary model for affective disorders

- The mechanism that regulates mood and therefore that which fails in affective disorders belongs to the most primitive (regulation of energy-activity level) and its precipitating factors also do (light duration and intensity)
- Other submechanisms for different stimuli (social, etc.) that add new responses to the basic reaction of IPM, dependent on light, giving the present vegetative, cognitive and behavior responses
- The triggering direction of the IPM is generally stopping the activity which is the functioning by defect. However, it may also be towards elevated mood. Thus, it generates depressions more easily than manias
- The process of ontogenic development of IPM in the elderly and children suggests that corticalization is necessary to respond to certain stimuli (above all social) adequately

ing the text. However, the data that are given by chronobiology merit a special section due to its extension. Essentially, chronobiology has determined that the sleep amount and rhythm are not mere symptoms of depression, but rather inform on its the evolution and have a role in its pathogenesis[75,76]. Thus, sleep deprivation improves 60 % of the depressions and may precipitate manic phases[77]. Altering sleep onset time without altering its duration changes mood: changing sleep from 5 pm to 1 am may improve depression and precipitate mania, changing sleep to the morning may precipitate depression[78].

The main structure of the circadian system, the suprachiasmatic nucleus (SQN), is a multi-oscillator system formed by different elements that are generally coupled, generating a single rhythm[79] that desynchronize in pathological states. Most of the body tissues have *in vitro* circadian rhythmic activity[80]. There are at least eigth genes involved in negative and positive feedback mechanisms of the SQN[81,82] and their mutation may give rise to affective disorders[83]. The SQN has marked sexual dimorphism in humans[84,85] and receptors for sexual hormones[86].

Melatonin is secreted based on the day length[87]. In patients with seasonal affective disorder (SAD), secretion duration of melatonin in winter is greater (above all in men), that is, they generate a biological signal of season change[88].

Patients with SAD have a delay in the circadian rhythm phase regarding that of sleep-wakefulness[89,90]. The maximum of all the behavioral variables such as cognitive state, short term memory, coincides with that of the maximum temperature (18:00).

Circadian period of humans is a mean of 25 hours and is genetically determined. There are evening (very long) and morning (very short) chronotypes. The evening chronotype has a positive correlation with extroversion[91], the optimistic-pessimistic character[92] and in the study of adolescent analogues, with depressive character[93].

Alterations of circadian rhythms produce symptoms that recall the affective disorders: irritability, fatigue, apathy, dysphoria, psychosomatic disorders and appetite disorders[94]. The relationship of biological rhythms and depression has been under debate for 20 years and quite varied alterations of the circadian rhythms have been found: early onset of the REM phase, increase of corticol, mood deterioration in the morning[95], rhythm phase advances[96], failures in the homeostatic mechanism that regulates sleep according to previous waking hours[97], altered REM sleep[98]. All antidepressants, lithium and anxiolytics alter some circadian variable[99,101].

It is more likely that some of the IPMs that we propose are some of the components of the already discovered circadian rhythms. Our interest, however, has not been to demonstrate this specific fact, but rather to show its possibility and to state the relationships between the possible IPM involved, hypothesize about its phylogenetic history and the way they explain the clinical and epidemiological data.

The main point of support on the connection between chronobiology and affective disorders is the fact that the alterations of the rhythms act as precipitating factors and serve as therapy of affective disorders (depressive and manic).

Rare atypical depressions pose difficulties in their explanation. Perhaps some components of chronobiology understood as IPM may help us. Thus, we see that the seasonal affective syndrome more frequently has atypical depression symptoms and that its etiopathogeny is related with a phase delay, while non-seasonal depressions have typical symptoms and their etiopathogeny is related with phase advance. This makes us think about a same IPM that functions by defect, generating a response (that of typical depression). However in certain condition, it may have the opposite symptoms (atypical).

Another application of these data make it possible to propose that the greater prevalence of depression in women is explained by a sexual dymorphism similar to that present in the SCN in certain IPM.

Why is it easier for depression to appear than mania?

There are more adverse situations than positive ones in life. Thus, it is not surprising that ontogenic sensitization and phylogenetic adjustment produce greater facility for triggering of the depressive reaction.

It is frequent in the nervous system that the way in which the two systems are related is that one functions by defect

and the other acts as a break (frontal lobe as break of lower centers, putamen and caudate as break of pallidus, etc.). Thus, we think that it occurs in the IPM that we have described, so that there is a certain tendency to optimism (evaluation of risk below the real one) and to action (greater in youth) in the normal functioning by defect of the IPM-As and IPM-AAs that must be stopped. Low mood is an activation of the break mechanism of this IMPA-A that regulates mood, among other things.

Evolutionary explanations to the greater prevalence of depression in women

One of the most consistent data of the epidemiology is that depression is more frequent in women. We will illustrate the capacity of generating causal hypotheses of the evolutionary theory around this data. The evolutionary explanations to explain why depressions are more frequent in women may be based on: its high involvement in the reproductive function, in the social role that the woman had in the phylogenetic past, in the different preexisting differences with the male, etc.

Reproductive function

Regarding a possible relationship with reproductive functions, we propose the hypothesis that as in NSQ the sensitivity of the main IPM or of the secondary ones is modulated by certain hormone mediators which, in the female gender, appear in different forms and concentrations[84-86]. In this case, a possible investigation could be based on the study of the reactions in those subjected to therapy of hormones of the other sex, although it must be supposed that there are sensitive periods in childhood for the action of these hormones that may distort results in adults.

Different social role of the women in the phylogenetic past

A serious hypothesis would be that women are exposed to more negative events or rather to event for which they are not phylogenetically prepared (e.g., assuming stresses associated to the masculine role, changes in the structure of the nuclear family, etc.) in their present ontogenic development. This hypothesis could help us to explain differences in prevalences between Western societies, non-Western modern societies, Neolithic ones that still persist, etc.

Pre-existing psychological differences with the male, which, although they may be positive, on the one hand may favor the appearance of depression on the other

To begin with, we say that the origin of these differences also deserves an evolutionary explanation. In the phylogenetic past, there were differences between men and women on the cognitive level due to: specializations, simple change and subsequent occupation of an ecological niche to cognitive level, etc. The differences are strengthened by co-evolution or other mechanisms. The hypotheses that this option generate are:

- The IPM that regulates the energy level and therefore mood, as we have seen, reaction to the loss of status or to the perception of domain by another with a reaction: the depressive, similar to submission (both reactions and both IPM must be compared). In this regards, women present, on the contrary to men, more traits and therefore more personality disorders due to dependency.
- Greater sensitivity to the subtleties and effects of social relationships. The hypothesis would be that women are more sensitive, more emphatic, more attending to detail and to the subtlety of affective expressions, and that this is related somehow with a greater mood lability and with the greater tendency to affective disorders. Being more sensitive to the changes in the environment would also imply a lower trigger threshold of the mechanism for affective changes, and this would favor the alteration of the sensitivity of the trigger mechanism.

During these lines, we have reviewed the evolutionary theory on affective disorders. We have also presented our model, that is essentially differentiated from the theories published up to now first of all in that it simultaneously explains depression and manic phases as well as subtypes of depressions, and in the second place, in that it does not consider these processes adaptive situations but rather dysfunctions. In our model, the emotions or affections are epiphenomenona aware of a more extensive response. This model is supported on two pillars: one is inheritance and development dependent on environmental stimulus of the IPM understood as neuronal networks involved in functions of high value for survival, and another is the generation of hypothesis on the way in which different neuronal networks of the IPM may have become linked over evolution to give increasingly more complex responses to different stimuli (from light to social ones).

We hope that this review and the proposal for new models serve to create a debate on the evolutionary theories and their application to psychiatry could generate new investigations that make it possible to resolve the problem on the etiology of some psychiatric disorders.

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