Executive Profile in 5-to-7 Year-Old Children in Ambato (Ecuador)

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Abstract- The importance of the study of Executive Functions, both the evolutionary aspects and their relevance in learning processes, is increasing. This paper presents the results obtained by 135 students from Ambato, between 8 to 12 years old, in the Attention-Executive Function scale of the NEUROPSI test battery. The analysis of the data has allowed us to verify that there are no significant differences according to sex and that the students with extreme scores, above or below the normative group, are those with more years of schooling.
The initial test in students from Ambato will serve as a basis for the implementation of a program to stimulate and strengthen their executive profile. The initial test in students from Ambato will serve as a basis for the implementation of a program to stimulate and strengthen their executive profile.

Keywords: Executive functions, Neuropsi attention and memory, executive profile.

1. Introduction

In 1982, The term Executive Functions (EF) was used for the first time by Muriel Lezak. Then, she conceptualized them as

"...the abilities that enable a person to function independently, purposefully, with self-sufficient behaviors and in a satisfying manner...as long as executive functions remain intact, a person can suffer substantial cognitive losses and continue to be independent, constructively self-sufficient and productive. When executive functions are impaired the subject is unable to care for himself, perform work for others, or maintain normal social relationships, regardless of how he retains his cognitive abilities." [… las *capacidades que permiten a una persona funcionar con independencia, con un propósito determinado, con conductas autosuficientes y de manera satisfactoria…mientras las funciones ejecutivas permanezcan intactas, una persona puede sufrir pérdidas cognitivas considerables y continuar siendo independiente, constructivamente autosuficiente y productiva. Cuando se alteran las funciones ejecutivas el sujeto no es capaz de autocuidarse, de realizar trabajos para otros, ni de mantener relaciones sociales normales, independientemente de cómo conserve sus capacidades cognitiva*] (Lezak, 1995, p 38).

La comunidad científica coincide con el autor en que las FE son el eje central que guía las conductas adaptativas y socialmente aceptadas y aceptables (Tirapu-Ustárroz, Cordero-Andrés, Luna-Lario y Hernáez-Goñi, 2017).

Since before birth, the neurobiological development of the human being is intimately linked to the acquisition of different skills. The prefrontal cortex is considered the neuroanatomical structure that is the basis of executive functioning. It contains a multitude of particular circuits and structures, and a specialized functional hierarchy (García Molina, Enseñat, Tirapu-Ustárroz, y Roig-Rovira, 2009; Pino y Urrego, 2013; Soprano, 2003). The development of EF is a long and complex process, beginning in pregnancy and extending into adulthood. It is influenced by a great variety of exogenous and endogenous processes (Anderson y Spencer-Smith, 2013). EFs develop and improve rapidly from 3 to 5 years old, a period in which differences in cognitive functions emerge (Zelazo, Fryey Rapus, 1996). In addition, the use of neuropsychological testing has made it possible to examine characteristic deficits associated with specific childhood conditions, such as Attention-Deficit/Hyperactivity Disorder (ADHD) (Curtis, Lindeke, Georgieff, y Nelson, 2002).

Despite increasing research on the construct, there is no consensus as to whether we are dealing with a unitary construct or a multimodal processing system with independent but interconnected components (Tirapu et al., 2017). What does seem consensual is that EFs represent the ability to adapt our cognitive resources according to the changing demands of the environment (Gilbert y Burgess, 2008; Verdejo-García y Bechara, 2010).

Barkley (1997, 2001) proposed his theoretical model emphasizing the role of inhibitory behavior in EF functioning. He built on Jacob Bronowski's (1977) contributions on ADHD and the fundamental role of language in human behavior, with its underpinning in the prefrontal cortex. He further integrated these initial contributions with Fuster's (1997) theory of prefrontal functions, Goldman-Rakic's (1995) work on working memory, and Damasio's (1996) somatic marker hypothesis. The central proposal of Barkley's model is based on the fact that inhibitory behavior favors self-regulation, as well as the performance of executive actions since it allows a delay in the decision to respond.

Barkley (2001) defines inhibitory behavior as a function of three interrelated processes: inhibition of a prepotent response, interruption of an already initiated response, and interference control. According to this proposal, behavioral inhibition allows the correct functioning of four other EFs: a) nonverbal working memory, b) verbal working memory or language internalization, c) self-regulation of affect-motivation-arousal, and d) reconstitution. These functions are considered a separate system from behavioral inhibition but hierarchically organized. The model further proposes that EFs mature from the external to the internal; that is, it conceptualizes EFs as forms of self-directed behavior that evolve from overt or public responses to

covert or private responses, as a means for self-regulation (Colombo, 2020).

In the last decade, the model proposed by Miyake et al. (2000) has been very influential. This model considers *three independent nuclear factors*: inhibition, working memory, and change. It is particularly attractive for developmental psychology, as it assesses these components from very early ages. The model excludes functions commonly considered executives, such as reasoning, planning, and organizational skills..

The Executive Control System proposed by Anderson (2002, 2008) also stands out. According to this author, EFs depend on higher-level and lower-level cognitive functions, so they cannot be considered in isolation. There is no consensus on the functions that comprise it, but there is an agreement in considering these functions to be especially important in everyday behavior. From this perspective, the different executive functions are categorized into four interdependent domains: information processing, attentional control, cognitive flexibility, and goal setting. These four domains interact and have bidirectional relationships. Anderson categorizes the different measures of EF available: a) attentional control; b) cognitive flexibility; c) goal setting; and d) information processing. Each of them is detailed in Table 1.

Table 1.
EF Measure Categories.

Category	Definition
Attentional control	Ability to selectively attend to specific stimulus
Cognitive flexibility	Ability to switch to new activities, cope with changes in routines, learn from mistakes and develop alternative strategies, multitasking and temporary storage processes (working memory)
Goal setting	The initiative, conceptual reasoning, planning skills (anticipating future events, formulating a goal, developing steps to achieve a goal), and organization (ability to organize complex information or to sequence in phases the mastery of a strategy logically and systematically).
Information processing	Focuses on speed, fluency, and efficiency in completing new tasks or solving a problema.

2. Context

The Universidad Técnica de Ambato proposed the Research Project "Empowerment of executive functions through a brain training and mediated learning program" intending to develop a training and empowerment program for EF in Ecuadorian school children.

As a first activity, 135 underage children were evaluated. Those results are shown in this work. Thus, their executive profile, strengths, and weaknesses have been established. These data have served as the basis for the design of the stimulation and reinforcement program.

3. Description

The research conducted is clinical, descriptive, and cross-sectional. The methodology is quantitative, with the application of the test battery and statistical data analysis.

3.1. Participants

The sample consisted of 135 students from Ambato, between the ages of nine, ten, eleven, and twelve.

The underage children's participation was voluntary. They all were from Ambato, between 5 to 7 years old. The students did not present any special needs.

The tests were applied during the third trimester of 2020.

3.2. Data collection instrument.

The testing instrument used was *NEUROPSI: Evaluación Nauropicológica Breve en Español* (Ostrosky Solís et al., 2012).

The Neuropsi battery evaluates attention, memory, and executive functions through 13 subscales. These subscales are grouped into five sections: I. Orientation, II. Attention and Concentration, III. Executive Functions, IV. Memory Encoding, and V. Memory Evocation.

The sum of the direct scores allows to obtain three global performance indexes in a) Attention-Executive Functions, b) Memory, and c) Total Attention and Memory. The direct scores are transformed into standarized scores, classifying the performance of each subject according to the ranges shown in Table 2.

Table 2.
Classification according to the standardized scoring

Standardized total score		Clasifications
116	127	High Normal
85	115	Normal
70	84	Slight Alteration
0	69	Severe Alteration

The data analyzed in this work correspond to the *Attention-Executive Functions* index since they are the ones that allow the establishment of the profile of the subject

The verification of the adequacy of the language tests was carried out by interviewing five teachers from the schools involved in the study. Ten students were also randomly selected to determine the level of education and comprehension of students. This verification made it possible to determine that the questions did not require any modification.

3.3. Statistical Analysis

Due to the global health situation, the application of the test was carried out individually through the Zoom virtual video-conferencing platform.

An exploratory data analysis was performed to identify missing data, errors, and outliers. The information consolidation process was carried out in an Excel spreadsheet to verify the information provided and to obtain data according to the research interest.

3.4. Ethical Aspects

Informed consents were applied individually to parents or guardians. They were informed of the purpose of the study, the safe and confidential handling of the data, as well as its use for academic purposes.

4. Results

The results obtained were evaluated according to the overall score obtained by the students, gender, and years of schooling.

4.1 Overall score of the Attention-Executive Function Index

The analysis of the total scores of the 135 children showed that most of them, 93.33%, obtained results that were within the "normal" range. Table 3 shows that only one student obtained a high normal result and two had a severe alteration.

Figure 1 shows the children's distribution according to the global score obtained in the Attention-Executive Function.

Table 3.
Distribution of underage children according to their global score

Evaluation Criteria Maximum P- Minimum P.		Clasificatio n	Number of students	%
116	127	High Norm.	1	0,74%
85	115	Normal	126	93,33%
70	84	Slight Alt.	6	4,44%
0	69	Severa Alt.	2	1,48%
Total			135	100%

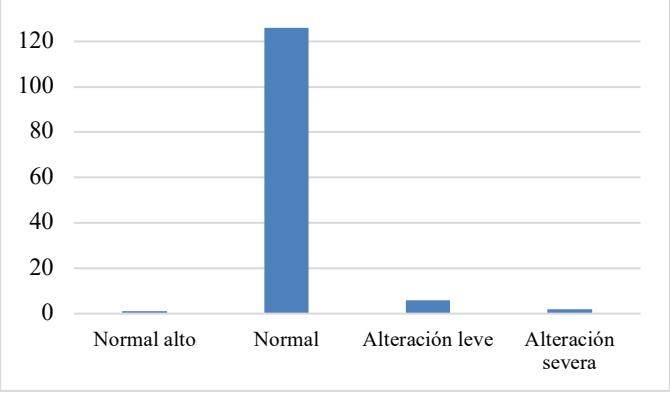

Fig 1. *Distribution of underage children according to their global score*

4.2. Results by gender

The overall results according to gender are shown in Table 4. The distribution of the classification criteria is similar for men and women (Figure 2).

Table 4. *Results by gender.*

Proposed evaluation criterion attention and executive functions		Clasification	Gender			
			M	%	F	%
116	127	High Normal	1	0,74%	0	0,00 %
85	115	Normal	66	48,89 %	60	44,44 %
70	84	Slight Alteration	3	2,22%	3	2,22 %
0	69	Severe Alteration	1	0,74%	1	0,74 %
TOTAL			71	52,59 %	64	47,41 %

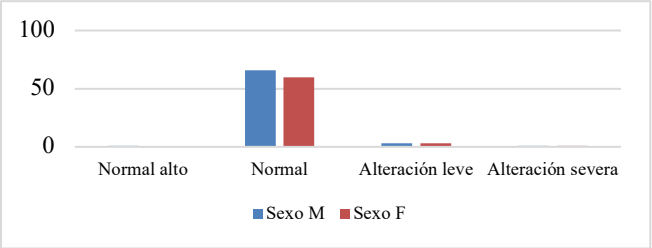

Fig 2. *Distribution of results according to gender*

4.3. Results according to years of schooling

Table 6 shows, the subjects with more years of schooling present a greater number of results classified as normal. In the groups with five and seven years of schooling, there is one child with a *severe alteration* classification, and in the group with seven years of schooling, there is one child with a *high normal* classification..

Tabla 6. Table 6. Results of the underage students according to years of schooling

Proposed evaluation criterion attention and executive functions		Clasificat ion	Schooling years					
Standardized total score			5	%	6	%	7	%
116	127	High Normal	0	0,00%	0	0,00%	1	1,68 %
85	115	Normal	32	88,89 %	37	92,5%	57	96,61 %
70	84	Slight Alteration	3	8,33%	3	7,5%	0	0,00 %
0	69	Severe Alteration	1	2,78%	0	0,00%	1	1,68 %
Total			36	26,67 %	40	29,63 %	59	43,70 %

5. Conclusions

The Students' evaluation allows us to affirm that most of them obtain "normal" results concerning their normative groups.

It has also been observed that there are no gender differences in the distribution of the scores and that the highest and lowest scores belong mostly to older children.

The analysis of each of the subtests that make up the Attention-Executive Function index will allow for a deeper analysis of the intragroup differences and the profile of each of the participating subjects.

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