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Predictive Influence of Executive Functions, Effortful Control, Empathy, and Social Behavior on the Academic Performance in Early Adolescents

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Abstract

In this study, we explored the predictive role of behavioral measures of Executive Functions (EFs) and a self-report measure of Effortful Control (EC) on the academic performance of early adolescents. We also analyzed the mediating role of self-reported empathy and social behavior rated by peers (i.e., prosocial behavior and social preference) and by the lead teacher (i.e., social competence). A sample of 244 adolescents aged between 12 and 13 years participated in the study. The resulting structural equation model indicated that EFs and EC predict academic performance in a complementary and independent way. Results also confirmed the mediating role of empathy and social behavior. The final model explained 64% of academic performance. We discuss the appropriateness of obtaining complementary measures of EFs and EC in predictions of academic performance as well as the importance of

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introducing activities involving self-regulation, empathy, and socioemotional skills in the school setting.

Keywords
academic performance, executive functions, effortful control, empathy, social competence

Executive Functions (EFs) and/or Effortful Control (EC) play a major role in explaining the academic performance and behavior of children and adolescents (Blair & Diamond, 2008; Eisenberg, Valiente, & Eggum, 2010) although the study of their link to school performance has generally focused on early childhood, disregarding later development. Self-regulation has a positive influence on the development and maturation of individuals. From birth to adult age, these skills gradually build an individual's personal autonomy and independence, affective regulation, and interpersonal relationships (Rueda, Posner, & Rothbart, 2005). EFs and EC also have great predictive power over empathy and social skills (Eisenberg, Spinrad, & Eggum, 2010). EFs, as top–down monitoring and control processes, are activated in the context of goal-directed behavior and include inhibition control, working memory, and cognitive flexibility (CF; Diamond, 2013). EC includes the abilities to voluntarily manage attention and inhibit or activate behavior when required to adapt, particularly in situations when someone does not wish to do so (Rothbart, 2007). Although both constructs are related, they have been explored separately in the majority of studies (Sulik, Daneri, Pintar-Breen, & Blair, 2016; Zhou, Chen, & Main, 2012). One of the aims of the present study was to explore the relation between EFs and EC in the prediction of academic performance in early adolescents. We also aimed to ascertain whether this relation is mediated by the students' empathy and social skills. Empathy is related to control processes (Decety & Lamm, 2009) while positive social relationships favor academic performance (Wentzel & Ramani, 2016). In previous research, Zorza, Marino, de Lemus, and Acosta Mesas (2013) found that the social status of secondary education students partially mediated the influence of EC on academic performance. Moreover, empathy, which was closely related to EC, had a considerable predictive influence on social status and partially mediated the relationship between EC and social competence.

Executive Functions and Effortful Control

EFs allow individuals to target their behavior to specific goals and are generally related to planning and problem solving (Diamond, 2013), school readiness, and academic achievement (Best, Miller, & Naglieri, 2011; Zorza, Marino, & Acosta Mesas, 2016). Some theorists argue that EFs are a unitary construct, a central executive system that establishes priorities in information processing and behavior control (Baddeley, 2000; Norman & Shallice, 1986). Others consider that EFs comprise a series of basic but interrelated components, the most important of which are working memory, inhibitory control, and CF (Best, Miller, & Jones, 2009; Miyake et al., 2000). EC is a component of temperament that is related to the voluntary control of behavioral approach and avoidance tendencies (Chen et al., 2015; Swanson, Valiente, & Lemery-Chalfant, 2012). Through its activating and inhibitory control mechanisms, EC enables individuals to regulate their behavior in situations of potential punishment or when an immediate reward is delayed in order to obtain a more important reward later on (Rueda et al., 2005). Given the partial overlap between both constructs (Sulik et al., 2016; Zhou et al., 2012) it is not surprising that similar neural networks have been associated with both EFs and EC, specifically the anterior cingulate cortex and the dorsolateral prefrontal cortex (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Koechlin & Summerfield, 2007; Rueda, Posner & Rothbart, 2011). Therefore, additional studies investigating the joint and independent modulation of these constructs in academic performance will make it possible to conduct a more refined analysis of these relationships.

Theoretical developments and research studies have addressed both constructs differently. EFs have often been conceptualized as a group of basic cognitive processes (i.e., inhibitory control, working memory, and CF) that allow problem solving, abstract reasoning, and goal-directed behavior (Diamond, 2013). Inhibitory control (IC) consists of the ability to control one's attention, behavior, thoughts, and impulses to override a strong internal predisposition or external lure, and instead do what is more appropriate or necessary (Diamond, 2013). Working memory (WM) involves the process of updating the information or thinking, planning possible alternatives, or relating one piece of information to another. The WM is required to hold and mentally work with information in the mind (Baddeley, 2000). CF involves the ability to change perspectives, either spatially or interpersonally, and to modify how we think about something in order to adjust to changing demands or priorities. The CF requires and builds on inhibitory control and WM (Diamond, 2013). EC—unlike EFs that are not regarded as personality traits or behavioral features—has been understood as a unitary construct and a dimension of temperament that is generally related to the self-regulation of behavior (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013). Although some psychometric studies have divided EC into several subcomponents (Rothbart, 2007), it is generally considered as a construct that encompasses multiple skills.

Traditionally, research on EFs has focused on tasks and demands with no affective demand. It is only recently that EFs have been associated with emotional regulation, and a distinction has since emerged between "cold" and "hot" EFs on a continuum of affective activation (Hongwanishkul, Happaney, Lee, & Zelazo, 2005). In contrast, the majority of studies on EC have been linked to emotional regulation in an attempt to make predictions regarding the socioemotional behavior and affective states of children, particularly in family or school settings (Zhou et al., 2012). EFs are assessed with behavioral tasks in emotionally neutral situations, whereas information on EC is usually obtained using questionnaires or self-reports in which everyday behaviors are described (Diamond, 2013).

Some researchers have recently included measures of EFs and EC in the same studies to explore the relations between them. The results indicate that they are only moderately correlated (Hongwanishkul et al., 2005; Rothbart, Ellis, Rueda, & Posner, 2003). It has even been observed that some EF measures are not related to EC. For example, Blair and Razza (2007) have shown that parental reports of the EC of kindergarten children were correlated with measures of inhibitory control tasks but not with attention-shifting tasks. Additionally, EC (as reported by teachers) and inhibitory control (evaluated with children's performance on a peg-tapping task) predicted achievement in mathematics and letter knowledge, but attention shifting (evaluated with a task switching task) did not. In adults, Bridgett et al. (2013) found a moderate correlation between neuropsychological tests that require the management of information in working memory (i.e., the Letter-Number Sequencing subtest of the Wechsler Adult Intelligence Scale–Fourth Edition [WAIS-IV] and verbal fluency tests) and self-report measures of EC (i.e., the Adult Temperament Questionnaire; Derryberry & Rothbart, 1988). However, contrary to what has been observed in children, the study did not find any relationship between inhibitory control (assessed with the Stroop task) and EC scores. It is possible, therefore, that the relationship between EFs and EC vary with development. An objective of our research is to examine the predictive value of EFs and EC for socioemotional processes and academic achievement in adolescence. EFs measures of 12- to 13-year-old students were obtained using Trail Making Test (TMT), Stroop task, and verbal fluency tests, whereas EC measures were obtained with a temperament questionnaire (Early Adolescence Temperament Questionnaire–Revised [EATQ-R]; Ellis & Rothbart, 2001).

Control Processes, Empathy, and Social Behavior

Empathy is also related to control and interpersonal regulation processes (Barkley, 2001) as it is particularly important to experience and understand the emotional states of other individuals. Furthermore, it implies regulating the affective experience, so that there is no emotional overreaction (Decety & Lamm, 2009). Control is involved in perspective taking and emotional regulation is required to reduce the personal discomfort generated in a situation of empathy (Eisenberg & Eggum, 2009). In the brain, empathy is partially supported by neural networks involving the prefrontal cortex, particularly the connections between the orbitofrontal cortex, the medial prefrontal cortex, and the dorsolateral prefrontal cortex (Decety, 2011). As has already been pointed out, some of these areas are also associated with EFs and EC.

It is therefore not surprising to note that EFs and EC have been positively associated with empathic abilities. For instance, Thoma et al. (2011) observed that CF—assessed with the TMT—and working memory—assessed with the Letter-Number Sequencing subtest of the WAIS-IV—were positively correlated with cognitive empathy, both in patients with depression and in a healthy control group. EC has been positively associated with dispositional empathy both in children and adolescents (Valiente et al., 2004; Zorza et al., 2013). In addition, Eisenberg et al. (2007) found that high levels of EC during childhood predict empathic responses during early adolescence.

In addition, EFs and EC have been related to the ability to establish positive relationships between classmates. Students with higher self-regulation levels are chosen by more peers and have a more positive relationship with their teachers as well as fewer behavioral problems (Eisenberg et al., 2005; Eisenberg, Valiente, & Eggum, 2010). However, it is still not clear how self-regulation processes influence social behavior among peers. EFs and EC may positively influence the social behavior of students by providing empathy. In fact, students who show concern about the emotions of others and perform prosocial behaviors are more favored and accepted by their peers and have a more positive perception of the social climate than those who do not (LaFontana & Cillessen, 2002; Zorza, Marino, & Acosta Mesas, 2015).

However, no studies to date have simultaneously explored the predictive power of measures of EFs and EC over empathy in adolescence. Some executive processes such as flexibility and working memory that are particularly important for emotional regulation in adolescence (Thompson, 2011; Zimmermann & Iwanski, 2014), should positively predict empathy, as should EC (Zorza et al., 2015). In early adolescence, parent-child conflicts are frequent (Laursen, Coy, & Collins, 1998) and negative emotions are more common than in later adolescence (Larson, Moneta, Richards, & Wilson, 2002). It is therefore important to learn more about these relationships.

Executive Functions, Effortful Control, and Academic Performance

There are many routes of influence of EFs and EC on the academic performance of children and adolescents. It has been reported that working memory, one of the components of EFs, is directly and positively related to grades in mathematics (Bull & Scerif, 2001). CF, another basic aspect of EFs, has been found to moderately predict literacy ability (Van der Ven, Kroesbergen, Boom, & Leseman, 2012) and the average grades of students aged 8 to 13 years (Best et al., 2011; Zorza at al., 2016). In contrast, EC is considered important for the academic motivation of students (Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). In particular, high levels of EC are associated with greater participation in class, a better relationship with teachers, and better academic performance (Liew, Chen, & Hughes, 2010; Rueda, Checa, & Rothbart, 2010; Valiente et al., 2013). Moreover, some aspects related to EC such as persistence in completing a task or in keeping one's goals are also associated with academic success in primary school (Blair & Razza, 2007).

Apart from this direct relationship, empirical results confirm the mediating role of empathy and social skills for the relationship between EC and academic performance. Zhou, Main, and Wang (2010) found that high levels of EC in preschool children facilitate school adaptation through the regulation of behavior and social skills. In a longitudinal study, Valiente et al. (2011) found that EC assessed at the age of 6 predicted the social functioning of children at the age of 8, which in turn significantly mediated the relationship between EC and academic performance at the age of 10. Zorza et al. (2013) also found that the social status of secondary education students partially mediated the influence of EC on academic performance. In this study, empathy, which was closely related to EC, had a considerable predictive influence on social status and partially mediated this relationship.

To explain academic performance, it is necessary to consider not only the self-regulation resources used by students to respond to academic demands, but also how students use these resources in empathic and interpersonal situations. In fact, better self-regulation resources allow adolescents to develop a steady and wide social network of peers. Wentzel and Ramani (2016) suggested that having positive social relationships with peers brings benefits that favor emotional and academic development. One of these benefits is the social and instrumental support gained through frequent contact with classmates. Students receive help from their peers to perform academic tasks and to solve social conflicts, which generates higher motivation and school commitment. This is particularly relevant in early adolescence, when the students

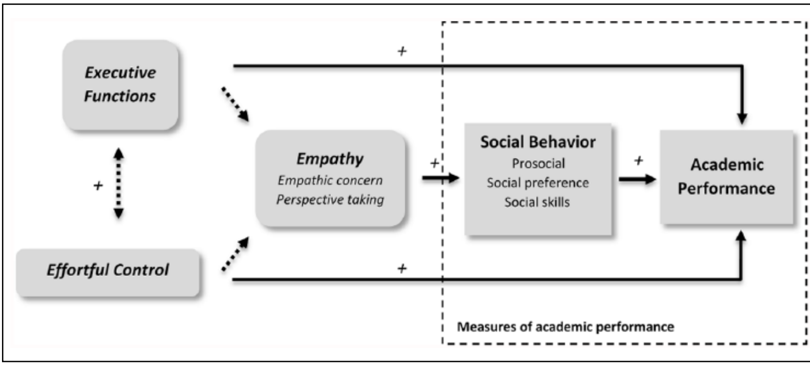

Figure 1. Proposed model of relations between executive functions, effortful control, empathy, social behavior, and academic performance.

are more sensitive to the opinions of others and there is a sustained development of their self-regulation abilities (Best et al., 2009; Best et al., 2011; Crone, 2009; Shulman et al., 2015).

The Present Study

The purpose of this study was to explore the interrelations between EFs, EC, and empathy in early adolescents—secondary education students—and determine the direct and indirect influence of these constructs on academic performance. We aimed to test a predictive model of academic performance (see Figure 1) that would allow us to do the following: (a) learn about the relations between several behavioral tasks that assess EFs (i.e., the TMT, Stroop task, and verbal fluency tests) and a self-reported measure of EC (i.e., the EATQ-R; Ellis & Rothbart, 2001), and we used first-generation classic EF tasks (Gruber & Goschke, 2004) that require the involvement of several cognitive processes at the same time (i.e., working memory, CF, inhibitory control, verbal fluency) even if one of them predominates in each task; (b) explore the differential relations between both measures of EFs and EC on one side and self-reported dispositional empathy on the other; and (c) analyze the differential relations between EFs and EC and social behavior and determine whether such relations are mediated by empathy. On the basis of the results of previous studies (Zorza et al., 2013; Zorza et al., 2015), we hypothesized that control processes influence social behavior by improving the emotional regulation and perspective taking that lead to the empathic response. Finally, considering that the literature shows possible gender differences in academic achievement (Valiente et al., 2008) and other study variables, we intended to explore whether these relationships vary according to the gender of the students.

Method

Participants

The sample was composed of 244 students (129 males) who attended four public schools (58, 67, 62, and 57 participants from each school) in the city of Granada, Spain. Participants from each school were grouped into two classes, and so were divided into eight different classes. The number of students per class ranged between 28 and 34. All participants were in the first year of secondary education and were aged between 12 and 13 years ($\bar{X}$ = 12.30, *SD* = .46 for females; and $\bar{X}$ = 12.25, *SD* = .43 for males). Eight lead teachers collected information about the students of their classroom. The families of participants from the four schools had similar medium-to-low socioeconomic status (i.e., education level and income). Most of the participants were Caucasian and had been born in Spain, and only 5.8% were immigrants from Latin America.

Measures of Executive Functions

Trail Making Test. We distributed the classic pen and paper version of Reitan and Wolfson (Lezak, 1995). The TMT is composed of two parts: A and B. Each part consists of 25 circles distributed over an A4 sheet of paper (21 cm × 28 cm). The subject has to draw a line to connect the circles in ascending order as quickly as possible without lifting the pen. In Part A, the circles are numbered from 1 to 25; in Part B, the circles include both numbers (1-13) and letters (A-L). In Part B, the subject alternates between consecutive numbers and letters (that is, 1-A-2-B . . .). The tasks are completed when the subject reaches numbers 25 or 13 (indicated with the word "END"), respectively. Errors are immediately pointed out by the examiner and the score on each part is the amount of time (seconds) required to complete the task. In this study, we used the scores of Part B, given that CF is required to alternate between numbers and letters (Kortte, Horner, & Windham, 2002; Sanchez-Cubillo et al., 2009).

Stroop task. Participants completed a version composed of two parts (Lezak, 1995). In the first (Part C), subjects were presented with an A4 sheet of paper (21 cm × 28 cm) with 112 words designating colors (blue, green, red, and black) printed in a color (blue, green, red, or black) that was different from that designated by the word. Subjects had to read the written word as quickly as possible. In the second (Part CP), participants were handed another A4 sheet of paper with the same number of words and equivalent manipulations between the meaning of the words and the ink they were printed in. In this part, participants had to name the color of the printed ink as quickly as possible. This task is usually more demanding because naming the color of the ink requires inhibiting the semantic processing of the word. The performance index is calculated by dividing the number of correctly named words by the seconds required. Errors are infrequent and participants require less time to complete Part C than Part CP. In the present study, we considered the results of the second part (Part CP). In order to respond properly, participants must inhibit the meaning of the word, that is, apply inhibitory control (Diamond, 2013)

Verbal Fluency (VF) Test. Finally, we administered a verb naming test (Piatt, Fields, Paolo, & Tröster, 1999). The students were asked to name as many verbs as possible in 1 minute. They were instructed to name the verbs in the infinitive and not to repeat them, and their responses were digitally recorded. The performance index included in the study was the total number of valid verbs. This task is complex as it requires controlling the selection (Hirshorn, Thompson-Schill, 2006) and recovery of words (Badre & Wagner, 2007). Participants must also inhibit words already evoked and change the semantic category after each response. The task requires searching and retrieving words in semantic memory with continuous monitoring of the word just evoked in working memory (Marino, Acosta Mesas, & Zorza, 2012).

These tasks—TMT, Stroop Test, and VF—are meant to measure mainly one EF—respectively, CF, inhibitory control, and working memory—and are considered to be "first generation tests." Nevertheless, they tap on several executive and cognitive operations simultaneously, although one predominates in each task.

Measures of Effortful Control

This construct was evaluated with the EATQ-R self-report (Ellis & Rothbart, 2001) translated into Spanish by Checa, Rodríguez-Bailón, and Rueda (2008). The EATQ-R assesses four factors of temperament (i.e., EC, extraversion/surgency, negative affect, and affiliation) and can be administered to participants aged 10 years or older. In this study, we used the total score of the 16 items that collect information about EC ($\alpha = .70$), which is composed of three subfactors: activation control (e.g., "If I have a hard assignment to do, I get started right away"), attention (e.g., "It is easy for me to really concentrate on homework problems"), and inhibitory control (e.g., "I can stick with my plans and goals"). Responses are provided on a Likert-type scale from 1 (*almost always untrue for you*) to 5 (*almost always true for you*). Prior studies (Valiente et al., 2008) have reported a similar internal consistency to that obtained in the present study (α = .73).

Measures of Empathy

Empathy was assessed with the Spanish adaptation (Mestre Escrivá, Navarro, & García, 2004) of the interpersonal reactivity index (Davis, 1983). This scale is one of those most widely used in the literature to measure dispositional empathy. It includes 28 items distributed into four subfactors: empathic concern, perspective taking, fantasy, and personal distress. As in other studies (Batanova & Loukas, 2011), we included scores on perspective taking and empathic concern, the two dimensions that provide the most accurate and direct assessment of empathic resources. Fantasy and personal distress factors are sometimes open to ambiguous interpretation and have low correlations with measures of behavior and cerebral activation (Decety & Lamm, 2009). Empathic concern (Emp-C) assesses whether individuals respond affectively to the emotional experience of others (e.g., "I often have tender, concerned feelings for people less fortunate than me"). Perspective taking (Emp-PT) provides information on an individual's cognitive ability to adopt the perspective of another person in everyday situations (e.g., "I try to look at everybody's side of a disagreement before I make a decision"). Participants responded on a scale ranging from 1 (*does not describe me well*) to 5 (*describes me very well*). Internal consistency indices (Emp-C: α = .68; Emp-PT: α = .72) were similar to those obtained by Mestre Escrivá et al. (2004) in the Spanish version.

Measures of Social Behavior

Evaluations of peers. We used a nomination procedure and a prosocial behavior classification scale. In the former, we assessed *social preference* with a sociometric procedure (Rodríguez Pérez, 2005): from the class list (between 25 and 34 students), each student nominated the three classmates with whom he or she would like to perform several activities (i.e., school tasks or recreational activities) and three classmates with whom he or she would not like to perform them. The latter assignment is delicate as it forces students to choose someone they would not like to work with. Nonetheless, this measure was included as it allowed us to identify the students who were excluded or rejected, which is a central measure from which to calculate social preference. Following the method proposed by Newcomb, Bukowski, and Pattee (1993), both the number of times each student was chosen and the number of times he or she was rejected was divided by the number of students in each class. The social preference index was obtained by subtracting the adjusted score of rejections from that of choices. To assess prosocial behavior (López Sánchez, 2006), students were asked to rate each of their classmates according to the degree of help they provided in various situations (i.e., performing school tasks, when they were sad or worried, or in situations of conflict with other peers). They were handed a list with the name of all their classmates and asked to rate them on a Likert-type scale ranging from 1 (*provides very little help*) to 5 (*is very helpful*). Scores for each student were normalized for each class.

Evaluations by teachers. The lead teacher of each class completed the *Escala de Valoración del Profesor I-S* [Intelligence and Socialization Teacher Assessment Scale] (Carrión, Hernández, & Gregorio, 1999), which collects information about the Socialization, Respect for Authority, and Intelligence of each student. The scale is composed of 24 items that are rated from 1 (*minimum*) to 10 (*maximum*) according to the degree to which they describe a skill of the student. In this study, we only considered the measures of the socialization subfactor (α = .93), which assesses the perception of teachers about students' social skills (e.g., "their ability to cooperate positively with their peers settling disputes").

Measures of Academic Performance

We included the mean of the final grades of each participant in the school year during which the assessments were made. The subjects used were mathematics, Spanish, English, social sciences (history), natural sciences (biology), physical education, and art/music. The rating scale ranged from 0 to 10 and the scores were standardized within subjects and then averaged to create a composite achievement score. It is considered that a student has passed a subject when he or she has scored 5 or more.

Procedure

Before beginning the study, consent from parents and the school authorities was obtained, and the study received ethical approval from the relevant committee. EFs were assessed individually in a quiet room in each school. The self-reports and questionnaires of the other measures were presented in booklets in which the order of presentation was randomly arranged. Participants completed the questionnaires in their classrooms in the presence of one experimenter and the lead teacher of each class, who did not know the scores obtained by the students in EF tests. Before the booklets were distributed, the examiner informed participants that their data would be totally confidential and verbally repeated the instructions on how to complete the questionnaires included in the booklet. Students performed the EF tasks and completed the questionnaires in their regular school hours in November, 2 months after the start of the school year. The lead teacher assessed each student with the *Escala de Valoración del Profesor I-S* in March, 7 months after the start of the school year. Each lead teacher assessed approximately 30 students. At the end of the school year, the school management provided the list of grades for each student.

Data Analysis

First, we conducted the descriptive analysis of each variable and explored its correlations in order to determine whether the pattern supported the proposed model, whether it was appropriate to create latent variables, and whether the mediation pathways hypothesized were plausible. Next, we tested the predictions of the models using structural equation modeling (SEM) with AMOS statistical software, Version 18.0. To control the influence of the "school" variable, we transformed the direct academic performance and social behavior scores into a *z* scale, normalizing the measures before conducting the SEM analysis. In addition, given that it was logical to expect a covariance between the error terms in the variables rated by the same evaluators, we introduced a covariance between measures of social preference and prosocial behaviors. The goodness of fit of the model proposed was assessed with a series of indices: χ^2, comparative fit index (CFI), Bentler-Bonett normed fit index (NFI), and root mean square error of approximation (RMSEA). If the model is an adequate representation of the data observed, the χ^2 test is *not* significant and therefore the associated p value should be greater than .05. Moreover, values lower than .95 in the NFI and CFI indices indicate that the model can be improved. The RMSEA value was also calculated, considering that any value equal to or lower than .06 indicates good fit. Because of the sensitivity of the χ^2 statistic to the sample size and the deviations with regard to assumptions of linearity, multivariate normality, and the χ^2/df ratio, it is considered that values equal to or lower than 3.0 indicate good fit. The χ^2 difference test and the Akaike information criterion (AIC) were used to compare the fit of the models (lower values indicate better fit).

To explore the direct and indirect relations (i.e., mediated by empathy and social behavior) between EFs and EC on one side and academic performance on the other, all the models included both pathways of influence. To identify the relation between behavioral measures of EFs and self-reported measures of EC, a latent variable for EF measures was included in Model 1; scores on the Trail Making Test (Part B; TMT-B), the Stroop-CP, and the verbal fluency of verbs (VF-V) tasks were separately included in Model 2. The comparison of both models was expected to indicate whether the relation between EC and EFs is general or specific for any particular executive process. To determine whether the influence of EFs and EC on social behavior was mediated by empathy, the indirect effects of this variable were added to the direct effects of measures of EFs and EC on social behavior in Model 3. Finally, we conducted a multigroup analysis to find out whether the model with the best fit was moderated by the gender of students.

Results

Preliminary Analyses

Descriptive statistics for each variable and correlation analyses are shown in Table 1. EF measures were significantly correlated with one another, which indicates that they are somewhat related. However, only the measures of VF-V were significantly correlated with EC. It therefore appears that the EF and EC constructs are somewhat independent. These results justified the creation of a latent variable for EF measures that was independent of EC. Correlations between reports from peers and the lead teacher regarding Prosocial Behavior, Social Preference, and Social Behavior were high and significant. Due to this, we created the latent variable "Social Behavior" in the structural equation model. Finally, we also obtained significant and high correlations between Perspective Taking and Empathic Concern, which allowed us to create another latent variable for the Empathy construct.

In addition, the pattern of correlations suggested that there may be multiple mediations between variables. All the measures except those derived from the Stroop task were significantly and positively correlated with Academic Performance. Moreover, significant correlations were found between VF-V measures and EC, between scores on the TMT-B and Empathy, and between both measures of EFs and Social Behavior. EC was also positively correlated with Empathy and Social Behavior; and Empathy was correlated with Social Behavior. This pattern of correlations was compatible with the predictive and mediation framework proposed in the model.

Structural Equation Models

We tested a first model (Model 1) with latent variables for EFs, Empathy, and Social Behavior. We included a direct pathway of influence of EFs and EC on academic performance and an indirect pathway mediated by Empathy and

Table 1. Mean, *SD*, and Pearson's Correlations Between the Variables Assessed in the Study.

Variable	$\bar{X}$ (*SD*)	Range	2	3	4	5	6	7	8	9	10
1. TMT-B	98.18 (36.19)	40-240	.22**	.32**	.11	.15**	.18**	−.02	.27**	.38**	.28**
2. Stroop-CP	1.78 (39.09)	0.1-3.1	—	.21**	.08	−.05	.08	−.17	−.08	.17	−.02
3. VF-verbs	15.52 (5.98)	4-33	—	—	.23**	.07	.11	.05	.25**	.34**	.59**
4. Effortful control	10.12 (1.55)	6.6-14.4	—	—	—	.25**	.25**	.17*	.26**	.24**	.43**
5. Emp-PT	21.74 (4.70)	8-35	—	—	—	—	.56**	.14	.22**	.31**	.26**
6. Emp-C	23.37(5.37)	6-35	—	—	—	—	—	.17**	.26**	.28**	.27**
7. Social pref.	.01 (0.18)	−0.6-.53	—	—	—	—	—	—	.70**	.45**	.28**
8. Prosocial	3.06 (0.59)	1.3-4.3	—	—	—	—	—	—	—	.54**	.49**
9. Social skills-T	6.04 (2.20)	1-10	—	—	—	—	—	—	—	—	.50**
10. Academic perf.	5.94 (1.60)	1.3-9.4	—	—	—	—	—	—	—	—	—

Note. TMT-B = Trail Making Test (Part B); VF = verbal fluency; Emp-PT = empathy–perspective taking; Emp-C = empathic concern; social pref. = social preference rated by peers; prosocial = prosocial behaviors rated by peers; social skills-T = social skills rated by teachers; academic perf. = academic performance.
*$p \le .05$. **$p \le .001$.

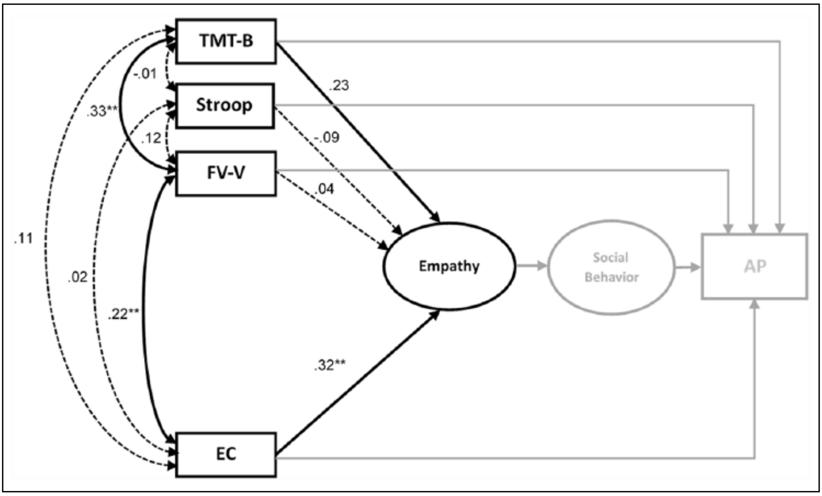

Figure 2. Initial structural equation model that showed significant fit (Model 2).
Note. Covariances between EFs and EC and the relations between them and empathy are highlighted. Solid lines represent significant paths. TMT-B = Trail Making Test (Part B); VF-V = verbal fluency–verbs; EC = effortful control; AP = academic performance.
$^*p < .05$. $^{**}p < .01$.

Social Behavior (see Figure 1). The model did not show adequate fit, $\chi^2 = 69.01$, $df = 29$, $p = .000$; $\chi^2/df = 2.38$; RMSEA = .07, CFI = .93, NFI = .89. To improve the fit, we eliminated the latent variable from EFs, as two of its three indicators did not show significant patterns of relations, suggesting that the variables measured did not contribute to the latent construct. Moreover, the variance explained was very low (TMT-B, $R^2 = .17$; Stroop-CP, $R^2 = .01$). In Model 2, we included the scores on the TMT-B, the Stroop-CP, and the VF-V tasks separately and found the same variables and relations as those found in Model 1. Results of indices were comparatively better, $\chi^2 = 56.91$, $df = 23$, $p = .000$; $\chi^2/df = 2.47$; RMSEA = .07, CFI = .94, NFI = .91.

In this model (Figure 2), the measures of the TMT-B and EC significantly predicted Empathy. In Model 3, we added the direct effect of measures of EFs and EC on Social Behavior. This model also showed good fit, $\chi^2 = 30.48$, $df = 20$, $p = .062$; $\chi^2/df = 1.52$; RMSEA = .05, CFI = .98, NFI = .95, with significantly better results than the other models[1] (see Table 2). As shown in Figure 3, Model 3 explained 64% of the variance in Academic Performance. In line with the proposed hypotheses, we found a direct relation between scores on the VF-V ($\beta = .40$, $p < .001$) and—to a lesser extent—EC ($\beta = .18$, $p < .001$) and Academic Performance. Scores on the TMT-B ($\beta = .20$, $p < .05$)

Table 2. Summary of the Comparative Fit Indices of Each Model Analyzed.

SEM	χ^2	*df*	CFI	NFI	RMSEA	AIC	$\Delta\chi^2$
Model 1	69.01	29	.93	.89	.07	141.01	—
Model 2	56.91	23	.94	.91	.07	140.91	12.1
Model 3	30.48	20	.98	.95	.04	120.48	26.43**

Note. Results of chi-square tests confirmed that goodness-of-fit indices were best in Model 3. We obtained the same result when using the AIC (Akaike, 1974). Model 3 had the lowest values, which indicates better fit. SEM = structural equation modeling; CFI = comparative fit index; NFI = normed fit index; RMSEA = root mean square error of approximation; AIC = Akaike information criterion.
*$p \leq .05$. **$p \leq .001$.

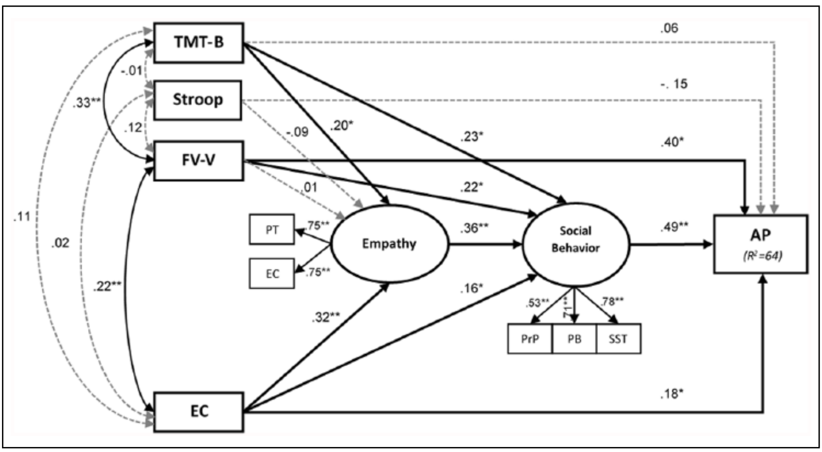

Figure 3. Final structural equation model (Model 3) that best predicted academic performance.
Note. Solid lines represent significant paths. TMT-B = Trail Making Test (Part B); FV-V = verbal fluency-verbs; EC = effortful control; PT = perspective taking; EC = empathic concern; PrP = social preference rated by peers; PB = prosocial behaviors; SST = social skills rated by teachers; AP = academic performance.
*$p < .05$. **$p < .01$.

and EC (β = .32, $p < .001$) also had a direct influence on Empathy ($R^2 = .16$). Moreover, scores on the TMT-B (β = .22, $p < .001$) and on the VF-V (β = .22, $p < .001$), EC (β = .16, $p < .05$), and particularly Empathy (β = .36, $p < .001$) predicted students' Social Behavior ($R^2 = .41$). Social Behavior was also an excellent predictor (β = .49, $p < .001$) of Academic Performance.

Table 3. Direct and Indirect Effects for the Final Model 3 to Predict Academic Performance.

	Direct				Indirect			
			CI 95%				CI 95%	
Variable	*B*	*SE*	LL	UL	*B*	*SE*	LL	UL
TMT-B	.06	.05	−.15	.04	.06**	.00	.00	.00
Stroop-CP	−.15	.04	−.23	−.04	.00	.03	−.07	.01
VF-verbs	.40*	.05	.37	.57	.04**	.01	.00	.02
Effortful control	.18*	.04	.15	.34	.06**	.02	.02	.13
Empathy	—	—	—	—	.07**	.03	.02	.14
Social behavior	.49**	.05	.17	.43	—	—	—	—

Note. CI = confidence interval; LL = lower limit; UL = upper limit; TMT-B = Trail Making Test (Part B); VF = verbal fluency.
*$p \le .05$. **$p \le .001$.

Considering Model 3, we conducted mediation analyses to determine whether empathy mediates the relation between (a) EC and Social Behavior and (b) scores on the TMT-B and Social Behavior. We also analyzed whether Social Behavior mediates the relations between (a) TMT-B measures and Academic Performance, (b) VF-V scores and Academic Performance, and (c) EC and Academic Performance. We estimated the indirect/mediated effects (see Table 3) using bias corrected and accelerated (BCa) bootstrapping methods with 2,000 resamples (Preacher & Hayes, 2008). For the first group of mediations, we found significant β = .07 (p = .009) indirect effects of EC on Social Behavior through empathy, with a 95% confidence interval (CI) = [0.034, 0.150]; we also found a significant β = −.05 (p = .017) indirect effect of the TMT-B measures on Social Behavior through empathy, with a 95% CI = [−.108, −.009]. For the prediction of Academic Performance, two significant indirect effects were obtained: a significant β = −.003 (p = .006) indirect effect of the TMT-B measures on Academic Performance through Social Behavior, with a 95% CI = [−.122, −.018], and a significant β = .06 (p = .003) effect of EC on Academic Performance through Social Behavior, with a 95% CI = [.026, .127]; the indirect effect of scores on the VF-V on Academic Performance was significant (β = .06, p = .000), with a 95% CI = [.006, .086].

Analysis of the moderation according to gender. Some studies have found that gender mediates the relationship between Empathy and Academic Performance (Valiente et al., 2008). To verify whether this influence was present in our results, we performed a multigroup SEM analysis. In particular, we explored another "restricted" model in which we forced the loadings on each factor and regressions so that they would be the same in males and females. An equivalence between them would suggest a lack of moderation (Byrne, 2001). The model resulting from the analysis showed adequate fit, $\chi^2 = 64.97$, $df = 44$, $\chi^2/df = 1.49$; RMSEA = .04, CFI = .96, NFI = .90. The difference between the "free" model (with no parameter limitations) and the "restricted" $\chi^2(23.34)$ model with 18 degrees of freedom was not significant ($p = .190$), indicating the fit of the proposed model for both girls and boys aged 12 to 13 years.

Discussion

There is abundant empirical evidence confirming that measures of EFs and self-regulation can predict both the social and academic performance of students (Blair & Diamond, 2008; Eisenberg, Spinrad, & Eggum, 2010). However, our knowledge regarding the relations between constructs associated with self-regulation processes remains limited. The overall objective of the present study, therefore, was to describe the relations between EFs and EC, learn about their predictive power on academic performance, and analyze the mediating role of empathy and social behavior in early adolescent students. The results indicate that some executive measures and self-regulation influence academic performance directly and also indirectly through empathy and social behavior. Only EC and scores on the VF-V task—but not scores on the TMT-B or Stroop-CP tasks—directly predicted academic performance. The confirmed model also suggests that EFs and EC are complementary but independent control and self-regulation systems. This pattern of relations is consistent with certain theoretical proposals (Eisenberg, Valiente, & Eggum, 2010) and the results of recent studies (Valiente et al., 2011; Zorza et al., 2013).

The model indicates that EFs and EC are moderately related to each other during early adolescence. In addition, not all EFs measures were correlated with EC. This indicates that while both constructs share some elements, they do not completely overlap. Inhibitory control and measures of CF were not significantly correlated with the self-reported measure of EC. In contrast, the measures of working memory, assessed with the VF-V, did reveal such correlations. Other studies have yielded similar results (Bridgett et al., 2013). The reason for this could be that, during adolescence, unlike during childhood, inhibitory control is not the prevailing control and regulation strategy; working memory and the maintenance of goals and targets, along with language skills, may be more relevant to regulate behavior at this stage (Steinberg, 2005). Verbal fluency tests require considerable support from working memory, continuous monitoring of information processing, and semantic executive control (Piatt et al., 1999). Additional studies are needed to obtain more information on the relations between both constructs and to confirm that working memory is particularly involved in EC (Rueda, Posner & Rothbart, 2011).

Our findings suggest that CF, and particularly EC, is positively associated with dispositional empathy. These results are consistent with those of other studies (Eisenberg et al., 2007; Zorza et al., 2013) while also providing support for some recent conceptual proposals according to which empathy is a multidimensional concept that includes emotional regulation as one of its major components as it facilitates prosocial behaviors (Decety & Lamm, 2009). In this regard, the model also revealed that students with high levels of empathy exhibit more prosocial behaviors and are favored by their peers. As in previous studies, we found close relationships between measures of the TMT-B and EC and empathy and between empathy and social behavior. This pattern of results has been consistently found in our studies (Zorza et al., 2013; Zorza et al., 2015). In early adolescence, there is an increase in the intensity of negative emotions and relationships with peers become more unstable (Larson et al., 2002). Students with good self-regulation resources can rely on empathic processes to regulate their relationships.

Social behavior does not depend exclusively on the mediatory effect of empathy. Measures of VF-V, the TMT-B, and EC showed a direct influence on social behavior. This confirms that, apart from the mediation of empathic socioemotional processes, control and self-regulation skills in themselves enhance social skills and acceptance by peers. Previous studies have also revealed this relationship (Zorza et al., 2013; Zorza et al., 2015). This seems to suggest that self-regulation processes promote respect for group norms and decrease impulsive behaviors (Eisenberg, Valiente, & Eggum, 2010; Eisenberg, Spinrad, & Eggum, 2010; Rueda et al., 2010). These aspects are positively rated both by peers and teachers during childhood and early adolescence.

Again, inhibitory processes, assessed with the Stroop-CP task, did not predict empathy or social behavior. During early adolescence, unlike younger ages, social skills may be more associated with the ability to regulate emotions through more complex processes such as the reappraisal of a situation (Gross, 2008). If this is the case, language skills and CF, evaluated with verbal fluency tasks, are likely to play a greater part in emotional regulation than behavioral inhibition (Gross, 2008; Gyurak, Goodkind, Kramer, Miller, & Levenson, 2012). Future studies are required to clarify the relations between semantic executive control mechanisms and emotional regulation during childhood and adolescence, and the influence of both on social behavior.

In summary, the overall model enabled a better prediction of academic performance than that obtained using only measures of EC (in Blair & Razza, 2007, $R^2 = .23$; in Checa et al., 2008, $R^2 = .47$) or EFs ($R^2 = .13$ in Zorza et al., 2016). The direct influence of the working memory and EC on academic performance is consistent with studies that attribute a considerable predictive power to EFs regarding performance in mathematics and literacy during childhood and adolescence (Best et al., 2011). Among the measures of EF included in the model, only VF-V exhibited this significant direct relation with academic performance. Inhibitory control and CF did not show a significant direct influence. Our results confirm the importance of working memory as well as other processes such as performance monitoring and semantic control, as evaluated by the VF-V task, in the prediction of academic performance in secondary education students. In fact, working memory had already been found to have a predictive influence on performance in mathematics in 7-year-old children (Bull & Scerif, 2001). The reason for this may be that academic demands at this education level require a high level of abstraction and a more strategic approach. To the best of our knowledge, no prior studies have shown such a close relation between the VF-V and academic performance. So far, most studies conducted with verbal fluency tests have been of a clinical nature. It is of importance, therefore, to explore the predictive power of measures of verbal fluency at different ages.

In support of proposals of a double pathway of influence of EFs and self-regulation on academic performance, it has been found that empathy and social skills also play a major mediating role with regard to academic performance (Eisenberg, Valiente, & Eggum, 2010). The model had a similar predictive power to that found in other studies that also included the influence of social behavior, participation in class, or the relationship with teachers as independent and/or mediating variables (Valiente et al., 2011, $R^2 = .50$; Valiente et al., 2008, $R^2 = .57$) regarding academic performance. This finding suggests that, during early adolescence—and probably to a greater extent than during childhood—the ability to become integrated into the peer group and adapt to the social environment is key for academic success (Wentzel, 2003). In this regard, EFs and EC may be related to academic performance because of their influence on processes that take place in the classroom. Future research could include school conflict, bullying, and social exclusion as mediator variables that may affect performance (Swanson et al., 2012).

The present study has some limitations. EC and empathy were only assessed with self-reports provided by students. Although the measurements obtained were reliable, it would be desirable to complete them with behavioral measures and information provided by the families and teachers of participants. In addition, the data analysis made it possible to establish predictive relations between the variables analyzed, but did not reveal their causal relationships. Finally, the generalizability of these results could be improved by conducting studies with samples of students from different sociocultural contexts.

Conclusion and Educational Implications

In conclusion, the results of this study confirm that cognitive control and self-regulation, included in the EF and EC constructs, should be given special consideration in educational programs aimed at ensuring academic success in secondary education. In recent years, programs have been designed to enhance executive control skills in preschool and primary education children (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). These are very promising initiatives that could be enriched by including empathic activities and adapting them to older student populations. EFs, EC, and empathy have been found to strongly predict social behavior in early adolescent students. The enhancement of social skills and academic performance should be placed within this framework of relationships, and educational interventions should consider the complex set of factors (i.e., cognitive, emotional, and interpersonal) involved in socioeducational demands.

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Note

1. We also verified whether Model 3 exhibited better fit when the measures of Executive Functions (EFs) and Effortful Control (EC) were considered separately. We created a model that restricted the covariances between EFs and EC. Although this restricted model showed good fit, $\chi^2 = 34.22$, $df = 21$, $p = .034$; $\chi^2/df = 1.63$; root mean square error of approximation (RMSEA) = .05, comparative fit

index (CFI) = .97, normed fit index (NFI) = .94, Model 3, in which relationships between EFs and ECs were not limited, showed significantly better fit, $\chi^2(3)$ = 12.8, p =.005, compared with the restricted model. This result confirms that the measures of EFs and EC are not statistically independent and need to be linked to each other.

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