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Executive functions and behavior in Ecuadorian high-school students

Funciones ejecutivas y conducta de estudiantes secundarios
ecuatorianos

Abstract

INTRODUCTION: Executive functions are a set of mental skills that allow students to self-regulate their behavior and cognition.

OBJECTIVE: To analyze the relationship between executive functions and behavior of high school students.

METHOD: The sample consisted of 250 Ecuadorian students between 12 and 18 years old. The measures were the EFECO rating and the behavior and academic performance grades of the school year 2015. The data analyses instruments used were the Pearson correlation and one-way ANOVA.

RESULTS: The executive functions of inhibitory control ($r=0.15$, $p=0.01$), organization of material ($r=0.22$, $p=0.01$), monitoring ($r=0.25$, $p=0.01$), initiative ($r=0.21$, $p=0.01$), working memory ($r=0.21$, $p=0.01$), and planning ($r=0.24$, $p=0.01$) are related to the behavior of high school students.

CONCLUSIONS: The results regarding the role of executive functions in behavioral control and academic performance of high school students in Ecuador are discussed.

Keywords

executive functions, behavior,
academic achievement.

Resumen

INTRODUCCIÓN: Las funciones ejecutivas son un conjunto de habilidades mentales que permiten a un estudiante auto-regular el comportamiento y la cognición.

OBJETIVO: Analizar la relación entre las funciones ejecutivas y la conducta de estudiantes secundarios.

MÉTODO: La muestra se conformó de 250 estudiantes ecuatorianos entre 12 y 18 años de edad. Se utilizaron como medidas el instrumento EFECO, la calificación de la conducta y rendimiento académico del año lectivo 2015. En el análisis de datos se utilizó correlación de Pearson y ANOVA de una vía.

RESULTADOS: Se encontró que las funciones ejecutivas: control inhibitorio ($r=0,15$, $p=0,01$), organización de materiales ($r=0,22$, $p=0,01$), monitorización ($r=0,25$, $p=0,01$), iniciativa ($r=0,21$, $p=0,01$), memoria de trabajo ($r=0,21$, $p=0,01$), y planificación ($r=0,24$, $p=0,01$), se relacionan con la conducta del estudiante secundario.

CONCLUSIONES: Se discuten los resultados en torno al papel de las funciones ejecutivas en el control conductual y desempeño académico de los estudiantes secundarios de Ecuador.

Palabras clave

funciones ejecutivas, conducta, rendimiento académico.

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Introduction

The executive functions are a set of cognitive abilities the human being possesses, which are involved in the organization and planning of a task, the planning of strategies for the achievement of goals or objectives, development of organized plans, inhibition of distractions to be able to comply with proposed goals, and the ability to react appropriately to certain situations. They make use of highly complex mental processes such as self-regulation, working memory, organization of materials, and planning, which are the main requirements for solving problems in everyday life.¹⁻²

Executive functions play an important role in the academic life of a teenager since they undertake a transcendental role in the consideration of short or long-term objectives, in problem-solving, and in developing effective strategies to achieve established goals. These executive capacities increase from childhood to adolescence, contributing to improve the resolution of problems as development progresses. Rosselli, Jurado, and Matute assert that from birth to the adolescent stage the performance of tasks that involve executive functions gets gradually better.³

From a neurophysiological perspective, executive functions are located in the frontal lobe and are performed mainly by the prefrontal cortex, which is recognized as the most evolved part of the human brain and gives us the characteristic of being rational individuals, setting us apart from the rest of the animal kingdom. It is known that the dorsolateral portion is associated with metacognitive processes such as planning, working memory, verbal and design fluency, solving complex problems, cognitive flexibility, generation of hypotheses, work strategies, seriation, and sequencing; the orbitofrontal portion is related to functions regulating behavior, inhibitory control, and adaptation of behavior to social norms; and the medial portion of the anterior cingulate is related to the regulation of motivation.⁴

The executive functions have been reported as important for the regulation of student behavior in the educational context, where these mental skills have a leading role in the achievement of educational success from pre-school to university.⁵ Ramos and Lozada submitted an investigation asserting that executive function monitoring plays a role in academic performance.⁶ The study mentions that students with low levels of monitoring present difficulties in performing adequate supervision of their behavior in the educational context, where they demonstrate behaviors such as acting without full awareness of the consequences of their actions, leaving aside activities that may influence the accomplishment of their tasks, submit homework without adequate verification of its quality, and skip classes to perform activities with immediate gratification, among others.

As described, executive functions are core skills in educational and social success in general. For example, inhibitory control allows the student to regulate a response or immediate reaction, letting them wait or execute a more prudent response, delaying gratification, inhibiting their first impulsive reaction, or replacing it with a more appropriate response.⁵

Furthermore, inhibitory control allows the student to keep at school tasks, finish the work although it may be tedious or highly complex, inhibit the temptation to do something more fun, and sustain their attention in a task for a long time without being distracted—even when the activity may be little motivating or useless.⁵

Another executive function with important influence on the student's behavior is the operative memory. This ability allows keeping information in mind while performing an activity.⁷ In order for a student to maintain adequate behavior in an educational environment, it is necessary to keep in line with the informative content of the social norms of behavior. When this function is weakened, it is likely that the student's behavior will be characterized as one that does not follow instructions, meets only some elements of a sequence of phases in an activity, or leaves tasks unfinished, etc.⁸

Cognitive flexibility allows the student to explore different behavioral responses and decisions on how to act in any given situation.⁹ According to Anderson, this executive function allows students to quickly change from one response to another using alternative strategies.¹⁰ This involves habitually analyzing the consequences of their own behavior and learning from their mistakes.

Regarding the rest of the executive functions, the organization of materials is an executive function that allows the student to efficiently make use of the different elements that will be used in the learning process. Monitoring provides the possibility of supervising the adequate performance in academic tasks and in behavior. Planning allows the elaboration of a sequential action scheme. Emotional regulation consists in the adequate control of emotional expressions in different situations. And, initiative provides the possibility for the student to act without needing an external motivator to activate the behavior.¹¹

Within the proposed context, a research question emerges: What is the relationship between student behavior and executive functions? As previously described, theoretically there is an interesting logic which invites an approach to answer the question since the association that exists between both variables is clear; however, as a contribution to the line of investigation regarding executive functions, in the present study we propose to report empirical evidence of this relationship. A significant aspect that must be underlined is that, in the Ecuadorian context, after having reviewed the main databases (Scopus, Web of Science and Latindex), no previous studies on the topic of interest of this article have been found, therefore, this research constitutes the first empirical contribution in this line of research in Ecuador.

Methods

Participants

We worked with a non-probability sample of 250 students in the educational system in the city of Quito, Ecuador. The distribution according to gender was 120 men (48%) and 130 women (52%). Their ages ranged between 12 and 18 years ($M=16.26$, $SD=1.56$). The socioeconomic level of the participants was middle class. We got an informed consent of voluntary participation in the study from all subjects; additionally, the principles of research ethics declared in Helsinki were respected at all times.¹²

Research Design

It is a study with nonexperimental quantitative methodology, transversal temporality, and correlational scope.

Measurement Tools

The deferred observation procedure was used as a measure of executive functions, using a behavioral report scale with great ecological validity, unlike classical laboratory tests.¹⁸⁻¹⁹ We used the EFECO scale (Evaluation of Executive Functions in Childhood through a Behavioral Observation Questionnaire) in a self-report version,¹³ which consists of 67 items that allow us to assess the executive functions: (a) inhibitory control, (b) cognitive flexibility, (c) emotional control, (d) organization of materials, (e) monitoring, (f) initiative, (g) working memory, and (h) planning. As a measure of academic performance and behavior, we used the grades obtained by the participants during the 2015 school year.

Data Analysis

In the statistical analysis, we used descriptive techniques of central tendency and dispersion. To analyze the relationship between executive functions and student behavior, the Pearson correlation procedure was used. To analyze the differences in academic performance considering as a factor the students' behavior, the one-way ANOVA was used.

Procedure

We began by requesting the voluntary participation of the students. The instrument was applied massively in groups of around 30 participants. The academic performance and behavior grades were obtained from the database records of the educational institutions to which the students belong. Subsequently, the data was entered into the statistical package SPSS14 to perform the statistical analyses.

Results

First, the reliability parameters of the instrument used were evaluated with the Cronbach's alpha. The [internal consistency] coefficients found were: inhibitory control $\alpha=0.76$, flexibility $\alpha=0.64$, emotional control $\alpha=0.83$, planning $\alpha=0.73$, organization of materials $\alpha=0.78$, monitoring $\alpha=0.72$, initiative $\alpha=0.77$, and working memory $\alpha=0.82$. When analyzing whether it would be necessary to eliminate an item to improve the coefficient of its corresponding scale we found that it was not useful to perform this procedure, therefore, all the items on the scale were worked with.

In the relationship between the executive functions and the student's behavior grade, we saw that inhibitory control ($r=0.15$, $p=0.01$), organization of materials ($r=0.22$, $p=0.01$), monitoring ($r=0.25$, $p=0.01$), initiative ($r=0.21$, $p=0.01$), working memory ($r=0.21$, $p=0.01$), and planning ($r=0.24$, $p=0.01$), are significantly related to the behavior that students present in their educational institution. The rest of the executive functions (cognitive flexibility and emotional control) did not present statistically significant relationships.

To contrast the executive functioning of the students according to the type of behavior, four groups of student behavior were organized (very satisfactory, satisfactory, unsatisfactory, and improvable), which were considered as factors in the ANOVA analysis. In the results it

was found that there are statistically significant differences in the executive functions of inhibitory control $F(3.226)=2.91$, $p=0.03$, organization of materials $F(3.226)=4.37$, $p=0.005$, monitoring $F(3.226)=7.24$, $p=0.001$, initiative $F(3.226)=3.76$, $p=0.01$, working memory $F(3.226)=5.19$, $p=0.002$, and planning $F(3.226)=7.18$, $p=0.001$. Whereas, in cognitive flexibility $F(3.226)=1.66$, $p=0.17$, and emotional control $F(3.226)=1.33$, $p=0.26$, no differences were found, according to the behavior factor analyzed. In all the comparisons made, it was observed that the greater the behavioral difficulty, the greater the deficit of the executive functions of the students. **Table 1** shows the descriptive values of the executive functions.

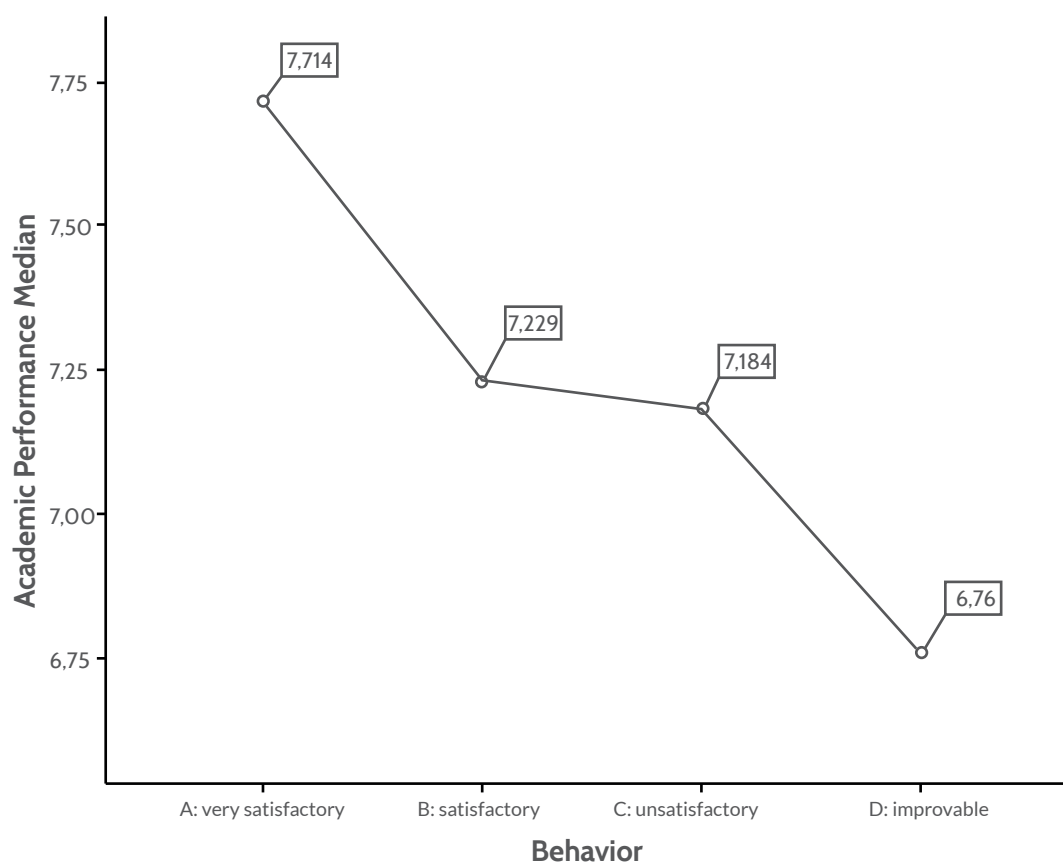
In the comparison of academic performance, we considered the behavior grade as an independent variable with four sublevels: very satisfactory, satisfactory, unsatisfactory, and improvable. The comparison of the academic performance through the behavior factors presented a statistically significant difference $F(3.226)=4.88$, $p=0.003$. **Figure 1** shows the average academic performance according to the level of behavior presented by students.

Table 1. Descriptives of executive functions.

	Minimum	Maximum	Median	Standard D.	Asymmetry	Typical Error	Kurtosis	Typical Error
Inhibitory Control	0	24	8.33	4.535	.683	.154	.471	.307
Cognitive flexibility	0	13	5.15	2.832	.565	.154	-.093	.307
Emotional Control	0	21	7.82	4.797	.548	.154	-.305	.307
Organization of Materials	0	19	6.29	3.967	.777	.154	.765	.307
Monitoring	0	18	5.88	2.995	1.128	.154	1.658	.307
Initiative	0	23	7.25	4.134	.834	.154	1.245	.307
Working Memory	0	26	8.09	4.595	.974	.154	1.672	.307
Planning	0	18	6.29	3.375	.853	.155	1.348	.308

IC = inhibitory control, CF = cognitive flexibility, EC = emotional control, OM = organization of materials, M = monitoring, I = initiative, WM = working memory, P = planning, BF = behavioral factor, Md = median, SD = standard deviation, VS = very satisfactory, S = satisfactory, US = unsatisfactory.

*. The comparison made in ANOVA is significant at 0.05.

Figure 1. Academic performance of the participants according to their type of behavior.

Discussion

In this article, we have reported an investigation that aimed to analyze the relationship between executive functions and the behavior of Ecuadorian high school students. As the main result, we found that the inhibitory control, organization of materials, monitoring, initiative, work memory, and planning are related to the behavior of the student. This relationship suggests that the greater the deficit in executive functions, the greater the student's behavior difficulties.

This result confirms the findings in the study conducted by Arango, Puerta, and Pineda, where they describe that executive functions would act in concert to effectively guide and supervise the behavior and responses set to achieve a goal, fulfill a task, or self-regulate behavior, according to what the environment demands from the individual, just as it happens with the students who get a better grade in the educational context.¹⁵

Considering the executive functions as responsible for behavioral supervision invites reflection on the role they have for the student to control impulsive responses, moving from one activity to another without difficulties in its correct execution, and regulation of responses of the emotional type (crying, anger, frustration, or aggression) in the pursuit of educational objectives—in short, to present a behavior within socially accepted standards.¹⁵

In addition, we analyzed the influence of behavior on academic performance and found there is a significant association between these variables. The students with the best academic performance presented a better behavioral score while the students with low academic performance presented worse behavioral score. This suggests that, although executive functions have an influence on student behavior, they would also have an influence on the student's academic performance, which would allow us to ratify what was mentioned by Diamond, who affirmed that

one of the most influential factors in educational success is executive functioning.⁵

This relates to the findings by Reyes, Barreyro, and Injoque-Ricle¹⁶ and Berninger, Abbott, Cook, and Nagy¹⁷ who described that the executive functions have an important incidence in academic performance mentioning working memory, verbal fluency, regulation of attention, and planning as the executive functions with the greatest impact on student academic performance.

As it has been described throughout the article, the executive functions have a significant impact on student behavior, which delineates possible future research where longitudinal experimental studies of intervention in the executive functions can be carried out to improve the behavior of high-school students.

Finally, as a limitation in the present study, we must mention the implicit subjective character of self-reporting as an assessment instrument of executive functions. It could bias the results described previously, since the makeup of individual behavior may be different for each student. Another limitation that must be kept in mind is the local character of the sample, which belongs to a specific city in Ecuador, and means that the results cannot be generalized to the entire population of the country. However, this situation is a motivation that invites us to continue in this line of investigation with a study with a greater scope at a national level.

Conclusiones

Faltan las conclusiones

Conflict of interest statement

The authors declare there are no relevant conflicts of interest in this study.

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