Cognitive tests battery to evaluate the executive functions to chess players

Batería de pruebas cognitivas para la evaluación de la función ejecutiva en ajedrecistas

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Abstract
The current investigation has as objective to identify the basic theoretical components of executive functions in chess players, based on the criteria contributed through a bibliographic review carried out about it, for the selection of a battery of cognitive tests that allow sports psychologists in our province to evaluate the executive functions in chess players. The main results through searching brought forward that these tests should measure the activation, impulse inhibition, attention management, goals, plannification, emotions management, memory management, effort maintenance, flexibility, and metacognition, as basic cognitive functions to for chess players.
Keywords: Chess players. Activation. Attention management. Emotions management. Metacognition.

Resumen
La presente investigación tiene como objetivo identificar los componentes teóricos básicos de las funciones ejecutivas en los jugadores de ajedrez, en base a los criterios aportados a través de una revisión bibliográfica llevada a cabo al respecto, para la selección de una batería de pruebas cognitivas que permitan a los psicólogos del deporte en nuestra provincia evaluar estas funciones en los jugadores de ajedrez. Los principales resultados a través de búsquedas adelantaron que estas pruebas deben medir la activación, inhibición de los impulsos, la gestión de la atención, objetivos, planificación, el manejo de las emociones, el manejo de memoria, el mantenimiento del esfuerzo, la flexibilidad y la metacognición, como las funciones cognitivas básicas de los jugadores de ajedrez.
Palabras clave: Jugadores de ajedrez. Activación. Manejo de la atención. Manejo de las emociones. Metacognición.

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Introduction

Chess game demands a continuous production, proposal, and problem solution in a creative way. On that perspective constitutes a didactic game for excellence that allows the development of logical operations of thoughts, making it faster, more precise, and productive, contributing also to will strengthen and to generate a self-critic spirit. (Lebredo, 2003)

The statements before mentioned lead us to investigate about what happens in the field of this sport in the moment of working the psychological training, taking into account that in this sport practice are mental exercises that contribute new experiences to these subjects, that's why they are learning sources. Following with this track of ideas is appropriate to investigate the impact that may have chess in the cognitive field, specifically on executive functions, how can contribute to mental area, what abilities contribute to develop, and how these are related to professional or amateur practice of this sport. Not leaving out the relation between the chess and the cognitive is bidirectional, as the development of professional expertise is given thanks to biological bases but at the same time the brain structure also is developed due to the proper stimulation of this sport.

The executive functions highlight as a relatively new concept, which shows up around the 1980's, due to the evolution of neuropsychology under the influx of theoretical models coming from the cognitive psychology. Luria (1980) conceptualized about brain functioning as a serial of Functional Units, among them we could find the third unit, that accomplish with the plannification task, to regulate and verify according to what was planned all the conscious activity. It is here where the existence of initiative, motivation, goals formulation, and action plans capacities are set out, all of them related to the frontal cortex.

Development

Cognitive functions in chess can be stimulated and trained, and in consistence can be improved through cognitive training techniques (and cognitive rehabilitation). It is already used with children to improve certain deficits or even to obtain performances above what we are so far used to. With older people they are used for example to prevent the memory deterioration, and in people with psychosis to recover intellectual loss in psychotic outbreaks. Lots of examples can be mentioned. The action field of this sport in a few years is enormously spreading out.

In chess the cognitive training is understood that is really effective when is carried out through a systematic and well-structured practice: the cognitive capacities - impulse inhibition, attention management, goals, plannification, emotions management, memory management, effort maintenance, flexibility, and metacognition – have a positive answer to constant exercise and repeated practice, through works of raising difficulty.

When the cognitive training is based in exercises for a work in specific areas (working with divided attention) is said that is a program

of training in specific processes, when in the contrary the goal is to carry out global intervention of general stimulation of cognitive capacities to obtain global improvement. The programs are called of unspecific training.

It is necessary to point out that when we talk about executive functions, we must start analyzing that is a relative new concept that turned up around the 1980´s, due to the evolution of neuropsychology under the influx of theoretical models coming from the cognitive psychology and besides this if is seen in chess context, requires a conception of executive function placed in the practice of high-performance in this sport.

The executive functions constitute a problematic study subject in cognitive neuroscience. Its domain is the neurocognitive processes of high levels that provides self-control in behavior, with the key intervention of prefrontal cerebral circuits (Miller y Cummings, 2007)

As a natural fact, the executive function represents a milestone in mankind phylogenetic, intervening with the healthy human development on an ontogenetic scale, show signs of deterioration in several neurological diseases (e.g. Inattention disorder with hyperactivity, dementia), and during the ordinary aging (Ardila, 2008). As epistemological interests object, the executive function opens opportunities for the generation of knowledge, trough projects that relate the cognitive neurosciences to other scientific disciplines and humanities (Diamond, 2007)

Although many attempts of conceptual systematization about executive functions (e.g., Tirapu-Ustarroz, Muñoz-Cespedes y Pelegrin-Valero, 2002) to the present it cannot be possible to construct and test a theoretical integrating model (Banish, 2009; Diamond, 2013). Wong and associates (2012) summarize the definition in use, understanding by executive functions as a various set of complex neurocognitive operations, with evolution relevance, which integration makes possible to carry behaviors out leading to goals, controlling efforts (Rueda, Posner and Rothbart, 2005) in no routine conditions (Norman and Shallice, 1986). Determined by genetic factors (Baune and associates, 2010) and environmentalist (Diamond and Lee, 2011), these operations facilitate the production of self-controlled behaviors, according to context opportunities and restrictions (Posner, 2008). They permitting objectives definition, anticipate actions to reach them, the coordinate fulfillment of different actions and its adaptive adjustments (Cummings and Miller, 2007; Fuster, 2008) which contribute in a decisive way in human performance (Ardila, 2008).

Various matters in traditional agenda in psychology research are associated to executive functions (EF). The processes of solving problems, decisions taking, learning or personality development are few of them. Opposite to conventional treatment they have received in different models and methodological approaches inside the disciple, the key contribution of cognitive neuroscience when studying EF begins in comprehension and empiric exploration of its neuronal basis. These are their material mechanism of existence and change.

Material substratum in EF lies in neuronal ring activation with distributed functionalism in parallel that organizes several brain regions, cortical and subcortical, around the high profile of prefrontal cortical circuits. The prefrontal cortex is located in the front area of motive and pre-motive cortex, occupying the biggest part in frontal lobes (Cummings and Miller, 2007). It is distinguished by indicators in its cellular composition and its non-irritation dopaminergic (Fuster, 2001, 2008). Numerous inferences can be high-lighted of projections from and in sensorial association areas, motive areas, limbic system, basal lumps, and the thalamus (Kandel, Schwartz and Jessell, 1997). This connection permits prefrontal cortex to act as superior control request in neuromuscular and neurocognitive operations (Hanakawa, 2011).

According to its topography, prefrontal cortex is divided into three circuits (Alvarez and Emory, 2006). The dorsolateral prefrontal circuit intervenes in several components of EF, stressing cognitive resources organization, cognitive flexibility, and the strategic plannification (Crone, Zanolie, Van Leijenhorst; Westenberg and Rombouts, 2008). The prefrontal dorsolateral circuit links to limbic system structures, for the modulation of emotional aspects in adaptive behavior, especially considerable during decision takings (Damasio, Everitt and Bishop, 1996). The orbitofrontal circuit represents the highest level in control hierarchy of autonomic functions and emotionals (Happaney, Zelazo and Stuss, 2004); (Schore, 2001, 2005); is essential in inhibitory control of automatic or imperious answers and to resist the interference while a new task is executed (Poletti, 2010).The before exposed leads to the origin of executive function term. The validity of the different neurocognitive tests to evaluate the EF concept manifestation and the neuroimaging data about multiple brain areas that recruit during the performance in such tests (Kramer and Quitania, 2007), make difficult to the arrival and consensus and identification of veil among neuronal rings in executive operations. Although some theoretical models provide a certain order to the established knowledge amount.

In previous studies fulfilled by 'The Laboratory for the Study of Brain Training', a project of Physical Culture Faculty in Mayabeque Province, with the aid of the Cuban Neurosciences National Institute, ten of these cognitive functions have been identified which are basic for chess players: activation, impulse inhibition, attention management, goals, plannification, emotions management, memory management, efforts maintenance, flexibility, and metacognition.

Activation

The brain learns to keep the necessary energy to accomplish a task. There is an alert situation that mobilizes the rest of mental functions. The game situation - interest, motivation- trains this function.

Impulse inhibition

Chess game is a very calmed game in which children (and adults) must control their impulsivity. From waiting their turn to having to calculate the moves, are activities that favor the impulse inhibition.

Attention management

The attention problem is crucial in education. Children must learn to put attention willingly, not only to be appealed by the most powerful stimulus. Chess needs concentration and also favors it, because the chess player is attentive to the opponent's move and has to anticipate their own.

Goals

What characterizes the EF is that they direct all mental operations to a no immediate goal. For this a goal has to be set, kept, and anticipates the future, this is essential in Chess.

Plannification

Plans are ways that lead us to reach a goal. Chess permits to train this capacity – essential for an efficient intelligence – in a game environment and game interest that facilitates it. Chess player besides can confirm if the plannification is working, which is a powerful reinforcement.

Emotions management

Chess effectiveness to teach how to manage emotions is one of the topics better studied.

Memory management

Executive intelligence leads the ´memory construction´ (that is what chess players do when they learn game moves), and also the memory implementation to real situations (working memory). Thanks to Russian psychologists investigation projects in chess we know this capacity can be trained.

Effort maintenance

This is a huge educative problem. It is needed that children learn to maintain action. The interest that arouses game in them favors this learning.

Flexibility

Is an executive function that permits plan changing or goal changing when is not working out. A good chess player should have the flexibility needed to get adapted to a great dynamic game.

Metacognition

Is the capacity to think what was done over? In Chess case refers to what was played. Chess teachers dedicate a lot of time to make children think their moves over and over. In all fields, metacognition speed up learning.

Starting from this last analysis de typical cognitive demands in this sport and reflecting through the interviews study to chess experts in different preparation areas, we could notice that the conventional way of training is learning and analyzing games moves, the stimulation ask to the brain to learn how to keep the necessary energy to accomplish a task and during the games there is an alert situation that mobilizes the rest of the mental functions -interest, motivation-.

We propose then for a deeper study of these functions in sportspeople, to make use of the following battery of tests which should be applied and compared with the application of these same in subjects that don't practice this sport, it should demonstrate that they may be an assessment indicator of mastery of chess sport. Tests are the following.

Cards Classification Test. Wisconsin

It is considered a measure of EF due to its reported sensibility to the frontal lobe. It was designed initially to evaluate the abstraction capacity, concepts formation, and cognitive strategies changing in response to environmental contingencies. Today constitutes a measure of the requested ability to develop and maintain strategies in problem solving needed to reach a goal.

Symbols and Digits Test. SDMT

Well known neuropsychological test focused in assessment of certain cognitive functions, mostly working memory, processing information speed, maintained, focused and selective attention, visual-space function and constructive proxies.

King Complex Figure Test

It is a test used for different purposes including the evaluation of brain damage in neurologic patients, to determine the presence of madness and to study the cognitive development level in children. This test measures several cognitive skills that include visual-space skills, plannification, and working memory (EF).

Declarations from (Ruiz et. al., 2006) that (Chi, 1982) that declarative memory is related to knowledge such as game settings, action tactics and strategies of sportspeople, finding that sports experts count on a higher systematic complexity in the disciplines they practice. Equally is talk about the procedural memory which allows the application of learned procedures and in this way to generate an adequate answer to the implicate environment, pointing out that the experts can accumulate in their memory huge amounts of tactics with their probable solutions, as happens with Chess Masters that are capable to handle thousands of chess settings with the solution alternatives.

About strategic knowledge, this is pointed out as the highest level of declaratory knowledge, in which the sportspeople have the needed knowledge in tactics and moves to overcome their rivals. The before exposed will be essential in the knowledge the own sportspeople have about their own capacity level, and their ability to anticipate the probable consequences that the game will bring in its development, due to the decisions they took on a certain moment.

Conclusions

The main executive functions relevant in chess players are activation, impulse inhibition, attention management, goals, plannification, emotions management, memory management, efforts maintenance, flexibility, and metacognition.

Recommendations

To apply the selected cognitive test battery to professional chess players and individuals who don't practice this sport to discriminate the significance level relevant among the development of executive functions described for both groups.

Bibliography

- Álvarez, J. A. y Emory, E. (2006). Executive function and the frontal lobes: A metaanalytic review. Neuropsychology Review, 16, 17-42.
- Ardila, A. Ostrosky-Solís, F. (2008). Desarrollo histórico de las Funciones Ejecutivas. En Revista de Neuropsicología, Neuropsiquiatría y Neurociencias, Abril, Vol.8, Nº 1, Pág.1-21
- Banich, M. T. (2009). Executive function. The search for an integrated account. Current Directions in Psychological Science, 18, 89-94.
- Cummings, J. L. y Miller, B. L. (2007). Conceptual and clinical aspects of the frontal lobe. En B. L. Miller y J. L. Cummings (Eds.). The human frontal lobes. Functions and disorders (2da ed., pp. 12-24). New York: Guilford Press.
- Diamond, A. & Taylor, C. (1996). Development of an aspect of executive control: development of the abilities to remember what I said and to 'do as I say, not as I do'. Dev Psychobiol; 29: 315-34.
- Fuster, J. M. (2001). The prefrontal cortex an update: Time is of essence. Neuron, 30, 319-333.
- Fuster, J. M. (2008). The prefrontal cortex: Anatomy, physiology and neuropsychology of the frontal lobe (4ª ed.). Amsterdam: Elsevier.

- Hanakawa, T. (2011). Rostral premotor cortex as a gateway between motor and cognitive networks. Neuroscience Research, 70, 144-154.
- Luria, A. (1980). En El Cerebro en Acción. Ed. Fontanella. Barcelona. p.81- 383.Citado en Rebollo, M; Montiel, S. Atención y Funciones Ejecutivas en Revista de Neurología, Febrero 2006, Vol.42, Suplemento 2, Pág. S3 – S7
- Miller, B. L. y Cummings, J. L. (2007). The human frontal lobes. Functions and disorders (2ª ed.). New York: Guilford Press.
- Poletti, M. (2010). Orbitofrontal cortex-related executive functions in children and adolescents: Their assessment and ecological validity. Neuropsychological Trends, 7, 7-27.
- Posner, M. I. (2008). Evolution and development of self-regulation. Seventy seventh James Arthur lecture on the evolution of the human brain. New York: American Museum of Natural History.
- Rueda, M. R., Posner, M. I. y Rothbart, M. K. (2005). The development of executive attention: Contributions to the emergence of self-regulation. Developmental Neuropsychology, 28, 573-594.
- Schore, A. N. (2001). The effects of relational trauma on right brain development, affect regulation and infant mental health. Infant Mental Health Journal, 22, 201- 269.
- Schore, A. N. (2005). Back to basics: attachment, affect regulation, and the developing right brain: linking developmental neuroscience to pediatrics. Pediatrics in Review, 26, 204-217.
- Tirapu-Ustárroz, J., Muñoz-Céspedes, J. M. y Pelegrín-Valero, C. (2002). Executive functions: The need for the integration of concepts. Revista de Neurología, 34, 673-685.
- Wong Carriera, A. (2013). Efectos del aprendizaje del Ballet. La Habana: Centro de Neurociencias de Cuba. Universidad de la Habana.
- Wong, A., Rodríguez, M., Quevedo, L., Fernández de Cossio, L., Borges, A., Reyes, A. et al. (2012). Questionnaire of executive function for dancers: An ecological approach. Assessment, 19, 383-387.
- Wong, A. (2012). Función ejecutiva: Entre el laboratorio y la cultura. En E. Saforcada (Comp.), Memorias del Segundo Simposio Internacional de Neurociencias, Salud y Bienestar Comunitario. Villa María: Universidad Nacional de Villa María.