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Relation between executive functions and empathy and their influence on academic performance in students of Basic Vocational Training

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Abstract

Introduction. One of the lines of research that has aroused great interest in recent years has been to determine the role played by certain cognitive abilities in academic performance. This article describes the relationship between executive functions (interference, flexibility and planning) and empathy and their influence on the academic performance of a group of students enrolled in an institute of Basic Vocational Training (BVT).

Method. The sample was composed of 80 students between the ages of 15 and 19 years. The instruments used were: STROOP (interference), Trail Making Test (TMT) (flexibility), Tower of Hanoi (planning) and TCAE (Test of Cognitive and Affective Empathy). The academic performance variable was assessed using qualifications obtained in the Social/Language and Science/Technology areas (grades from the different subjects). Pearson correlations and multiple regressions were applied.

Results. The results show no significant relation between executive functions and empathy. The level of executive functions explained 15% of the variability in academic performance, while empathy had no significant influence.

Discussion and conclusions. This study demonstrates the importance of examining development of executive functions in adolescent BVT students, and determining their influence on academic performance.

Key words: executive functions, empathy, basical vocational training, academic performance.

Resumen

Introducción. Una de las líneas de investigación que mayor interés ha despertado durante estos últimos años ha sido determinar el papel que juegan ciertas habilidades cognitivas en el desempeño académico. Este artículo describe la relación existente entre las funciones ejecutivas (interferencia, flexibilidad y planificación), la empatía y su influencia en el rendimiento académico de un grupo de alumnos que estudia en un instituto de Formación Profesional Básica (FPB).

Método. La muestra estuvo compuesta por un total de 80 alumnos/as entre los 15 y los 19 años de edad. Los instrumentos empleados fueron: STROOP (interferencia), Trail Making Test (TMT) (flexibilidad), Torre de Hanoi (planificación) y TCAE (Test de Empatía Cognitiva y Afectiva). La variable rendimiento académico fue medida a partir de los resultados obtenidos en el ámbito sociolingüístico y en el científico-tecnológico (calificaciones de las distintas asignaturas). Se aplicaron correlaciones de Pearson y regresiones múltiples.

Resultados. Los resultados indican que no existe una relación significativa entre las funciones ejecutivas y la empatía. El 15% de la variabilidad del rendimiento académico se puede explicar mediante el nivel de las funciones ejecutivas. En cambio, la empatía no influye en el rendimiento académico.

Discussion and conclusions. El estudio demuestra la importancia de contemplar el desarrollo de las funciones ejecutivas en los adolescentes que cursan la FPB y determinar su influencia en el rendimiento académico.

Palabras Clave: funciones ejecutivas, empatía, formación profesional básica, rendimiento académico.

Introduction

Over the past decades, neuroscience and education seem to be joining efforts to achieve a praxis oriented to whole-person development of students. Notwithstanding, it can be an arduous task to find points of convergence between the theories that describe cognitive processes involved in learning, and educational practice in the framework of the present-day educational system. The educational community must adopt this challenge as its own if we wish to meet the needs of today's students.

In present-day Spain, a number of social challenges are emerging, creating trends in a new profile of students. Olmos (2014) calls attention to this and describes the causes of poor academic performance in the school context. He cites factors of a personal, socio-family, and psychological nature, as well as factors of social support, adaptation, learning style and teaching style, all of which contribute to students' behavior in the educational context. When secondary students present difficulties adapting to the demands of ordinary education, or present discipline problems leading to a significant lack of motivation, interest and self-esteem, it is because their prior educational experience has been poor (Ritacco & Amores, 2015). And according to Diamond (2013), one of the most important components for successful childhood and adolescent development are the executive functions. These functions and attention constitute the driving force of intellectual activity and emotional responses; because of them, our actions are the result of our thoughts (Portellano, 2014).

Empathy and affectivity

Empathy and affectivity, as components that make up emotional intelligence under the Salovey and Mayer model (Ibarrola, 2013), seem to be related to students' socio-scholastic adjustment (Jiménez & López, 2009). Emotional intelligence is a kind of catch-all category for a number of psychological skills that influence student behavior. These skills have to do with self-control, mood, enthusiasm, self-motivation, empathy, self-awareness, perseverance, mental agility and the ability to interact with others (García, Tirapu, Luna, Ibañez & Duque, 2010). This type of intelligence is essential due to its pervasiveness in daily life; it consists of finding an ongoing balance between the rational mind (frontal lobe) and the emotional mind (limbic system). Cognitive control is also very important in making socio-affective decisions (Prencipe, Kesek, Cohen, Lamm, Lewis & Zelazo, 2011).

The literature suggests that adolescents with greater empathy and capacity for emotional regulation adapt better to their social environment (Salguero, Fernández, Ruiz, Castillo & Palomera, 2011). There is also evidence that the cognitive dimension and the affective dimension of empathy are related to emotional intelligence, gender and age, with a higher level of empathy present in the female gender. However, in research by Gorostiaga, Balluerka and Soroa (2013), there were no significant correlations with age.

The Spanish Educational System, conscious of the difficulty of addressing all students, adopted Organic Law 8/2013, of 9th December, for improving educational quality (LOMCE, 2013). Its Preamble IV supports a pedagogical model that incorporates students' cognitive development and seeks to erradicate educational exclusion and school failure; Basic Vocational Training (BVT) is offered for better preparation of graduates, through acquisition of transversal competencies that enable satisfactory completion of this stage of education.

Basic Vocational Training is considered Level 1 Vocational Training according to the National Catalogue of Vocational Qualifications, and also includes complementary training in general knowledge. Its purpose is to encourage social, educational and job placement of youth, usually between the ages of 15 and 17, who drop out of the educational system without obtaining a diploma. Three modules are organized over two school years: the specific modules, the guidance and homeroom module, and the general knowledge module. The subjects within these modules are grouped into two areas: the Social/Language area (Spanish, Basque, English and Social Sciences) and Science/Technology (Mathematics and Natural Sciences).

These programs help to ensure that the training, the opportunities and the outcomes do not depend on students' socioeconomic situation, or other factors that might tend toward an educational disadvantage, such as disability, emigration, social exclusion, unequal opportunities, etc. For adolescents, the success of meeting an academic goal sparks motivation and the desire to succeed in the face of difficulties. Adolescence is a transitional stage between childhood and adulthood, it is a natural time for learning and adjustment; motivations are influenced by one's social experiences and related to one's feelings and priorities regarding that goal. Moreover, adolescence is time of special vulnerability, due to the gradual development of executive functions (Crone & Dahl, 2012).

Executive functions

Bausela (2014), building on the model proposed by Miyake, Friedman, Emerson, Witzki, Howerter and Wager (2000), defends the independence of three components of Executive functions: working memory, flexibility and inhibitory control. These three are easily operationalized and can be studied using common tasks. Planning is one of the most important executive functions because it is a practical component of carrying out daily life. Working memory, inhibitory control and cognitive flexibility are believed to form a class of "cool" executive functions, and they make it possible to activate thought and goal-directed conscious behavior (Prencipe et al., 2011). The hot functions, however, involve stimuli, decisions and motivations associated with the emotional and the affective. Other lines of research recognize the interaction between the two when one acts and makes decisions (Cunningham & Zelazo, 2007); however; the hot functions seem to develop at a later time in adolescence than do the cool functions, and emotionally significant stimuli seem to interfere in cognitive control during adolescence (Crone & Dahl, 2012).

This investigation studies the variables of *interference, cognitive flexibility* and *planning*; these allow us to organize and plan our behavior, as well as to program the necessary sequences for meeting an objective. Thanks to these functions, a human being is able to inhibit distraction and avoid interference from irrelevant stimuli, by regulating attentional processes (Portellano, 2014). Furthermore, interference in the development of inhibitory control allows the student to carry out mental tasks that require processing competing information, using the optimal procedure for solving a task (Flores, Castillo & Jiménez, 2014). Cognitive flexibility allows the student to generate an alternative response, taking an efficient approach to problem-solving and planning. It enables students to move forward in organizing their school activities and personal actions, by being able to establish priorities and a succession of actions that lead to meeting a goal (Flores et al., 2014). According to Pérez and Beltrán (2014), some of the symptoms that underlie poor academic performance are students' low cognitive flexibility, low working memory, low behavior inhibition, learning strategies, low motivation and difficulty with emotional regulation. On the emotional level, the *empathy* variable is assessed in the educational context through understanding different points of view (adopting perspectives), empathic stress, and the capacity to sympathize with others' happiness and successes (empathic happiness).

Empathy has to do with the ability to understand others' feelings and emotions, and is an indispensable skill for adolescents, whose life takes place in complex social contexts (López, Arán & Richaud, 2014). However, while it is possible to individualize each component associated with the concept of empathy, in normal functioning they are all interrelated and involved in social cognition. Some lines of research on the topic have found a relationship between school stress and empathy; in other words, when there is lower school stress, we find greater empathy, or the group situation favors a form of interaction with greater capacity for students' understanding each other's emotions (Sierra, Urrego, Montenegro & Castillo, 2015).

Objectives and hypotheses

The objective of the present study is to determine what relationship may be found between executive functions and empathy, and their influence on BVT students' academic performance. Specifically, this investigation pursues the following objectives: 1) To study the relationship between executive functions (interference, flexibility, and planning) and empathy (adopting perspectives, understanding emotions, empathic stress, empathic happiness); 2) To study the influence of executive functions on academic performance (Social/Language area and Science/technology area); and 3) To study the influence of empathy on academic performance. The study's initial hypothesis is that executive functions and empathy are related, and that executive functions and empathy have significant influence on academic performance.

Method

Participants

The sample was composed of a total of 80 students from first and second year in the Ermua-Mallabia Institute for Basic Vocational Training. Each year this school opens its doors to approximately 90 students, from two of the three provinces that make up the Autonomous Basque Region (Bizkaia and Gipuzkoa), representing close to 20 different municipalities. Of the total sample, nearly 96% were living with some family member, while 4% were from foster homes or centers. Girls represented 31.3% of the students (n=25), and boys made up 68.8% (n=55). The male majority is owing to the three specializations that the school offers: Assistant hairdresser and esthetician (24 students, 14 in first year and 12 in second), Vehicle maintenance assistant (28 students, 16 in first year and 12 in second) and Operator in the

manufacture of metal elements (28 students, 16 in first and 12 in second). None of the participants were repeating a year in school. Even though there were two boys enrolled in hairdressing, and two girls in vehicle repair, most students who study the specializations of vehicle repair and manufacture of metal elements are male. The students' ages ranged from 15 to 19 years (M=16.58, SD=1.07). Each school subject was graded by its corresponding teacher, but the evaluation system was the same in all subjects.

Instruments

The variables measured in the present study were fundamentally three: executive functions (interference, flexibility, and planning), empathy (adopting perspectives, understanding emotions, empathic stress, empathic happiness) and academic performance (Social/Language and Science/technology spheres). Four tests were used for measuring these variables: Stroop (for measuring interference), Trail Making Test (TMT) (for measuring flexibility), Tower of Hanoi (to measure planning) and Test of Cognitive and Affective Empathy (TCAE) (to measure empathy):

STROOP Colors and Words Test (Delis, Kaplan & Kramer, 2001; Charles & Golden, 1994). The Stroop test is an attention test that assesses one's ability to resist verbal interference. The test is applied on an individual basis and has a 5-minute duration. It uses 3 printed sheets that contain five columns of 20 elements; there is a three-centimeter separation between columns. To start, the student reads the first sheet aloud during 45 seconds; this is called "word reading (W)". The sheet contains the names of three colors (red, green and blue), repeated throughout the test in random order and printed in black ink. Next, the student reads sheet two, called "color reading (C)", also for a 45-second duration. This sheet is made up of five columns of symbols like "XXX", these are randomly printed in one of the three colors mentioned above. Finally, the student reads the third and final sheet called "Words-Colors (WC)", for 45 seconds. The names of the three colors are again repeated throughout the test, but the typeface is randomly shown in any of the three colors, with no correspondence between the color name and the typeface color. After obtaining measures of the three indices W, C and WC, each of which indicates the number of words that the student read correctly during the 45 second interval, the interference variable is calculated as follows: WC"= (words (W) x colors (C)) / (words (W) + colors (C)). Finally, the difference between the score actually obtained (WC) and the estimate of what should have been obtained (WC") is the indicator that reveals to what extent the pupil allows interference from the Stroop effect.

The Stroop test-retest reliability is quite consistent, ranging from .71 to .89 for direct scores on each of the three sheets.

The Trail Making Test (TMT) (Army Individual Test Battery, 1944). The Trail Making Test measures cognitive flexibility (mental flexibility and processing speed). It contains two parts (A and B). Part A consists of using a pencil to connect 25 numbers, in numerical order, as quickly as possible and without lifting the pencil from the paper. Part B consists of connecting twelve numbers and twelve letters that are displayed randomly on the page as quickly as possible and without lifting the pencil from the paper, alternating one letter and one number, the numbers in numerical order and the letters in alphabetical order. The assessor measures the time (in seconds) that the person takes to finish each part of the test (A and B). Measurement of the variable is produced by this formula: seconds for Part B / seconds for part A. The instrument's internal consistency is .70. Interjudge reliability falls between .96 and .98, and test-retest reliability between .70 and .78 for direct scores.

Tower of Hanoi Test (León, 1997). This test measures cognitive planning. Although there are several versions of this test, it was administered here in digital format. It consists of three "towers" or rods, and three disks of different sizes, which can be placed on any rod. The puzzle starts with the disks stacked on the first rod in order from largest to smallest radius, while the other two rods are empty. The objective of the puzzle is to move the entire stack to the third rod, stacking them in the same order as they were placed on the first rod. To do this, only one disk may be moved at a time; no disk may be placed on top of a smaller disk; and each move consists of taking the upper disk from one of the stacks and placing it on top of another stack or on an empty rod. The variable is measured as the number of moves needed to pass the disks from tower one to tower three, in their correct order; reliability according to Cronbach's alpha is .72.

Test of Cognitive and Affective Empathy (TCAE) (López-Pérez, Fernández-Pinto & Abad, 2008). This questionnaire measures empathy and affectivity through 4 scales: Adopting perspectives (A.P), Understanding emotions (U.E), Empathic stress (E.S) and Empathic happiness (E.H). The test is composed of 33 items (belonging to the aforementioned scales). Using a Likert-type scale, students must assign a score from 1 to 5 according to their level of agreement with the item given (1=Totally disagree to 5=Totally agree). Afterward, the score assigned to each item must be noted on the answer sheet. To calculate scores for the four test

scales, the score for each item is copied into the shaded box that appears in the same row to the left. Afterward, scores are added up by column, and the result is recorded in the box that corresponds to the direct score (DS) for each scale: A.P (18-31), U.E (22-38), E.S (17-28) and E.H (19-37). To calculate the total test score, scores from the four scales are added together, and the result recorded in the box for total direct score (total DS 88-124). Cronbach alpha is .86 for the global TCAE, and ranges between .70 and .78 for the four dimensions (A.P, U.E, E.S and E.H).

Academic performance. Year-end grades were recorded for the two areas of knowledge. The Social/Language area comprises the subjects of Spanish (language arts), Basque language, English language and Social Sciences. The Science/Technology area comprises the subjects of Mathematics and Natural Sciences. The score obtained is the year-end grade that the student obtained in each area, assessed on a scale of 0 to 10.

Procedure

Permission was requested from the school administration before administering the tests, given that significant student involvement would be required, especially in terms of their time. The teaching staff was also informed, and their help was requested for organizing the participants, so as to interfere as little as possible in school life and the rhythm of classes. Students who made up the sample were authorized to participate in the present study by the signed informed consent of their legal guardians.

The variables (interference, flexibility, and planning) were measured on an individual basis over four weeks, during the month of May. The average time required for each pupil to complete the three tests was approximately 35 minutes. A dedicated space was prepared for test administration, free of noises (to facilitate concentration), and with all the tools needed for their execution (computer, test printouts, writing pens, stopwatch). The same instructions were given to all students, in brief, clear and concise fashion. The Test of Cognitive and Affective Empathy was used to measure the empathy variable. This test was applied during the guidance and homeroom hour. The test followed a rigorous procedure, with a safe, calm and trusting atmosphere created for the student. A silent, reflexive environment was offered, ensuring good comprehension, while avoiding time pressure. The maximum test duration was 60 minutes. In order to obtain measurements of the final variable (academic performance), it was necessary to wait until the end of the school year (June), when teachers met together to

assign grades. From the report cards, we collected grades from each of the subjects comprising the two academic areas under study (Social/Language and Science/technology).

Data analyses

For sample description, we used the mean and standard deviation of age, as well as frequency (N) and percentage (%) of participants' gender. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, version 21). For Objective 1, Pearson correlations were applied (given that all the assumptions for parametric analysis were fulfilled). Due to the high number of correlations applied in Objective 1 (15 correlations), it was considered necessary to apply Bonferroni's adjustment (.05 / 15 = .003), by which $p < .003$ was considered significant. For objectives 2 and 3, multiple regressions were applied (two-step regression methodology). The following variables were included in the regressions: academic performance as a dependent variable (doing a different regression for each of the educational areas, Social/Language and Science/technology), the three variables that assess executive functions (interference, flexibility, and planning) as independent variables of Objective 2, and the four subscales of empathy as an independent variable of Objective 3. Since the sample included a broad range of ages (15 to 19 years), we decided to include age in the regression analysis, to see what influence this variable might have on academic performance, even though it was not considered one of the study variables. We included the age variable in the first step of every regression and calculated the change in R^2 (control variables). In step 2 we included all the variables of interest of our study. Two regressions were carried out for Objective 2 (one for each academic field) and 2 regressions for Objective 3 (one for each academic field). A .05 level of significance was considered for the regressions.

Results

Correlation between executive functions and empathy

As seen in Table 1, there is no statistically significant correlation between the three variables that measure executive functions and the total scale for cognitive and affective empathy ($p > .003$). Nor were there significant correlations between the different subscales of affective empathy and the 3 measures of executive functions.

Table 1. *Correlations (r) between executive functions and affective empathy, Mean and Standard Deviations*

Variable	*Interference*	*Flexibility*	*Planning*	*M*	*SD*
Adopting perspectives	.00	.11	.11	25.63	4.15
Understanding emotions	-.33	.03	-.01	30.75	3.84
Empathic stress	-.04	.08	.13	22.32	4.31
Empathic happiness	-.15	.10	.06	28.63	3.50
TOTAL affective empathy	-.18	.05	.08	107.35	10.86
M	-.14	3.33	13.57		
SD	7.12	1.36	6.46		

Note: * p<.003

Influence of executive functions on academic performance

Table 2 shows the results obtained in the multiple regressions. One can observe that the three variables of executive functions (interference, flexibility, and planning) were able to predict 15% of the variability of academic performance (in the Social/Language and Science/Technology spheres) (p <.05), eliminating the effect of age. Age represented between 6% and 9% of the academic performance variable (older participants obtained higher scores in academic performance, β = .30 and β = .25).

Regarding the *interference* variable, β values indicate that it had a positive influence on academic performance in both fields (Social/Language and Science/Technology), indicating that students with a greater ability to resist interferences were the ones who had better grades in both areas (β = .35 and β = .26, respectively). The *flexibility* variable only had significant predictive ability in the Science/Technology field (β = -.18), indicating that students with higher scores on the flexibility test (and therefore lower flexibility), presented lower grades. Finally, the *planning* variable was found to have significant influence in the Science/Technology field (β = -.21); the students who needed a greater number of moves to complete the test obtained lower qualifications in this area.

In summary, significant predictive capacity was found between grades in the Science/Technology field and the three variables of executive functions, showing that students with higher grades were the least affected by interference, they were more

cognitively flexible, and they had greater capacity for planning. However, in the Social/Language field, the only significant correlation observed was for the interference variable (Table 2).

Table 2. *Multiple regression analysis of the influence of executive functions on academic performance*

	Academic performance					
	Social/Language			Science/Technology		
Predictor	ΔR^2	β	R^2 Change	ΔR^2	β	R^2 Change
Step 1	.08**		.09**	.05**		.06**
Control of variables (age)		.30**			.25**	
Step 2	.21***		.15**	.18**		.16**
Interference		.35**			.26**	
Flexibility		-.12			-.18*	
Planning		-.07			-.21**	

Note: *p<.10. **p<.05. ***p<.001

Influence of empathy on academic performance

With the application of multiple regressions (Table 3), the measurements of affective empathy were not clearly predictive of academic performance in either of the two fields (p> .05). Just as in the previous objective, a significant influence from the age variable was found, making it possible to predict an additional variability of 6-9% of academic performance (β = .30 and β = .25).

Table 3. *Multiple regression analysis of the influence of affective empathy on academic performance.*

	Academic performance					
	Social/Language			Science/Technology		
Predictor	ΔR^2	β	R^2 Change	ΔR^2	β	R^2 Change
Step 1	.08**		.09**	.05**		.06*
Control of variables (age)		.30**			.25**	

Step 2	.07*		.03	.03	.03
Adopting perspectives		.02		.10	
Understanding emotions		-.10		-.20	
Empathic stress		.14		.06	
Empathic happiness		.09		-.02	

Note: *p<.10. **p<.05. ***p<.001

Discussion and Conclusions

Although no statistically significant correlation was found between variables that measure executive functions (interference, flexibility, and planning) and the total scale of cognitive and affective empathy (adopting perspectives, understanding emotions, empathic stress, empathic happiness), executive functions were found to predict 15% of the variability of academic performance, indicating the influence of these three components of executive functions on academic performance. The adolescent BVT students who showed less interference, greater capacity for planning and greater flexibility had better academic performance in the Science/Technology Sphere. By contrast, no influence was found from empathy/affectivity on academic performance.

The important mediating role of empathy and social skills in academic performance has been revealed in recent research, such as Zorza (2016); in this study, however, the inhibited processes assessed with the STROOP task were not observed to predict empathy or social behavior. Another line of research revealed that having empathy did not exert any significant influence on the level of scholastic grades; Freitas (2015) did not find significant correlations between the TCAE test and students' performance, although it was confirmed that the lower the empathy score (TCAE total), the higher the scores in mathematics, in male students only.

Nonetheless, the cognitive and affective dimension of empathy seems to be closely related to emotional intelligence (Gorostiaga et al., 2013). In their study, persons who dealt well with their emotions extrapolated this skill to the interpersonal area, thus facilitating and improving their adaptive and relational capacity. Students who showed a more sensitive, empathic and cooperative attitude, in other words, those who had greater social skills, obtained higher academic outcomes than students who showed asocial attitudes (Gutiérrez & Expósito, 2015). However, no direct relationship was found between emotional intelligence and academic performance, it was considered essential to take into account the method, the

instruments, and the statistical analysis performed, along with other variables. These results concur with those found in the present study, where it was not possible to determine the relationship between empathy (adopting perspectives, understanding emotions, empathic stress, and empathic happiness) and academic performance (Social/Language and Science/Technology areas).

The present study offers evidence of a relationship between executive functions (interference, flexibility, and planning) and academic performance (Science/Technology area). The study's initial hypothesis proposed that executive functions and empathy influenced academic performance. Based on the results obtained, we see that this hypothesis was partially fulfilled; that is, executive functions were found to have influence on academic performance (in Science/Technology). Thus, the results allow us to establish a student profile that achieves better performance based on the cognitive variables analyzed, with a significant correlation being observed between grades in the Science/Technology sphere and the three variables of executive functions. Students who obtained higher qualifications presented less interference, had greater cognitive flexibility and greater capacity for planning. Students who showed less cognitive flexibility obtained lower grades.

Our results concur with those found in several studies, such as in De los Ángeles (2012), where significant, negative correlations were found between cognitive flexibility and performance in mathematics, that is, students who attained higher academic performance had greater inhibitory control. Fonseca, Rodríguez and Parra (2016) also found significant relationships between executive functions and academic performance, observing better performance in planning, cognitive flexibility and inhibitory control as students grew older, thereby revealing the importance of neuro-development and of higher cognitive processes in learning. Other lines of research, such as Bigras and Guay (2011) or Simmons, Willis and Adams (2012), found support for academic performance being closely related to certain cool executive functions like working memory and cognitive flexibility.

The literature suggests that working memory, strategic memorization and visuo-spatial planning are more developed in late childhood, and that the capacity for planning by sequences finishes developing in late adolescence (Flores et al., 2014). Through their study, they showed that maximum performance on the Tower of Hanoi was attained at about age 15, and they affirmed that planning, among the intermediate executive functions, was the latest in

reaching its maximum development. However, more information is still needed about how these functions become integrated with each other (especially during adolescence), and how they are integrated with other cognitive capacities throughout development. As Canet, Introzzi, Andrés, and Stelzer (2016) affirm, several cognitive processes come into play when accessing information: the planning process, cognitive control based on intentionality and self-regulation, the attention process, maintenance of cognitive activity, as well as selecting and maintaining attention.

Results obtained in the present study invite us to consider the importance of executive functions in adolescents, and specifically in BVT students, for the purpose of improving their academic performance and understanding their path of development. It is important to study how children and adolescents are able to combine these skills, that it might result in participation behaviors, good performance at school, planning for their future, and the development of meaningful social relations (Crone & Steinbeis, 2017).

Nonetheless, the data obtained in the present study must be interpreted with caution due to a number of limitations. One such limitation is sample representativity nationwide, that is, the sample was selected from a single autonomous region (Basque Country) and it is not possible to extrapolate the results to the whole country. It is also important to recognize that the instrument applied to assess the emotional dimension, the TCAE test, only assesses emotional and affective empathy, and does not look at other emotional aspects that are equally important. This may account for the results obtained here (where empathy had no relationship with either academic performance or with executive functions). It would be interesting to make a comparison of the results obtained here with students from other educational levels, such as students in compulsory secondary education or post-compulsory university-preparatory education. It was not possible to measure the participating students' IQ, but none of the students involved were diagnosed with any intellectual disability.

The findings suggest that the lines between cool and hot executive functions are quite permeable, given that (1) executive functions themselves do regulate cognitive and emotional processes and that, (2) according to Pfeifer and Allen (2012), while the brain and behavior have been shown to follow similar developmental paths for a given function, one ought to consider whether one path causes the other. In any event, if a person's emotional, social and physical dimension are taken into account, we will be working toward academic excellence

from a comprehensive perspective, capable of contributing to motivation for learning and to academic success in BVT students (Sarceda, Santos & Sanjuán, 2017).

In conclusion, according to the results obtained, executive functions and empathy do not appear to be related (they are independent) in adolescents in BVT. In addition, high development of executive functions seems to ensure good academic performance.

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