DESARROLLO DE LAS FUNCIONES EJECUTIVAS EN NIÑOS PREESCOLARES: UNA REVISIÓN DE ALGUNOS DE SUS FACTORES MODULADORES

DEVELOPMENT OF EXECUTIVE FUNCTION IN PRESCHOOL CHILDREN: A REVIEW OF SOME MODULATORS FACTORS

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RESUMEN

Durante el transcurso de las últimas dos décadas, se ha generado un creciente interés científico en el estudio del desarrollo de las funciones ejecutivas (EF) durante el periodo preescolar. Dicho interés, ha nacido en parte del notorio desarrollo que tales procesos experimentan durante este periodo. Asimismo, numerosas investigaciones han hallado un vínculo entre el rendimiento en tales procesos, y la presencia de diferentes trastornos psicopatológicos. El presente artículo, constituye una revisión del desarrollo de las EF durante el periodo preescolar. El objetivo que se persigue en el mismo, es describir los cambios observados a nivel cognitivo-comportamental en el FE durante este periodo; vinculándolos a sus posibles bases anatómico-funcionales. Asimismo, se procurará analizar el impacto de algunos factores considerados moduladores de este proceso sobre el mismo. Se concluirá destacando la necesidad de profundizar en el estudio de los factores moduladores de tal desarrollo, dada la importancia que las EF presentarían para la adaptación del individuo al ambiente.

Palabras claves: Factores moduladores, funciones ejecutivas, neurodesarrollo, preescolares.

ABSTRACT

During the course of the last two decades, there has been a growing scientific intresting in the study of exective functions development during preschool years. This interesting arise in part in these processes experience considerable development during this period. Also, numerous studies have found a link between performance in these processes and the presence of different psychopathological disorders. This article is a review of EF development during preschool years. The objective pursued in it, is to describe the observed changes in EF in cognitive-behavioral level during this period, linking them to those potential anatomical -functional bases. Although, we will analyze the impact of some factors considered modulators of this process. We concluded emphasizing the need for further study of the factors modulating such development, given the importance of EF for individual's adaptation to the environment.

Key words: Modulators Factors, Executive Functions, Neurodevelopment, Preschool

Introduction

Executive functions (EF) is a controversial construct, under which are grouped different cognitive processes directed towards the suppression or inhibition of reactive tendencies or automated and regulation of behavior according to the achievement of goals (Garon, Bryson & Smith, 2008) . Among these have been considered: working memory, attentional control, inhibitory control, planning, cognitive flexibility, among others. During the course of the last two decades has generated widespread interest in the study of EF development during childhood. This interest arose as part of the link between such processes and found different psychopathological and behavioral disorders in both adult life as in childhood (Biederman et al., 2010; Närhi, Lehto-Salo, Ahonen, & Marttunen, 2010) . Furthermore, differences in executive performance have been associated with higher social skills and better academic performance (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009, Carlson & Moses, 2001; McClelland, Cameron, Connor, Farris,

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Jewkes, & Morrison, 2007; Rueda, Posner, & Rothbart, 2005). Given the importance of the success of such processes involved for the proper adaptation of the individual to his environment, the recognition of periods of increased sensitivity in executive development, is a key task in the design of educational and social policy. Likewise, the identification of the different variables that influence on the process, facilitate the design of specific intervention programs, for populations most vulnerable.

While different executive functions, have dissimilar development curves, many authors have noted that performance in various tasks considered executive experience significant improvements during the preschool years (Carlson, 2005). Furthermore, these advances have been linked to the maturation of specific cortical regions during this period (Garon, Bryson, & Smith, 2008; Gogtay et al., 2004) Such findings would be consistent with the hypothesis that the preschool years, constitute a the most sensitive periods for development of executive functioning (EF).

Depending on the importance of such period, the present paper is a review of different jobs for the study of development of the FE. In this, it aims to describe the changes observed in the FE in cognitive-behavioral, as well as possible anatomic-functional bases associated with them. Also seek to analyze the impact of some factors considered modulators of this process during this period: the nature of parenting, health and nutritional status of child temperament and socioeconomic status of this.

Cognitive models of executive functioning.

At present coexist different cognitive models that attempt to account for the EF construct. Some of these, suggest that the EF constitute a unitary construct that has a number of sub-processes associated (Braddeley, 1986, Norman & Shallice, 1986). An example of such a view of executive functioning (EF), are models of Norman & Shallice (1986) and Braddeley (1986). The first authors have postulated that cognitive control processes involved in Fe, are characterized by the intervention of a supervisory attentional system (SAS), which regulate different sub-processes linked to it. On the other hand, are designed Braddeley EF model focused on the role of working memory. This model postulates the existence of a central executive system, which controls and integrates information from two subordinate subsystems, called respectively, articulatory loop and visuo-spatial.

By contrast, other authors emphasize that there would be a series of differentiated processes behind the EF construct (Carlson, Moses & Claxton, 2004, Davidson, Amso, Anderson, & Diamond, 2006). Ie, there would be a central process which modulates the activity of different sub-components. For example, Diamond (1997) has postulated that working memory and inhibitory control would be dissociated components together, would present independent developmental trajectories. Likewise, other authors in favor of a non unitary construct, have used the factor analysis of the results of the tests considered executive, for the establishment of the different components of EF (Miyake et al., 2000). On the other hand, other researchers have used neuroimaging techniques to the recognition of the different components involved in executive control (Aron, Behrens, Smith, Frank, & Poldrack, 2007; Aron, Durston, Eagle, Logan, Stine, & Stuphorn, 2007). That is, have linked the various processes involved in Fe, the activity of specific neuronal networks. Such partnerships would enable the discrimination of the different components of the construct.

From another perspective, Zelazo (2003) has proposed a functional view of FE, in which the ability to solve problems involved in it, could be divided up into different sequences of «representation» execution «are intended to achieve a goal. These steps involve: (a) representation of the problem, (b) planning the action to perform, (c) implementation of the previously established plan, and finally (d) evaluation of the results. Each of these steps require the ability of individuals to build and run systems of conditional rules (representations) that regulate the behavior, thoughts and emotions as the achievement of a goal. Different executive functions considered, would be involved in differential mode in the different steps for troubleshooting. Thus, the functional perspective of the EF proposed by Zelazo, facilitate the study of executive control process in the framework sequence of specific actions aimed at solving problems.

On the other hand, the author (Zelazo, 2003) raises a distinction between executive functions such as «hot» and executive functions of type «cool. « The first would be

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linked to the control of motivational and emotional processes. Ie, they would be linked to the representation of rules involving the control of behavior in the presence of stimuli associated with reinforcement or punishment. On the contrary, the executive functions of such «cool», were linked to the tasks of an abstract or decontextualized. That is, conditional rules attached to them emotionally neutral stimuli represent. An example of the use of such rules, would be reflected in attentional control tasks. On the same subject must respond differently depending on the characteristics of the stimulus that trigger this (ie before the presentation of a triangle, press the «x» to the presentation of a circle, press the «y «) . The stimulus and context of presentation, in such tasks would be emotionally neutral, that is, they should not promote emotional response in the rat. However, if the set of stimuli - eg pictures of stimuli associated with rewards or punishments, «evoke an emotional response or motivational in the subject, and the goal of the task would be to reach the regulation or inhibition of that response, the rules that the participant should generate involve executive control processes such as «hot.

FE development in cognitive-behavioral

Zelazo (2003) to postulate that the improvement in the FE observed during the preschool years, they would be linked to the growing capacity during this period, using hierarchical systems of mental representations (rules) to regulate behavior. Furthermore, these changes have been correlated with the development of social skills and emotional regulation (Carlson & Moses, 2001, Carlson & Wang, 2007; Zelazo & Cunningham, 2007).

Some studies have shown that after two years of age, children have difficulties with the use of pairs of arbitrary rules to classify different objects (eg classify vs noisemakers. silent objects) (Garon, Bryson & Smith, 2008) . Also, children of that age tend to persevere in such tasks using one of the criteria for classification. Subsequently, close to 3 years of age, infants acquire the ability to represent and use contrasting pairs of rules together (Zelazo, Craik, & Booth, 2004). However, these children have difficulties in having to switch on the use of incompatible pairs of rules (Zelazo, 2003). Finally, between 4 and 5 years of age, the ability to switch between the use of conflicting rules is greatly improved.

Consistent with the above, Carlson (2005) has found that children's ability to respond to tasks involving the use of abstract or decontextualized rules considerably improved during the course of 3 to 5 years of age. Also, Hongwanishkul, Happaney, Lee, & Zelazo (2005) have shown that the performance of children in tasks such demands improvement during the course of 4 to 5 years of age. Finally, these findings are in line with previous research (Diamond, Prevor, Callender, & Druin, 1997, Frye, Zelazo, & Palfai, 1995).

On the other hand, with regard to the development of capacity use rules involving the control of stimulus-reward associations simple, «Delay of gratification Paradigms, « Hongwanishkul et al. (2005) have observed that children's performance on tasks that demand is optimized during the course of 4 to 5 years. These authors have postulated that these changes would reflect the development and maturation of neural systems associated with these functions (orbitofrontal cortex [OFC], anterior cingulate cortex [ACC] ventral).

Anatomic-functional basis of executive functioning

From the anatomical point of view, executive functioning (EF) has been linked mainly to the activity of the prefrontal cortex (PFC) (Zelazo, 2003) and previous cingulate cortex (ACC) (Posner, 2007). In regard to the CPF, it has been associated with the representation and use of rules to regulate behavior, thought and affection. The activation of this region would be noticeable when to use conditional rules have not been automated or ad hoc must be generated in an unfamiliar environment. The CPF is composed of different sub-regions, among which include: the orbitofrontal cortex (CPFOF), the ventrolateral cortex (CPFVL), the dorsolateral (DLPFC) and cortex lateral face (CPFRL). Different studies have indicated that such regions would be involved in differential mode in the representation of rules aimed at regulating the behavior. On this point, the CPFOF has been linked to the ability to generate simple rules that regulate behavior based on stimulus-reward associations. This link is based on some studies that show that, both in humans and primates, damage to this region impairs the ability of the deferral of rewards (Dias, Robbins, & Roberts, 1996, Rolls, Hornak, Wade, & McGrath 1994 .)

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On the other hand, the DLPFC and CPFVL have been associated with the representation of sets of conditional rules univalents and bivalents. Univalent rules are characterized by a linear association between stimulus and its corresponding response. That is, before the presentation of a stimulus «X», the subject must express a particular answer «Y». An example of such a rule would find in urban management laws, in which the driver must go before the green light and stop at red lights. By contrast, in the case of bivalent rules, the required response to the stimulus presentation, would vary depending on the contingencies of the context in which that stimulus is presented. Following the example above, an example of bivalent rule would green light to move forward, however, if an accident when it occurs, the driver must stop. Some studies in primates CPFVL injured in that region show that learning is critical to univalent and bivalent rules. Furthermore, studies with functional MRI (fMRI) in humans, show that both the DLPFC CPFVL as active for the maintenance of sets of conditional rules. Also, both regions show a higher level of activation when it comes to keeping bivalent rules or abstract (Crone, Wendelken, Donohue, & Bunge, 2006). Some studies (Crone et al., 2006) have shown that the DLPFC is particularly engaged when subjects have to switch the use of a bivalent rule on the other, thus eliminating the previously used rule. On the other hand, research in humans and primates show that CPFVL is particularly involved in the process of representing sets of conditional rules. Thus, the DLPFC would be involved primarily in the suppression of interference from previously learned rules, while the CPFVL in the representation of conditional rules.

Development of neural networks associated with executive functioning

As mentioned earlier, although the development of the various executive functions has different maturational curves, numerous studies have shown that during the preschool period there is a significant development for much of the same (Carlson, 2005; Garon, Bryson & Smith, 2008; Zelazo, Craik, & Booth, 2004). Some authors have speculated that the emergence of such capabilities would be based on the maturation of neuronal circuits involved in Fe (Bunge, 2004). Thus, during this period would be a remarkable maturity and refinement of the inter-neuronal connections between the prefrontal neural networks, which would enable an abstract representation of rules to govern the conduct, and other brain regions such as the cingulate cortex anterior (ACC) and limbic areas.

Some studies indicate that the different regions involved in the PFC, the orbitofrontal region is the first reaches adult levels of brain configuration. By contrast, the DLPFC CPFVL and more ripen late (Gogtay et al., 2004). Also, cross-sectional studies suggest that CPFRL shows slower rates of maturation within the CPF (O ‘Donnell, Noseworthy, Levine, & Dennis, 2005).

On the other hand, Crone et al. (2006) have observed, through the use of fMRI-greater activation of the DLPFC to the stimulus presentation bivalent character in children 8 years. However, such experiments have been conducted in younger children. Thus, there is evidence indicating that the changes in the use of rules in children between 8 and 12, are based on changes in the DLPFC. However, it is still necessary to study whether these changes constitute the basis of the behavioral changes observed during the preschool years (Zelazo, Craik, & Booth, 2004).

Possible factors modulating the development of executive functioning during the preschool years

Many of the factors modulating executive performance during the preschool years, have an impact prior to this period of cognitive development in general and the first manifestations of executive control processes in particular. This fact, hinder the study of how each of the modulating variables considered governs the FE during this specific period. Some studies have indicated as possible factors modulating the characteristics of the stimulation provided by foster parents, how they exercise discipline over the child, the sensitivity and responsiveness of these-the health and nutritional status the child, the same temperament, the socio - economic development of eastern and health status of parents. Depending on the values that such factors may have previously experienced the impact of these during the preschool years might be different. For example, children who have suffered prenatal iron deficiency have an increased impact of this factor on the deficit FE persist during the period considered (Georgieff, & Schallert, 2006; Lozoff, Beard, Connor, Felt, Lukowski et al ., 2010).

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Sheese work, Voelker, Rothbart, & Posner (2007) and Voelker, Sheese, Rothbart, & Posner (2009) are paradigmatic examples of studies that investigate the influence of paternal parenting quality on the development of control mechanisms executive in infants. Sheese et al. (2007) analyzed the influence of paternal parenting quality on the expression of genotypes that showed children involved in the gene encoding dopamine receptor D4 and children who had no repeat allele 7. This gene has been linked to attention deficit disorder with hyperactivity (ADHD) and personality trait called «sensation-seeker. « These authors found that behavioral expression level of children with a genotype with allele 7 repeated, varied depending on the quality of parenting. Thus, it was observed that parents classified as a «foster high quality» - although they had children which showed temperamental characteristics of the trait «sensation seeker» - the scores of these children for this feature were lower than that of children parents with low scores on «quality of parenting. « The latter had higher scores for the trait. Finally, children without the 7 repeat allele did not show any influence of paternal parenting variable on the scores for the trait «sensation-seeker.»

On the other hand, Voelker et al. (2009) examined the relationship between COMT gene haplotype variations, gene involved in dopamine degradation, paternal parenting quality and performance of children 2 years of age on visual attentional tasks sequencing. The results of this study revealed that the presence of certain haplotypes (haplotypes grouped as «low pain» [low pain haplotypes]) - had better attentional performance only when the group was connected to a high quality of parenting. Thus, the results obtained from both studies (Shesee et al., 2007, Voelker et al., 2009) showed that the interaction between quality of breeding and genetic makeup, plays an important role in the development of self control (Shesee et al., 2007) and FE (Voelker et al., 2009).

On the other hand, a significant portion of the literature on the relationship between nutrition and cognitive development of children, has focused on the impact of inadequate incorporation of nutrients might have on it. Within this, it is considered as malnutrition, deprivation excesses or imbalances in energy intake, protein and / or other nutrients (Mata, 2008). This concept would include both under-nutrition as overeating.

Several studies have linked malnutrition structural and functional disorders of the brain. At the structural level, malnutrition cause growth retardation brain at prenatal and postnatal alterations in cell differentiation, reducing the number of synapses and neurotransmitters, delayed myelination and reduced expansion of dendritic arborization. The changes observed in brain maturation, in turn alter the formation of new neural circuits and their subsequent refinement. Such changes could produce permanent changes together at a cognitive level (Levitsky & Strupp, 1995).

As for the impact that malnutrition would have on the FE, Bhoomika, Shobini & Chandramouli (2008) have found that infants who have chronic deficiencies in protein intake show a delayed development of certain executive processes. Moreover, such alteration could lead to permanent deficits in the FE of children that would not be compensated by increasing age. Based on these results, Bhoomika et al. postulated that since the FE is a remarkable development during the preschool period, this would be strongly committed to nutritional deficiencies experienced during the course of it.

On the other hand, numerous studies have linked socioeconomic status of the child with the presence of alterations in nutrition, child health and parenting. As the phenomenon of poverty is a multidimensional phenomenon, for the purposes of this article, we will mention some of the main alterations found in the values of these modulating factors. At the nutritional level has been observed in children raised in situations of chronic structural poverty, the presence of deficits of iron and folic acid during prenatal development. A level of health, immunological and growth. In terms of parenting, parents with less care and attention abilities of their offspring. These factors would impact the development of the processes of attention, inhibitory control, planning and working memory (Lipina, Martelli, Vuelta, Injoque-Ricles, Colombo, 2004).

Conclusions and future directions

During school, the child must have the ability to regulate their behavior according to the activities proposed by the teacher, keeping a level appropriate to the motivational and attentional performance in the same optimum. Also, the child should be able to inhibit their response to stimuli that may

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alienate the achievement of the goal set by the teacher. Finally, the child must have acquired a number of social skills that allow you to interact with peers, adjusting their behavior to the set of rules the school system (eg waiting for turns, modulation of emotional expressions according to school context [actors present , Setting, etc..]).

The proper development of executive control processes experienced during the preschool years, will enable the infant to adapt to the above series of demands (Brock et al., 2009, Duncan et al., 2007; Graziano, Reavis, Keane, & Calkins, 2007, Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003, McClelland et al., 2007). Numerous investigations have shown that some alterations in the development of FE could expose infants to situations of school failure and exclusion by their peers and teachers (Blair, 2002; Blair & Razza, 2007, Bull & Scerif, 2001). Likewise, deficits in FE have been associated with various psychopathological and behavioral disorders in childhood and adulthood (Biederman et al., 2010; Närhi, Lehto-Salo, Ahonen & Marttunen, 2010). We believe that there are still many questions to be answered regarding the specific impact of each of the modulating factors in the development of EF. We believe that deepening the study of them may be a possible way to generate more targeted interventions aimed at promoting full and integral development of individuals.

References

Aron, A.R., Behrens, T.E., Smith, S., Frank, M.J., & Poldrack, R.A. (2007). Triangulating a cognitive control network using diffusionweighted magnetic resonance imaging (MRI) and functional MRI. Journal of Neuroscience, 27, 3743–3752.

Aron, A.R., Durston, S., Eagle, D.M., Logan, G.D., Stinear, C.M., & Stuphorn, V. (2007). Converging evidence for a fronto-basal-ganglia network for inhibitory control of action and cognition. Journal of Neuroscience, 27, 11860–11864.

Baddeley, A. (1986). Working memory. Oxford, England: Oxford University Press.

Bhoomika, R.K., Shobini, L.R., & Chandramouli, B.A. (2008). Cognitive development in children with chronic protein energy Malnutrition. Behavioral and Brain Functions , 4:31 doi:10.1186/1744-9081-4-31

Biederman, J., Petty, C.R., Wozniak, J., Wilens, T.E., Fried, R., Doyle, A., Henin, A., Bateman, C., Evans, M., Faraone, S.V. (2010). Impact of executive function deficits in youth with bipolar I disorder: A controlled study. Psychiatry Res. doi:10.1016/j.psychres.2010.08.029

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. American Psychologist, 57, 111–127.

Blair, C., & Razza, R.P. (2007). Relating Effortful Control, Executive Function, and False Belief Understanding to Emerging Math and Literacy Ability in Kindergarten. Child Development, 78 (2), 647 – 663.

Brock, L.L., Rimm-Kaufman, S.E., Nathanson, L., Grimm, K.J. (2009). The contributions of 'hot' and 'cool' executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. Early Childhood Research Quarterly, 24, 337–349.

Bull, R., & Scerif, G. (2001). Executive function as a predictor of children's mathematics ability: Inhibition, switching, and working memory. Developmental Neuropsychology, 19, 273–293.

Bunge, S.A. (2004). How we use rules to select actions: A review of evidence from cognitive neuroscience. Cognitive, Affective, and Behavioral Neuroscience, 4, 564–579.

Bunge, S.A., Kahn, I., Wallis, J.D., Miller, E.K., & Wagner, A.D. (2003). Neural circuits subserving the retrieval and maintenance of abstract rules. Journal of Neurophysiology, 90, 3419–3428.

Carlson, S. (2005). Developmentally Sensitive Measures of Executive Function in Preschool Children. Developmental Neuropsychology, 28 (2), 595–616.

Carlson, S., & Moses, L. (2001). Individual differences in inhibitory control and children's theory of mind. Child Development, 72, 1032– 1053.

Carlson, S., Moses, L., & Claxton, L. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. Journal of Experimental Child Psychology, 87, 299–319.

Carlson, S., Wang, T.S. (2007). Inhibitory control and emotion regulation in preschool children. Cognitive Development, 22, 489–510.

Crone, E.A., Donohue, S.E., Honomichl, R., Wendelken, C., & Bunge, S.A. (2006). Brain regions mediating flexible rule use during development. The Journal of Neuroscience, 26(43), 11239 –11247.

Crone, E.A., Wendelken, C., Donohue, S.E., & Bunge, S.A. (2006). Evidence for separable neural processes underlying flexible rule use. Cerebral Cortex, 16, 475–486.

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Davidson, M.C., Amso, D., Anderson, L.C., Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: evidence from manipulations of memory, inhibition, and task switching. Neuropsychologia, 44 (11), 2037-78.

Diamond, A., Prevor, M., Callender, G., & Druin, D. P. (1997). Prefrontal cortex cognitive deficits in children treated early and continuously for PKU. Monographs of the Society for Research in Child Development, 62 (4, Whole No. 252).

Dias, R., Robbins, T., & Roberts, A. (1996). Dissociation in prefrontal cortex of affective and attentional shifts. Nature, 380, 69–72.

Duncan, G.J., Dowsett, C.J., Claessens, A., Magnuson, K., Huston, A.C., Klebanov, P., et al. (2007). School readiness and later achievement. Developmental Psychology, 43, 1428–1446.

Frye, D., Zelazo, P.D., & Palfai, T. (1995). Theory of mind and rule-based reasoning. Cognitive Development, 10, 483–527.

Garon, N., Bryson, S.E., & Smith, I.M. (2008) Executive Function in Preschoolers: A Review Using an Integrative Framework. Psychological Bulletin, 134 (1), 31–60.

Gogtay, N., Giedd, J.N., Lusk, L., Hayashi, K.M., Greenstein, D., Vaituzis, A.C., Nugent, T.F. III, Harman, D.H., Clasen, L.S., Toga, A.W., Rapoport, J.L., &Thompson, P.M. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. Proceedings of the National Academy of Sciences USA, 101, 8174–8179.

Goldberg, E., & Bider, R.M. (1987). The frontal lobes and hierarchical organization of cognitive control. In E. Perecman (Ed.) The frontal lobes revisited. Hillsdale; NJ: Erlbaun.

Graziano, P.A., Reavis, R.D., Keane, S.P., & Calkins, S.D. (2007). The role of emotion regulation in children's early academic success. Journal of School Psychology, 45, 3–19.

Hongwanishkul, D., Happaney, K.R., Lee, W.S.C., & Zelazo, P.D. (2005). Assessment of hot and cool executive function in young children: age-related changes and individual differences. Developmental neuropsychology, 28 (2), 617-44.

Howse, R. B., Calkins, S. D., Anastopoulos, A. D., Keane, S. P., & Shelton, T. L. (2003). Regulatory contributors to children's kindergarten achievement. Early Education and Development, 14 (1), 101–119.

Kerr, A. & Zelazo, P.D. (2004). Development of «hot» executive function: the children's gambling task. Brain and cognition, 55 (1), 148-57.

Levitsky, D.A., Strupp, B.J. (1995) Malnutrition and the brain: undernutrition and behavioural development in children. J Nutr, 125, 2212-2220.

Lipina, S.J., Martelli, M. I., Vuelta, B. L., Injoque-Ricle, I., Colombo, J. A. (2004) Pobreza y desempeño ejecutivo en alumnos preescolares de la ciudad de Buenos Aires (República Argentina). Interdisciplinaria: Revista de Psicología y Ciencias Afines. , 21 (2), 153 – 193.

Lozoff, B., Beard, J., Connor, J., Felt, B., Georgieff, M., & Schallert, T. (2006). Long-Lasting Neural and Behavioral Effects of Iron Deficiency in Infancy. Nutrition Reviews, 64 (5), 34-43.

Lukowski, A.F., Koss, M., Burden, M.J., Jonides, J., Nelson, C.A., Kaciroti, N., Jimenez, E., & Lozoff, B. (2010). Iron deficiency in infancy and neurocognitive functioning at 19 years: evidence of long-term deficits in executive function and recognition memory. Nutr Neurosci., 13 (2), 54-70.

Luria, A.R. (1973). The working brain: An introduction to neuropsychology (B. Haigh, trans.). New York: Basic Books.

Mata, L. (2008). Malnutrición, desnutrición y sobrealimentación. Rev. Méd. Rosario, 74, 17 – 20.

McClelland, M.M., Cameron, C.E., Connor, C., Farris, C.L., Jewkes, A.M. &, Morrison, F.J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. Developmental Psychology, 43 (4), 947-959.

Miyake, A., Friedman, N., Emerson, M., Witzki, A., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex «frontal lobe» tasks: A latent variable analysis. Cognitive Psychology, 41, 49–100.

Närhi, V., Lehto-Salo, P., Ahonen, T., Marttunen, M. (2010). Neuropsychological subgroups of adolescents with conduct disorder. Scand J Psychol, 51(3), 278-84.

Norman, D., & Shallice, T. (1986). Attention to action: Willed and automatic control of behaviour. In R. Davidson, G. Schwartz, & D. Shapiro (Eds.), Consciousness and self-regulation (Vol. 4, pp. 1–18). New York: Plenum Press.

O'Donnell, S., Noseworthy, M.D., Levine, B., & Dennis, M. (2005). Cortical thickness of the frontopolar area in typically developing children and adolescents. NeuroImage, 24, 948–954.

Posner, M. (2007) Evolution and Development of Self-Regulation. James Arthur Lect., 77, 1-25.

Rolls, E., Hornak, J., Wade, D., & McGrath, J. (1994). Emotion-related learning in patients with social and emotional changes associated with frontal lobe damage. Journal of Neurology, Neurosurgery, and Psychiatry, 57, 1518–1524.

Rueda, M.R., Posner, M.I., Rothbart, M.K. (2005). The development of executive attention: contributions to the emergence of self-regulation. Dev Neuropsychol., 28 (2), 573-94.

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Sheese, B.E., Voelker, P.M., Rothbart, M.K., and Posner M.I. (2007). Parenting quality interacts with genetic variation in Dopamine Receptor DRD4 to influence temperament in early childhood. Developmental and Psychopathology, 19 (4),1039-46.

Voelker, P., Sheese, B.E., Rothbart, M., & Posner, M.I. (2009) Variations in catechol-o-methyltransferase gene interact with parenting to influence attention in early development. Neuroscience, 164 (1), 121-30.

Zelazo, P.D. (2003). The development of executive function. Monographs of the Society for Research in Child Development, 68, 1-27.

Zelazo, P.D., Craik, F.I.M., & Booth, L. (2004). Executive function across the life span. Acta Psychologica, 115, 167–184.

Zelazo, P.D., & Cunningham, W.A. (2007). Executive function: Mechanisms underlying emotion regulation. In J. J. Gross (Ed.), Handbook of emotion regulation e (pp. 135–158). New York: Guilford.

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