

Links between motivation and metacognition and achievement in cognitive performance among primary school pupils

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Título: Relaciones de la motivación con la metacognición y el desempeño en el rendimiento cognitivo en estudiantes de educación primaria

Resumen: Diversas investigaciones destacan la importancia de la motivación en el rendimiento cognitivo y también la importancia de la motivación en la metacognición. El objetivo de esta investigación es indagar en las variables motivacionales que influyen en el rendimiento de tareas cognitivas y en la metacognición. La investigación se ha realizado en un colegio público de la Comunidad de Madrid. La muestra de este estudio corresponde a 354 alumnos de educación primaria, entre los 8 y 11 años de edad. Los instrumentos de medida seleccionados son: el cuestionario de Motivación hacia el Aprendizaje (MAPE-I), para las variables motivacionales; el Junior Metacognitive Awareness Inventory (Jr. MAI), para las variables metacognitivas y la batería de pruebas de Evaluación Neuropsicológica de las Funciones Ejecutivas en Niños (ENFEN), para la evaluación del rendimiento cognitivo. Los resultados obtenidos muestran efecto de la motivación de orientación al aprendizaje en relación con el rendimiento cognitivo en las pruebas que implican inhibición, flexibilidad y memoria operativa. También se observa efecto significativo entre la disposición al esfuerzo y la regulación del conocimiento. Igualmente, se analizan las relaciones entre las variables por curso para determinar el efecto de la edad. Se valoran las implicaciones educativas de los resultados.

Palabras clave: Rendimiento cognitivo. Motivación. Metacognición. Motivación a metas. Logro académico. Educación primaria.

Abstract: Sundry studies have emphasised the importance of motivation in cognitive performance, as well as its link to metacognitive development. The objective here is to explore the motivation variables that influence the performance of cognitive tasks, along with their effect on metacognition. The study sample consists of 354 primary school pupils aged 8-11 at a state school in the Community of Madrid (Spain). The following measuring instruments have been used for studying the variables: *Motivación para el Aprendizaje y la Ejecución* (MAPE-I) [Motivation for Learning and Execution], a questionnaire on motivation variables; the Junior Metacognitive Awareness Inventory (Jr. MAI), for metacognitive variables, and the battery of tests in the *Evaluación Neuropsicológica de las Funciones Ejecutivas en Niños* (ENFEN) [Neuropsychological Assessment of Executive Functions in Children], for assessing cognitive performance. The results reveal a significant effect between the motivation for focusing on learning and cognitive performance in the tasks that involve inhibition, flexibility, and working memory. We also find a significant effect between increased effort and knowledge regulation. Furthermore, we analyse the relations between the variables by school year to determine the age effect. We evaluate the results' academic implications.

Keywords: Cognitive performance. Motivation. Metacognition. Goal motivation. Academic achievement. Primary school.

Introduction

Any study of the learning process needs to consider the sundry variables involved in students' performance in academic tasks (Short & Weissberg-Benchell, 1989). When the aim is to involve students in this process, it is important for them to learn self-regulation. In other words, they should be capable of managing and focusing their actions, thoughts and feelings toward the achievement of academic goals (Barca-Lozano et al., 2012; Gaeta, 2006). The development of self-regulation strategies will empower students to deal with the different levels of schooling and, in due course, employment (González-Pienda, 2003; Short & Weissberg-Benchell, 1989). In turn, consideration needs to be given to any possible differences between students according to their level of performance and their capacity for self-regulating their metacognitive skills, cognitive processes, and motivation for learning (Gaeta et al., 2012; Karlen, 2016).

A clear link has yet to be established between the different constructs that may be involved in learning, despite the increase in the number of studies conducted in recent years on self-regulated learning (SRL) (Núñez Pérez et al., 1998).

This article therefore seeks to analyse how motivation is related to the learning process of pupils aged 8-11 and their metacognitive skills and cognitive performance.

Theoretical underpinnings

Motivation plays a key role in learning in terms of academic performance, as it helps to predispose students toward studying and learning (González-Pienda, 2003; McCombs, 1988). It also explains the performance of certain tasks or the persistence in their pursuit of goals, and it has an impact on the acquisition, transfer and use of knowledge and skills (Bahri & Corebima, 2015; Dweck, 1986). One of the research streams in motivation for learning involves achievement goal theory (Dweck, 1986; Elliot & Dweck, 1988). It may therefore be affirmed that a goal consists of the motivational beliefs, skills and attributions that underpin students' behaviour (Barca-Lozano et al., 2012). Accordingly, achievement goal theory makes an important distinction between the types of goals that students may focus on. A focus on a goal and the undertaking of cognitive tasks predispose a student's reactions to success or failure (Dweck, 1986; Elliott & Dweck, 1988; González-Pienda, 2003). Likewise, this has an influence on performance, and alters the way of explaining a student's results in the task (González Cabanach et al., 1996; Tapia & Ferrer, 1992).

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Motivation for achievement or learning goals

Learning and performance goals are highlights within an academic setting. Achievement goal theory thus assumes that students focused on learning goals will be more interested in a task's process and development. These students will seek to increase their personal competence by acquiring new skills and knowledge. These types of goals could therefore be related to intrinsic motivation, as students enjoy the effort required to master the task (Dweck, 1986; Elliott & Dweck, 1988). Several studies have also found that goal-focused motivation is associated with students' greater effort, persistence, attention, and regulation, through motivational control (Barca-Lozano et al., 2012; Gaeta et al., 2012; González Cabanach et al., 1996). This effort to achieve a goal has a positive effect on controlling and directing SRL (Karlen, 2016; Schunk, 2005). On the other hand, there are goals involving the actual undertaking or performance, whereby students will focus on their ability to obtain positive ratings or avoid negative ones (Dweck, 1986; Elliott & Dweck, 1988). Students therefore focus on obtaining outside rewards, such as high marks or grades (extrinsic motivation) (González Cabanach et al., 1996).

This means that students pursuing both these types of goals perceive their success in tasks in a fairly similar way, but differ in the case of failure. Students focusing on performance goals see them as a test of their capabilities, which means that failure is understood to be a lack of competence. This may lead to anxiety or rejection. By contrast, students focusing on learning understand goals to be a way of achieving their objective and implementing their strategies. For these students, the attributions of failure do not involve a rejection of the task, as instead they understand it as a challenge that drives them to a greater effort to carry out their self-regulation strategies (Dweck, 1986; González Cabanach et al., 1996). Students may assess the situation, the tasks to be undertaken and their expectations depending on their focus on the type of goals.

Importance of motivation in SRL

Several models have been proposed that link motivation, cognition, metacognition and SRL with academic performance, such as those by Borkowski, Chan, and Muthukrishna (2000), Coutinho and Neuman (2008); McCombs (1988); and Sungur (2007a). These models have shown that altering the motivation for school tasks has an impact on students' metacognitive and cognitive focus and performance (Gaeta, 2006; Sungur, 2007).

Students' age of development has a major bearing on the study of metacognitive skills, executive functions, and the focus of their motivation (García, Rodríguez et al., 2016; González-Pienda, 2003; Spiess, Meier y Roebbers, 2016). For example, metacognition improves with age, probably due to the students' lack of awareness of the strategies or skills they

have used in the earlier stages of their schooling (Coutinho & Neuman, 2008).

Relationship between motivation and cognitive performance

Learning and improving students' performance requires working on their capabilities, their knowledge, their strategies, and their motivation. This will activate the mechanisms for guiding them towards the educational goals or objectives they want to achieve (García & Pintrich, 1994; McCombs, 1988; Pintrich & De Groot, 1990). Cognitive strategies or skills are fostered by complex tasks that involve the regulation of effort and persistence (Núñez Pérez et al., 1998). Accordingly, the inclusion of cognition in the study of motivation, goals and self-concept have played a prominent part in most of the theories for improving the synthesis of research into motivation in education (González Cabanach et al., 1996).

Cognitive skills are required for learning, remembering and understanding, and they include strategies for processing, transforming and organising information (Karlen, 2016; Suárez & Fernández, 2011). Cognitive variables are therefore commonly used in the prediction of academic performance (González-Pienda, 2003). The processes of coordinating cognition and honing academic skills involve executive functions (Follmer & Sperling, 2016; Spiess et al., 2016). The importance of these functions lies in their interaction when mediating in cognitive performance and behaviour for academic achievements (García et al., 2016; Roebbers, 2017).

Executive functions assist task performance, and they often act in unison for cognitive performance. This complicates their independent study (Miyake et al., 2000). The most widely studied functions in students are working memory, the flexibility for change, and the capacity for inhibition (Diamond, 2013; Kane & Engle, 2003; Miyake et al., 2000; Spiess et al., 2016). The capacity for inhibition helps students to focus their attention. Working memory is related to the refreshing of information for its short-term storage and handling. Finally, flexibility for change allows for adapting when resolving tasks (Brocki & Bohlin, 2004; Kane & Engle, 2003).

Relationship between motivation and metacognition

Metacognitive strategies encompass students' skills for planning, monitoring and regulating their cognition for implementing their cognitive strategies. Metacognition therefore has two components: knowledge and knowledge regulation (Flavell, 1979). Evidence has been found of metacognition's importance in motivational instruction (Barca-Lozano et al., 2012). In turn, and in relation to the achievement of learning goals, metacognition and motivation have a positive effect on achievement experiences (Landine & Stewart, 1998). Along these same lines, metacognition in SRL helps to reveal a task's requirements, together with the competences and strategies needed to resolve it (McCombs, 1988).

Metacognitive strategies can therefore be used to assess effort and motivation (García & Pintrich, 1994). Understanding the role that metacognition plays in SRL may explain the motivational processes that support the sustained use of strategies for resolving academic tasks (Follmer & Sperling, 2016).

Method

Participants

The study has used a cohort of 354 pupils selected by non-probabilistic sampling at a state school in the Community of Madrid (Spain). The pupils are aged between 8 and 11, corresponding to Years 3, 4, and 5 of primary education ($M = 8.71$; $SD = .90$). The overall sample is broken down into 145 pupils in Year 3 (40.96 %), 107 in Year 4 (30.23 %), and 102 in Year 5 (28.81 %). The group tests involve 184 boys (52 %) and 170 girls (48 %). The school has been chosen from a pilot group taking part in a project on the implementation of digital educational resources. The school has met the necessary requirements for conducting the research, expressing an interest in taking part in the study.

In view of the individual nature of the cognitive performance test and the fact it has been held outside the classroom, only 168 of the 354 pupils were involved in it ($M = 8.71$; $SD = .091$). Out of these 168 pupils, 74 are in Year 3 (44.05 %), 46 are in Year 4 (27.38 %), and 48 are in Year 5 (28.57 %). The distribution of the percentage of each sex in the cognitive performance test is similar to that in the group tests, with 90 boys (53.57 %) and 78 girls (46.43%).

Assessment instruments

The data have been gathered through the following psychometric instruments:

Model A of the Junior Metacognitive Awareness Inventory (Jr. MAI) has been selected, as it has been adapted to the ages of 8-11 for the assessment of knowledge and metacognitive regulation (Sperling, Howard, Miller, & Murphy, 2002). It contains two factors: metacognitive knowledge and knowledge regulation. The factors are rated on a Likert scale from 1 to 3, with a Cronbach's α of .76 (Sperling et al., 2002). The model has been translated into the pupils' mother tongue, Spanish, following the recommendations made by Muñiz, Elosua, and Hambleton (2013).

The MAPE-I questionnaire has been designed to assess the types of goals for the pupils' main academic tasks, as well as their increased effort (Tapia & Ferrer, 1992). MAPE-I has been adapted for pupils as of the age of 11. It is divided into three dimensions and eight factors. Each one of these dimensions comprises several factors related to the study variables. The answers to the items involve a dichotomous Yes/No format. A prior pilot test was held and no changes were required. MAPE-I's dimensions are as follows:

- *Focus on the result and avoidance versus focus on learning (D1)*. This factor is defined by the following: the inhibitory anxiety of performance, the attempt to avoid negative opinions on competence versus the attempt to increase competence, and finding positive opinions on competence versus attempts to increase competence. This factor has a Cronbach's α of 0.83 (Tapia & Ferrer, 1992).
- *Apathy toward effort (D2)*. This factor is defined by the following scales: interest in activities that do not require effort versus interest in academic activities, self-conceptualisation as a worker. This factor has a Cronbach's α of 0.87 (Tapia & Ferrer, 1992).
- *Motivation to excel versus the absence thereof (D3)*. This factor consists of the following scales: motivation for excellence and the anxiety that drives performance. This factor has a Cronbach's α of 0.77 (Tapia & Ferrer, 1992).

Concerning the variables for predicting academic performance in school tasks, the performance at cognitive level has been assessed through the ENFEN battery of tests (Portellano et al., 2011). This questionnaire has been validated for its commercialisation by the TEA publishing house (supplementary material). This means that measuring the development of executive functions enables us to evaluate aspects related to the capacity for resolving problems, behaviour, sustained attention, mental flexibility, working memory, verbal fluency, etc. It has been adapted for pupils aged 6-12, and consists of the following tests:

- *Verbal Fluency*: this test is in turn divided into two tasks, Phonological fluency (F1) and Semantic fluency (F2). The score involves the number of correct answers obtained over the number of words spoken in a minute in each one of the tasks. In the phonological fluency task, the words have to begin with the letter M, while in the semantic fluency tasks the pupils are asked to say all the words they can think of in the animal category.
- *Trails*: this test is also divided into two tasks, Grey Trails 1 (S1) and Colour Trails 2 (S2). Both tests involve joining numbers with a line as quickly as possible. Grey Trails 1 (S1) consists of joining the number in descending order. The numbers in Colour Trails 2 (S2) follow an alternating colour code, and they have to be joined in ascending order. The result of these tests is decided by the right answers and the time taken, with any mistakes or omissions being marked down.
- *Rings task (A)*: this test requires the pupils to reproduce the figures displayed using a medium that involves moving different coloured rings, transferring them between three different columns. This test is scored by the time spent on each one of the 14 subtasks, although a record is kept of the number of movements made to compose the figure. The score for this test is inverse, as it is evaluated by the time taken on the task.
- *Interference (IN)*: this task requires the pupil to say aloud the word's colour rather than the word itself. The result

in this test is based on the correct answers and the time taken on the task, with any mistakes or omissions being marked down.

Procedure

Following a briefing on the procedure and the consent of the governing board, teaching staff and parents, the tests were administered during school time over the course of one month at the beginning of the 2018-2019 school year. It was also announced that the data gathered would be used solely for research purposes. The Jr. MAI and MAPE-I were administered on a group basis to the different classes and years. These questionnaires were completed separately in class time under the supervision of the class tutor or teacher. Pupils over the age of 11 are expected to take 20 minutes to complete the MAPE-I questionnaire. Given the length of the questionnaire, the time allowed for MAPE-I for those younger than that age was extended to the whole 50 minutes of class-time to ensure the pupils could perform satisfactorily.

Given that the ENFEN questionnaire required the pupils to leave the classroom, their parents or guardians were informed of the test's conditions. Out of the 354 pupils that took part on a group basis, consent for leaving the classroom on an individual basis was forthcoming for 168 of them. These individual tests were conducted on the school premises by two people from outside the school.

The questionnaires were chosen after consulting experts and conducting a literature review, with a view to adapting them to the age of the cohort selected for the study, given the scarcity of psychometric tests available. Nevertheless, it should be stressed that the self-report tests used to measure the motivation and metacognitive variables have been questioned in the literature. This is due to the complexity of self-assessment for pupils of these ages (Pintrich & De Groot, 1990; Sungur 2007). On the other hand, the little specificity

or structure of neuropsychological tests such as those of ENFEN means that doubts have been raised over their use in studies of this nature, although they are considered representative of cognitive performance (García et al., 2016). This test has been chosen because it is available on the market and has been validated in the same sample population as used in the study.

Data analysis

The purpose of this research is to analyse the impact that motivation has on cognitive performance and metacognition. Thus, the first step involves a Pearson's correlation, together with an analysis of the descriptive statistics. This was followed by an ex post facto design of the study, dichotomising the motivational variables according to their corresponding median, for studying the difference between the groups created through a general multifactorial linear model with bootstrapping. The dependent variables are cognitive performance and metacognition. The independent variable is motivation. Furthermore, these analyses have included school year as an independent variable. To do so, the pupils have been divided by year as an age-related variable. This allows determining whether age may have an impact on the relationships found.

Results

The results forthcoming from Pearson's correlation analysis record low significances, as reflected in Table 1. Note should be taken of the moderate correlation between the variable *Motivation for focusing on the result and avoidance versus focus on learning* and the cognitive performance tests of *Colour Trails 2*, as well as with the *Interference* test. A further highlight is the moderate correlation between the variable *Apathy versus increased effort* and *Knowledge regulation*.

Table 1. Correlations between motivation, metacognitive and cognitive performance variables. Motivation variables: D1, Motivation for the focus on results and avoidance vs. focus on learning; D2, Apathy vs. increased effort; D3, Motivation for excellence vs. absence thereof. Metacognitive variables: K, Knowledge; R, Knowledge regulation. Cognitive performance variables: F1, Phonological fluency; F2, Semantic fluency; S1, Grey Trails 1; S2, Colour Trails 2; A, Rings task; IN, Interference.

	K	R	D1	D2	D3	F1	F2	S1	S2	A
R	.276**									
D1	-.111	-.105								
D2	-.094	-.283**	.351**							
D3	.166*	.154*	.301**	-.184*						
F1	.117	-.076	-.100	-.036	.052					
F2	.080	-.079	-.120	.059	-.018	.453**				
S1	.054	-.159*	-.170	.064	-.073	.208**	.296**			
S2	.153	-.064	-.375**	.054	-.117	.285**	.369**	.574**		
A	-.030	.047	-.022	.066	-.053	-.224**	-.300**	-.258**	-.411**	
IN	.128	-.050	-.319**	.084	.011	.231**	.278**	.284**	.519**	-.346**

The means recorded for each one of the items of the variables of motivation, metacognition and cognitive performance are shown in Table 2. The results reveal a general in-

crease in the scores, rising over Years 3 to 5. This improvement in the scores might be due to the pupils' development according to the year they are in.

Table 2. Descriptive statistics of the scores recorded for each one of the variables. There are variations in the sample number (N) as the calculation of the variable has excluded those items for which some of the answers have not been completed. The mean (M) and standard deviation (SD) are also included.

School year	Motivation									Metacognition					
	D1			D2			D3			K			R		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD
Year 3	66	12.42	5.26	54	12.37	5.15	67	12.06	3.05	130	14.95	1.59	130	14.08	2.20
Year 4	77	9.22	4.75	70	12.43	4.87	71	10.32	3.63	105	15.71	1.50	101	14.28	1.99
Year 5	75	9.47	6.07	75	14.33	4.38	82	10.56	3.79	97	15.79	1.53	99	13.60	2.32
All groups	218	10.28	5.55	199	13.13	4.84	220	10.94	3.59	332	15.44	1.59	330	14.00	2.19

School year	Cognitive performance													
	F1		F2		S1		S2		A		IN			
	N	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	
Year 3	75	9.35	3.71	15.35	4.06	21.52	7.02	10.94	3.90	212.36	37.57	56.83	13.88	
Year 4	46	9.89	3.81	15.91	3.79	23.79	4.44	14.05	4.18	184.82	36.40	68.43	16.43	
Year 5	47	10.72	3.33	18.26	4.94	26.82	8.11	15.83	4.81	196.59	36.46	69.06	17.20	
All groups	168	9.88	3.66	16.32	4.41	23.62	7.08	13.16	4.72	100.41	38.52	63.43	16.58	

The next step involved the dichotomisation of the motivation variables for the ex post facto design. The effect these variables had on cognitive performance and metacognition was determined by using a general multivariable linear model with bootstrapping. The analyses have discarded any incomplete questionnaires.

Analysis of the effect of the motivation variable: D1

An analysis of the motivation variable involving the focus on learning and the cognitive performance tests revealed

an effect on IN, $F(1) = 10.453, p = .002 (p < .05), \eta^2 = .091, p = .893$; and S2, $F(1) = 8.323, p = .005 (p < .05), \eta^2 = .073, p = .816$. The effects were large. By contrast, no significant effects were found among the other cognitive performance tests with motivation to focus on learning.

Figures 1 and 2 provide the descriptive statistics for the cognitive performance variables of *Trails* and *Interference* by comparing the two groups created through the dichotomisation of the motivation variable D1.

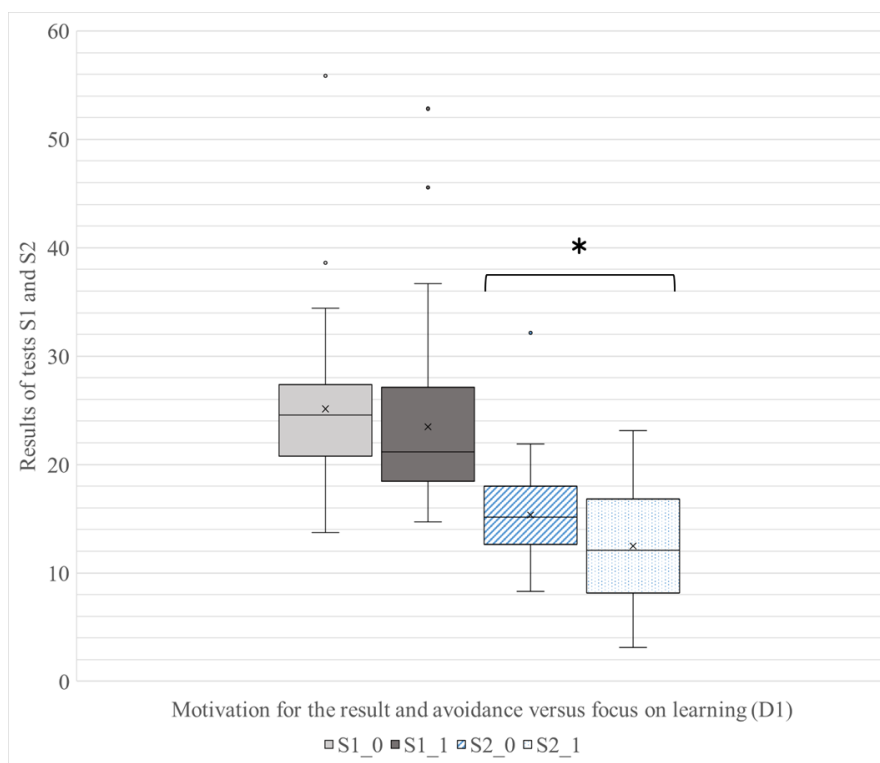


Figure 1. Schema of the differences in the descriptive statistics of the cognitive performance results in the tests of *Grey Trails* 1 (S1) and *Colour Trails* 2 (S2) in relation to the two groups obtained from the motivation variable (D1) of *Focus the result and avoidance* (Group 1, N = 52) versus *focus on learning* (Group 0, N = 55).

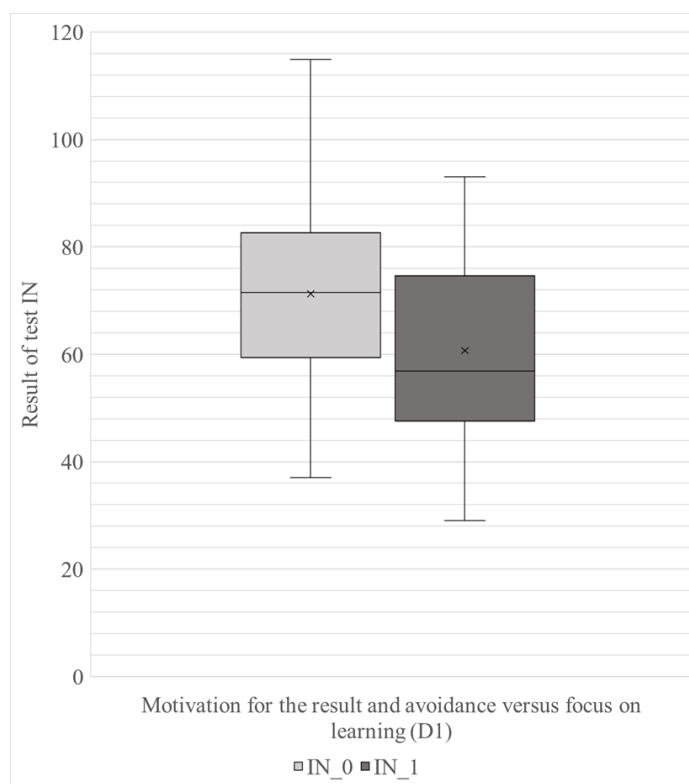


Figure 2. Schema of the differences between the descriptive statistics of the cognitive performance results in the test of *Interference (IN)* in relation to the motivation variable (*D1*) of *Focus on the result and avoidance* (Group 1, $N = 52$) versus *focus on learning* (Group 0, $N = 55$)

The introduction of school year as an independent variable together with *D1* reveals a significant effect with cognitive performance in *IN*, $F(1) = 4.739$, $p = .032$ ($p < .05$), $\eta^2 = .045$, $p = .578$. All the years record significances in the differences in cognitive performance in *F2*, $F(2) = 3.538$, $p = .033$ ($p < .05$), $\eta^2 = .065$, $p = .647$; *S1*, $F(2) = 7.040$, $p = .001$ ($p < .05$), $\eta^2 = .122$, $p = .922$; *S2*, $F(2) = 10.111$, $p = .001$ ($p < .05$), $\eta^2 = .167$, $p = .984$; *A*, $F(2) = 4.220$, $p = .017$ ($p < .05$), $\eta^2 = .077$, $p = .728$, except for *F1* and *IN*. This might indicate that age, together with motivation for learning, plays a key role in tasks involving working on the inhibition of responses.

No significance is found for the effects of the results obtained between the motivation variable *D1* and *K* or *R*. No effect is found for the motivation to focus on learning with the metacognitive variables.

An analysis of the school year records an effect with metacognitive knowledge, $F(2) = 4.577$, $p = .013$ ($p < .05$), $\eta^2 = .083$, $p = .765$. This may be because Year 5 pupils clearly have more metacognitive knowledge than their counterparts in Year 3.

There is no interaction between the motivation variable *D1* and school year. The Bonferroni correction shows that the years with significances between the different scores are mainly Year 3 and Year 5 in the following tests: *F1*, *F2*, *S1*, *S2*, *IN* and *K*. The tests *S2*, *IN* and *K* also record significance between Years 3 and 4. Test *A* only records significant

differences between Years 3 and 4. There are no significant differences across the Years. The biggest differences are found as the pupils get older, albeit without recording major differences between Years 4 and 5. This might be due to the academic change occurring between Years 3 and 4 when passing on to the second cycle of primary education, and which is not so accentuated in the step from Years 4 to 5 as regards the development of cognitive performance.

Analysis of the effect of the motivation variable: *D2*

The results of the cognitive performance tests for the variable *Apathy vs. increased effort* do not show any significant effects. No effect is found between motivation for effort and cognitive performance.

Secondly, when conducting an analysis by school year, the study's results record a significant effect with the cognitive performance tests of *F2*, $F(2) = 9.241$, $p = .001$ ($p < .05$), $\eta^2 = .177$, $p = .973$; *S1*, $F(2) = 8.683$, $p = .001$ ($p < .05$), $\eta^2 = .168$, $p = .965$; *S2*, $F(2) = 14.398$, $p = .001$ ($p < .05$), $\eta^2 = .251$, $p = .998$ and *IN* $F(2) = 6.185$, $p = .003$ ($p < .05$), $\eta^2 = .126$, $p = .882$. This is not the case for the tests *F1* and *A*, which indicate differences in cognitive performance across the pupils' ages.

The results obtained in the metacognitive variable of *R*, $F(1) = 6.790$, $p = .011$ ($p < .05$), $\eta^2 = .070$, $p = .732$ are significant with *D2*. Although no significant effect is record-

ed with the variable of K. Accordingly, the increased effort might help the pupils to improve their regulation of metacognitive processes. Figure 3 presents the descriptive statis-

tics of the dichotomisation of the motivation variable D2, which reveal significance with the metacognitive variables.

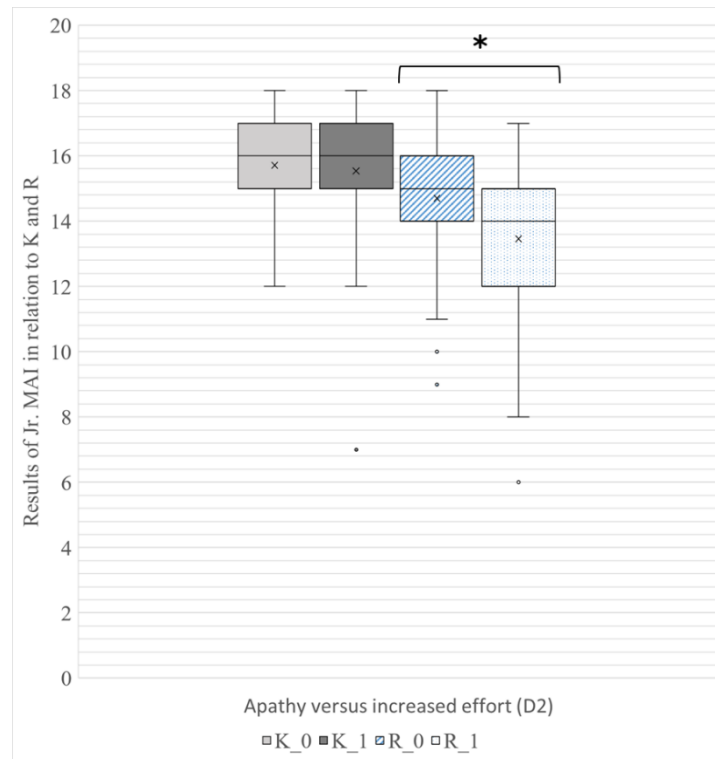


Figure 3. Schema of the descriptive statistics of the results of the variables *Knowledge (K)* and *Regulation (R)* of metacognition in relation to the motivation variable of *Apathy versus increased effort (D2)*. Group 1, $N = 50$; Group 0, $N = 42$.

When Year is included with the motivation variable D2, the only effect observed is between increased effort and R, $F(1) = 5.061, p = .027 (p < .05), \eta^2 = .056, p = .604$. No effect is detected with the independent variable Year in relation to K.

There is no interaction between D2 and Year. There are significant differences between Year 3 and 4 groups and Year 5 in the tests of F2, S1, S2 and IN. There are also differences in the F1 test between Years 3 and 5. Nevertheless, there are no differences across the groups for A in cognitive performance or in the metacognitive variables.

Analysis of the effect of the motivation variable: D3

The results for *Motivation for excellence vs. Absence thereof* do not reveal a significant effect with either the metacognitive or cognitive performance variables.

The analysis by Year records significance with the cognitive performance variables F2, $F(2) = 3.414, p = .037 (p < .05), \eta^2 = .063, p = .630$; S1, $F(2) = 3.343, p = .039 (p < .05), \eta^2 = .062, p = .620$; S2, $F(2) = 12.565, p = .001 (p < .05), \eta^2 = .199, p = .996$; A, $F(2) = 5.516, p = .005 (p < .05), \eta^2 = .098, p = .842$; IN, $F(2) = 6.977, p = .001 (p < .05), \eta^2 = .121, p = .919$. Regarding metacognition, there is

an effect with K $F(2) = 3.363, p = .039 (p < .05), \eta^2 = .062, p = .623$. No differences have been found for school years in the F1 and R variables. Age is a factor that may affect the pupils' performance in the tests.

The Bonferroni correction records differences between Year 3 and Years 4 and 5 for the tests of S2 and IN. In turn, there are differences between Years 3 and 5 for F2 and S1. Test A's results record differences between Year 4 and Years 3 and 5. No differences have been found across the years for F1, K and R.

Discussion

The results obtained corroborate the effect of motivation with cognitive memory, working memory, and the ability to inhibit interferences between the group of pupils focused on learning and the group focused on performance. The performance in the tests that evaluate cognitive flexibility, working memory and inhibition is better in the learning-focused group, as reflected in Figures 1 and 2 corresponding to the tests of S2 and IN. This better performance in task-solving may be linked to achievement goal theory (Elliot and Dweck, 1988). Furthermore, these executive functions have often been used in studies on the performance of complex tasks,

such as academic ones and the academic success related to students' self-regulation (Miyake et al., 2000; Best et al., 2011). The results obtained coincide with those of other studies, such as those by Barca-Lozano et al. (2012) and Schunk (1996), in which the focus on learning goals improves students' performance. What's more, the focus on results or the fear of failure diminish performance, which might coincide with the lower results. In the same way, Pintrich and De Groot (1990) contend that motivational components affect a student's cognitive commitment, and therefore their academic performance. Nevertheless, no effects have been found for motivation in any of the other tests, nor of the other motivation variables with cognitive performance.

The tasks in which we have found an effect of motivation on cognitive performance correspond to the tests of IN and S2. Both tests record a convergence of the evaluation of executive functions such as operating memory, the capacity for inhibition, and the flexibility for change. These executive functions underpin the importance of maintaining goals for the competence in performance and the ability to provide a focused response to the task's goal (Brocki & Bohlin, 2004; Kane & Engle, 2003; Roebers, 2017). As in the study by Spiess et al. (2016), the most salient results of the effect of motivation for learning have been recorded with the IN inhibition test, being also associated with school year. On the other hand, the effect of motivation for learning is lost in the cognitive performance associated with operating memory and flexibility toward change when including age. The reason for this may be that the IN test explicitly evaluates inhibition by being considered a Stroop task, while S2 works more on operating memory and flexibility toward change. The results also show the effect of age on the pupils' cognitive performance according to school year. The difference observed is greater between Years 3 and 5. The pupils in the higher year have recorded better results in cognitive performance. This corresponds to a greater development of executive functions. It is also likely that the results obtained coincide with the development of inhibition, related to operating memory and flexibility toward change, in the capacity to remain focused on the goal (Miyake et al., 2000).

Regarding the metacognitive variables, the results show an effect of increased effort with the metacognitive regulation between the group of pupils making a greater effort and the group more inclined to apathy. In other words, pupils making a greater effort are better prepared to regulate their metacognitive knowledge. This difference is reflected in Figure 3 on results. Our findings are consistent with relationships that have been reported between motivation and metacognition in studies such as those by Follmer and Sperling (2016), Gaeta et al. (2012), Landine and Stewart (1998), Park and Bae (2014), and Pintrich and De Groot (1990). These cases have revealed the significance of effort and the effect of motivation for academic tasks when using strategies that involve the regulation of metacognition, as well as in SRL. Furthermore, greater motivation may be related to a greater

capacity for the effort in using metacognitive regulation strategies in tasks (McCombs, 1988; Park & Bae, 2014).

Our research, however, has not been able to identify any effects between all the other motivation variables and metacognition, nor between increased effort and metacognitive knowledge. This contrasts with the study by García et al. (2016), in which students with metacognitive regulation also record high metacognitive knowledge, as it is considered prior to the development of regulation skills. As verified with pupils with high motivation, they are more likely to have metacognitive skills. Likewise, their focus on learning goals will predict the use of metacognitive strategies (Gaeta, 2006; Konrad, 2015). Self-regulated students will therefore make more frequent use of metacognitive strategies for persisting in complex or less interesting academic tasks (Pintrich & De Groot, 1990).

Our results also highlight the effect of the motivation that predisposes the pupils to regulate their metacognitive knowledge, regardless of their age. In turn, a highlight among the school years is the motivation for learning with metacognitive knowledge. This difference between Year 3 and Years 4 or 5 might be explained by the acquisition of metacognitive knowledge in each school year, being lower in Year 3.

Study limitations

Pupils aged between 8 and 11 have limited knowledge about metacognitive phenomena for their self-evaluation, which may interfere with their answers to the questionnaires (Flavell, 1979). Furthermore, regarding the gathering of information on motivation variables, the pupils in higher years are more likely to evaluate their self-efficacy with greater accuracy, determine the value of learning, and set goals for assessing their progress (Schunk, 1996, 2005). At the same time, learning and performance are conditioned by personal and environmental variables (González-Pienda, 2003). This study has focused on the personal aspect. A limitation on this point, whereby the children self-assess their metacognition and motivation, is that their answers will often reflect what each one considers to be socially more acceptable in their environment (García & Pintrich, 1994). The results need to be replicated with other metrics in order to compare the results forthcoming. Nevertheless, self-reports continue to be the measuring resource of choice for large samples (Karlen, 2016).

There is also some debate over the use of neuropsychological tests and the difficulty in individually assessing executive functions. The tests normally encompass numerous variables that may be affecting the performance of the tasks, which hinders their assessment or concrete outcomes (Brocki & Bohlin, 2004; García et al., 2016). These other variables could include other emotional and motivational factors that might be prompting effects that are not captured by these measuring instruments, as myriad relationships may be established within the variables of SRL (McCombs, 1988).

Conclusions

Although the research into academic performance has often focused on cognitive performance measures, there is still no robust model between motivation and cognition for SRL (Núñez Pérez et al., 1998). Studies such as those by McCombs (1988) and Sungur (2007, 2007a) report that motivational engagement has an influence on the cognitive and metacognitive strategies involved in performing a task that calls for the regulation of effort and persistence. Other studies, such as those by Sungur (2007a) and Karlen (2016), report the pupils' need to have a certain degree of motivation in order to resort to the use of metacognitive and cognitive processes. According to our results, it may therefore be posited that motivation has an impact on metacognitive regulation and on tasks that work on inhibition for the achievement of academic success. It should be noted that the use of cognitive or metacognitive strategies without self-regulation does not lead to a high academic performance (Pintrich & De Groot, 1990). By contrast, other studies have reported that SRL could compensate for a low level of metacognitive and cognitive strategies with high levels of motivation for learning. There is still a need to continue investigating this relationship with a view to defining it (Bahri & Corebima, 2015; Karlen, 2016).

The focus on goals, therefore, plays an important part in the self-regulation of learning and academic performance (Schunk, 2005; Sungur, 2007). An example of this is the study by Pintrich and De Groot (1990). Their research posi-

tively correlates the prediction of academic achievement with self-regulation, the use of metacognition, cognitive strategies, and motivation for learning. Students may use motivational strategies for acquiring knowledge and emotional relationships with the learning activities that will steadily broaden during their development (García & Pintrich, 1994). Students may therefore adapt or alter their strategies according to personal and contextual factors, and they can always learn new strategies (Suárez & Fernández, 2011). This supports the learning models that link the study's constructs. Nevertheless, more longitudinal studies are required to confirm and understand issues of causality (Gaeta et al., 2012; Suárez & Fernández, 2011).

The inclusion in the teaching models of strategies for focusing on goals in learning experiences, as well as feedback, and self-control and cognitive flexibility schemes, may help students to improve their academic performance (Best et al., 2011; Spiess et al., 2016). SRL may be used to improve their ability to set goals, assess their progress, and change their learning strategies (Dweck, 1986; Schunk, 1996, 2005).

Supplementary material.- Further information on the ENFEN battery of tests is available through the following link: <http://web.teadecisiones.com/Who-we-are.aspx>

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