

## Metacognition and executive functioning in Elementary School

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**Título:** Metacognición y funcionamiento ejecutivo en Educación Primaria

**Resumen:** Este trabajo analiza las diferencias en habilidades metacognitivas y de funcionamiento ejecutivo entre dos grupos de estudiantes (10-12 años) con diferentes niveles de conocimiento metacognitivo (alto  $n = 50$ , bajo  $n = 64$ ). Los grupos fueron establecidos en función de la puntuación en una prueba de reconocimiento de estrategias. Las habilidades metacognitivas se evaluaron mediante auto-informe. Los estudiantes indicaron la frecuencia de empleo de estas habilidades en las fases de planificación, ejecución y evaluación del aprendizaje. Por último, la información sobre el funcionamiento ejecutivo fue proporcionada por familias y profesorado, los cuales cumplimentaron dos formas paralelas de un inventario de calificación de la conducta. Los resultados indicaron que: a) los estudiantes con alto conocimiento metacognitivo señalaron emplear más frecuentemente las habilidades metacognitivas que sus compañeros con bajo conocimiento metacognitivo. Estas diferencias se encontraron principalmente en las fases de planificación y ejecución; b) tanto familias como profesorado informaron acerca de unas mejores habilidades de funcionamiento ejecutivo en los estudiantes con alto conocimiento metacognitivo, siendo estadísticamente significativas las diferencias en planificación, memoria funcional, focalización de la atención y atención sostenida. Estos resultados muestran la existencia de una asociación entre diferentes niveles de conocimiento metacognitivo y las habilidades metacognitivas y de funcionamiento ejecutivo, sugiriendo la necesidad de incidir en el conjunto de variables estudiadas para promover entre los estudiantes niveles crecientes de control sobre su proceso de aprendizaje.

**Palabras clave:** metacognición; funciones ejecutivas; conocimiento; habilidades; aprendizaje.

**Abstract:** This study analyzes differences in metacognitive skills and executive functioning between two groups of students (10-12 years) with different levels of metacognitive knowledge (high  $n = 50$ , low  $n = 64$ ). Groups were established based on students' score on a test of knowledge of strategy use. Metacognitive skills were assessed by means of self-report. Students reported the frequency with which they applied these strategies during the phases of planning, execution, and evaluation of learning. Information about student executive functioning was provided by families and teachers, who completed two parallel forms of a behavior rating scale. The results indicated that: a) the group with high levels of metacognitive knowledge reported using their metacognitive skills more frequently than their peers in the other group. These differences were statistically significant in the phases of planning and execution; b) both family and teachers informed of better levels of executive functioning in the students with high metacognitive knowledge. Statistically significant differences were found in planning, functional memory, focus, and sustained attention. These results show the existence of an association between different levels of metacognitive knowledge, and differences in metacognitive skills and executive functions, and suggest the need to emphasize this set of variables in order to encourage students to acquire increasing levels of control over their learning process.

**Key words:** metacognition; executive functions; knowledge; skills; learning.

### Introduction

Academic performance depends largely on students' ability to carry out executive control processes, also known as *executive functions* (hereafter EFs). From early schooling years, students are required to acquire increasing degrees of responsibility, as well as to learn how to organize, integrate, and manage increasing amounts of information. Responding successfully to the demands of the school setting implies the intervention of processes such as the ability to prioritize the desired goals; organize time, information, and materials; behave flexibly and according to the situation; judge the appropriateness of a possible course of action; or monitor one's own progress in the performance of a task. The term EF, therefore, refers to a wide range of processes or skills that are in charge of goal-oriented behavior (Anderson, Jacobs, & Anderson, 2008; Flores-Lázaro, Castillo-Preciado, & Jiménez-Miramonte, 2014; Meltzer, 2013), and involve components such as working memory, organization and planning, response inhibition, cognitive flexibility, attentional capacity, or control of one's own emotional state (Diamond, 2013; Kor-

zeniowski, 2011; Van De Voorde, Roeyers, Verté, & Wiersema, 2010).

Difficulties in EF frequently manifest in the school context as problems related to writing, reading, and mathematical reasoning, among others (García et al. 2013; Lee, Lynn, & Fong, 2009; Toll, Van der Ven, Kroesbergen, & Van Luit, 2011; Van der Ven, Kroesbergen, Boom, & Leseman, 2013). These difficulties become even more evident as students progress to higher levels of schooling, in part due to the increase in the volume and complexity of the information to be processed. As a result, many students do not achieve what is expected of them in view of their actual capacity, which can be extremely frustrating, affecting their motivation as well as their academic and social performance.

However, another important part of academic performance is the students' ability to assess their own learning process and differentiate the strategies that are useful to them, knowing how to determine why, how, and when to apply them. This ability to reflect on one's own thinking and learning has been defined as *metacognition* (Flavel, 1979).

Metacognition is a multidimensional construct. Two components have traditionally been differentiated: metacognitive knowledge and metacognitive skills (Flavell, 1979; Lucangeli & Cabrele, 2006; Pennequin, Sorel, & Mainguy, 2010). *Metacognitive knowledge* refers to several aspects: declarative knowledge about learning strategies and about oneself as a learner or problem solver; procedural knowledge about

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how to use these strategies; and conditional knowledge about when and why to use them. This knowledge is based on a relationship between the person, the task characteristics, and the available strategies in a learning situation. On the other hand, *metacognitive skills* refer to higher order skills and involve a component of regulation of one's own cognition and behavior. Hence, metacognitive skills imply components such as planning, monitoring and reflection about one's task performance (Thronsdon, 2011; Pennequin, Sorel, & Mainguy, 2010). These skills lead to a deep and transferable learning (Panadero & Alonso-Tapia, 2014). Evidence of this distinction lies in the fact that both components—knowledge and skills—seem to develop at different rates: metacognitive knowledge emerges before the metacognitive skills, which are based on the former (Blöte, Van Otterloo, Stevenson, & Veenman, 2004; Pennequin, Sorel, Nanty, & Fontaine, 2010; Weil et al., 2013). In this sense, Pennequin, Sorel, Nanty et al. point out that, while metacognitive knowledge begins to develop at the age of six years, the self-application of this knowledge (i.e., metacognitive skills) does not seem to reach maturity until eleven or twelve years of age. Thus, as noted in Valle et al. (2009), in order for students to be successful in their learning, it is not sufficient for them to understand and know which strategies should be applied, but rather, they should know how to effectively apply them to learning situations.

Both types of components, EF and metacognition, have a close relationship. In this regard, the review of the literature has confirmed the role of various EFs such as planning, memory, organization, or cognitive flexibility to control the process of learning, as well as effort and persistence in the task (Corso, Sperb, Inchausti de Jou, & Fumagalli, 2013; Lyons & Zelano, 2011; Meltzer, 2013). However, despite the conceptual and practical relationship between the two components, most of the studies focused on these aspects are conducted from very different orientations. In this sense, whereas studies on metacognition were conducted from the field of Psychology and Education, most of the studies on EF appear to have developed within more clinical contexts, primarily from Neuropsychology (Corso et al., 2013; Pennequin, Sorel, & Mainguy, 2010). Few studies, therefore, have analyzed the relationship between the two aspects from a comprehensive point of view (for example, Garner, 2009; Kuhn, & Pease, 2010; Pennequin, Sorel, & Mainguy, 2010; Roebers, Cimeli, Röthlisberger, & Neuenschwander, 2012; Schneider, 2010). These studies have revealed the importance of the relationship between the two components at different ages and educational stages. Specifically, the study of Garner (2009), with 108 college students who completed EF and learning strategies questionnaires, found that planning skills significantly predicted the use of cognitive and metacognitive strategies, as well as the regulation of academic effort. In the same vein, the work of Pennequin, Sorel, and Mainguy (2010) highlighted the relevance of aspects such as working memory and cognitive flexibility to support both metacognitive knowledge and metacognitive skills in adults.

On the other hand, in the work of Roebers et al. (2012), with a sample of 209 students in the first years of Primary Education, the results indicated that performance in various EF tasks (inhibition, cognitive flexibility, and verbal fluency) was significantly related to students' levels of metacognitive control, which was an important predictor of performance in math, reading, and writing. Lastly, Kuhn and Pease (2010) and Schneider (2010) have shown the importance of the skills of response inhibition and working memory for metacognitive development in childhood and adolescence.

Although these studies are not numerous, one of their common features is the type of EF assessment instruments used. In this case, most of them have applied neuropsychological tests or performance-based measures. Also called Neuropsychological Tests, such tests are usually applied in clinical settings and consist of individual tests or batteries that measure a series of objective indicators related to the subjects' execution, such as response times, number of errors, and omissions. Examples of these tests would be the Stroop Test (Martín et al., 2012; Stroop, 1935) to measure response inhibition, or the Hanoi Tower (Borys, Spitz, & Dorans, 1892; Díaz et al., 2012) to measure planning. These tests have been widely used, generally showing their usefulness to assess EFs. However, they have been criticized for not being sufficiently specific, being too structured, and presenting models that are not very representative of the real world. For this reason, they are attributed with low ecological validity (Burin, Drake, & Harris, 2007; Chevignard, Catroppa, Galvin, & Anderson, 2010; Gioia, Kenworthy, & Isquith, 2010; Lee, 2011; Lezak, Howieson, Bigler, & Tranel, 2012).

An alternative to this type of measure is the use of behavior rating questionnaires. They allow the assessment of a variety of components from the point of view of behavioral observation of children and adolescents at home and at school. They are based on information provided by families and teachers about the frequency or intensity of certain problem behaviors, which would be indicative of difficulties in EFs. Such measures have been widely developed in recent years, in part due to the recognition of the fact of EFs not only involve cognitive aspects, but also behavioral and emotional ones, many of which can only be observed in habitual contexts (Egeland & Fallmyr, 2010; Mares, McLuckie, Schwartz, & Saini, 2007). Among the best-known standardized assessment instruments are the Child Behavior Checklist (CBCL; Achenbach, 1991), the Children Executive Function Inventory (CHEXI; Thorell & Nyberg, 2008), the Behavior Rating Inventory of Executive Functions (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), and, more recently, the Barkley Deficits in Executive Functioning Scale - Children and Adolescents (BDEFS-CA; Barkley, 2012). However, none of these instruments is available in Spanish. In this regard, the "Escala de Funcionamiento Ejecutivo para Profesorado" (EFE-P; in English, the Executive Functioning Scale for Teachers; García, Álvarez-García, González-Castro, Álvarez & Seguro, 2014) and the "Escala de Funciona-

miento Ejecutivo para Familias” (EFE-F; in English, the Executive Functioning Scale for Families; García, Álvarez-García, Cueli, González-Castro, & Álvarez, 2013) have been developed in our country. Designed as two parallel scales, the first available data show their potential usefulness in the assessment of these components in our population.

However, despite the advantages of the use of observation-based measures as a method to assess EFs in everyday situations, other factors must be taken into account. In this regard, numerous studies have shown a low correspondence between the performance of children and adolescents in performance-based tests and the difficulties observed in various areas of everyday life (Bishop, 2011; Lezak et al., 2012; McAuley, Chen, Goos, Schachar, & Crosbie, 2010), as well as a low-to-moderate agreement between different informants, primarily families and teaching staff (Rettew et al., 2011; Salbach-Andrae, Lenz, & Lehmkuhl, 2009). These aspects often lead to conflicting results; hence, there is no unique EF pattern related to the metacognitive learning components. In this sense, having different informants, or failing that, various types of measures, is essential in order to more accurately define this relationship.

In short, although the studies that have analyzed the relationship between different EFs and metacognition are scarce in the current context, they suggest the existence of an association between the two components, underlining working memory, planning, cognitive flexibility, or response inhibition among the most relevant factors. However, aspects such as the conceptual and evolutionary distinction between metacognitive knowledge and skills, or the type of EF measures employed (mainly performance-based, with their implications for ecological validity of the measures) impose some restrictions on the generalization of the results obtained in previous studies. Thus, and based on the conception that metacognitive knowledge develops before metacognitive skills do and is the key to their development, the objective of the present study was to analyze differences in metacognitive skills and EFs in two groups of students from the third cycle of Primary Education (10 to 12 years of age), who have different levels of metacognitive knowledge (high vs. low). We used the “Conocimiento de Estrategias de Aprendizaje” questionnaire (CEA; in English, the Learning Strategies Knowledge Questionnaire of Rosário, Mourão, Núñez, González-Pienda, & Solano, 2006) to assess metacognitive knowledge, and the “Inventario de Procesos de Autorregulación del Aprendizaje (IPAA; in English, the Inventory of Self-Regulation of Learning Processes; Rosário et al., 2010) to assess metacognitive skills. This latter questionnaire assesses the use of metacognitive strategies during the phases of planning, execution, and evaluation of learning. Finally, in order to avoid a possible bias in the assessment of EF, we administered two parallel forms of the above-mentioned EFE scale to families and teaching staff (García, Álvarez-García et al., 2013, 2014).

The specific objectives and hypotheses of this study are presented below:

- To determine whether students with good metacognitive knowledge, compared to those who display low knowledge, show better metacognitive skills (i.e., they use metacognitive strategies more frequently in the phases of planning, execution, and assessment of learning). As metacognitive knowledge is the basis for the development of metacognitive skills, it is expected that students with good metacognitive knowledge will generally show significantly higher scores in the metacognitive skills questionnaire compared with the group with low metacognitive knowledge.
- To examine whether students with different levels of knowledge of metacognitive strategies differ in the diverse EF components, as assessed through the information provided by families and teachers. Taking into account previous studies, we expect to find statistically significant differences between the two groups, mainly in the EF components of planning, memory, organization, inhibition, and cognitive flexibility. Students with high metacognitive knowledge will display higher levels of EF than their peers with low metacognitive knowledge.

## Method

### Participants

The sample was made up of 114 students from the Third Cycle of Elementary Education from 9 schools in Asturias. Of the total sample, 49 students were female (43%) and 65 (57%) were male. The participants' ages ranged from 10 to 12 years ( $M = 11.25$ ,  $SD = .686$ ). A total of 31 students (27.2%) were in fifth grade, whereas 83 (72.8%) attended sixth grade of Primary Education. The total sample was divided into two groups according to the level of knowledge of metacognitive strategies (high vs. low), assessed by means of the CEA questionnaire (Rosário et al., 2006). We chose percentile 50 as a criterion for assigning students to the groups. The students were distributed in the following way:

Group 1 (high metacognitive knowledge) was made up of 50 students, of whom 28 (43.8%) were female and 36 (56.3%) were male. Participants' mean age was 11.10 years ( $SD = .647$ ). Students who obtained a score higher than percentile 50 in the CEA questionnaire were assigned to this group (Rosário et al., 2006).

Group 2 (low metacognitive knowledge) included 64 students, of whom 21 (42%) were female and 29 (58%) were male. The mean age of the participants was 11.36 years ( $SD = .698$ ). Students with a score equal to or less than percentile 50 in the CEA questionnaire formed this group.

The students participated voluntarily in the study, after obtaining informed consent of the families. The selection of the sample was by accessibility (Casal & Mateu, 2003). Students with any prior diagnosis were excluded from the analysis. There were no significant age differences between the two groups,  $F(1,112) = 3.128$ ,  $p \geq .05$ . There were no statistically significant differences between the groups in the pro-

portion of females,  $\chi^2(1) = 1.000, p \geq .05$ ; and males,  $\chi^2(1) = .754, p \geq .05$ .

## Instruments

The main variables and assessment tools are described below:

*Metacognitive knowledge.* This was assessed through the application of the “*Conocimiento de Estrategias de Aprendizaje*” questionnaire (CEA; Knowledge of Learning Strategies Questionnaire (Rosário et al., 2006). This test is based on the recognition of different metacognitive strategies. It presents 10 questions with 3 response alternatives, of which only one is true. The student must indicate the correct option. The items concern 10 of the most important metacognitive strategies, which refer to cognitive, motivational, and affective aspects. The maximum score on this scale is 10. High scores are indicative of good metacognitive knowledge. The reliability for the scale, estimated with Cronbach’s alpha, was .89.

*Metacognitive skills.* We used the “*Inventario de Procesos de Autorregulación del Aprendizaje*” (IPAA; Inventory of Self-Regulation Processes of Learning; Rosário et al., 2010). This questionnaire consists of 12 items assessing the use of metacognitive strategies in different phases of the process of self-regulation of learning (planning, execution, and assessment; Zimmerman, 2008). Each phase or dimension is measured by 4 items, rated on a 5-point Likert-type scale, ranging from 1 (*never*) to 5 (*always*). It assesses the frequency with which the student uses these strategies during learning situations. The maximum score in each component is 20. Higher scores in each of these items and dimensions indicate better metacognitive skills. The reliability of the scale, estimated through Cronbach’s alpha was .80 for the dimension of Planning, .85 for Execution, and .87 for Assessment.

*Executive Functions.* We used the “*Escala de Funcionamiento Ejecutivo*” forms for teachers (EFE-P; in English, the Executive Functioning Scale; García, Álvarez-García et al., 2013) and families (EFE-F; García, Álvarez-García et al., 2014). They are designed as two parallel forms and are applicable from 6 to 18 years of age. These scales assess the frequency with which children and adolescents display a series of behaviors, indicative of possible EF deficits, in the educational setting or at home. For this purpose, they are based on information supplied by families and teachers. They are made up of 27 items each, assessing a total of 9 components (Control of Impulsivity, Control of Hyperactivity, Emotional Control, Concentration, Focus, Planning, Organization, Functional Memory, and Cognitive Flexibility). The items are rated on 5-point Likert type scale, ranging from 1 (*never*) to 5 (*always*). The maximum score in each component is 15. High scores on these components are indicative of EF difficulties. Both scales have been tested on a sample of 1019 and 616 students, respectively, belonging to 41 schools in Asturias (Spain). Confirmatory factor analysis showed a good fit of the data to the nine-factor model, with rates of reliability ranging from .77 to .89 for the different components in both forms of the scale.

The correspondence between the information provided by families and teachers in this study is shown in Table 1. As seen, we found statistically significant correlations between the pairs of components, with the exception of the variable Cognitive Flexibility. These correlations were positive, ranging from low to moderate in all cases. The lowest correlations (close to .25) were found in the components of Emotional Control, Functional Memory and Control of Impulsivity whereas the highest correlations (above .37) were found in Planning, Sustained Attention, Focal Attention, and Organization.

**Table 1.** Bivariate correlations between scores on the EFE-F and the EFE-P scales.

EFE-F	EFE-P								
	1	2	3	4	5	6	7	8	9
1. Control of Impulsivity	<b>.282**</b>	.261**	.207*	.276**	.084	.097	.208*	.233*	.112
2. Control of Hyperactivity	.302**	<b>.312**</b>	.241**	.332**	.181	.135	.219*	.247**	.137
3. Emotional Control	.166	.155	<b>.218*</b>	.192*	.098	.026	.137	.204*	.101
4. Focus	.251**	.293**	.247**	<b>.390**</b>	.256**	.190*	.281**	.313**	.093
4. Concentration	.223*	.306**	.215*	.428**	<b>.397**</b>	.316**	.413**	.402**	.177
6. Memory	.243**	.294**	.226*	.338**	.277**	<b>.232*</b>	.324**	.387**	.164*
7. Planning	.206*	.281**	.177	.377**	.338**	.243**	<b>.417**</b>	.370**	.146
8. Organization	.166	.244**	.161	.333**	.271**	.197*	.314**	<b>.371**</b>	.125
9. Cognitive Flexibility	.227*	.192	.268*	.018	.053	.002	.094	.119	<b>.035</b>

Note: N = 114; EFE-F = Executive Functioning scale for families; EFE-P = Executive Functioning Scale for teachers.

\*\*  $p < .01$ . \*  $p < .05$ .

## Procedure

This study was carried out in accordance with the Declaration of Helsinki (Williams, 2008), which includes the ethical principles for research with human beings. Once the study was submitted to the school directors, we obtained their authorization and the informed consent of the families,

after which we collected the data. The questionnaires were administered to the students collectively in a regular class session (approximately 50 minutes). Students' participation was voluntary, bearing in mind at all times their anonymity and the confidentiality of their data. The EF questionnaires were handed out to the tutors, who in addition to completing their own questionnaires, were responsible for the delivery

and collection of the questionnaires administered to the families. The families completed the questionnaires in their homes. Instructions on how to complete the scales were provided along with the questionnaires. Only those questionnaires that had both the completed forms (families and teachers) were considered in this study.

### Data Analysis

In this work, a comparative cross-sectional design was used (Ato, López, & Benavente, 2013). In view of our goals, we decided to perform multivariate analysis of variance (MANOVA) in order to analyze the differences between the groups with different metacognitive knowledge: metacognitive skills (planning, execution, and evaluation phases), and the nine EF components as appraised by families and teachers.

We used the SPSS 19.0 program for the statistical processing of the data. The differences were statistically significant at a level of  $p \leq .05$ . Taking into account the need to know the practical significance in addition to the statistical significance of the differences, an indicator of the effect size was included (Ato et al., 2013). For this purpose, we used Cohen's (1988) criterion according to which the effect is small when  $\eta^2 = .01$  ( $d = .20$ ), medium when  $\eta^2 = .059$  ( $d = .50$ ), and high when  $\eta^2 = .138$  ( $d = .80$ ). Finally, given that the present study is based on the analysis of the differences between two groups, along with the means and the analysis of their differences, the values of skewness and kurtosis were obtained separately for each group and analyzed variable (Tables 2 and 3). Finney and Di Stefano's (2006) criterion was used to check the suitability of these values. According

to this criterion,  $\pm 2$  and  $\pm 7$  are acceptable maximum values of skewness and kurtosis to use parametric analysis. The variables in this study met this condition (Tables 2 and 3).

## Results

### Differences in metacognitive skills between groups with high and low metacognitive knowledge

Table 2 shows the means of the students with different levels of metacognitive knowledge (high vs. low) in the use of metacognitive strategies during different phases of self-regulated learning. These means indicated that the students in the group with high metacognitive knowledge reported using these strategies more frequently and systematically in all phases. In this sense, the MANOVA carried out confirmed the existence of statistically significant group differences in the set of above-mentioned variables,  $Wilks' Lambda = .873$ ,  $F(3, 110) = 5.333$ ,  $p < .001$ ,  $\eta^2 = .127$ . This analysis also revealed that Planning ( $p < .001$ ) and Execution ( $p < .01$ ) were the phases in which these differences were found, mainly in the former, with a considerably larger effect size. In terms of the Assessment phase, we found no statistically significant group differences ( $p = .25$ ).

Taking into account the means of both groups in these variables, we observed infrequent use of metacognitive skills in the phases of Assessment, and above all in Planning (with a mean close to 8, when the maximum for this subscale score can reach 20), whereas the use of these strategies was much more frequent in the Execution phase.

**Table 2.** Descriptive analysis and group differences in the use of metacognitive strategies.

Metacognitive Skills (IPPA)	Group 1 ( <i>N</i> = 50)			Group 2 ( <i>N</i> = 64)			Differences	
	<i>M</i> ( <i>SD</i> )	Skewness	Kurtosis	<i>M</i> ( <i>SD</i> )	Skewness	Kurtosis	<i>F</i> (1, 112)	$\eta^2$
Planning	8.560 (1.296)	-.460	-.875	7.677 (1.299)	-.986	2.559	12.965 ***	.104
Execution	15.780 (2.565)	-1.210	2.982	14.479 (2.739)	-.501	.405	6.688 **	.056
Assessment	11.960 (1.947)	-.183	-.222	11.544 (1.922)	-.306	-.209	4.851	.011

Note: Group 1: high metacognitive knowledge; Group 2: low metacognitive knowledge; IPPA = Inventory of Processes of Self-Regulation of Learning.  
\*\*\* $p < .001$ . \*\* $p < .01$ .

### Differences in Executive Functioning (assessed by families and teachers) between groups with high and low metacognitive knowledge

The means of both groups in the EF variables as assessed by families and teachers are shown in Table 3. In general, students with high metacognitive knowledge were assessed more positively by their families and teachers (reporting a lower EF deficit) than the group with low metacognitive knowledge. This can be observed attending to the means obtained in the EF components, which are lower in the former group in most cases. Only in the components of Control

of Impulsivity, Emotional Control, and Flexibility as assessed by teachers was a different pattern found, with slightly higher means in the group with high knowledge of metacognitive strategies.

The MANOVAs carried out revealed the existence of statistically significant group differences in the set of the assessed EFs, both when the informants were the families,  $Wilks' Lambda = .826$ ,  $F(9, 104) = 2.438$ ,  $p = .015$ ;  $\eta^2 = .174$ , and when they were the teachers,  $Wilks' Lambda = .807$ ,  $F(9, 104) = 2.766$ ,  $p = .006$ ,  $\eta^2 = .193$ . Statistically significant differences were found in both forms of the scale on the components Focal Attention, Sustained Attention, Memory,

and Planning. Statistically significant differences were also found in the component of Organization on the scale for families but with a smaller effect size. The Planning component presented the biggest effect size using both scales.

Again taking into account the means of both groups, it can be observed that the means of the questionnaire completed by the teachers were lower than those completed by the families in all of the assessed components, which indi-

cates that the teachers reported better EF (e.g., lower deficit) in the students. In both cases, however, the means indicated an absence of major difficulties in the assessed behaviors. In this sense, although the maximum score in each component is 15, the means ranged from 4.82 to 7.84 in the questionnaire completed by the families and from 4.14 to 6.66 in the one completed by the teachers.

**Table 3.** Descriptive analysis and group differences in the EF components as assessed by families and teachers.

EFE - F								
Executive Functions	Group 1 (N = 50)			Group 2 (N = 64)			Differences	
	M(SD)	Skewness	Kurtosis	M(SD)	Skewness	Kurtosis	F(1, 112)	$\eta^2$
Control of Impulsivity	6.78 (2.243)	.999	.575	7.27 (2.674)	.647	.196	1.064	.009
Control of Hyperactivity	5.76 (1.985)	1.081	2.110	6.20 (2.297)	.790	.680	1.175	.010
Emotional Control	6.68 (2.817)	.564	-.674	6.34 (2.869)	1.187	1.313	.392	.003
Focus	6.48 (2.288)	.751	.504	7.66 (2.692)	.571	-.436	6.101*	.052
Concentration	6.38 (2.230)	.660	-.323	7.55 (2.594)	.418	-.390	6.412*	.054
Memory	4.82 (1.662)	1.131	1.155	5.94 (2.390)	.595	-.067	7.929**	.066
Planning	6.16 (2.566)	.788	.128	7.84 (2.940)	.352	-.440	10.278**	.084
Organization	5.76 (2.568)	1.121	1.170	6.86 (2.828)	.409	-.915	4.595*	.039
Flexibility	6.08 (2.156)	.937	.634	6.56 (2.349)	.889	1.639	1.272	.011
EFE- P								
Executive Functions	Group 1 (N = 50)			Group 2 (N = 64)			Differences	
	M(SD)	Skewness	Kurtosis	M(SD)	Skewness	Kurtosis	F(1, 112)	$\eta^2$
Control of Impulsivity	5.36 (2.724)	1.541	2.472	5.25 (2.777)	1.697	2.910	.045	.000
Control of Hyperactivity	4.92 (2.554)	1.448	1.535	5.14 (2.636)	1.770	3.216	.202	.002
Emotional Control	4.88 (2.471)	1.402	1.123	4.63 (2.640)	.652	2.020	.277	.002
Focus	5.54 (2.443)	1.096	.774	6.58 (2.224)	.849	.262	5.609*	.048
Concentration	4.70 (1.940)	1.456	1.873	6.20 (2.644)	.592	-.624	11.368***	.092
Memory	4.14 (1.841)	1.729	2.248	5.14 (2.403)	1.055	.710	5.942*	.050
Planning	5.08 (2.415)	1.307	1.065	6.66 (2.540)	.556	-.460	11.286***	.092
Organization	4.80 (2.286)	1.239	.730	5.59 (2.683)	1.143	.716	2.792	.024
Flexibility	5.30 (2.742)	1.787	2.852	5.05 (2.134)	1.020	.683	.307	.003

Note: Group 1: high metacognitive knowledge; Group 2: low metacognitive knowledge; EFE-F = EF scale for families; EFE-P = EF scale for teachers. High scores in EFE-P and EFE-F are indicative of EF difficulties.

\*\*\*  $p < .001$ . \*\*  $p < .01$ . \*  $p < .05$ .

## Discussion and conclusions

The goal of this work was to analyze the differences in metacognitive skills and EF between two groups of students from the Third Cycle of Primary Education (10-12 years) with different levels of metacognitive knowledge (high vs. low). The results are discussed below in relation to the goals and hypotheses:

### Differences in metacognitive skills between groups with high and low metacognitive knowledge

Firstly, students with high metacognitive knowledge reported using metacognitive strategies analyzed more frequently in the phases of planning, execution, and assessment. In this regard, greater metacognitive knowledge was related to better metacognitive skills, which is consistent with previous studies such as that of Blöte et al. (2004), Pennequin, Sorrel, and Mainguy (2010), and Weil et al. (2013), indicating that metacognitive knowledge is prior to metacognitive skills

and an important precursor to their development. These differences were statistically significant in the planning and execution phases, but not in the phase of assessment of learning.

Related to the latter result, a notable aspect is the fact that, considering the scores of both groups on the metacognitive skills scale, the students generally reported using these metacognitive skills more frequently in the execution phase, in contrast to the assessment phase and, particularly, to the planning phase. This prominence of the use of strategies in the execution phase and their lower use in assessment and planning is in line with previous studies suggesting that students of these ages (final courses of Primary Education) are mainly "executive" in the sense that they spend most of their efforts on task execution, rather than on designing a prior plan and on the subsequent evaluation of their results (Cleary & Chen, 2009; Kramarski & Gutman, 2006; Montague, Enders, & Dietz, 2011). These works show that many students tend to display poor metacognitive skills in learning situations, acting directly, responding impulsively, and using the same strategy over and over even when it is inappropriate, which often leads them to using strategies of trial and er-

ror. This profile observed in the total sample may explain why, despite some differences between the two groups in the use of metacognitive strategies in the assessment phase (although they were not as pronounced as in the planning phase), they did not reach statistical significance. Another possible explanation for the absence of significant differences in this respect could be due to the possibility that students in general have difficulties recognizing the appropriate type of strategies for this phase, which would make it more difficult for them to decide whether or not to apply them. It would be necessary to study this in more depth in future studies.

These results, taken as a whole, indicate the existence of a relationship between metacognitive knowledge and skills, as well as the need to promote development of both components from an early age in two ways: firstly, to promote a good understanding of metacognitive strategies as a basis for the further development of metacognitive skills; and secondly, directly influencing the application of this knowledge in real tasks. Intervention strategies of self-regulated learning have been shown to be beneficial in two ways, primarily for students with learning difficulties or low academic achievement (González-Pienda, Fernández, Bernardo, Núñez, & Rosário, 2014; Moos & Ringdal, 2012; Stoeger & Ziegler, 2008).

#### **Differences in EF (assessed by families and teachers) between groups with high and low metacognitive knowledge**

Regarding the second issue raised in this study, the findings indicated that, although the students did not present major EF difficulties either when they were assessed by their families or by their teachers, both informants generally attributed better EF performance to the group with high metacognitive knowledge. The differences between the groups were found mainly in focal attention, sustained attention, functional memory and planning in both versions of the scale, as well as in capacity of organization in the case of the form administered to the families. In this sense, high metacognitive knowledge was related to better executive control skills (or lower deficit) in the assessed components.

It is, however, noteworthy that there were statistically significant differences in response inhibition and cognitive flexibility, which had been found in previous studies (Corso et al., 2013; Garner, 2009; Kuhn & Pease, 2010; Meltzer, 2013; Pennequin, Sorel, & Mainguy, 2010; Schneider, 2010). A possible explanation of this is linked to the type of assessment measures of EF mainly employed in previous studies, based on the performance of different executive tasks. These measures have been described by some authors as somewhat unspecific in the sense that different functions can intervene in the correct execution of a task (Burin et al., 2007; Chevignard, et al., 2010; Lee, 2011; Lezak et al., 2012). In the present study, the use of behavior rating scales seems to support the distinction proposed by several authors between the so-

called *hot* and *cool functions* (Brock, Rimm-Kaufman, & Nathanson, 2009; Zelazo & Carlson, 2012). Hot functions deal with emotional information, including components such as impulse control, the interpretation of bodily signals, decision-making, and recognizing another person's perspective, and are more closely related to the individual's social functioning. Cool functions perform a more rational treatment of information and are related to reasoning and abstract information processing, such as the working memory, planning, conceptualization, and categorization, among others. These functions are more closely related to aspects of learning and to knowledge of metacognitive strategies. Therefore, these are the functions that generated the statistically significant differences between the groups in the present study.

These results again reveal the existence of a relationship between specific EF skills and metacognition, at least with regard to the component of metacognitive knowledge. In this sense, both components (EF and metacognition) are related insofar as they involve components of planning, organization, memory, and attention. But for authors like Roebers et al. (2012), this relationship could be partly explained from an evolutionary point of view (these authors argue that progress in EFs during childhood and adolescence is accompanied by the development of a better understanding and control of one's own learning processes), and the results obtained in this study do not allow us to determine the direction of this relationship. In any case, promoting progress in one component (metacognition or EFs) would benefit the development of the other component. However, although numerous works focus on promoting the development of the metacognitive components at school ages, interventions in EF have been carried out mainly in clinical settings. Taking into account the implications that functions like those analyzed in this study have on students' school learning and behavioral control (García, González-Castro, Areces, Cueli, & Rodríguez, 2014; Marcovitch & Zelazo, 2009; Van De Voorde et al., 2010), it becomes increasingly necessary to generalize these aspects of the intervention to new contexts, like the educational setting or the family.

Finally, although the correspondence between information provided by families and teachers in the EF scales was moderate (Table 1), in line with previous studies in this field (Papageorgiou, Kalyva, Dafoulis, & Vostanis, 2008; Rettew et al., 2011; Salbach-Andrae et al., 2009), data from this study have shown that, when students are classified according to an external criterion (in this case, assignment to a group according to the number of correct answers given in the CEA metacognitive knowledge questionnaire), the information provided by families and teachers tends to converge. Therefore, these results indicate the desirability of having several informants when the assessment consists of behavioral observation.

Finally, there are a number of limitations in the present study that should be taken into account. First, the sample size imposes certain restrictions on the generalization of the results obtained. Likewise, along with a larger sample, it

would be interesting to establish more extreme levels to assign the participants to the different groups. Although percentile 50 was used as a cut-off point in this study, levels like percentile 25 or 75 may achieve a clearer pattern of significant differences. Secondly, the type of assessment of the metacognitive skills employed must be taken into account. Although these components are usually assessed with self-reports, as in the present study, many authors indicate that the use of other types of measures, based on the analysis of the process, would be more appropriate to assess this type of procedural and strategic components (Azevedo & Alevén, 2013; Lazakidou & Retalis, 2010; Veenman, 2011). These methods, like the Think-aloud protocols (Montague et al., 2011) or the Triple Task and its variants (Piolat, Kellogg, & Farioli, 2001; Piolat, Olive, & Kellogg, 2005), are based on the collection of data concurrent to the execution of a cognitive task and are complementary to the use of questionnaires. Thirdly, and after solving the above limitations, another aspect to consider is the appropriateness of extending this

study by analyzing the relationship between EF and the metacognitive skills component. This would allow us to more accurately determine the relationship between EF and metacognition. Fourthly, although this study has shown the relevance of certain EF skills—such as attention, planning, memory, or the ability to organize—with regard to metacognitive knowledge, the results obtained do not allow us to determine whether EF explains the development of metacognitive knowledge or vice versa, or whether other variables such as the type of instructional method affect this relationship. Finally, as previous studies have reported that the components of metacognition and EF are related to academic performance in various areas such as mathematics or language, it would be of great interest to include some kind of indicator of these subjects in future studies. This would enable us to determine the relationship between the two components and whether this relationship influences performance in different curriculum areas.

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