Psychotherapies and epigenetics

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Abstract of subject:

The difficulty of implementing this type of approach probably explains the absence of work on this subject, knowing that this difficulty is largely overcome in Morocco thanks to the establishment in research units of laboratories that work on sequencing. and bioinformatics. Thanks to the collaboration of researchers in psychology and molecular biology, these studies remain possible, starting from a main hypothesis: the effect of psychological treatments would occur through epigenetic mechanisms. This work requires collaboration between the various stakeholders including researchers in psychology and biology, psychiatrists and psychologists. It is by adopting such an approach that we can study the gene-environment relationship, thus facilitating the diagnosis of psychological disorders, understanding epigenetic mechanisms and perfecting appropriate psychological treatments.

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Introduction

More than a century ago, Sigmund Freud noticed that psychic traumas in childhood have a lasting impact on our personality until adulthood, we are thus marked for the rest of our lives. Freud did not have proof of this observation, but several clinical studies have subsequently proven this observation: those who have suffered trauma during childhood are generally more exposed to anxiety, depression, personality, the spectrum of schizophrenia, or even neurological and cardiovascular diseases (Ledoux Ugo, 2015). Worse still, this malaise can be transmitted from one generation to another, it is an observation that psychology has established and which makes consensus between the different psychological disciplines.

Currently, the new answer to Freud's observation comes from epigenetics: because of molecular changes, early negative experiences become part of the genetic heritage through biochemical modifications.

So what is the nature of this epigenetic marking? How can these negative experiences be engraved in our body? Are these changes reversible and transmissible? Can psychotherapeutic treatments reverse these imprints? Or even correct epigenetic marking in people at risk?

To answer these questions, we will present in this article a synthetic state of current knowledge on epigenetic experiences (animals/humans) and on the epigenetic effects of psychotherapeutic treatments in the case of certain psychic disorders. In addition, we do not aim here to do historical work on epigenetic experiences, but rather we propose to see how to improve non-drug psychotherapeutic techniques through the understanding of epigenetic mechanisms.

Definition: Epigenetics

Epigenetics refers to an expression created as early as the 19th century, the first definition was formulated in 1942 by Conrad Waddington, according to

which epigenetics is “a new science aimed at studying the mechanisms by which the genotype generates the phenotype”. This new discipline aroused growing interest in the scientific community (Waddington, 1942).

The latter would concede epigenetics as the branch of biology that studies the interactions between the "gene" and "environment" systems that give rise to the phenotype of the individual (Holliday, 2006). Subsequently, Arthur Riggs and Robin Holliday proposed a second meaning for the concept of epigenetics, as a set of factors contributing to the control of gene expression through DNA methylation or modifications of chromatin components. (Holliday, 1975; Riggs, 1975). Since the 1990s, the word has referred to mechanisms regulating gene expression without a change in DNA sequence (Wolfe & Matzke, 1999). In 2004, a study published in “Nature Neurosciences co-led by Michael Meaney and Moshe Szyf” marked the beginning of the rise of behavioral epigenetics (Barry et al, 2011). Indeed, this study showed that there is a close relationship between the nature of maternal care of rats, their behaviors vis-à-vis stress and the methylation of certain genes in their DNA. In 2010, during a symposium organized by the New York Academy of Sciences, behavioral epigenetics was described as "the application of the principles of epigenetics to the study of the psychological, genetic, environmental and developmental mechanisms to man and animals. Research typically focuses on chemical changes, gene expression, and biological processes that underlie normal and abnormal behavior” (Barry et al, 2011).

The current molecular definition proposed by British biologist Robin Holliday designates “the study of transmissible and reversible modifications of gene expression not accompanied by changes in nucleotide sequences” (Alain Claeys and Vialatte, 2016).

The common point of these definitions is to try to go beyond the limits of genetics by specifying that the modifications of the expression of a gene are done without the DNA sequence of this gene being modified. These environmentally induced epigenetic changes are reversible, transmissible and

heritable. It is the subject of much research, which began in biology and then extended to medicine in fields such as oncology, endocrinology, neurology and psychiatry.

In any case, in the field of psychology and in particular clinical applications, this multiplicity of definitions is accompanied by another debate, on the one hand on the use of this discipline to understand the mechanisms impacting the structure of DNA during mental illnesses, on the other hand on the improvement of suitable psychotherapeutic techniques.

Epigenetics, Darwinism and Lamarckism

The theory of evolution became clearer after the works of Lamarck, then of course those of Darwin on heredity and natural selection.

In 1808 Jean Lamarck described his theory thinking that environmental adaptives such as the neck of the giraffe are transmitted to the next generations, however he did not have the proof, 50 years later Darwin will publish his natural theory, this one states that the birth of a long-necked giraffe being a coincidence, gives this animal a selective advantage which will be transmitted to the next generation (Lamarck, 1809). His theory is supported by the discovery of the mutation. But it was asshole Waddington in 1942 who defined epigenetics and who proved the possibility of modifying the expression of genes without modifying the genetic code (Waddington, 1942). This expression occurs through epigenetic mechanisms.

Thanks to epigenetics, Lamarck's theory has made a comeback, indeed epigenetics seems to partly confirm the thesis of the transmission of epigenetic marks "Neo-Lamarckism" over more than one generation (Lebrun Hector, 1912). Indeed, this science has confirmed the transmission of acquired traits from one generation to another "liking and growing" without changing the sequence of DNA or genes.

However, the discovery of epigenetics contradicts the theory of evolution "Neo Darwinism" which considers that genetics is solely responsible for

heredity and the transmission of characters (DeSinéty, 1910): Contrary to this idea of 'fixist heredity of a single type of molecule which is the substrate of heredity, the transmission of characters takes place thanks to epigenetic mechanisms involving different molecules and this, according to different processes which cooperate in order to create what is called memory epigenetics.

In addition, biology remains a fixist and indeterminist science of nature "it is difficult to admit that things can change", an idea reinforced by the discovery of the double spiral structure of DNA, by Watson and Eric, who formed an additional argument to the germline continuity theory. This structure of the DNA in two complementary strands made possible biochemically the manufacture of an exact copy of the molecule in the cell which allows the transmission of genetic material during somatic cell division as well as germinal, which makes it possible to explain how the support of heredity can be copied in several copies and without change, except possibly if there are errors: the mutations postulated by Darwin which can provide possible variants on which natural selection acts, but these mutations remain rare and crash them. This discovery of DNA structure in addition to replication, transcription and translation mechanisms suggests a plausible mechanism of heredity and the impossibility of transmission of acquired traits.

Epigenetic mechanisms

DNA is the molecule that contains our genetic makeup in the form of genes. According to cellular needs, genes are expressed by two processes which are transcription and translation. Transcription is the transformation of DNA into messenger RNA (mRNA) and translation is the transformation of RNA into protein. These are mobilized according to cellular needs. The regulation of this process is orchestrated by epigenetic mechanisms which, among other things, allows cells to differentiate and evolve as a distinct cell type (Labonté & Turecki, 2012).

These epigenetic mechanisms are dynamic regulators of gene expression. They therefore intervene not at the level of the DNA sequence of the gene but at the level of the processes (transcription and translation) which allow the gene to be expressed (Monhonval and Lotstra, 2014).

The most studied epigenetic mechanisms in psychiatry are histone modifications impacting chromatin structure and in particular post-translational modifications of histone tails, DNA methylation and regulation by non-coding RNAs (microRNAs) (Bestor et al, 2015).

Changing the spatial conformation (open or compact state) of chromatin (DNA wrapped around histone proteins) allows DNA to unwind in such a way that the transcriptional machinery may or may not reach the genes. Certain chemical reactions such as acetylation, methylation or phosphorylation are capable of modulating gene expression by modifying the compact structure of chromatin allowing or preventing access of the transcriptional machinery to DNA, favoring or not transcription and gene expression (Bale, 2006).

Methylation

Methylation is the addition or removal of methyl (CH3) groups to DNA. This reaction is catalyzed by a group of enzymes, DNA methyltransferases (DNMTs) (Klose & Bird, 2006). Normally, each gene is preceded by a regulatory region called a promoter which allows the transcriptional machinery to dock, and to express the gene by the synthesis of an mRNA molecule. Extensive methylation at the promoter part, which is located at the front of the gene, can prevent its binding to transcription factors, because the methyl groups bind to protein groups, which makes the chromatin compact. Once the chromatin has been condensed, the transcriptional machinery is no longer able, for lack of space, to approach the gene promoter in order to initiate the transcription of this gene, which would allow its expression. The gene therefore remains silent (Monhonval and Lotstra, 2014). The hypermethylation of the promoter regions could interrupt the binding of transcription factors and would lead to the

maintenance of the inhibition of gene expression; the latter, once activated, would on the contrary present a demethylation of their promoter (Labonté and Turecki, 2012).

Jaenisch & Bird (2003) demonstrated at the level of many genes an inverse correlation between the degree of DNA methylation and the level of gene expression.

MicroRNAs

The second epigenetic mechanism is characterized by the interference of small non-coding RNAs: these are short RNA sequences with a length ranging from 21 to 23 nucleotides, resulting from the transcription of DNA but which are not intended to be translated into proteins, they have been classified into different types of classes according to their size and their mechanisms of action: microRNAs, small interfering RNAs, RNAs interacting with piwi4 proteins and small nuclear RNAs (Monhonval and Lotstra, 2014). They regulate transrational or translational processes, controlling protein synthesis through the inactivation or degradation of messenger RNAs. By binding to the messenger RNA of the genes, they generate a double-stranded RNA which will be degraded by the cell, thus leading to post transcriptional extinction (Denli et al, 2004). This role is far from negligible since, according to a study (Pinzòn Restrepo et al, 2013), more than 60% of coding genes in humans are controlled by microRNAs. The latter could therefore be important actors in the mediation of environmental effects on humans (Sato et al, 2011). The best-known example is that of XIST, a long non-coding RNA involved in the inactivation of the X chromosome in female mammals (Schaukowitch and Kim, 2013).

All of these epigenetic modifications constitute the epigenome. The epigenome is stable, transmissible during cell divisions, but can be modified by multiple environmental factors, making it an essential substrate for the G×E interaction (Rivollier et al, 2014).

These mechanisms can be reversible and therefore constitute a process by which psychological disorders change the expression of a gene. This is an essential characteristic, which links epigenetics to psychotherapeutic treatments.

Epigenetic modifications (Animals/Human)

According to the literature, epigenetic mechanisms have been observed in animals and humans in different psychological processes such as learning, long-term memory, psychological conditions such as addiction, anxiety disorders, depression and bipolar (Pauline Monhonval, Françoise Lotstra, 2014). Table 1 presents summaries of studies showing the epigenetic traces that can cause certain psychological conditions on DNA, as well as gene expression and behavioral change. Indeed, several studies have highlighted the involvement of certain genes in the regulation of the stress response through epigenetic modifications. Indeed, the epigenetic methylation of the GR (including those located in the hippocampus) and the demethylation of the FKBP5 gene have been implicated directly in the stress response (McGowan et al, 2009). These conditions can cause an increase in cortisol levels.

The BDNF gene has also been shown to undergo epigenetic changes in response to childhood adversity. Indeed, BDNF gene methylation has been associated with suicides (Keller et al, 2010) as well as the development of borderline personality (Perroud et al, 2013).

The experiments also showed that the degree of methylation of the promoters of certain genes such as glutamic acid decarboxylase (GAD1) (Zhang et al, 2010) and N-methyl D-aspartate (NMDA) (Rodenas-Ruano et al, 2012) impacts the neurotransmitter system, the normal development of synapses and their consolidation.

On the clinical level, the clarification of the epigenetic-psychology relationship in general could question the current etiology of psychic diseases, the previous phase would be to highlight the therapeutic techniques capable of

triggering the epigenetic mechanisms favoring a psychic improvement (Monhonval, and Lotstra, 2014).

Studies	Results or findings	Epigenetic mechanisms	Remarks
Mothers adopting a high maternal behavior (number of licks administered to her raised pups) LG: Attentive mothers. Mothers with low maternal behavior who have low LG towards their pups: Neglecting mothers	In pups raised by LG mothers: depressive behaviors, more sensitive to stress, low level of expression of the GR gene, modification of the activity of the HPA axis similar to those found in depressed animals (LIU and Diorio, 1997). - excess corticosterone, the stress hormone produced by the adrenal glands in times of stress (Claeys and Vialatte, 2016).	Difference in DNA methylation at the promoter gene in the hippocampus (the glucocorticoid receptor) in offspring from low LG and high LG mothers. In low "LG" pups the levels of methylation of the promoter of the "GR" gene are significantly higher than in high "LG" pups and are associated with a decrease in the expression of the "GR" gene in the hippocampus (Weaver and Cervoni, 2004).	Causal effect between caring nature and epigenetic changes at the gene level in the hippocampus, indeed, caring for the mother Program through epigenetic mechanisms the genes that regulate the behavior of their babies (Turecki, 2014). The epigenetic changes caused by licking and grooming during early life therefore seem (to some extent) heritable (Meaney, 2001).
Comparison of the DNA of mothers of healthy children with that of mothers of children with a serious chronic illness (autism, motor and cerebral disability) (Duval, 2014).	In women subjected to chronic psychological stress, there is a shortening of telomeres "the end of the chromosome" reflecting accelerated aging from 9 to 17 years. 1	an increase in the concentration of the stress hormone "cortisol" reduces telomerase activity, which abnormally shortens the end of the chromosome and accelerates cell aging.1	A direct link between stress and DNA morphology

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Separation of newborn rodents from their mothers in unpredictable ways (Weaver, 2007).	Higher plasma corticosteroid levels than controls, depressive behaviors, impaired resistance to stress and anxiety … (Weaver, 2007).	Anxiety is due to a direct impact on the promoter of the hippocampal glucocorticoid receptor gene named Nr3C1, this promoter becomes highly methylated preventing the binding to the transcription factor and the expression of the hippocampal glucocorticoid receptors (Weaver et al. al, 2004).	Anxious rats, for lack of adequate care at birth, will in turn become anxious mothers, with inappropriate behavior in relation to their young. It is therefore an inherited behavior transmitted by epigenetic modifications.
900 people from the city of Atlanta with frequent exposure to psychological trauma and who are at risk of developing high post-trauma stress (anxiety disorder) (Binder et al , 2008).	Saliva sampling and study of FKBP5 genes. Significant methylation of the FKBP5 gene (Binder et al, 2008). ,	FKBP5 gene: is part of the regulation of stress, it slows down the transcription of genes upstream and therefore the production of peripheral glucocorticoids.2 (Monhonval and Lotstra, 2014)	the study made it possible to establish a clear link between the gene and environment association (early stress)
2000 people from the city of Atlanta, blood draw 1 1 (Klengel, 2013)	Large and significant methylation of the promoter of the FKBP5 gene if and only if the person had suffered trauma during childhood.		

Studies	Results or findings	Epigenetic mechanisms	Remarks
Children who survived long-term trauma (childhood abuse and abandonment) (Vijayendran et al, 2012).	Hypermethylation of glucocorticoid receptor gene promoters in adult white blood cells (Tyrka et al, 2012).	Methylation of glucocorticoid receptor gene promoters	
Sexually abused women	Hypermethylation of serotonin transporter genes in the white blood cell (Vijayendran et al, 2012).	Methylation of promoters of serotonin transporter genes	
-122 veterans with post-traumatic stress disorder (EPST) -Veterans not presenting with post-traumatic stress (Control) (Yehuda et al, 2012).	Analysis of blood samples showed that the "NR3C1" gene was less methylated in fighters without EPST, Decrease in certain mi-RNAs associated with high inflammation (Yehuda et al, 2012) Blood samples,	Methylation of the "NR3C1" gene promoters. Activation of "mi-RNA" microRNAs	
A cohort of 239 people from a favorable socio-economic background (analogy with high LG pups) and another from an	global DNA hypomethylation in people belonging to unfavorable socioeconomic categories	Global DNA methylation	

Studies	Results or findings	Epigenetic mechanisms	Remarks
unfavorable socio-economic background (analogy with poorly cared for pups: low LG) Dagmara McGuinness et al, 2012).			
Depressive passions and control group (Dagmara McGuinness et al, 2012).	Methylation at the level of 14,000 genes detected using DNA chips, difference in methylation between depressive patients and controls.		
Post-mortem examinations of 24 suicides, 12 people suffered acts of mistreatment in their childhood (abuse, neglect, etc.), 12 people did not suffer such acts (Meaney and Szyf, 2004).	Significant methylation of the glucocorticoid receptor gene promoter "same gene as that demonstrated in rats" and less expression of these receptors in the hippocampus of abused and traumatized suicide patients, unlike the others (same discovery in pups deprived of adequate maternal	Glucocorticoid receptor gene promoter methylation	An increase in methylation induces a decrease in GR expression by interfering with a transcription factor that normally potentiates gene expression (Labonte and Yerko, 2012)

Studies	Results or findings	Epigenetic mechanisms	Remarks
	care). (McGowan et al, 2009).		
Post-mortem study of prefrontal cortex tissue in subjects with psychosis and control subjects (Millan , 2013). .	Significant difference in the level of methylation of gene promoters of GABA transporters enzyme that catalyzes the formation of GABA from glutamate	Methylation of GABA transporter gene promoters	Gene methylation also impacts the neurotransmitter system
36 children aged 13 Blood samples: -Epigenetic analysis on specific genes -After 10 years: Epigenetic analysis: the same protocol (Veru et al, 2015).	- Epigenetic changes on 1675 points - The mother's stress leaves a broad signature on all of the DNA, indeed on certain genes the higher the prenatal objective stress had been, the more methylation there was.	Gene methylation	
Subjecting mice to a fairly painful stress at the same time, there is release of an odor (Pavlovian reflex) (Dias and Ressler , 2014)	Future generations have a feeling of stress at the same smell		Transmission of epigenetic characters (a quite perfect example of Lamarckian transmission)
101 an adult subjects with	A significantly higher percentage	Deregulation of the gene coding for the	

Studies	Results or findings	Epigenetic mechanisms	Remarks
borderline personality disorder, characterized by instability in interpersonal relationships, emotions and impulsivity Control sample (Perroud et al. 2011)	high epigenetic changes on DNA in subjects who were abused in childhood (physical, sexual and emotional abuse, affective deficiencies) compared to those who did not suffer such abuse	GR, disrupts stress management in adulthood. (Perroud et al, 2011).	

Table 1: Implications of epigenetic processes in different psychological conditions

Psychotherapy and epigenetics

In psychology, epigenetics is considered the missing link between the psychic and the physical. In this literature review, we try to highlight the essential role of certain non-drug psychotherapeutic therapies in the activation of epigenetic reactions favoring behavioral change. This therefore suggests a preliminary analysis of the numerous results available concerning the various experiments on animals and humans which have elucidated the epigenetic effect of these treatments. Indeed according to the bibliography, psychotherapeutic treatments have shown great success in the field of psychological health by acting on several levels, namely the epigenetic, neural and endocrine level (Christopher and Miller, 2017).

Reflection on the epigenetic effect of psychotherapies began after the results of experiments dealing with the quality of maternal care in mice (Table) which showed that the promoter site (exon 1) of the GR gene is highly methylated in the offspring of mothers. Negligent whereas it is little methylated in the young

of caring mothers. The latter respond to stress with morphological and chemical changes in the hippocampus, frontal cortex and amygdala (Anacker et al, 2014).

According to the experiments quoted in the bibliography, one can even modify the behavior of the rats in the experiment (table) by psychological treatments, Indeed in mice cross-parenting (as psychological treatment) reverses the level of methylation of the GR gene, that is to say, if little mothered rat pups are entrusted to a mother who takes care of them a lot during the first week of life, the promoter site of the GR gene becomes little methylated and the expression of the GR receptors is restored in the hippocampus. This suggests a direct relationship between maternal care and the rate of methylation of the promoter region of the gene to bind the transcription factor that initiates GR gene transcription and the HH axis stress response. So here we have a psychological change that resulted in an epigenetic change at the DNA level followed by a change in behavior.

These types of experiences have prompted researchers to transmit their work on the effect of psychotherapeutic treatments such as CBT, psychoanalytic therapies, Somatic Experiencing, Emontional Freedom technique, hypnosis…) on Man. These treatments will be more effective if epigeneticists are able to measure the possible epigenetic modifications that any psychological treatment can cause. For example, if we follow a CBT against a social phobia, does the epigenetic program of the cured patient change? If so, at what level of the gene and what is the mechanism highlighted? What variation at the level of the CNS zone (Amygdala, hippocampus, etc.) and at the level of the neural circuits? (Figure 1).

Epigenetics has therefore opened up a new horizon for psychology and has found a platform between two antagonistic clinical schools: one favors genetic predisposition, the other favors the effect of the environment in the appearance of diseases psychic.

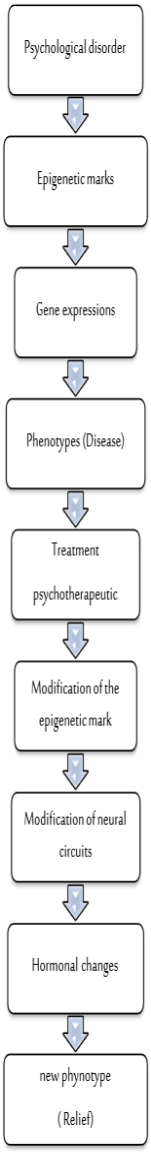

Figure 1**:**

In a study using CBT (Cognitive- Behavioral Therapy) to treat panic disorders EPST: a psychiatric disorder that affects 20% of veterans and is characterized by changes in neural circuitry with an increase in cerebral amygdala response and a decrease in response of the prefrontal cortex. The methylation of the MAO-A (monoamine oxidase A) gene has been studied in blood cells (Ziegler et al, 2016). Panic disorder has generally been associated with hypomethylation of this gene, which therefore favors their transcription and high expression (Domschke, 2012), thus showing an inverse correlation between

methylation and the severity of symptoms (Ziegler et al , 2016) .This gene is responsible for the degradation of serotonin, norepinephrine and dopamine, the excess of which may be associated with hyperreactivity of the amygdala (Armbruster, 2009) . After six weeks of CBT treatment, Ziegler et al. (2016) showed that treated subjects had increased MAO-A gene methylation (reaching levels similar to controls). From a neurobiological point of view, hypermethylation of this gene leads to an increase in the concentration of serotonin which would serve to decrease the activation of the areas of the brain involved in avoidance and fear responses during panic attacks, thus facilitating a remarkable adaptation of the patient (Graeff and Del-Ben, 2008).

Prolonged exposure (PE) is a psychotherapy also used against post-traumatic stress disorder (PTSD: post-traumatic stress disorder) (Foa et al, 2005). One study looked at white blood cell DNA in patients with PTSD. After 12 weeks of PE treatment, two epigenetic changes were observed: a negative correlation between the methylation of the GR of the NR3C1 gene (exon 1F) and a positive correlation of the methylation of the GR of the FKBP5 gene, with respect to the symptoms of PTSD (Yehuda et al, 2013). In parallel, these changes go hand in hand with a decrease in cortisol concentration (Pacella et al, 2014).

These two techniques (CBT and EP) can promote epigenetic changes and reconfigure neural circuits by improving symptoms (Miller, 2017). After 12 weeks of psychotherapy following PTSD (Yehuda et al., 2013), a higher level of methylation in the NR3C1 gene and a lower level of methylation in the FKBP5 gene could be associated with a better response to treatment. Their effectiveness has also been shown by a decrease in the activity of the amygdala and an increase in the activity of the anterior cingulate cortex (ACC) as well as the hippocampus.

Dialectical Behavioral Therapy (Dialectical behavioral therapy: DBT has also shown great success in the treatment of borderline personality disorders (BPD: Borderline Personality Disorder) (Thaler et al, 2014), indeed after four weeks of DBT, 115 subjects showed a significant decrease in the methylation of

exons I and IV of the BDNF gene in leukocyte DNA. This decrease in methylation is correlated with symptomatic improvement (depressive symptoms, despair and impulsivity).

In addition to this work, several studies have shown the limits of the drug-only approach in the treatment of mental disorders. Indeed, two studies in particular have highlighted this remark in rodents (Alboni et al, 2017). Mice subjected to chronic stress, received long-term treatment with fluoxetine, and then were exposed to a calm or stressful environment. In the first group, there was a decrease in depressive behaviors, an increase in BDNF gene expression in the hippocampus, and a decrease in corticosterone. While in the second group where the conditions are stressful, despite being on fluoxetine, there was worsening of depressive symptoms, lower levels of BDNF gene expression in the hippocampus and higher corticosterone . This of course suggests a plasticity of genes according to the "environment" variable (Belsky, 2009).

In humans, the treatment of depression with a drug "Citaloprame" mounted a positive response, only if the living conditions are favorable, namely the socioeconomic status (Jakubovski and Bloch, 2014). Better still and in order to accelerate responses to CBT treatment of stress-related disorders, some psychiatrists use D-cycloserine (DCS), whose action goes in the same direction as the plasticity effect of the NMDA gene (Hofmann et al, 2013).

Conclusion

The difficulty of implementing this type of approach probably explains the absence of work on this subject, knowing that this difficulty is largely overcome in Morocco thanks to the establishment in research units of laboratories that work on sequencing. and bioinformatics. Thanks to the collaboration of researchers in psychology and molecular biology, these studies remain possible, starting from a main hypothesis: the effect of psychological treatments would occur through epigenetic mechanisms. This work requires collaboration between the various stakeholders including researchers in psychology and biology,

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العلاج النفسي وعلم التخلق الجيني (البيولوجي)

الملخص

قادت مجموعة من الأبحاث العلماء الى الانتقال من دراسة الجينوم إلى ما فوق الجينوم وذلك بفضل علم التخلق الذي يلعب دورا جوهريا في تنظيم العملية البيولوجية من خلال تعديل حمضنا النووي كيميائيا دون تغيير مورثاتنا حيث يؤثر عل طريقة كتابة أو تشكيل الجينات وليس عل تركيبة الحمض الخلوي الريبي الخالي من الأكسجين. وببزوغ هذا العلم لم تعد الحتمية الوراثية التي كانت سائدة في الماضي سارية. فالأمر لم يعد يتعلق بتوريث الطفرات الجينية حسب فرويد، ولكن يمكن توريث التغيرات فوق الجينية كانت سلبية أو إيجابية من جيل لأخر، اعتمادا على مناطق الجينوم الذي يصيبها التأثير. وذلك من خلال مجموعة من الاليات كمثيلة الحمض النووي التي تؤدي الى تنشيط أو تثبيط هذه المورثات أو إلى تغيير في شكل الكروماتين والهيستونات. ويهدف هذه المقال إلى تحليل الدراسات في هذا المجال والتي وضحت أن سلوك التنشئة لدى الحيوان أو الانسان يُشَكِل ما فوق الجينوم - خلال علامات أو بصمات فوق جينية - في صغارها ويصوغ سمات شخصياتها ويحفز تغييرات كيميائيات في الدماغ بتنظيم كمية الهرمونات مثل هرمون التوتر التي تفرزها الغدد الكظرية لدى الكائن. لكن المثير للغاية أن هذه التغيرات ليست نهائية رغم أنها مستقرة، ولكن يمكن تغييرها وجعل تأثيرها عكسيا وذلك بالتدخلات العلاجية النفسية الملائمة، من خلال إعادة التنظيم الفوق الجيني الذي يؤدي إلى تشكيل دارات جديدة بين الخلايا العصبية، تتبعها تغيرات هرمونية وسلوكية.

مع استمرار الاكتشافات فوق الجينية في تقديم أدلة على أن لدينا بعض السيطرة على تراثنا الجيني، أصبح من اللازم التعاون بين مختبرات العلوم البيولوجية والنفسية لمواجهة التحديات التي تواجها الصحة النفسية.

الكلمات المفتاحية: علم التخلق، مثيلة الحمض النووي، التقنيات العلاجات السلوكية المعرفية، البصمات فوق الجينية، التنظيم الفوق الجيني ....