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Chapter 2

Stress and Cognition: Psychological Basis and Support Resources

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Additional information is available at the end of the chapter

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Abstract

Executive functions are processes that help in tasks such as reasoning, planning, troubleshooting, and management of the individual's own life. A consequence of the specific connections of stress is that executive functions tend to be interrupted when the stimulation load is so big that the individual becomes stressed. The level of cellular stress becomes evident with the increase of cortisol. Cellular processes such as inflammation, proliferation/death, and oxidative stress have been shown in murine models resembling cognitive impairment in humans. This impairment translates into behavioral changes, loss of memory, inability for decision-making, and attention problems. The incorporation of factors, such as drug use and bullying, promotes the impairment of executive functions. Resorting to strategies, such as exercising, environmental enrichment, and changes in the diet, constitutes an excellent aid in the promotion of academic achievement. In this chapter, we discuss the impact of stress on cognitive executive functions associated with academic achievement and also suggest strategies to reduce the impact of stressing factors.

Keywords: academic achievement, cognition, executive functions, psychosocial stressor, physiological stressor

1. Introduction

Stress is a biological response to internal or external demands which have an impact on cellular homeostasis. The frequency and intensity of the stressful stimuli can promote physiological and psychological effects on the body, such as the executive functions of the brain. Executive functions are a set of cognitive skills that allow for the anticipation and establishment of goals,

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the design of plans and programs, the initiation of the activities and the mental operations, self-regulation, and task monitoring. The prefrontal cortex acts as a controller of executive functions. The executive functions, which help us to organize thoughts, tend to be interrupted when the stressors load is too high [1].

The study of the determinants of academic performance has attracted a remarkable interest in the last few years, given the need to investigate new variables that explain frequent school failure and discouragement in students. Predicting the effect of executive functions on academic performance is important for adequate adaptation of the individual to the specific requirements of the school context. The association between chronic or acute stress and academic performance might be mediated by the effects of cortisol in the prefrontal cortex, which promotes impairment in cognitive functions. Prolonged exposure to stress during different stages of development interferes with both academic achievement and executive functions that provide a basis for learning [2, 3].

Several studies conducted both in animal and human models indicate that factors, such as physical activity, sleep, and a healthy diet, promote optimal cognitive functioning and better academic performance. In this chapter, we discuss both the impact of psychosocial and physiological stressors on executive functions associated with academic performance and some strategies that reduce the impact of stressors. This manuscript compiles a comprehensive review of articles and books indexed in PubMed, SciELO, Scopus, and Google Advanced Scholar.

2. Stress

2.1. Neuroendocrine response

The term "stress" was coined by Hans Selye in 1936 and is defined as a non-specific response of the organism in the presence of any demand imposed. It is produced by the alteration of the cellular homeostasis, with physiological and psychological consequences in the body [1]. At molecular level, stressors can generate the activation of oxidative stress, which is explained by the imbalance of reactive oxygen species such as O_2, O_2^-, OH^-, H_2O_2, and the antioxidant molecules (vitamin C, E, flavonoids) [4]. Stress at cellular level is always present to facilitate the processes of cell proliferation, maintenance, and death [5].

At behavioral level, it is recognized that stressors are a threat to which the body requires adaptive adjustments that will allow it to maintain homeostasis and ensure the survival based on experience, biological predisposition, and the status of the organism [6]. During stress, three phases have been distinguished: (1) alarm, (2) resistance, and (3) exhaustion phase. In the alarm phase, the initial reaction of the body to a stimulus generating stress, which restores homeostasis; in this phase, the stressor promotes the stimulation of hypothalamus to secrete ACTH-releasing hormone (CRH). In the resistance phase, prolonged exposure to the stressor leads the exit of the stressful condition or adaptation. During the exhaustion phase, the gradual reduction of the stress response leads to the gradual loss of adaptive capacities [7].

The physical and psychological stressors can trigger the activation of neuronal circuits and peripheral process, for example the inflammation. Cytokines produced by the cells of the immune system can exercise their anti- or pro-inflammatory effect on the cells of the CNS and peripheral organs [8]. The IL-1, IL-6, and IL-17 act on the HPA axis by increasing the secretion of ACTH and cortisol [9]. The TNF-alpha has the ability to destroy certain cell lines and initiates the cascade of proinflammatory cytokines [10]. The regulatory suppressive function of the immune response will depend on the balance of the synthesis of cytokines. If the inflammation is prolonged, other systems will also be activated such as the endocrine system and neurotransmission systems (e.g. noradrenergic, serotonergic, and dopaminergic) [11] (**Figure 1**).

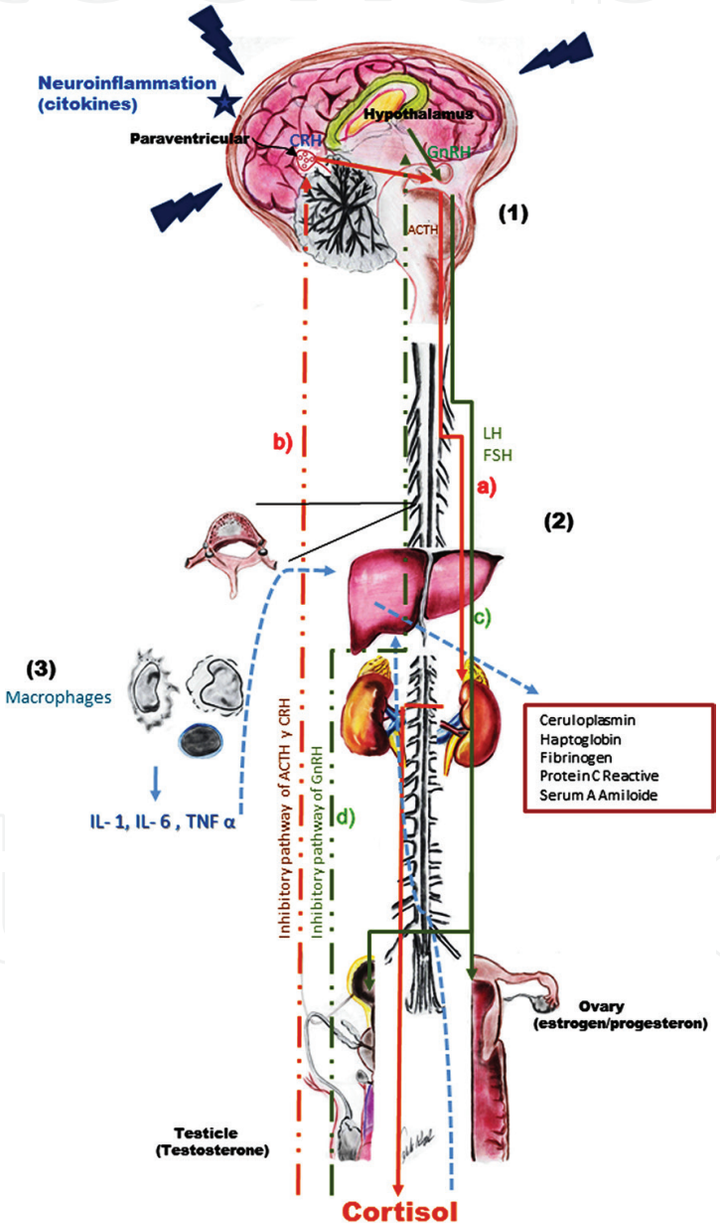


Figure 1. Neuroendocrine response to stressors. Stressors (physical, chemical, or psychological) lead to the activation of components of the endocrine system, brain, and systemic inflammatory processes. (1) Neural activation and neuroinflammation, (2) peripheral release of modulators of stress, and (3) inflammatory peripheral process. (a) ACTH release, (b) ACTH inhibitory pathway, (c) production of cortisol, and (d) cortisol inhibitory pathway.

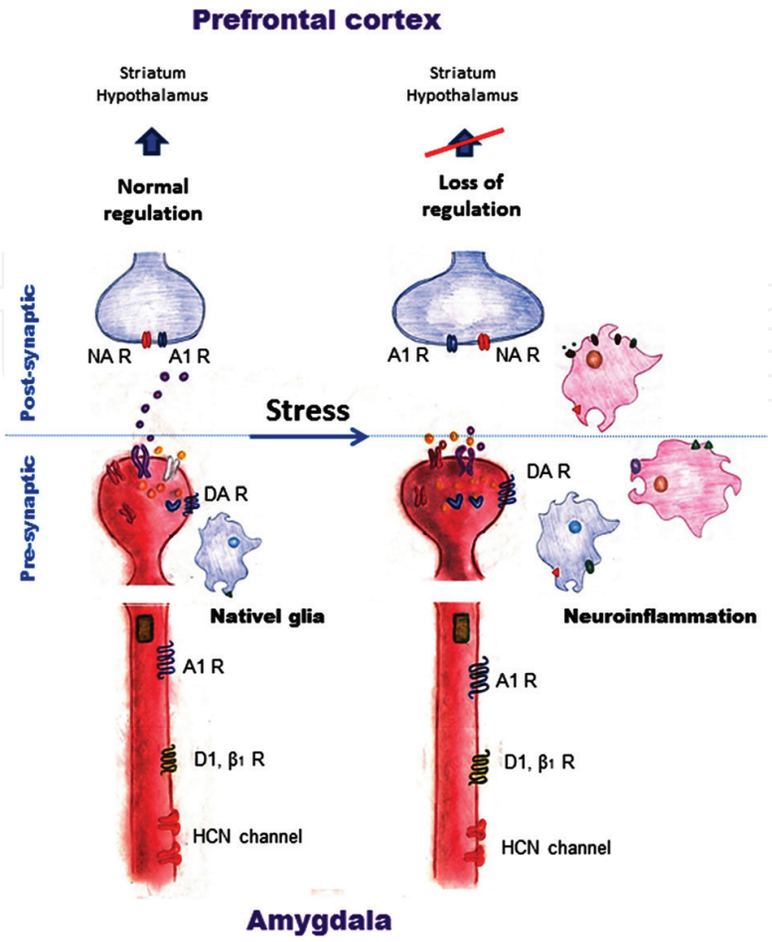


Figure 2. Overview of cellular process associated with executive functions.

Studies in humans and in experimental animals have shown that psychological stressor can suppress or increase the immune response, depending on the length of the stress (acute or chronic). Both in acute and chronic stress, physical exercise induces increase in the production of IL6, IL-4, IL-10, IL-13, IL-17, and TNFα [12]. However, few studies have explored the variation of cytokines in individuals with physical activity; in the case of the IL-17, it has been determined that their serum levels are not altered by the effect of practicing vigorous physical activity (chronic stress) [13]. The real impact of stressor is associated with intensity and frequency.

2.2. Stress and cerebral cortex

The prefrontal cortex allows efficient connectivity between the circuits associated with emotions, memory, and planning. An example of this is the intricate relationship with neurons of the *locus coeruleus*, *substantia nigra pars compacta,* and ventral tegmental area, by neuromodulators such as norepinephrine and dopamine. Despite to neuroanatomical location and catecholaminergic nature of its afferents, the prefrontal cortex is highly sensitive to damage; for example, during acute stress in rats, the neurites change shape and length over several weeks post damage [7, 14]. In preclinical studies in rats, two sensors and/or regulators of stress associated with the prefrontal cortex have been identified. (1) The direct connection with the

amygdala provides an important point of regulation. In the presence of stressful conditions, the prefrontal cortex becomes highly sensitive to damage due to the catecholaminergic nature of its innervating afferents. (2) The critical point of regulation of the amygdala to the prefrontal cortex is characterized by the promotion of the release of noradrenaline and dopamine, which will act at the level of different receptors (D1, D2, A1, β1), activation of hydrogen, calcium, and nitrogen bombs (HCN channels), and even as triggers of the release of neurotrophic factors such as BDNF and GDNF (**Figure 2**). In addition, the endocannabinoid-mediated pathway also acts as a regulator of stress and emotions [15].

Human studies have revealed that the "self-control of stress" can promote reduction of the action of the amygdala, and the subject can solve the stressful situation. An opposite situation will lead deleterious effect on mental and physical health. It has been determined that the absence of control of stress can promote the acquisition of addictive behaviors. During adolescence, addiction to nicotine [16], or even to the internet [17], causes cortical alterations due to decreased mesolimbic dopaminergic function [18]. Limited studies that have focused on this topic have opened a new line of study. Interestingly, the incidence of stressors can promote the establishment of three levels of response to stress in humans: (1) mesencephalic nuclei, (2) cellular response, and (3) systemic (immune-endocrine) [19]. This leads us to infer that: a lack of control strategies can promote alterations at these three levels, increasing the levels of cortisol in the blood, which has an impact on the psychomotor integrity of the individual. At present, diverse activities are being suggested to manage the impact of academic stressors, such as arts-based activities [20] or controlled physical activities [21].

3. Executive functions

Executive functions are a set of cognitive skills that allow for anticipation and establishment of goals, the design of plans and programs, the initiation of activities and mental operations, self-regulation, task monitoring, the precise selection of behavioral, flexibility for cognitive tasks, and organization in time and space. On the other hand, various authors have defined cognitive control as an "executive control" which refers to a set of higher order processes that modulate the interactions of the environmental context of the subject [22, 23]. These functions aim to optimize the selection, management, and coordination that underlie aspects such as perception, memory, and execution [24].

According to Diamond [25], the key executive functions are inhibitory control, working memory, and cognitive flexibility. Other functions, such as reasoning, planning, and organization, would be built from the three main functions. Other authors have defined the executive functions using warm and cold. Warm executive functions are cognitive/emotional processes related to decision-making, motivation, and social cognition. Cold executive functions are related to the rational/cognitive process of high order skills that are used when emotions are not an important factor [26].

Executive functions can be assessed using neuropsychological tests and are dependent on the prefrontal cortex. The frontal lobes plan, regulate, and control human behavior. This control

allows the individual to evaluate and select the most appropriate response and avoid impulsive responses, restraining compulsive behavior, and appetitive behavior. At neural level, the prefrontal cortex, particularly the dorsolateral portion, is a fundamental region involved in executive functions. Other regions, such as the orbitofrontal cortex portion, are closely related to the limbic system. The thalamus and the basal ganglia are brain regions also involved in executive functions [27].

3.1. Executive functions and academic performance

When a child enters school, he/she is in need of a series of cognitive processes (comparison, attention, differentiation) to be able to develop reading and writing and mathematical calculation, that is why, a proper neurological maturation is essential to deal successfully with the demands of learning, as the alteration of cognitive processes translates into learning problems [28].

The predictive effect of executive functions on academic performance is important for the proper adaptation of the individual to the specific requirements of a learning context; the correct development of the executive processes makes it possible for the individual to recognize and represent mentally different problematic situations, in addition to designing strategies for the resolution of them. There have been some works that have focused on evaluating executive function and academic performance.

A study was conducted in which the relationship between performance in mathematics and the performance in tasks of working memory and processing speed was assessed, finding that children with normal performance in the area of mathematics were faster and had greater accuracy in responding to tasks that required numerical identification, recovery and retention of numerical information, and ability to do mathematical calculations in relation to children with poor performance. In error-detection tasks, both groups of children (low performance and normal performance) could recognize the errors without difficulty. However, children with poor performance failed in the detection of such errors at a rate of 1 of 3 tests [29]; one of the explanations of the authors is that there is an inappropriate intervention of the central executive that regulates cognitive processes such as the transmission of information to long-term memory, planning, and recovery strategies.

Blair and Razza [30] conducted a longitudinal study in which they measured the capabilities of the temperamental factor associated with self-control (Effortful Control), understanding of false belief, inhibitory control, and shift of attention. The objective was to study the relationship between some skills involved in executive functions and academic performance in mathematics and language. The results showed that the scores of children at the initial level, in shift of attention and inhibitory control, did not predict performance in the tasks of phonological and letter recognition. However, the scores on inhibitory control were related with the performance at the mathematical tasks during pre-school period (3–5 years). During this period, the scores of inhibitory control and attention shift were associated with the literary capacity of children (phonetic recognition and knowledge of letters).

A longitudinal study in children from 5 to 7 years evaluated the way in which short-term memory, working memory, inhibitory control, cognitive flexibility, and planning impacted on

academic performance. The results showed that performance on tasks of short-term memory and working memory was associated with better initial performance of children in reading and math skills. Likewise, analyses of correlation and regression carried out revealed that the visuospatial memory and working memory operated as predictors of children's mathematical performance in all the periods in which they were evaluated. On the other hand, inhibitory control, flexibility, and planning acted as predictors of general learning capacity, but were not associated with the performance of any specific domain [31].

Reyes and colleagues [32] found that the correlation between the variables identified significant relationships between academic performance and executive functions. At the age of 6, significant correlations are found between selective sustained attention and working memory with all the courses understanding that these courses require the constant ability to select the most important information and focus attention for long periods of time within the classroom, mainly in the areas of Math, English, and Social Sciences; considering that the children of 4–6 years have short periods of sustained attention in the presentation of a task, from 6 years, the attention that children can give to a task or to a game can be extended for a long time.

In summary, the different studies mentioned show that a good academic achievement is predictive of the executive capacity that individuals have, this must be considered to promote strategies for improvement in the executive functions of the students through training to have impact in academic performance.

3.2. Stress and executive functions

One of the factors that can affect executive functions is stress. As we mentioned earlier, stress occurs when demand exceeds the regulatory capacity of the organism. It is very difficult to determine the extent of the impact and the duration of daily stress, especially if in acute stress situations where the individual is facing situations with a physical or psychological stimulation in which he/she must decide quickly or make an assessment of a particular situation. Stressors promote physiological, psychological, and behavioral reactions, but individuals react differently to stressors. That makes a laboratory setting very useful for the study of the psychophysiological responses to stressors of different nature, which allow evaluate subjects under controlled modulatory variables [33].

There is evidence of the negative effect of high levels of circulating of stress-induced glucocorticoids on cognitive performance [2, 34]. The different studies related to declarative memory tasks have focused on the hippocampus [35, 36]; some other studies have examined the effect of stress on working memory [37], which has shown that the administration of cortisol can also adversely affect the performance of the working memory [35, 38]. Some authors have evaluated one or two components of the executive functions under conditions of stress where they have observed that stress can reduce attention in inhibition [39, 40]; the administration of tasks assessed with paradigms of dual task was improved under stressful conditions [41], while the administration of tasks through a paradigm change of tasks was observed to be impaired under conditions of stress [42]. A systematic study investigated the effect of stress in five components of the executive functions: attention and inhibition, task management,

planning, monitoring, and coding. The results showed that stressed participants had a better performance compared with non-stressed participants in all the components with the exception of the monitoring [43]. One study evaluated the relationship between specific stressors and deficits in executive functions in undergraduate students. The results determined that general social abuse was the factor most correlated with deficits in executive function. Factors such as challenges of development (struggle and dissatisfaction with cognitive and physical attributes and abilities) and dissatisfaction with school were also predictive of diminished executive functions [44].

Chronic stress can generate high levels of cortisol in the prefrontal cortex, which can lead to an impairment of cognitive functions. There is evidence that stressors such as bullying and addiction can affect the executive functions; although they are not the only existing stressors, they are to be found with higher prevalence in the school setting.

Questions about how stress can affect or improve behavior are important in different contexts and in this particular case on academic performance. One of the factors that interfere suggests that the controllability is a key factor on the impact of stress on behavior; to learn how to control stress-causing factors protects people from the negative effects of stress in tasks of high cognitive demand. In addition, research suggests that the impact of stress on cognitive functioning depends on an individual's response to stressors: moderate responses to stress can lead to improved performance, while extreme responses (high or low) can lead to a low performance [45–47].

Factors such as bullying and addictions stimulate stress by promoting specific neurophysiological responses, followed by alterations in executive functions. Components such as physical activity, good nutrition, and sleep hygiene can reduce academic stress and its neurophysiological consequences (**Figure 3**).

3.3. Bullying

Bullying is characterized by intentional, repetitive, and persistently aggressive behavior causing harm to a victim [48]. Several studies have investigated the social and emotional aspects related to bullying; however, few studies evaluate how cognitive aspects are involved. Studies

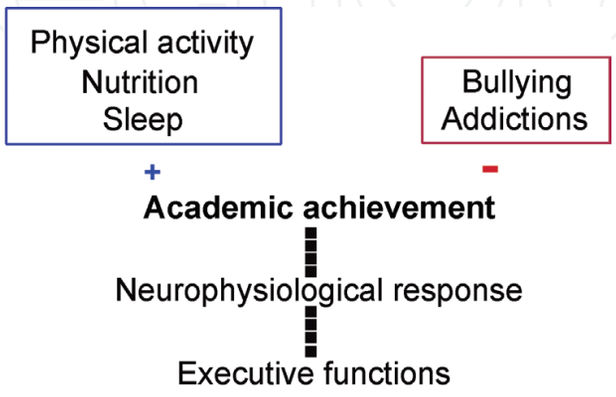


Figure 3. Interaction of positive and negative components in academic achievement.

with aggressive individuals indicate a malfunction in cognitive functioning and decision-making. One study found that children who were not involved in bullying situations such as bullies or victims had better scores on intelligence tests. Both victims and bullies had greater difficulties in the inhibitory control according to the reports given by the parent version of the Behavior Rating Inventory of Executive Function (BRIEF); the result suggests a probable deficit in executive functioning related to being involved in situations of bullying [49].

Medeiros and collaborators evaluated decision-making, inhibitory control, working memory, and cognitive flexibility in children. They found that the bully made less favorable decisions in assessments for decision-making, while the group of victims took more time to complete assessments of cognitive flexibility. This study suggests that bullies have difficulties in warm executive functions, while victims have lower performance in cold executive functions [50].

3.4. Addictions

The association between the low academic performance and the use of alcohol (risk consumption) has been studied by several authors in the literature [51]. Due to their biological limitations in the ability to engage and integrate executive functioning, teens are very susceptible to the noxious consequences of the use of tobacco, alcohol, and other drugs. Unlike adults, alcohol causes greater impact on the brain of adolescents and young adults in the areas of working memory and learning. The early onset of nicotine use leads to deterioration in memory capacity and increases the frequency of episodes of depression and heart irregularities. Marijuana consumption associated with low academic performance has been described [52]. Other drugs, such as stimulants and opioids, are directed to the dopaminergic receptors in the brain and can cause damage throughout life to the development of impulse control and the ability to experience reward. Substance abuse contributes to the delay in skills of the executive functions and in immature or under-controlled emotional responses

4. Strategies for the good academic performance: Physical activity, sleep, and diet

4.1. Physical activity

Several studies conducted on animal and human models provide sufficient evidence for an important relationship between various factors such as physical activity, sleep, and healthy food, with optimal cognitive functioning. This invariably leads to a better academic performance. These studies have been conducted through different stages of development, from prenatal to old age. Some of the cognitive functions that may be affected by the activities or changes throughout life are short-term and long-term memory, learning, attention, spatial memory, and working memory, among others. Evidence suggests that the connection between these cognitive functions, physical activity, nutrition, sleep time, and social interactions have a direct impact on the structure and function of the central nervous system [53].

Consequently, cognitive control has been implicated as an important and necessary component of academic performance, in that it relates to brain areas that are involved in processes of behavior and processing of information required to interact with the environment in both children and adults. Neuroimaging studies such as magnetic resonance imaging (MRI) have been used to demonstrate potential mechanisms by which physical activity improves cognitive health. These techniques have demonstrated that physical activity improves the function and structure of the brain [53, 54], possibly associated with an increase in the neuroplasticity, and neurogenesis due to BDNF which can be measured peripherally in blood serum or plasma (pBDNF) [55]. Therefore, it is possible to analyze a direct correlation between physical activities with neurocognitive changes and subsequent blood analysis directly after the physical activation. BDNF belongs to the most important family of proteins in the brain, which plays an important role in neurogenesis, synaptic plasticity, learning, and memory. Therefore, a low concentration of pBDNF can lead to a poor execution of cognitive tasks associated with spatial memory in the hippocampus [56].

Physical activity is defined as bodily movement that requires energy output above normal with physiological demands, which can be measured through records and data obtained by accelerometers or other devices. It has been demonstrated that physical activity can have an indirect effect on the body by reducing stress and with it, the oxidation and inflammation, improving cognitive function, and reduced risk of developing dementia [57]. In addition, it has also been observed that a decrease in physical activity coincides with an increase in age. This in turn shows an impact on the functioning of neurotransmitters of the dopaminergic system [58], which is important for both processes. The absence of dopamine can anticipate problems with working memory and learning [59]. It has also been suggested that there is a relationship between cardiovascular exercise and the volume of gray matter in the hippocampus and prefrontal cortex in the elderly population, which results in an improvement in the memory. Other self-report studies of subjects with memory problems have shown that physical activity over 6 months significantly improves memory compared with those subjects who did not perform physical activity as a control group [60].

Recently, a group of researchers conducted a comprehensive analysis of studies done in humans over the past 15 years. The aim of this study was to determine the relationship between various factors, such as age and physical activity, and the performance of cognitive skills and memory. The results showed a strong relationship between cognitive skills and physical activity, which reduced by up to 10% the risk of developing neurodegenerative diseases such as Alzheimer's and dementia. In addition, they also showed that the intensity of exercise impacts differently on the functions and cognitive skills. For example, low-intensity aerobic exercise has a positive effect on visual perception and attention, while moderate physical activity impacts in a general way the cognitive skills such as memory, verbal memory, and attention. The previous, intense exercise requires much more attention and less cognitive processing due to a reduction in reactions, selective attention, and flexibility toward the tasks. Currently, there is controversy about the type of exercise and the greater benefits in the cognitive performance; in this sense, this study suggests that physical activity is without doubt a good factor of cognitive improvement, but more studies are needed on the intensity, type of exercise, and cognitive activity, which deserve to be analyzed in depth and from different scientific points of view [61].

In summary, all these studies point to the fact that physical activation at different stages of life is an important factor for the maintenance of a healthy body and, in addition, for mental health and cognitive therapy. In children, physical activity significantly improves selective attention, working memory, and learning diminishing behavioral problems and overweight and improving their academic performance. In adults and the elderly, it prevents the deterioration of memory and improves the execution of tasks, as well as maintenance of optimal mental health through the activation of the dopaminergic system and neurogenesis, which can prevent the development of neurodegenerative diseases [62].

4.2. Sleep

Today, reduced and/or disrupted sleep has become common among people of all ages, including pre-school children. The reduction in the hours of sleep in adolescents is considered a public health problem by the American Academy of Pediatrics. These changes can lead to the deterioration of various physiological functions, particularly in the brain, such as learning, memory, and the deterioration of cognitive processes and therefore of academic performance. Sleep is a physiological process controlled and orchestrated by diverse brain areas, including the cortex, brainstem, hypothalamus, thalamus, and hippocampus, and the release of neurotransmitters that in addition to generating the wake-sleep cycle is also involved in the execution of tasks and behaviors on a daily basis [63]. It has been suggested that during sleep there is a flow and storage of information between the hippocampus and cerebral cortex; the interaction between these areas promotes the consolidation of information gained during the day, suggests that the storage´s model promote the short-term memory consolidation into hippocampus, and long-term memory on the brain cortex [63]. In the first place, it is known that Rapid Eye Movement (REM) sleep and slow-wave sleep (NREM) provide different processes of memory storage, for example, it has been proposed that NREM facilitates declarative memory or explicit memory, while REM facilitates the non-declarative or procedural memory and learning [64]. During NREM sleep, the hippocampus consolidates the memory and transfers the information to the cortex for the long term. Stickgold and colleagues suggest that during REM sleep cortical plasticity could be promoted, which plays an important role in procedural memory or in a high-level cognitive processing, but not so in episodic memory bound to a hippocampal process [65]. In addition, it is believed that the processes of neuronal plasticity take place both in the NREM [66] and in the REM [67].

The pace of activity currently has led us to a reduction and alteration of the wake-sleep cycle and with that the presence of many disorders associated with this. It is for this reason that many studies have focused their attention on studying the deleterious effects of deprivation and/or alteration of sleep on different processes of the body as is cognitive deterioration. Currently, sleep deprivation is very common among students, which have been associated with poor academic performance and a decrease in physical activity. For example, numerous investigations have found evidence that sleep in infants plays an important role in the consolidation of memory, making the process more stable and less prone to forgetfulness [65]. Another study conducted on infants from 6 to 12 months of age showed that taking naps for at least 30 minutes significantly improves learning and memory in association

with objects in comparison with those infants who did not take naps. In addition to the benefits on learning and memory, it has been shown that naps may be beneficial for language learning. It is known that the sleep in adolescents may be affected by the use of electronic devices at night. This directly affects the neurons of the suprachiasmatic nuclei and the pineal gland, inhibiting the secretion of melatonin and delaying or disrupting sleep. In addition, the wavelength and intensity of light can negatively affect attention during the morning [68]. Given that the use of electronic devices may not be restricted completely, it is advisable not to use them at night in order to avoid the effects on sleep and health in general. In adults, a short nap has an impact on stress response. Cognitive disorders, such as the formation and storage of memory, including attention, executive functions, emotional reactivity, decision-making, and judgment, result in a reduction of their quality of life in general [69]. In this sense, a good night sleep is an essential factor for maintaining mental health on cognitive processes associated to learning and academic performance such as memory, attention, perception, and physical activity.

4.3. Nutrition

Academic performance may be susceptible to change or impact on various factors, such as those we have previously addressed like sleep and physical activity among others. However, it is important to know if the supply or nutrition can modify the student's academic performance or cognitive functioning, with the aim of generating strategies that support mental health in school-age children and adolescents. During childhood and adolescence, eating behaviors are very important. Given that in this stage, brain uses the most glucose or energy to the processes of attention, memory, and learning [70].

In addition to the breakfast hours, various analyses have noted the relationship between the types of food and academic performance. For example, fast food or "junk food" which contains the greatest number of calories and few nutrients. It was noted that low consumption of this type of food is associated with a better academic performance in children of preschool age, particularly with less consumption of sugary drinks [71]. As was expected, the intake of vegetables and fruit improves academic performance, although more studies are needed in this regard in different population [72].

A group of researchers recently analyzed the dietary effect of breakfast on scholar achievement in children from 8 to 15 years of age. The research consisted of a variety of diets such as fruit, vegetable, and sweetened drinks. The goal of the research was to analyze the relationship between the consumption of these diets and the grades of the students. The results showed that diet is associated with higher academic grades in children who consumed vegetables and fruits compared with those children who consumed sweetened drinks, who showed the lowest scores, mainly in grammar, reading, and writing [73].

The consumption of proteins and other nutrients from a diet of fish showed that there also exists a significant association related to academic performance and vocabulary scores in a study that observed 700 students between 12 and 18 years of age in the Netherlands. Nevertheless, more studies are necessary with respect to age, sex, and academic trajectory, as well as with different populations [74].

On the other hand, a recent study of a meta-analysis of 226 patients in a random study demonstrated that resveratrol, a natural phenolic compound contained in a normal diet, has been attributed to have a wide spectrum of biological properties, such as anti-carcinogen, anti-inflammatory, and antioxidant, in addition to a therapeutic effect on cognitive disorders. Resveratrol does not have an effect on memory or cognitive skills, including linguistic ability or retention of information [75].

However, the direct consumption of vitamins and other nutrients, such as iron, omega 3, among others, also shows a solid relationship between academic performance and intake [76]. The majority of studies suggest that there is an important association between the selective consumption of foods with the cognitive and academic performance. It is, therefore, necessary to research this further using animals in pre-clinical studies to provide sufficient evidence of the effect of diet, nutrients, and the quantity of food on the cognitive capacity and academic achievement.

5. Conclusion

This chapter has looked at studies in executive function and stress through the eyes of neurophysiology. Self-control of stress can promote a reduction in the action of the amygdala, and the subject can resolve the stressful situation. However, if we do not have control, it will cause alteration in the prefrontal cortex affecting the mental and physical health of the subject.

In relation to academic stressors, the lack of control strategies can promote increasing blood cortisol levels, which affect the psychomotor integrity of the individual. One of the factors that can affect executive functions is stress. The relationship between specific stressors and the deficit in executive functions in academic performance includes factors such as bullying and addictions. This knowledge leads to creating information strategies to alert teachers and parents about the consequences of these factors on cognition.

This chapter has also described a number of interventions designed to increase the level of executive function. Physical activity, good sleep, and nutrition at different stages of life are important factors for the maintenance of the body health. These are essential factors for maintaining mental health on cognitive processes associated with learning and academic performance such as memory, attention, and perception. The authors contend that using any of these different techniques may prove successful in alleviating the chronic or acute stress that permeates the school setting and is predictive of executive function deficits.

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