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Neurosciences and Emotional Self-Regulation Applied to Mental Health Contexts

Prisla Ücker Calvetti, Fernanda de Vargas and Gabriel Gauer

Abstract

Mapping the self-regulation in the therapeutic process may be important to characterize the picture better, to contribute to the planning of the therapy and to select strategies for practical guidance of the patient, which will favor positive gains. It is important to know more and more the cognitive responses and behavioral characteristics of patients, such as associative learning, motivation and regulation of emotion, which may be linked to the genesis and maintenance of disease. We highlight self-regulation that is an executive function managed by the prefrontal cortex of the frontal lobe of the brain, essential to keep the individual active in the process to achieve their goals. It is a complex phenomenon that involves behavior (activation, monitoring, inhibition, preservation and adaptation), emotions and cognitive strategies to achieve desired goals. The neurosciences can contribute to the knowledge in emotional self-regulation in children and adolescents to health contexts in CBT.

Keywords: neurosciences, emotional self-regulation, health

1. Introduction

During the process of structuring the personality, there are many social and individual factors that can motivate or inhibit aggressive conduct. So it is necessary to consider there is a complex relationship between social risk factors psychological and biological, that is, the behavior is multidetermined by a set of variables [1]. In addition studies in the aforementioned areas are gaining space also in the field of law, since discoveries about brain development can contribute to the understanding of human behavior [2].

The advancement of neurosciences enabled the understanding that during adolescence there is an incomplete development of some brain regions [3], among these would be those responsible for behavioral control and impulsiveness [4]. In addition empirical research shows that experiences can produce alterations in the neural structure of the subjects, thus, it is reasonable to affirm that the cerebral cortex can be continuously remodeled from new experiences, from which comes the idea of brain plasticity in adolescence [5].

Therefore, studies in the field of neuroscience corroborate to understand the development of children and adolescents as regards the individual characteristics of adolescents in socio-educational measures. These findings may contribute to

the proposed care programs in the implementation of the hospitalization measure can be more effective and coherent with the individualization of measures and the pedagogical character of the same. Appropriate interventions can enable the development of new cerebral connections and the change of perception about the crime, the fulfillment of the measure, the relationships established outside the institution among other aspects. In this way, it would be feasible to think that the integration of different variables, social and individual, could make socio-educational measures more effective. This chapter has the objective of shows the contributions neuroscience and emotional self-regulation in mental health contexts to cognitive behavioral therapy (CBT). For this, it is important to considerer the human development in the period from adolescence to adult life.

2. Adolescence: peculiar period of development

Puberty is a phenomenon that has always existed in the history of mankind, however the concept of adolescence,¹ as it is currently defined, began to be discussed only from the eighteenth century onwards. In this way, adolescence is correlated with many changes that have occurred at the cultural, social, economic and historical level in several civilizations [6].

In the eighteenth century, with the Enlightenment, a new movement of the society at that time, there is a redefinition of the social roles of women and children, as well as there is a new focus on family issues. The child is seen as the future of the family and the object of love of the parents, and with that there is a greater investment in the relationship between parents and children. At this moment the child is not seem merely as a miniature adult, but as a person, a subject of wills, rights [7] and peculiar characteristics. Still in the nineteenth century, adolescence becomes perceived as a critical moment of human development, which poses potential risks to the subject and also to society, and therefore becomes thematic studied among physicians and educators [8].

From this, it arises the need to specify the transformations arising in adolescence, physical and also behavioral modifications. The adolescence is defined by the psychological and social maturation process that accompanies or begins with puberty. On the other hand, it can be considered a biological phenomenon that produces physiological and morphological changes [9]. Thus, adolescence is characterized as the phase of the life cycle in which the personality is structured, and that there is emotional instability in the face of physical modifications that occur in body and the search for identity formation [10].

In addition to changes in the body, at 11, or 12 years old, some cognitive structures of the child also mature. The kid will develop the reasoning and logic needed to troubleshoot solutions. Piaget [11] called this period “formal operations”. Among the biological changes of this period it can be emphasized the changes in the activities of different regions of the brain, which are part of the process of cerebral maturation [12]—childhood and adolescence seem to be essential phases in this process. Research shows that childhood experiences will exert significant influence on the development of behaviors in adulthood and that, environmental stimuli influence the development of different neural circuits in that period [13].

¹ The World Health Organization (WHO) separates adolescence in two phases, the first of 10–16 years of age and the second, from 16 to 20 years. Legislation Brazilian, according to the Statute Child and Adolescent Considers adolescent people between the ages of 12 and 18 years old.

2.1 Adolescence and development: neuropsychological aspects

It is thought that in adolescence there is neurocognitive immaturity, because there are some brain areas that are still in development. The situations lived during this period are also significant for the myelination of areas of the brain, mainly of prefrontal areas, responsible for rationalization, taking impulse control. In addition, recent findings show that this myelination may extend to the third decade of life. Previous longitudinal studies have already evidenced that the maturation process that depends on myelin could go up to the 21-year-old, according to the population studied.

In addition to an incomplete development in areas related to impulse control, there is also a higher intensity of impulsiveness in adolescents. With the use of functional magnetic resonance imaging, researchers observed that in a given task performed by the sample studied, referring to the gratification, the nucleus *accumbens*, a brain structure related to the reward system, showed a more pronounced activation than in adults who performed the same task. Thus, studies of this type corroborate the existence of exacerbated impulsiveness in adolescence [14].

It is during adolescence also, that the process of consolidation of different devices related to social cognition occurs, such as: the ability to interact with others based on the perception and recognition of emotions expressed by the face; the understanding of other people's mental states; and the regulation of behaviors in the face of an interpersonal situation [15]. These functions are of utmost importance in the face of understanding behavior. They are the ones that make it possible for subjects to interact, meet, perceive and relate to the world and the people around them. It is noteworthy that the interest in understanding the relationship established between the brain and the cognitive processes has increased in recent years [16].

Among the most researched cognitive processes currently, are the executive functions (EF) [17], complex mental functions responsible for the ability of the subject to engage in attitudes aimed at goals, that is, how this subject organizes and plans their actions in search of specific goals. Other skills related to executive functions are to create strategies, solve problems, monitor behavior, make decisions, abstract, reason, among others.

Moreover, the EF will allow the management of emotions and impulses, seeking a more appropriate response to the situations, what we can call autoregulation [18]. Considering that impulsivity can be classified as a poorly adapted response, without prior planning and associated with the desire for immediate satisfaction [19], the ability to resolve conflicting information and inhibit automatic replies when necessary, is understood as an indicator of the ability to direct future-oriented behavior [20]. Subjects who have decreased impulse control capacity can commit harmful acts to themselves and others [21]. Moreover, impulsiveness appears as a symptom of different psychiatric disorders, such as conduct disorder, personality disorder antisocial, personality disorder borderline, attention deficit and hyperactivity (ADHD), psychopathy, among others [22].

In view of this, the number of researches that have been focused on the neuropsychological assessment of impulsiveness and inhibitory control is increasing. Like this, the continuous performance tests (Go/No Go Task) have been presented as a promising task to evaluate mechanisms involved in the impulsive behaviors and self-regulation of the emission of motor responses [23]. This task is development in display (on computer) stimuli target (words, images, videos, and others) for the participants. These are instructed to press a computer key as quickly as possible (for the stimuli *act*) and do not perform any response in the presence of stimuli *don't act*, according to each task. From this, it is possible to observe three important aspects to evaluate the behavior: the omission in executing a response expected the realization of an undue response and the time each participant took to make the answers. The

frequency of omission errors is often related to inattention in the execution of the task, while the frequency of commission errors is associated with impulsiveness and failure to inhibit a prepotent response. The reaction time for the responses, allows to identify the speed of the processing of the information [24].

So, it aims to evaluate the performance of children and adolescents in relation to the inhibitory component of executive functions, from Go/No Go tasks have been performed in different contexts. The study of Bilous, Small and Salles [25] with children presented as a result, to higher performance in the Go/No Go task in children in early school grades, being in agreement with other studies [26, 27]. That indicates the maturation of the cortical regions associated with executive functions with increasing age and with this, possibly the improvement in the performance of these tasks. With teenagers, this result is similar, [28] found differences statistically significant in the Go/No Go task performance according to the age range, demonstrating a chronological increase in the inhibitory control, in addition to finding differences in the performance between the participants gender (lower inhibitory control in females) and in private and public school students (better performance in private school students).

These results converge to the understanding that executive functions are related to different aspects of development and need to be evaluated taking into account different variables. Therefore, research in this field suggests that early interventions geared towards self-regulation are effective in promotion of executive functions skills [29, 30]. Activities such as, Yoga, mental training, aerobic exercises, among others, can provide ample benefits for the control of impulses, working memory and change of focus of attention, these skills, involved in the EF [31].

The Go/No go task has also been used to investigate the brain areas involved (activated) during the process of inhibiting responses, based on the use of neuroimaging techniques. An example of this is the study by Goya-Maldonado and collaborators [32] which found a positive correlation between the activation of areas of the ventrolateral prefrontal cortex and motor impulsiveness, during successful responses of inhibition a Go/No Go task. This study corroborates the interpretation that the prefrontal cortex is involved in the processes of planning, self-regulation of behavior and inhibitory responses.

The neurological bases of the EF are located in the prefrontal cortex, more specifically the region lateral and anterior cingulate gyrus [33]. It is noteworthy that the prefrontal cortex is not only involved in cognitive processes, because a region orbital frontal is related emotional aspects of the inhibitory control, so prefrontal lesions can also cause cognitive and emotional disturbances [34]. That is because the orbitofrontal cortex maintains connections with the limbic system, unit responsible for the emotions and by social behaviors. In addition, the frontal lobe comprises limbic structures, since the anterior portion of the cingulate plays an essential role in primary emotions, along with the amygdala [35].

In this way it is observed that the executive functions need the activity of several neural circuits, being correct to affirm that the whole brain participates in this process. However, the prefrontal cortex region is the last to develop, that is, to reach the maturational [36], therefore the EF takes longer to mature, and in adolescents this process is still under development. It is emphasized that the maturation of the executive functions occurs continuously, but there are outbreaks of development in certain ages of the individual, such as at 2, 6 and 8 years of age, lasting significantly until the end of adolescence and early adulthood [37].

When executive function changes occur, the syndrome, which is related to several cognitive and psychiatric disorders, may be related to neurological injuries or dysfunctions. In view of this context, there was an increase in research on executive functions, and about psychiatric and cognitive disorders related to dysfunctions

of the same. However, as regards studies with children and adolescents in Brazil, most of the studies are about attention deficit hyperactivity disorder (ADHD) [38], autism, learning disabilities [39], and use of psychoactive substances [40], few national studies discuss the theme of executive function related to violence and the committing of crimes in adolescents.

However, international studies [41] evidence of low performance of executive functions, in neuropsychological measures, in individuals with psychiatric disorders that are associated with aggression, such as antisocial personality disorder, conduct disorder, bipolar disorder among others. In addition, several researches [42, 43] feature a significant relationship between cerebral dysfunctions and violent behavior, both in adults and adolescents, evidencing biological aspects as risk factors for this type of behavior.

In view of the above, it is observed that failures in the inhibition of antisocial behaviors are related to a less responsive brain circuit that does not fulfill its function of managing the behavior in a full way, based on social values established [44]. This occurs in both adults and adolescents, however, the phase of adolescence is peculiar, in the sense that the cortex prefrontal is the last structure to develop, which would explain some characteristics of this phase, such as, impulsiveness, difficulty in planning, limitation in braking the search for immediate pleasure and the fragile concern with the consequences of their actions.

In this sense, many studies have turned to the understanding of psychopathy and its development. Although criminal behavior is not an essential diagnostic criterion in this disorder, some central characteristics of psychopathy favor the involvement in anti-social behaviors [45]. Thus, even if psychopathy is a diagnosis that can only be performed after 18 years of age, many studies are performed with adolescents, seeking to identify possible neurocognitive dysfunctions and traces of the disorder that present some level of relationship with the picture in adulthood. One of the neurocognitive dysfunctions that has been investigated in children and adolescents, it concerns deficits in the processing of information about different types of emotional content, since such characteristics do not develop suddenly in adulthood, these deficits, traits and tendencies that can culminating in a psychopathic disorder can be observed already at early ages [46].

In this way, the besides studies conducted with adults, researches with children and adolescents have also been conducted in order to investigate deficits in the processing of certain emotions and have found of the convergent results with regard to the existence of these deficits in relation to the expression of fear, in children and adolescents with a tendency to psychopathy when compared to control groups [47–49]. Researchers have also found a relationship between the different facets of the psychopathy framework (affective facet and antisocial facet) and deficits in recognition of expressions, for example, the affective facet, related to emotional insensitivity was more associated with the deficits of fear recognition, while the antisocial facet was more associated with the attribution of rabies in neutral faces [50].

In adults, the results of studies show similar to those found in younger populations. Compared the performance in identifying negative emotions (anger, sadness and fear) expressed by the face, in criminal and non-criminal individuals with different levels of psychopathy, using the Go/No Go task. Individuals with “more severe” psychopathy presented worse performance than groups with “low psychopathy” in recognizing expressions of fear and sadness. These results reinforce the idea that psychopathy is related to the low ability to identify fear and sadness in facial expressions. Different studies have been converging on the diminished capacity of psychopaths in identifying certain facial expressions. Most of the findings suggest that there seems to be a deficiency in the processing emotional psychopaths [50].

Studies with neuroimaging also find similar results, since the limbic system, more specifically, the amygdala, are involved in this capacity [51].

These results may explain the “coolness” found in the psychopathic conditions, because a lesser capacity to respond adequately to other people’s emotions seems to be at the root of different antisocial behaviors. Therefore, researches in this field can generate greater understanding about these deficiencies and contribute to the development of interventions of emotional recognition training, among others, in an early way, with the objective of generating greater effectiveness in treatment of adolescents with antisocial behaviors.

Finally, most studies and theories that sought to understand violence, involved almost in its entirety, social models and sociological, it is noteworthy that neuropsychology is also an area that can contribute in the knowledge of criminal behavior. The attention on the anatomical base that involves these behaviors is important for the treatment of violence and the crimes present in our society [52].

In this sense, it is not about denying the importance of the environment in the formation of the subjects, but of recognizing that the social factors are relevant in the development of the violent behavior, which can occur from an interaction with biological aspects. In addition, the experiences experienced in the environment contribute to biological changes that are related to the predisposition to violence.

Among these biological aspects one can think of genetic factors; hormonal factors; brain factors, both with regard to the structure and the functionality of the cerebrum; among other aspects. From this understanding, the subjects with violent or criminal behavior, can be considered as a “puzzle” biopsychosocial, that is, with biological, psychological and social parts. Although several studies have already evidenced this relationship, it is still a challenge to understand how these pieces fit, or even, how biological processes relate to psychological and social processes.

Thus, it is important to consider the heterogeneity and subjectivity that are associated with the criminal and/or violent act, seeking to evaluate elements such as repentance, empathy, commotion, motivation, chronicity and severity of antisocial behavior. It is believed that these elements may present indicative data on the need to consider. These aspects are for the determination of interventions under the modality of cognitive behavioral therapy during socio and educational measures of hospitalization as well as other mental health contexts.

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