

Funciones ejecutivas y rendimiento académico en estudiantes de bachillerato dependiente de una casa hogar

*Executive functions and academic achievement in students from a
baccalaureate integrated to an orphanage*

*Funções executivas e desempenho acadêmico em estudantes do ensino
médio dependentes de uma casa*

Leonardo Manriquez-López

Universidad Autónoma del Estado de Morelos, México

leonardo.manriquezl@uaem.edu.mx

<https://orcid.org/0000-0002-3453-8648>

Resumen

Aunque se ha investigado la relación entre las funciones ejecutivas (FE) y el rendimiento académico (RA) en diferentes etapas vitales, no hay ninguna sobre dicha relación en el nivel medio superior; lo cual es trascendente por incluir una época vital de transición para el desarrollo neuropsicológico frontal. Esto se indaga en el presente trabajo. Para ello se aplicó la Batería Neuropsicológica de Funciones Ejecutivas a 50 estudiantes de un bachillerato dependiente de una casa hogar, que cuenta con población interna y externa. Se realizaron análisis de correlación y comparación intragrupal, de tipo no paramétrico, entre las dimensiones y tareas de funcionamiento ejecutivo, las medidas de rendimiento académico, y la condición de los estudiantes (internos vs externos) y otras variables demográficas. Se encontraron correlaciones distintas entre las FE de Inhibición, Memoria de Trabajo y Flexibilidad Mental, con los tipos de RA (álgebra, expresión oral y escrita, y tronco común) y con las variables demográficas (género, especialidad y condición); sin embargo, los análisis intragrupal por niveles de desempeño (bajo, medio y alto) arrojaron menos relaciones de significancia entre las variables; siendo las diferencias intragrupal en el RA en álgebra el resultado más constante.

Palabras clave: bachilleres, desarrollo neuropsicológico, funciones ejecutivas, neuroeducación, rendimiento académico.,

Abstract

Although the relationship between executive functions (EF) and academic achievement (AA) at different stages of life has been investigated, there is no research on this relationship at the upper secondary level. This is important because the transition for the frontal neuropsychological development in this period of life. This was investigated in the present work. For this, the Bateria Neuropsicológica de Funciones Ejecutivas was applied to 50 students from a baccalaureate integrated to an orphanage. Non-parametric intra-group correlation and comparative analysis were carried out between the dimensions and the tasks of executive functioning, the measures of academic performance, the condition of the students and other demographic variables. Significant correlations were found between inhibition, Working Memory and Mental Flexibility, and AA categories and demographic variables; however, the intra-group analyzes by performance levels showed less significant relationships between the variables. The correlations and intra-group differences in algebra AA are the most constant result.

Keywords: academic achievement, high school, neuropsychological development, executive functions.

Resumo

Embora a relação entre funções executivas (EF) e desempenho acadêmico (AR) em diferentes fases da vida tenha sido investigada, não há relação entre essa relação no nível médio superior; que é transcendente porque inclui um período de transição vital para o desenvolvimento neuropsicológico frontal. Isso é investigado no presente trabalho. Para este fim, a bateria neuropsicológica de funções executivas foi aplicada a 50 alunos de um bacharelado dependente de uma casa, que tem uma população interna e externa. Realizou-se correlação intra-grupo e análise de comparação, não paramétrica, entre as dimensões e tarefas do funcionamento executivo, medidas de desempenho acadêmico e a condição de alunos (internos versus externos) e outras variáveis demográficas. Diferentes correlações foram

encontradas entre a FE de Inibição, Memória de Trabalho e Flexibilidade Mental, com os tipos de AR (álgebra, expressão oral e escrita e tronco comum) e com as variáveis demográficas (gênero, especialidade e condição); entretanto, as análises intragrupo por níveis de desempenho (baixo, médio e alto) mostraram relações menos significativas entre as variáveis; sendo as diferenças intragrupos na AR em álgebra o resultado mais constante.

Palavras-chave: bachilleres, desenvolvimento neuropsicológico, funções executivas, neuroeducação, desempenho acadêmico.

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Introduction

In Mexico, and in other parts of the world, there is a clear problem, of great social impact, in relation to academic performance (AR) and the dropout levels of students at the baccalaureate level (Secretaría de Educación Pública [SEP], 2012)) and, although the performance of high school graduates has been investigated in relation to variables, social, institutional and personal (Caso-Niebla and Hernández-Guzmán, 2010), it is surprising how little research has been done regarding the neuropsychological aspect (Anderson, Anderson, Northam, Jacobs and Catroppa, 2001), especially if we assume that, at this stage, the frontal areas are accelerated -considered those responsible for the planning, regulation and verification of the activity (Luria 1979/2000) -associated with the operation executive (Casey, Jones and Somerville, 2011) that theoretically plays a crucial role in school learning and performance (Welsh, Peterson and Jameson, 2017).

Executive functions (FE) are considered to be involved with "the ability to perform non-stereotyped behavior in response to specific environmental demands (Garon, Bryson and Smith, 2008, as cited in Stelzer and Cervigni, 2011); due to this, they allow the regulation of behavior by inhibiting automatic responses, regulating cognitive, affective and behavioral performance and carrying out planned actions for the solution of life problems in turn (Luria, 1979/2000, Stelzer and Cervigni, 2011) .

The cognitive processes that are part of the FE and the way in which they interact ParaStelzer and Cervigni (2011), there are models in which there is a central control process that modulates other supprocesos; models in which the FE groups independent cognitive processes; and mixed models with a central component and partially independent subcomponents. This may well explain why, although there seems to be consensus on the presence of a relationship between such performance areas, there are large differences in relation to the specific relationships between the components of EF and performance in different academic domains (Stelzer and Cervigni, 2011).

Research by Bryce, Whitebread and Szücs (2015) indicate that inhibitory control and working memory contribute significantly to this performance in children and adolescents, and relationships have been found between attention change, the understanding of false beliefs , cognitive flexibility, planning and, monitoring, with academic domains such as reading, problem solving, science and, particularly, mathematics (Stelzer y Cervigni, 2011).

In university students the information is contradictory. Barceló, Lewis and Moreno (2006) were not able to find relationships between the different tasks of the Wisconsin Card Classification Test, the Stroop Test and the Verbal Fluency Test (phonological), with the academic average of their participants (36 engineering students, between 18 and 23 years old); although it was observed that family, psychological and academic backgrounds contributed to the differences between low and high performance students. Vergara (2011) also found no relationship between the FE and the RA (academic average) of its participants, whose ages ranged from 17 to 25 years and were studying the first year of psychology. As FE they were included in the Work Memory, Planning, Mental Flexibility, Attention and Inhibition; The Ruff Design Fluency Test, the Trail Making Test, the Wisconsin Card Classification Test, the Stroop Word and Color Test and the Verbal Fluency Test were used as executive performance measures.

Finally we have the work of Casas (2013), which investigated the executive functioning (cognitive flexibility, inhibitory control, resistance to interference, working memory and

planning) of 30 adults between 18 and 25 years old. The Trail Making Test, the Stroop Word and Color Test, the ZOO Map, and the working memory subtest of the WAIS-III were used for this purpose. In the study, significant relationships were found between inhibitory control, working memory, and planning with the RA (school average).

In summary, although the research is clear about the existence of relationships between EF with different forms of RA in childhood, it is still not clear if this is maintained at later ages. In this regard, Best, Miller and Naglieri (2011) found that, in a sample of 2036 subjects between 5 and 17 years old, who were evaluated with the Cognitive Assessment System (CAS), performance in FE tasks (Matching Numbers, Planned Codes, Planned Connections and the total score of the CAS) improved until the age of 15 years and then this improvement decreased, with different patterns among the different tasks used. In his case, the RA measure was the Woodcock-Johnson Tests of Achievement-Revised, and they did not find real differences between the area of mathematics and reading. Among its most important results was that the relationship between time and accuracy to perform tasks depended on the task and the age of the person.

In this way, more research is still required in the area and, particularly at intermediate ages, to the studies carried out so far; especially because of the changes during adolescence that in the development of the frontal lobes have been described in the literature (Casey, et al, 2011, Kuhn 2006, Rosselli, Jurado and Matute, 2008). In this sense, there seems to be a consensus on a sequential development of the FE throughout life, ranging from an isolated development among its components to its complex integration, a pyramidal development in which the most basic ones support the development of the most complex , and a linear increase in childhood that has its plateau in adolescence (Flores-Lázaro, Castillo-Preciado and Jiménez-Miramonte, 2014).

In this regard, Flores-Lázaro, et al. (2014) states:

The review of the literature indicates that in early childhood the detection of risk selections and inhibitory control are developed; in late childhood working memory, mental flexibility, strategic memorization, and visuospatial planning; while in late adolescence the sequential planning is completed. In the youth they continue their development verbal fluency and abstraction, but only in school contexts (p. 468).

Given the information accumulated so far, we must consider that, independently of the differential development of EF throughout life, theoretically its importance for academic performance continues to be maintained, because FE allows the planning, regulation and verification of behavior, particularly in the face of novel contexts, such as those found in school activities and which are becoming more and more demanding as the level of education advances.

The inconsistencies between the findings may be due to several situations. First, to the methodological differences between executive functioning components involved and the specific tasks used to measure them. But also, due to the type of population included. In the case of the university students, it is clear that for that level there has already been a clear elimination of a large population band, leaving the most apt to contend with the studies, which could mean a more homogeneous performance in both the FE and the RA . The same measurement of RA would be another of the differences to be taken into account among the studies, because, while in the investigations with children the measures have been differentiated, in the young and adults generally only the general average has been taken.

With regard to executive functioning measures, it must be considered that their study has been more specifically linked to neuropsychology, which has achieved its advances from research with people with brain damage, so many of the evaluation tasks used in this area they seek the detection of neurological damage and, with this, the distinction between a normal and an abnormal performance is more sharp compared to other cognitive measures developed from other disciplines. Despite this, it is also true that the most popular tests of executive functioning, such as the Wisconsin Card Sorting Test or the Trail Making Test, were created in contexts unrelated to neuropsychology (Marino and Julián, 2010).

On the other hand, there is the problem that in research some authors use a complete test as a measure of a specific area, while others divide the test into subtasks and use them as measures of different abilities. Therefore, a solution to the methodological difficulties inherent in the evaluation is the use of measures based on neuropsychological models of executive functioning, as is the case of the Neuropsychological Battery of executive functions (Flores, Ostrosky-Solís and Lozano, 2008). its selection of the tests included in it, in a model of executive functioning associated with anatomic-functional regions of the frontal cortex.

In relation to the study population, one option to the possible homogeneity of the groups is to compare the results by level of performance. This has been done, however, if the population of average educational levels has been homogenized, the differences in the yields will be lower with what the sample variance will tend to be too and this could minimize the effects. Another option is to have samples of populations markedly disadvantaged with others more favored in terms of their background of environmental stimulation and / or socioeconomic status.

Taking all this into account, this study sought to find out (a) if there are relationships between the tasks and components of executive functioning, measured by BANFE, with the academic performance of the participants, and (b) if there are differences in academic performance. and / or the executive functioning by condition of origin, and other demographic variables among students of a baccalaureate that has an internal population to a home and external students to the same.¹

¹¹ Cabe mencionar que, en la revisión de la literatura llevada a cabo, no se pudo identificar ningún estudio de habla inglesa o española que hubiese investigado la relación entre las variables señaladas en el nivel bachillerato, con lo que el estudio propuesto sería el primero en realizarse.

Method

A field study of systematic evaluation was carried out (Scott and Wertheimer, 1981) under a simple transversal strategy (Baltes, Reese and Nesselroade, 1981) and with an intragroup design (Bialystok, 1988), non-experimental (Kerlinger and Lee, 2002) .

Participants

It counted with the participation of 50 students of first semester of technological baccalaureate, attached to a home. Due to this characteristic, the baccalaureate has a population of internal students, coming from different points of the Mexican Republic, although with greater representation of the states of Morelos and Guerrero; as well as external students of the State of Morelos. The interns have stories of different degrees of abandonment, poverty and marginalization. Some have been abandoned and others, although they have parents or close relatives are not able to pay for their studies for this reason they are interned in the home. The age of admission to the institution varies from early childhood and adolescence. Due to these circumstances and others linked to the internal organization of the home, the internal students tend to enter the baccalaureate at later ages and with a greater range of difference than the external students.

The selection of both the population and the sample was done in a non-probabilistic manner and was accidental (Kerlinger and Lee, 2002). To gather the sample, the objectives of the research were explained to all the students of the first semester and the group of participants was formed with those who voluntarily decided to do so and met the inclusion criteria. In order to obtain the authorization, a letter of consent was given to the parents of the external students and to the guardianship authority of the inmates.

The baccalaureate offers biannual study programs over 3 years, providing the specialties of accounting, electronics, childcare and tourism, so this was taken as a research variable, as well as gender and age. The final study population was formed as shown in Table 1. In total there were 26 external adolescents and 24 internal adolescents, with an age range of 15 to 19 years.

Tabla 1. Características básicas de los estudiantes incluidos en la muestra.

	Estudiantes		Estudiantes		Total
	Hombres	Mujeres	Hombres	Mujeres	
Contabilidad	2	4	1	3	10
Electrónica	4	2	6	2	14
Puericultura	0	9	1	5	15
Turismo	2	1	2	6	11
Total	8	16	10	16	

Fuente: Elaboración propia

The inclusion criteria contemplated the following conditions:

- Students who belong to the first semester of high school
- In regular academic status.
- Conclude with the application of study instruments

Instruments

The Neuropsychological Battery of Executive Functions and Frontal Lobes (BANFE-2) was used (Flores, Ostrosky-Solís and Lozano, 2008). This instrument groups 15 neuropsychological tests that have shown a high reliability and validity in the evaluation of cognitive processes dependent on the prefrontal cortex. Its design is based on an anatomical-functional division of the frontal cortex in four areas: orbito-frontal cortex, medial prefrontal cortex, dorsolateral prefrontal cortex and anterior prefrontal cortex. The tasks that comprise it are of low cognitive complexity and high sensitivity to damage of a specific brain area. The processes evaluated by BANFE are presented in Table 2 and are organized according to their greater-lesser complexity.

The rating of the battery is given in terms of dimensions that involve different test tasks. Thus, a test like Labyrinths has tasks that provide information for the orbitomedial dimension and others for the dorsolateral dimension. Another characteristic of the BANFE, linked to its rating is that not all the information (differentiated scores) of each subtest is taken into account for the elaboration of the final profile. Therefore, for this study only the scores that provide information for the performance profile were taken into account. Finally, the battery performs a classification of the scores by dimensions in performance levels; namely: Normal

High, Normal, Mild-Moderate Alteration and Severe Alteration. These levels were also taken into account for the analysis.

Tabla 2. Mapa conceptual de la BANFE

Metafunciones (Corteza Prefrontal Anterior).	Metamemoria.
	Comprensión de sentido figurado.
	Actitud abstracta.
Funciones Ejecutivas (Corteza Prefrontal Dorsolateral).	Fluidez verbal.
	Productividad.
	Flexibilidad mental.
	Planeación visoespacial.
	Planeación secuencial.
	Secuenciación inversa.
Memoria de trabajo (corteza Prefrontal Dorsolateral).	Control de codificación.
	Memoria de trabajo visual autodirigida.
	Memoria de trabajo verbal ordenamiento.
Funciones básicas (Corteza orbitofrontal y Corteza Prefrontal Medial).	Memoria de trabajo visoespacial secuencial.
	Control inhibitorio.
	Seguimiento de reglas.
	Procesamiento riesgo-beneficio.

Fuente: Adaptado de Flores, Ostrosky-Solís y Lozano (2008, p. 145).

The tests that make up the battery are: Stroop Effect, Labyrinths, Card Game, Self-Directed Pointing, Visospace Work Memory, Alphabetic Word Ordering, Classification of Cards, Tower of Hanoi, Consecutive Subtraction and Summing, Verbal Fluency, Selection of Sayings, Semantic and Metamemory Classifications.

Academic performance

The academic performance was obtained by the average at the end of the semester of the subjects of algebra and oral and written expression, as well as the general average of the common core subjects; that in addition to the previous two included chemistry, English, science, technology, society and values and information and communication technology.

Process

The BANFE was administered to the participants individually by trained examiners, in a room of the own baccalaureate, isolated from the noise, wide and well lit. The administration procedures described by the battery were followed and the application was given in a single session.

Statistical analysis

Because some of the variables analyzed were of a categorical type and, because the Shapiro-Wilk tests showed that most of the continuous variables did not behave in a normal manner, nonparametric analyzes were carried out for the analysis of the data. First, Spearman correlation analyzes were performed to identify the significant relationships among the demographic variables (gender, age, spatiality and origin group [internal and external]); of executive functioning (diagnostic dimensions of the BANFE, and subtests of the diagnostic profile); and academic performance (Common Core, Algebra and Oral and Written Expression). Secondly, Kruskal-Wallis tests and / or Mann-Whitney U tests were carried out among the variables that presented significant correlations.

Results

Relations and general comparisons

Table 3 shows that there were significant relationships between several of the FE dimensions with the RA variables as well as the demographic ones; while only the origin of the participants was related to the Oral and Written Expression. With this the FE shows important in the expression of RA in general; with the exception of the Anterior Prefrontal dimension that showed no significant relationship with any area of the RA.

The results of the Kruskal-Wallis tests carried out among the variables that showed interactions (see table 4), when each RA variable was divided into performance levels, only Algebra showed significant differences between the groups. The Mann-Whitney U tests performed to investigate between which groups the differences occurred, showed that, in the case of orbitomedial EFs, the level of executive functioning differed between the low and medium performance groups ($z = -2.288$, $p < .05$) and between the low and high performance groups ($z = -2.746$, $p < .01$). For the dorsolateral EFs, the differences were between the low and high performance groups ($z = -2.305$, $p < .05$) and between the medium and high performance groups ($z = -2.396$, $p < .05$). The same happened in the case of the global score in the BANFE ($z = -2.805$, $p < .01$ and $z = -2.255$, $p < .05$, respectively).

Tabla 3. Coeficientes de correlación de Spearman entre las variables demográficas, las de Rendimiento Académico y las dimensiones diagnósticas de la BANFE.

	1	2	3	4	5	6	7	8	9	10	11
Media	--	--	--	--	7.92	7.78	8.44	192.82	18.40	172.20	383.22
DE	--	--	--	--	1.16	1.52	1.57	6.88	3.51	24.56	27.75
1. G	1.00										
2. E	.02	1.00									
3. Esp	-.17	-.15	1.00								
4. P	.05	-.69**	.15	1.00							
5. TC	-.21	-.03	-.21	.25	1.00						
6. A	-.03	-.11	-.18	.16	.80**	1.00					
7. EOE	-.15	-.03	-.17	.28*	.87**	.60**	1.00				
8. OM	-.07	-.03	-.30*	-.01	.31*	.39**	.19	1.00			
9. PA	-.19	.28*	-.01	-.17	.03	-.07	-.04	-.01	1.00		
10. DL1 y 2	.35*	-.16	-.27	.29*	.33*	.33*	.29*	.25	.17	1.00	
11. BANFE	.27	-.12	-.31*	.26	.36**	.38**	.30*	.41**	.26	.97**	1.00

G: Género; E: Edad; Esp: Especialidad; P: Procedencia; TC: Tronco Común; A: Álgebra; EOE: Expresión Oral y Escrita; OM: Orbitomedial; PA: Prefrontal anterior; DL1 y 2: Dorsolateral Memoria de Trabajo + Funciones Ejecutivas; BANFE: resultado total.

*. La correlación es significativa en el nivel 0,05 (2 colas).

** . La correlación es significativa en el nivel 0,01 (2 colas).

Fuente: Elaboración propia

Tabla 4. Comparaciones de los resultados en las FE para los diferentes niveles de RA, mediante la Prueba de Kruskal-Wallis.

FE	Niveles de RA	Tronco Común			Álgebra			Expresión Oral y Escrita		
		N	R	X ^{2*}	N	R	X ^{2*}	N	R	X ^{2*}
OM	Bajo	9	23.67		9	13.78		7	19.71	
	Medio	12	19.50	3.462	28	26.61	8.028**	12	25.88	1.313
	Alto	29	28.55		13	31.23		31	26.66	
DL1 y 2	Bajo	9	20.17		9	22.61		7	22.29	
	Medio	12	25.54	1.572	28	22.14	7.057**	12	22.63	1.301
	Alto	29	27.14		13	34.73		31	27.34	
BANFE	Bajo	9	20.17		9	19.17		7	22.43	
	Medio	12	24.58	1.818	28	23.16	7.855**	12	22.25	1.463
	Alto	29	27.53		13	34.92		31	27.45	

*2 gl.

**P<.05

Fuente: Elaboración propia

Table 5 shows the results of the Mann-Whitney U for the dorsolateral dimension and for the RE in Oral and Written Expression by the demographic variables of gender and origin. In all cases statistically significant differences were observed between the groups. It should be noted that a correlation that was also significant was the study specialty, on the one hand, and the orbitomedial FE and the total score of the BANFE, on the other; however, when

carrying out the statistical tests, no significant differences could be demonstrated between the different interactions.

Tabla 5. Comparaciones de los resultados en las FE para las diferentes categorías de Género y Condición de Procedencia.

	Género	N	R	Z
DL1 y 2	Mujer	32	21.69	-2.467*
	Hombre	18	32.28	
DL1 y 2	Interno	24	21.21	-2.001*
	Externo	26	29.46	
EOE	Interno	21.46	21.45	-1.969*
	Externo	29.23	29.23	

R: rango promedio

*P<.05

Fuente: Elaboración propia

Relationships and specific comparisons between the orbitomedial tasks and the RA

As can be seen in Table 6, most of the correlations that were significant were with the average of Algebra, followed by the Common Core and only one with Oral and Written Expression. It should also be noted that time and Stroop Type Errors, which showed significance, correlated inversely with academic performance, while the other tasks did so directly; even for the errors of crossing, in the case of Labyrinths. This last data is interesting because it seems to indicate that those that are less controlled in the trace in the Labyrinths have a better common trunk average. It should also be noted that, although the orbitomedial tasks that make up the BANFE are associated with the FE of Inhibitory Control, Rules Tracking and Risk-Benefit Processing, all the tasks that were significant are associated with the Inhibitory Control and there were none that belonged to the the other areas.

When examining the intragroup relationships, according to the performance levels, it was observed that the times that are traversed in Laberintos showed intra-group differences for the yield in the Common Trunk; that there were no significant differences in the case of the Oral and Written Expression and that it was the Algebra variable that showed the most intragroup differences. Table 7 shows the results that were significant.

Tabla 6². Coeficientes de correlación de Spearman entre las variables de Rendimiento Académico y las Tareas Orbitomediales.

	1	2	3
Media	7.92	7.78	8.44
DE	1.16	1.52	1.57
1. Tronco Común	1.000		
2. Álgebra	.803**	1.000	
3. Expresión Oral y Escrita	.872**	.599**	1.000
4. Laberintos: Atraviesa	.375**	.257	.256
5. Juego de Cartas: Puntuación Total	-.047	-.084	.046
6. Juego de Cartas: Porcentaje de Cartas de Riesgo	.073	.169	.108
7. Stroop A	.391**	.428**	.327*
8. Stroop A: Tiempo	-.199	-.287*	-.148
9. Stroop A: Errores Tipo Stroop	-.201	-.256	-.145
10. Stroop B: Aciertos	.444**	.480**	.273
11. Stroop B: Tiempo	-.277	-.314*	-.181
12. Stroop B: Errores Tipo Stroop	-.286*	-.300*	-.158
13. Clasificación de Cartas: Errores de Mantenimiento	.041	.061	.090

*. La correlación es significativa en el nivel 0,05 (2 colas).

** . La correlación es significativa en el nivel 0,01 (2 colas).

Fuente: Elaboración propia

Tabla 7. Comparaciones de las tareas de FE orbitomediales para los diferentes niveles de RA, mediante la prueba de Kruskal-Wallis.

	Categorías de RA	N	Rango promedio	X ^{2*}
LA	Tronco Común bajo	9	24.17	8.895*
	Tronco Común medio	12	17.00	
	Tronco Común alto	29	29.43	
SA-A	Álgebra bajo	9	13.56	8.778*
	Álgebra medio	28	26.63	
	Álgebra alto	13	31.35	
SB-A	Álgebra bajo	9	15.89	11.912**
	Álgebra medio	28	23.82	
	Álgebra alto	13	35.77	
SB-ETS	Álgebra bajo	8	31.44	6.011**
	Álgebra medio	28	26.34	
	Álgebra alto	13	18.15	

*P<.05

** P<.01

Fuente: Elaboración propia

The Mann-Whitney U tests conducted to investigate between which groups the differences were given, showed that not all the relationships that were significant had intergroup differences by level of performance; except Laberintos Atraviesa and some of those

² Para los fines del trabajo, no interesaba mostrar las relaciones entre las tareas de funcionamiento ejecutivo, la tabla de correlaciones se presenta recortada para facilitar su lectura.

associated with Stroop tasks. In the case of Laberintos Atravesa, there were differences between the performance groups in the low and middle Common Trunk ($z = -2.108, p < .05$) and between the performance groups in medium and high Common Core ($z = -2.859, p < .05$). For Successes in Stroop A, the differences were given, in the case of Algebra, between the groups of low and medium academic performance ($z = -2.235, p < .05$) and between the groups of low and high performance ($z = -3.133, p < .01$). In the case of Stroop B hits, the differences were found between the low and high performance groups ($z = -3.221, p < .01$); and between medium and high performance groups. ($z = -2.712, p < .01$). The same happened with the task of Type Stroop Errors B ($z = -2.245, p < .05$ y $z = -2.015, p < .05$)

Relationships and specific comparisons between the dorsolateral tasks (Work Memory) and the RA

Table 8 shows the significant correlations between the dorsolateral tasks of working memory and those of RA. In it it can be observed that there were more relationships between the RA in Oral and Written Expression than in the other two performance variables; and that the successes in the task of Consecutive Subtraction B were related to the three areas of operation. It is interesting to note that the task that involves time is inversely related to the areas of performance of Algebra and Oral and Written Expression, while the other tasks are directly, although some represent erroneous performances; for example, the perseverations in the self-directed signaling so that, as they increase, so does the performance of Algebra and the Common Core. It should also be noted that, although the dorsolateral tasks that make up the BANFE are associated with the Memory Fees of Sequential, self-directed and verbal sorting work, the tasks that were significant are associated to the first two only and there was no association with tasks of verbal memory of ordering.

The Kruskal-Wallis tests performed to observe the possible intra-group differences between the variables with significant correlations showed significance in the case of RA in Algebra. The results for said variable are shown in Table 9. On the other hand, the Mann-Whitney U-tests indicated as significant the differences between the low and medium performance groups ($z = -2.579; p = .01$) for the perseverations in Self-Directed Signaling.

Tabla 8.³ Coeficientes de correlación de Spearman entre las variables de Rendimiento Académico y las Tareas Dorsolaterales: Memoria de Trabajo.

	1	2	3
Media	7.78	8.44	7.92
DE	1.52	1.57	1.16
1. Álgebra	1.000		
2. Expresión Oral y Escrita	.599**	1.000	
3. Tronco Común	.803**	.872**	1.000
4. Señalamiento Autodirigido: Perseveraciones	.284*	.194	.351*
5. Señalamiento Autodirigido: Tiempo	-.134	-.105	-.095
6. Señalamiento Autodirigido: Aciertos	.276	.132	.191
7. Resta Consecutiva "A": Tiempo	-.211	-.309*	-.327*
8. Resta Consecutiva "A": Aciertos	.181	.148	.158
9. Resta Consecutiva "B": Tiempo	-.096	-.217	-.201
10. Resta Consecutiva "B": Aciertos	.404**	.435**	.387**
11. Suma Consecutiva: Tiempo	-.207	-.145	-.115
12. Suma Consecutiva: Aciertos	.081	.171	.084
13. Ordenamiento Alfabético 1	-.114	-.096	-.123
14. Ordenamiento Alfabético 2	-.021	-.158	-.133
15. Ordenamiento Alfabético 3	-.071	-.257	-.148
16. Memoria Visoespacial: Secuencia Máxima	.021	-.019	-.056
17. Memoria Visoespacial: Perseveraciones	.196	-.013	.001
18. Memoria Visoespacial: Errores de Orden	-.135	.068	-.005

*. La correlación es significativa en el nivel 0,05 (2 colas).

** . La correlación es significativa en el nivel 0,01 (2 colas).

Fuente: Elaboración propia

Tabla 9. Comparaciones de las tareas de FE dorsolateral (Memoria de Trabajo) para los diferentes niveles de RA, mediante la Prueba de Kruskal-Wallis

	Rango de Álgebra	N	Rango promedio	X ^{2*}
SA-P	Rendimiento algebra bajo	9	14.83	6.286*
	Rendimiento algebra medio	28	27.00	
	Rendimiento algebra alto	13	29.65	
RCB-A	Rendimiento algebra bajo	9	20.00	7.055*
	Rendimiento algebra medio	28	23.09	
	Rendimiento algebra alto	13	34.50	

*P<.05

Fuente: Elaboración propia

³ Para los fines del trabajo, no interesaba mostrar las relaciones entre las tareas de funcionamiento ejecutivo, la tabla de correlaciones se presenta recortada para facilitar su lectura.

Relationships and specific comparisons between the dorsolateral tasks (Executive Functions) and the RA

As shown in Table 10, both the Classification of Cards: Successes and FV-P Verbal Fluency: Perseverations were significantly related to the three RA variables. Verbal Fluency: Successes, it did with Common Core and Algebra, and Semantic Classification: Total Average, only related to Algebra. All the relationships were directly proportional even though it could be considered a wrong performance; which is the case of FV-P Verbal Fluency: Perseverations. It should also be noted that, although the dorsolateral tasks of the Executive Functions that make up the BANFE are associated with the FE of Verbal Fluidity, Productivity, Mental Flexibility, Visuospatial Planning, Sequential Planning, Reverse Sequencing and Coding Control, all the tasks that were significant were they associate to the function of Mental Flexibility and there was not one that belonged to the other areas.

When the comparison tests were carried out using Kruskal-Wallis, it was found that Algebra is the variable with the most intra-group differences, while the other two performance variables had intra-group differences for only one of the relationships studied (table 11). The Mann-Whitney U tests could not be carried out for the relationship found between Verbal Fluency: Perseverations and Common Trunk, because there were not enough valid cases. Regarding Algebra, the tests showed differences between the low and high performance groups for Card Classification: Success ($z = -2.173$; $p < .05$); Semantic Classification: Total Average ($z = -2.182$, $p < .05$); Verbal fluency: Success ($z = -2.455$; $p < .05$); and Verbal Fluency: Perseverations ($z = -2.667$; $p < .05$). There were also differences between the groups of average and high performance in question to Algebra with respect to the tasks of Classification of Cards: Successes ($z = -2.329$, $p < .05$); Semantic Classification: Total Average ($z = -2.190$, $p < .05$). For the academic performance in Oral and Written Expression, in relation to the task of Verbal Fluency: Perseverations, the differences were between low and high performance groups ($z = -2.701$; $p < .01$) and among those with average performance and high ($z = -1.992$; $p < .05$).

Tabla 10.⁴ Coeficientes de correlación de Spearman entre las variables de Rendimiento Académico y las Tareas Dorsolaterales: Funciones Ejecutivas.

	1	2	3
Media	7.78	8.44	7.92
DE	1.52	1.57	1.16
1. Álgebra	1.000		
2. Expresión Oral	.599**	1.000	
3. Tronco Común	.803**	.872**	1.000
4. Laberintos: Planeación	.171	-.047	.124
5. Laberintos: Tiempo	-.047	-.116	-.091
6. Clasificación de Cartas: Aciertos	.389**	.329*	.396**
7. Clasificación de Cartas: Perseveraciones	-.258	-.187	-.224
8. Clasificación de Cartas: Perseveraciones Diferidas	-.202	-.095	-.182
9. Clasificación de Cartas: Tiempo	.079	.065	.025
10. Clasificación Semántica: Total de Categorías	.036	-.082	-.018
11. Clasificación Semántica: Promedio Total	.285*	.070	.079
12. Clasificación Semántica: Puntuación Total	.046	.004	.014
13. Fluidez Verbal: Aciertos	.361*	.216	.315*
14. Fluidez Verbal: Perseveraciones	.449**	.344*	.423**
15. Torre de Hanoi 3 Discos: Movimientos	.056	.125	.112
16. Torre de Hanoi 3 Discos: Tiempo	-.100	.059	.019
17. Torre de Hanoi 4 Discos: Movimientos	-.120	-.244	-.225
18. Torre de Hanoi 4 Discos: Tiempo	-.223	-.181	-.257

*. La correlación es significativa en el nivel 0,05 (2 colas).

** . La correlación es significativa en el nivel 0,01 (2 colas).

Fuente: Elaboración propia

Other comparisons

It was decided to carry out nonparametric comparisons to establish if the diagnostic levels of the BANFE (from severe alteration to high normal) were different for each category of origin (using Mann-Whitney U); and to determine if the average returns on the academic performance variables were different according to the diagnostic levels of the BANFE (using Kruskal-Wallis). In neither of the two cases were statistically significant differences, so the diagnosis given to the students does not appear to be different according to their origin, nor do they seem to differentiate between the averages obtained in the different areas of academic performance.

⁴ Paralos fines del trabajo, no interesaba mostrar las relaciones entre las tareas de funcionamiento ejecutivo, la tabla de correlaciones se presenta recortada para facilitar su lectura.

Discussion

From the analysis of the processes associated with the specific tasks of each test of the BANFE with the RA, it was possible to confirm that the EFs that showed association with the RA are the inhibitory control, the sequential and visuospatial working memory, and the flexibility mental. This agrees with the works that have shown this type of associations at an early age ((Bryce, et al., 2015, Stelzer and Cervigni, 2011) and, partially with the work of Casas (2013), when the associations agree on the inhibitory control and working memory, but not in the planning (result of it) or in the mental flexibility (result of this work) The results agree with the literature that shows differences on different types of RA measurements. , the relationships were stronger and consistent in the case of the average in Algebra which is also consistent with previous studies (Stelzer y Cervigni, 2011).

Tabla 11. Comparaciones de las tareas de FE dorsolateral (Funciones Ejecutivas) para los diferentes niveles de RA, mediante la Prueba de Kruskal-Wallis

	Niveles de RA	N	R	X ²
FV-P	Tronco Común bajo	9	17.56	8.250*
	Tronco Común medio	12	20.67	
	Tronco Común alto	29	29.97	
CC-A	Álgebra bajo	9	21.33	6.604*
	Álgebra medio	28	22.71	
	Álgebra alto	13	34.38	
CS-PT	Álgebra bajo	9	21.50	6.061*
	Álgebra medio	28	22.96	
	Álgebra alto	13	33.73	
FV-A	Álgebra bajo	9	16.28	7.301*
	Álgebra medio	28	24.89	
	Álgebra alto	13	33.19	
FV-P	Álgebra bajo	9	17.56	7.851*
	Álgebra medio	28	24.50	
	Álgebra alto	13	33.15	
FV-P	Expresión Oral y Escrita bajo	7	14.50	9.919**
	Expresión Oral y Escrita medio	12	20.67	
	Expresión Oral y Escrita alto	31	29.85	

*P<.05

**P<.01

Fuente: Elaboración propia

In addition, it was possible to demonstrate that the division of the students by groups of performance allowed to verify different uses among them, having better scores those of high performances in comparison with those of medium and low performance. What could not be demonstrated is that the clinical classification dimensions of the BANFE distinguish between the RA of the students. This seems to mean that abnormal neuropsychological performances in EF, even severe, are not necessarily associated with a consequent RA; but yes, a low academic performance, particularly in Algebra, is more likely associated with lower performance in FEs. This is a novel result and could imply mechanisms of compensation among the students in the face of their neuropsychological difficulties that, finally, allow them to contend with their studies in a normal way; but that before specific evaluations they are manifested in the areas indicated by the literature.

The fact that the average in the Common Core and in the Oral and Written Expression, had less association with the FE and less intra-group differences, is a sign that the relationship between FE and RA is differentiated, and that there may be internal interactions between these variables that were not explored in this study. In addition, the problem of the assignment of qualifications between each subject must be pointed out, which entails the problem of subjectivity or partiality of the same, and that could not be controlled in this work, so subsequent studies should measure the RA with objective evaluations. and standardized independent of school grades, in the manner of Best, et al. (2011). The results of this work also show that using the global average as an indicator of RA could be hiding some specific relationships between FE with specific areas of academic functioning, so it is recommended to have RA measures by areas of knowledge, as has been done in the investigation of infants. Regarding the specific tasks that showed consistent relationships with the intra-group comparisons, a surprising result is that the perseverations in Verbal Fluency and Self-Directed Pointing were associated with better RA, since it is a possible disorder in the executive function (Sandson and Albert, 1984). Since perseverations can occur at different levels of pathology and have different physiopathological mechanisms (Goldberg, 1986), the origin and meaning of this result is not clear and should be the subject of a separate study.

Regarding the demographic variables, although the specialty of study, gender and condition of origin, showed associations with some dimensions of executive functioning, it was not possible to confirm global associations with academic performance. The only thing observed was that the memory tasks of visuospatial and self-directed work showed differences by gender and origin; with which they could be playing a mediating role in such dorsolateral tasks. It should also be noted that, in the case of the condition of origin, there was no specific measure of the differences among the internal students in terms of their history of stimulation, abandonment and abuse, which could be better indicators of executive functioning than the mere internal-external distinction. This should be taken into account in other studies that seek multivariate analysis and not only associations between two variables (RA and FE in this case).

Currently it is known that the RA depends on social, institutional and personal variables and, for example, Caso-Niebla and Hernández-Guzmán (2010) have developed an explanatory model of the RA based on different variables of that nature, the truth is that it does not They have included FEs within their model. In the light of the present findings and of the previously found, it would be advisable to carry out works of that nature; that is, they also include FEs as part of an explanatory model. A typological approach, centered on people, would be especially useful for its ability to distinguish between types of students and for being suitable for work with categorical and continuous variables; besides dealing with interactions between variables of different levels and being resistant to the artifact of linearity in research (Magnusson, 1998).

Conclusion

The study of the relationship between FE and RA, particularly the upper middle level, is still far from being exhausted. This study is in line with those that have shown significant relationships between some components of FE and measures other than RA, however, it should be considered that the results do not come from a sample selected at random and are restricted to a specific population that, Due to its institutional characteristics, it is different from other high school populations. The results, with this, are difficult to generalize to the rest of the students of the high school level. In spite of this, due to the fact of coinciding with the scientific literature, on which the EF of Inhibitory Control, Memory of Work and Mental Flexibility are associated to the RA in younger ages, constitutes a significant contribution, because it allows to continue investigating the subject in a level educational in which no research has been done in this regard, and of which the present seems to be the first experience in the area. The study also makes significant contributions on the specific association between the variables studied, and on the need to include differentiated measures of RA. Therefore, it is necessary to continue researching the subject, both at a restricted level, and with other populations of the same educational level, as well as in studies that include other social and institutional variables that allow the RA to be understood holistically; for this it is suggested to use a person-centered approach, as suggested by the science of development (Magnusson, 1998).

Referencias

- Anderson, V., Anderson, P., Northam, E., Jacobs, R. y Catroppa, C. (2001). Development of Executive Functions Through Late Childhood and Adolescence in an Australian Sample. *Developmental Neuropsychology*, 20(1), 385-406. doi: 10.1207/S15326942DN2001_5
- Baltes, P. B., Reese, H. W. y Nesselroade, J. R. (1981). *Métodos de investigación en psicología evolutiva: enfoque del ciclo vital*. Madrid, España: Morata.
- Barceló, E., Lewis, S. y Moreno, M. (2006). Funciones ejecutivas en estudiantes universitarios que presentan bajo y alto rendimiento académico. *Psicología desde el Caribe*, 18, 109-138. Recuperado de <https://www.redalyc.org/pdf/213/21301806.pdf>
- Best, J., Miller, P. y Naglieri, J. (2011). Relations between Executive Function and Academic Achievement from Ages 5 to 17 in a Large, Representative National Sample. *Learning Individual Differences*, 21(4), 327–336. doi:10.1016/j.lindif.2011.01.007
- Bialystok, E. (1988). Levels of bilingualism and levels of linguistic awareness. *Developmental Psychology*, 24(4), 560-567. doi: 10.1037/0012-1649.24.4.560
- Bryce, D., Whitebread, D. y Szűcs, D. (2015). The relationships among executive functions, metacognitive skills and educational achievement in 5 and 7 year-old children. *Metacognition and Learning*, 10(2), 181–198. doi: 10.1007/s11409-014-9120-4
- Casas, S. (2013). *Relación entre las funciones ejecutivas y el rendimiento académico en la educación de adultos* (tesis de maestría inédita). Universidad Internacional de La Rioja, La Rioja, España. Recuperado de https://reunir.unir.net/bitstream/handle/123456789/3008/CatalinaMaria_Martorell_Mir.pdf?sequence=1&isAllowed=y
- Casey, B. J., Jones, R. y Somerville, L. (2011). Braking and Accelerating of the Adolescent Brain. *Journal of Research on Adolescence*, 21(1), 21 – 33. doi: 10.1111/j.1532-7795.2010.00712.x

- Caso-Niebla, J. y Hernández-Guzmán, L. (2010). Modelo Explicativo del Bajo Rendimiento Escolar: Un Estudio con Adolescentes Mexicanos. *Revista Iberoamericana de Evaluación Educativa*, 3(2), 145-159. Recuperado de https://www.researchgate.net/publication/277271374_Modelo_Explicativo_del_Bajo_Rendimiento_Escolar_Un_Estudio_con_Adolescentes_Mexicanos
- Flores, J.C., Ostrosky-Solís, F. y Lozano, A. (2008). Batería de Funciones Frontales y Ejecutivas: Presentación. *Revista Neuropsicología, Neuropsiquiatría y Neurociencias*, 8(1), 141-158. Recuperado de <https://dialnet.unirioja.es/descarga/articulo/3987630.pdf>
- Flores-Lázaro, J., Castillo-Preciado, R. y Jiménez-Miramonte, N. (2014). Desarrollo de funciones ejecutivas, de la niñez a la juventud. *Anales de Psicología*, 30(2), 463-473. Recuperado de <https://www.redalyc.org/pdf/167/16731188009.pdf>
- Goldberg, E. (1986). Varieties of perseveration: A comparison of two taxonomies. *Journal of Clinical and Experimental Neuropsychology*, 8(6), 710-726. doi: 10.1080/01688638608405191
- Kerlinger, F. N. y Lee, H. B. (2002). *Investigación del comportamiento. Métodos de investigación en ciencias sociales*. México: McGraw-Hill.
- Kuhn, D. (2006) Do Cognitive Changes Accompany Developments in the Adolescent Brain? *Perspectives on Psychological Science*, 1(1), 59-67. doi: 10.1111/j.1745-6924.2006.t01-2-.x
- Luria, A. (1977/2000). *Las funciones corticales superiores en el hombre* (3ra ed.). México: Fontamara.
- Magnusson, D. (1998). *The logic and implications of a person-oriented approach*. En Cairns, R. B., Bergman, L. R. y Kagan, J. (Eds.), *Methods and models for studying the individual* (pp. 33-82). London, U.K.: Sage Publications.
- Marino, D. y Julián, C. (2010). Actualización en tests neuropsicológicos de funciones ejecutivas. *Revista Argentina de Ciencias del Comportamiento*, 2(1), 34-45. Recuperado de <https://www.redalyc.org/articulo.oa?id=333427068004>

- Rosselli, M., Jurado, M. B. y Matute, E. (2008). Las funciones ejecutivas a través de la vida. *Revista Neuropsicología, Neuropsiquiatría y Neurociencias*, 8(1), 23-46. Recuperado de <https://dialnet.unirioja.es/descarga/articulo/3987451.pdf>
- Sandson, J. y Albert, M. (1984). Varieties of perseveration. *Neuropsychologia*, 6, 715-732. doi: 10.1016/0028-3932(84)90098-8
- Scott, W.A. y Wertheimer, M. (1981). *Introducción a la investigación en psicología*. México: El Manual Moderno.
- Secretaría de Educación Pública [SEP] (2012). *Reporte de la Encuesta Nacional de Deserción en la Educación Media Superior. México*. SEP-COPEEMS. Recuperado de [http://www.sems.gob.mx/work/models/sems/Resource/10787/1/images/Anexo_6Reporte de la ENDEMS.pdf](http://www.sems.gob.mx/work/models/sems/Resource/10787/1/images/Anexo_6Reporte_de_la_ENDEMS.pdf)
- Stelzer, F. y Cervigni, M. (2011). Desempeño académico y funciones ejecutivas en infancia y adolescencia. Una revisión de la literatura. *Revista de Investigación en Educación*, 9(1), 148-156. Recuperado de <http://reined.webs.uvigo.es/index.php/reined/article/view/107/97>
- Vergara, M. I. (2011). *Funciones ejecutivas y desempeño académico en estudiantes de primer año de psicología de la corporación universitaria minuto de dios, en Bello Antioquia* (tesis de maestría inédita). Universidad de San Buenaventura, Medellín, Colombia. Recuperado de https://s3.amazonaws.com/academia.edu.documents/38439002/Funciones_Ejecutivas_Estudiante_Vergara_2011.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1547574033&Signature=MxnuIZzgH8mpUR%2BFi7%2FomSc6i8Y%3D&response-content-disposition=inline%3B%20filename%3DFunciones_Ejecutivas_Estudiante_Vergara.pdf
- Welsh, M., Peterson, E. y Jameson, M. (2017). History of Childhood Maltreatment and College Academic Outcomes: Indirect Effects of Hot Execution Function. *Frontiers in Psychology*, 8, 1-13. doi: 10.3389/fpsyg.2017.01091