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Development of executive functions in late childhood and the mediating role of cooperative learning: A longitudinal study

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ABSTRACT

We examine the developmental changes in Executive functions (EFs) throughout late childhood and how the contextual factor of classroom methodology mediates such changes. Using data collected from fifty-three pupils at two time points (between the 5th and 6th grades of Primary School) we observed the longitudinal development of cool (Working Memory (WM), Cognitive Flexibility, Inhibitory Control, and Planning) and hot-EFs (Emotional Intelligence-EI-). The participants were selected from two schools with different methodological approaches (Cooperative and Individualistic learning) to examine the mediating role of classroom methodologies in developmental changes in EFs. The results revealed age-related improvements in performance on WM, cognitive flexibility, and planning tasks. Moreover, Cooperative Learning (CL) significantly affected performance on WM and self-control tasks. Our findings highlight the importance of studying the development of EFs at the end of the Primary School stage, since natural development involves numerous contextual factors that deserve attention, particularly for improving methodological proposals and learning processes.

1. Introduction

Executive functions (EFs) are generally considered to be processes that allow thoughts and actions to be directed toward a goal through the planning, monitoring, and controlling of behaviors and emotions (Diamond, 2013). These cognitive processes are essential for effective, creative, and socially adaptative behavior (Bryck & Fisher, 2012; Lezak, 1982). EFs are involved in cognitive and social abilities such as language, problem solving, abstract reasoning, and regulation of emotions. In fact, an unsuitable development of EFs have been related with a poor efficiency on these skills (Boerma & Blom, 2020; Kotsopoulos & Lee, 2012; Ropovik, 2014; Spruijt et al., 2018).

The development of EFs during childhood implies the development of a set of cognitive abilities that must allow the child to: a) manage information; b) self-regulate and adopt reflexive and non-impulsive decision-making behavior; and c) adapt their behavior to

Abbreviations: CL, Cooperative learning; IL, Individualistic learning; EFs, Executive functions; WM, Working Memory; EI, Emotional Intelligence.

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the demands of the current context. Consequently, EFs contribute towards the acquisition of participative, active, and reflective attitudes necessary in the teaching-learning processes (Marcovitch et al., 2008). The development of EFs begins at a very early age and extends throughout the lifespan, with middle and late childhood being a critical period due to the changes associated with the development of neural networks involving the prefrontal cortex (PFC) during this stage (Anderson, 2002; Zelazo & Carlson, 2012).

Due to the relevance of EFs for children's cognitive and social functioning, it is important to understand how EFs develop and identify those factors that could play a mediating role in individual development during late childhood (Lensing & Elsner, 2018). In this sense, previous investigations have suggested that CL (as contextual factor) plays an important role on EFs as well as cognitive and socio-emotional development (Staiano et al., 2012). The kind of social interaction promoted by cooperative structures in classroom might have a significative impact on learning abilities and/or cognitive and socio-emotional processes (as well as problem solving, creative thinking or social skills) compared to individualistic or competitive methodologies (Authors, 2020; Beghetto, 2016; Fawcett & Garton, 2005; Pai et al., 2014; Sabol et al., 2013).

Therefore, the present study aimed to observe the cognitive and socio-emotional changes in late childhood over two years. Moreover, we examined the mediating role of two different classroom methodologies (Cooperative and individualistic learning) in these developmental changes in EFs.

2. Executive functions: cool and hot

Traditionally, EFs have been understood as domain-general functional construct, although some researchers have suggested that these processes could act differently depending on the context a task is performed. In this sense, Zelazo and Muller (2002) proposed a two-dimensional model of Efs: 1) *Cool-EFs*: cognitive processes which support goal-directed behavior under relatively abstract, decontextualized, non-emotional conditions; and 2) *Hot-EFs*: related to affective aspects associated with situations that involve emotional regulation and motivation (Zelazo & Carlson, 2012; Zelazo et al., 2005).

Regarding *Cool-EFs*, three key cognitive components have been identified: WM, Inhibition, and cognitive flexibility (Diamond, 2013; Garon et al., 2008; Lehto et al., 2003; Miyake & Friedman, 2012), which could be the base for more complex executive processes such as reasoning, problem solving, and planning (Diamond, 2013). Although there are some differences in their developmental trajectories (Author, 2021), these three components appear to operate in an interactive manner (Best & Miller, 2010).

WM is responsible for actively operating and mentally maintaining and manipulating information (Diamond, 2013). Even though WM is a limited capacity system whereby information is temporarily stored, it allows this information to be managed and transformed into thoughts and actions, and thereby supports essential processes such as written or spoken language, or mathematical reasoning (Titz & Karbach, 2014).

Some authors have suggested to include processes such as updating and manipulation under the umbrella of WM (even they have been considered synonymous) which are considered the capacities to continuously replace old information with new and relevant data, and they allow for establishing connections between various ideas, and the consideration of various response options (Carriedo et al., 2016b; Garon et al., 2008). Baddeley (1986) has suggested that these processes require a coordination of complex component of WM such as central executive. In this sense, Baddeley (2003) proposed a multi-component model which is one of the most widely accepted cognitive frameworks of WM among researchers in the study of executive functions. Baddeley's model includes a central coordinating executive system and at least two slave components: the phonological loop which maintains speech-based (phonological) information; and the visuospatial sketchpad that supports nonverbal, visual, and spatial data. The central executive system is assumed to maintain and encode information when the phonological loop and visuospatial sketchpad are saturated, that is, it is a control system capable of facing the demands of the task that would otherwise limit the processing space and cognitive resources of the subsidiary systems (Gathercole et al., 2004).

The term inhibition refers to the control procedure whereby the individual suppresses contextually inappropriate responses to generate mental and/or behavioral responses that are adapted to environmental demands. Inhibitory control comprises two cognitive components: a) Inhibition of prepotent responses (i.e., exogenous and endogenous interference) and b) Selective attention, which avoids distractor interference (i.e., the ability to ignore irrelevant information; Friedman & Miyake, 2004). The adequate development of inhibitory control is linked to normal performance on other neuropsychological abilities such as Working Memory, spoken language, and self-regulation (Barkley, 1997).

Cognitive flexibility concerns the ability to efficiently switch between tasks, operations, or mental sets (Miyake et al., 2000). Cognitive flexibility allows children to shift attention, efficiently focus on changing environmental demands, and adapt their behavior to new situations. This component of EFs has been linked to problem solving efficiency, writing skills, and arithmetic (Bull & Scerif, 2001; Hooper et al., 2002).

From the three core EFs, other higher-order processes emerge such as planning, which is defined as the ability to mentally organize behaviors to generate and structure sequences of responses. Thus, planning enables children to coordinate sequences of actions in time and space when a goal requires the achievement of a series of intermediate steps. Normal development of this planning ability allows for implementing flexible and adaptive behaviors necessary for cognitive skills such as problem solving or reasoning (Ward & Allport, 1997).

There is generally a degree of consensus among researchers that hot-EFs are those processes of control that are required in situations with a significant motivational and emotional component, or those that elicit a conflict between immediate reward and long-term goals (Zelazo & Carlson, 2012). However, there is rather less agreement regarding the composition of hot-EFs. Some authors consider that Emotional Intelligence (EI) and related aspect of social cognition (such as theory of mind, emotional regulation, empathy, or social skills) should all be included under the category of hot-EFs (Author, 2021; De Luca & Leventer, 2008; Happaney et al., 2004;

Keifer & Tranel, 2013; Kerr & Zelazo, 2004); whilst others claim that some of these abilities are not as closely associated with hot-EFs (Zelazo et al., 2005).

Studies conducted during middle and late childhood have found a link between EI and performance on tasks typically related to hot-EFs (e.g., Iowa Gambling task; Li et al., 2017). Moreover, some researchers have suggested that EI (e.g., sociability, social awareness or capacity to perform interpersonal relationships) could predict performance on hot-EF tasks in adults (e.g., Telle et al., 2011). EI has traditionally been considered a set of emotional and socially adaptive skills. According to Mayer and Salovey (1997) EI includes four basic processes: a) the accurate perception and expression of emotions, b) the use of emotion to facilitate thinking through the ability to access and/or generate feelings, c) the understanding and knowledge of emotions, and d) the management and regulation of emotions.

Salovey and Mayer (1990) model considers empathy central to social understanding and interactions given the role on appraisal and expression of emotion applied to others. Empathy is the ability to perceive, understand and/or share feelings with others — as well as thoughts and emotions — are all processes associated with empathy. Previous studies with adult population have suggested that empathy is closely associated and correlated with other components of EI such as perception, understanding or emotional management (Mayer et al., 1999). These studies suggest that the basis of the emotional understanding of others is based on the knowledge of one's own emotions (Extremera & Fernández-Berrocal, 2004). Moreover, empathy is related to interpersonal and prosocial behavior, as well as lower levels of aggression and fewer bullying behaviors in Primary school (Abramson et al., 2020).

Empathy includes two dimensions: 1) the cognitive dimension, which refers to the ability to recognize and understand the emotions of others. Cognitive empathy can be indicated by the capacity of a perceiver to understand the subjective states of others; and 2) the affective dimension, which refers to the ability to share and experience an emotion observed in others, even when the event does not directly affect the perceiver (Jolliffe & Farrington, 2006).

3. Development of EFs

The processes attributed to EFs begin to develop at an early age and undergo rapid and significant changes during the preschool period, with development extending into late childhood after adolescence (Carlson, 2005). The gradual maturation of EFs co-occur in parallel with the prolonged development and integrity of the pre-frontal cortex (PFC), a brain region related to skills such as planning, organization, and complex decision making, along with abstract thought and emotional regulation (Daniels et al., 2006). Developmental studies have suggested changes in EFs across the lifespan, specifically, in middle and late childhood. Regarding WM, Alloway and Alloway (2013) found significant changes between the ages of 5–12 years in performance on manipulation and maintenance of information in WM tests (both verbal and visuo-spatial content). In a similar vein, Siegel and Ryan (1989) compared the capacity to maintain and update information in children of three different age groups (7–8, 9–10 and 11–13 years), and found significant developmental changes in both verbal and non-verbal WM tasks.

On the other hand, significant improvements in inhibitory control during middle and late childhood have been found, although empirical studies have produced mixed outcomes. For instance, Mullane et al. (2014) found evidence for developmental changes in executive control in children aged 6.5–12.5 years. Their findings indicate an improvement in the capacity to resolve interference caused by simultaneously activating correct and incorrect responses during middle and late childhood. These findings are in accord with those of other studies using flanker tasks, which suggest that executive control (i.e., interference control) improves during this period (Enns & Akhtar, 1989; Ridderinkhof et al., 1997; Simonds et al., 2007). However, Rueda et al. (2004) in a cross-sectional experiment, compared different age groups and found no changes in executive control beyond the age of 8 years. In a similar vein, Ridderinkhof et al. (1997) found improvements from 5 to 10 years, but almost no differences between the age of 10 years and adulthood. These findings therefore suggest that conflict resolution introduced by incongruent flankers is stable after this age. Regarding cognitive flexibility (switching between rules), it is a well-established finding that this improves during childhood (Buttelmann & Karbach, 2017; Jacques & Zelazo, 2001). Davidson et al. (2006) found significant improvements in performance on switching tasks between the ages of 4–13 years, although the participants did not reach adult levels at this latter age. Similarly, Dick (2014) explored cognitive flexibility in 6- to 10-year-old children and adults and found improvements in switching-task performance with the passage of time. Unlike Davidson's study, Dick's findings suggest that children reach adult levels of performance at 10 years of age. With regard to the development of planning, some studies have reported age-related changes in late childhood. Bishop et al. (2001) found substantial variations in performance on the Tower of Hanoi task in participants between 7 and 26 years old. The authors observed a rapid increase in early childhood (up to 12 years old), which then slowly declined (13- to 15-years-old), before reaching a stable level in young adulthood. Similarly, Matute Villaseñor et al. (2008) revealed a notable increase in performance on the Tower of Hanoi task from the early years until the age of 11. Improvements in this higher-order skill have traditionally been linked to the development of the core EFs (WM, cognitive flexibility, and inhibition; Diamond, 2013).

Emotional development occurs during sensitive periods such as transition between middle childhood and adolescence (Gee, 2016). However, this sensitive period is determined by environmental stimuli that may ultimately influence an individual's behavior in both positive and negative ways across the lifespan (Masten & Cicchetti, 2010). Dramatic changes in emotional competence have been observed throughout the first year of life. The first evidence for the development of emotional skills (i.e., perception and recognition of emotions) can be observed at 3–5 months (Heck et al., 2018). After this, a cascading series of events occurs (e.g., language development) which lead to the appearance of more complex emotional abilities such as understanding or regulation of emotions, along with social skills (Rosenblum et al., 2009). Subsequently, in this developmental process, children learn to express and label their emotions and feelings, and use these as a guide to regulate their own behavior (Zeidner et al., 2003). A study conducted by Kolb et al. (1992) has indicated that there are some critical periods in this developmental process. The results of their study showed a significant improvement in emotion recognition between 6 and 8 years, with few changes observed up until the age of 14 years. The understanding and management of emotion regulation strategies could depend upon the individual development of skills such as language. A suitable linguistic competence (e.g., a more elaborated and organized discourse) is related to an emotional skills that allows the child both express their emotions correctly and generate appropriate communication during social interactions. (Stern & Cassidy, 2018; Zeidner et al., 2003). Nonetheless, affective and cognitive empathy could develop in different rates due to the fact that the mechanism underlying these aspect (e.g., capacity to mentally represent others people felling, and/or to share the felling of others) rely different neuro-cognitive circuits (Singe, 2006). However, additional longitudinal researches are needed to investigate the developmental differences in empathy (cognitive and affective) across the late childhood and adolescence as well as the factors could mediate in this development.

4. EF development and the school context: Cooperative Learning vs individualistic learning

Traditionally, the development of Efs has been reciprocally related with social interaction (Moriguchi, 2014). In this sense, classroom context is an environmental factor involved situations in which children must synthesize the cognitive, social, and emotional activity (Bohlmann & Weinstein, 2013; Poulou, 2014). Classroom methodologies with an important social component (e.g., collaborative) have an impact on the child's cognitive and socio-emotional development (Staiano et al., 2012). Moreover, cooperative structures could be an important predictor for learning skills (Sabol et al., 2013) and executive performance (cognitive and socio-emotional) from early years (Bodrova and Leong, 2006; Hamre B, 2013; Hamre B.K, 2013; Rimm-Kaufman et al., 2009; Staiano et al., 2012; Weiland et al., 2013). Moreover, some authors have suggested that CL is more beneficial for the cognitive processes in students (e.g., problem-solving, creative thinking), and their academic achievements or social skills when compared with learning that is based on individual and competitive work (Authors, 2020; Beghetto, 2016; Fawcett & Garton, 2005; Pai et al., 2014). CL characteristics are associated to affective and positive social interactions within the classroom which could promote emotional states that would favour the exchange of information and responses more adapted to contextual situations (Willis, 2007). On the contrary, stress situations are associated to negative interactions (including parents, teachers and/or classmates) which could have negative effects on the cognitive development of students (Berry, 2012; Blair & Raver, 2015). In this sense, previous studies highlight the impact of the emotional and psychological climate on development of Efs (Hamre & Pianta, 2007; Hamre B, 2013; Hamre B.K, 2013; Hatfield et al., 2013; Veraksa et al., 2020). For instance, Hatfield et al. (2013) suggested that those children involved on a high emotional environments (e.g., sensitive and warm attention from the teacher, or recognition of the opinions and ideas of the students) reduced stress and their cognitive development was favoured comparing to those children from environments characterized by lower emotional support. Fawcett and Garton (2005) found that children showed significantly better performance on problem-solving tasks when taking part in a collaborative interaction than children who worked individually. It could be congruent with those studies which suggest relations between social interaction and cognitive processes (e.g., Working Memory) (de Wilde et al., 2018).

CL is a pedagogical practice that favors positive social interaction and is based on the notion of respect for diversity and individual needs, as well as the learning styles of the students (Johnson & Johnson, 2009). In CL, students work together in mixed-ability groups of four individuals or less, which facilitates task distribution and greater interaction between students (Gillies, 2014). By promoting interactions, children establish reciprocal dialogue and learn to share new experiences and realities, encouraging each other and exchanging resources among themselves (Mercer, 1994). CL provides a balance between individual performance and group success, and a context in which individual accountability is clearly established, while the goals are achieved by the collaborative efforts of all group members. Through face-to-face interaction, CL promotes social skills (e.g., respecting norms and roles), children can use language distinctively and creatively, and they can construct new ways of thinking and learning. CL supports a group-based dynamic which involves self-evaluation of the involvement and accountability of each member, and the analysis of the most effective strategies within the learning-process (Kyndt et al., 2013).

Despite the empirical evidence on the importance of learning strategies for EF development, more studies are needed to clarify the mediating role of teaching methodology (particularly CL) in EF development throughout the school stages.

5. The present study

The purpose of this study was to longitudinally examine the development of various EF components (*cool* and *hot*) in children throughout the 5th and 6th grade of Primary School (9–12 years), and to determine if the classroom methodology (Cooperative and individualistic learning) could mediate individual developmental differences. Therefore, we expected to find: (1) a significant increase throughout late childhood in *cool* and *hot-EFs*, and (2) that children involved in Cooperative Learning (CL) as a classroom methodology significantly improve compared with those who engage in individualistic learning (IL) in terms of the cognitive and socio-emotional processes related to EFs.

6. Material and methods

6.1. Participants

We recruited fifty-three students (23 boys and 30 girls) from two elementary schools in the same urban area of the province of Almería (Spain). All participants were evaluated twice, at the beginning of the 5th grade (November) and at the end of the 6 t^{h} grade (June) of Primary Education (2016–2018). At time 1 (T^1), the mean age was 9.81 years (*SD* =.48); whilst at time 2 (T^2), the mean age was 11.35 years (*SD* =.52). The participants were both monolingual Spanish speakers ($n = 20$) and Spanish speakers from migrant families ($n = 33$; 60.38%). Children from migrant families (Morocco, Romania, Portugal, and Sub-Saharan countries) were born in Spain or schooled at early ages in the Spanish educational system. For all participants, competence in the Spanish language was considered to be at the level demanded by the school curriculum.

The two participating schools were selected based upon similarities in demographic characteristics. Previously to this study, both schools taught individualistic methodologies. At the beginning of this study (after T^1), one of the schools implemented the CL methodology over two years while the other one continued applying individualistic learning. Finally, 25 students were selected from the Cooperative leaning school, and 28 from the Individualistic Learning school (Table 1). The teachers of each participating group-classrooms in this study were interviewed to gather details about both teaching methodologies, which are shown in Table 2. Moreover, teachers reported information about their training. CL teachers (two teachers) regularly attended face-to-face and online training sessions (Teacher training center of Consejería de Educación y Deporte of Andalucía). The training was focused on knowledge of the theoretical foundation, the management of CL (implementation sequence), the learning of cooperative techniques, and planning and evaluation through CL. After training, teachers obtained a certificate of attendance and attainment. In the classroom, CL was conducted in Language, Math, and Arts subjects. Through a wide range of cooperative routines or techniques, the teachers were expected to foster cordial relationships and positive interdependence and individual accountability toward the achievement of common objectives. They promoted face-to-face interaction to develop social and interpersonal skills and provided a structure for evaluation of the CL processes (including self-evaluation, co-evaluation, and student achievements). Structurally, students were distributed in mix-abilities group of 3–4 members. The teacher in CL manages and provides resources necessary for academic achievement and tends to agree on objectives, contents, and planning aspect with the students. The students view the teacher's role as being a guide and adviser. No exams were used exclusively to evaluate student achievements. Moreover, they used final work, portfolios, and the various materials developed in class.

Teachers from the Individualistic learning school (two teachers) did not report any training or specific strategies that were developed in the classroom. Their teaching was characterized by the systematic use of a textbook. They explained a lesson by sharing a reading, and subsequently students were involved in various individual activities. Structurally, students were sitting individually without sharing any materials and activities with their classmates. A Fortnightly exam was the main tool used to assess academic achievement.

6.2. Procedure

At both T^1 and T^2, students completed all the computerized tasks individually in a quiet room provided by the school, under the guidance of trained research assistants during a 1-hour session. The emotional intelligence and Empathy questionnaires were administered collectively in the usual classroom in a 30-minute session, after all participants had performed the computerized tasks. All personal information was treated in accordance with the Spanish personal data protection law of the 5th of December 3/2018.

All the above-mentioned tasks were designed and managed on a personal computer using the software E-prime v.2.0 (Psychological Software Tools, Pittsburgh, PA).

Informed consent, in accordance with the Ethical Principles for Medical Research Involving Humans of the World Medical Association's Declaration of Helsinki, was obtained from the parents prior to both evaluations. All procedures were approved by the research ethics board of the University and by the Provincial authority of Education of the government of the Autonomous Community of Andalucía (N/Rfª: SOE/CB/MC).

6.3. Executive function tasks

6.3.1. Sternberg-type task

This task evaluates the coding and maintenance of the information in WM (Sternberg, 1969). The Sternberg-type task involves presentation of a set of stimuli (between 3 and 9 consonant letters) to be memorized. On each trial, a set of stimuli is presented for a period (coding-time) which varies from 3000 to 9000 ms (ms) depending on the length of the set. After a brief maintenance interval (white screen) one stimulus is presented in the center of the screen. The participant was required to indicate if the stimulus had been presented (or not) in the previous set of stimuli (Fig. 1). Participants performed a practice block of 5 trials followed by 56 experimental trials. The task was programmed so that a set of stimuli (of 3, 4, 5, 6, 7, 8 or 9 letters) appeared 8 times each, 4 occasions on which the target stimulus appeared in the previous set and 4 on which it had not. We calculated the mean number of correct responses of the

Table 1
Socio-demographic characteristics of Cooperative (CL) and Individualistic Learning (IL) groups and statistical analysis.

		CL ($n = 25$)	IL ($n = 28$)	*Statistic*	*p*
Age	T^1	9.84 (*Sd*=.47)	9.78 (*Sd*=.49)	$t = 1.48$	.148
	T^2	11.44 (*Sd*=.51)	11.28 (*Sd*=.53)	$t = 1.58$	.123
Gender	*Girls*	14	16	X^2= .007	.933
	Boys	11	12		
Ethnic Background				X^2= 1.91	.136
Spanish		8	12		
Migrant families		17	16		

Table 2
General characteristics of the teaching methodologies in both CL and IL groups.

	CL ($n = 25$)	IL ($n = 28$)
Grouping[a]	Based on CL / Work groups of 3 or 4 students	Individualistic Learning / Work with peers (not systematically)
Materials/ resources	Standardized textbooks/ Laptops (at least 1 day per week)[b]/ Own material design.	Standardized textbooks / Laptops (not systematically used).
Activity types	Students must meet the following requirements: 1. Decide on a subject to investigate by consensus, and a final product. (e.g., a Chinese Tourist Guide). 2. Complete certain daily activities designed by the teacher (Teacher designed some basic activities based on the subject to ensure compliance with curricula contents). For instance, solve a mathematics problem about distances, or read some stories or news about different cultures. 3. Design a portfolio to record group agreements and norms, planning, activities, information, and other matters related to the project.	Students must follow the structured activities of a textbook divided into didactic units (fortnightly). Structural planning based on: 1. Introductory text about a given subject (e.g., Decimals) 2. Learning about a subject and rules (e.g., operation with decimal numbers) 3. Extension and problem-solving activities.
Knowledge evaluation instruments	Portfolio (work-group)/ Individual activities/Final Products (work-group)/ Self- and co-evaluation	Final individual exam/ Extra individual activities

[a] In the CL group, 14 h per week of cooperative-learning methodology was implemented (in Language and Literature subjects, Math, and Arts) since not all teachers (e.g., foreign language, Science, and physical education) gave lessons using this methodology. In contrast, there were no differences in teaching methodology between teachers of the IL group.

[b] Laptops was used as a complementary tool for searching for information, while no special treatment was given as well as training or play

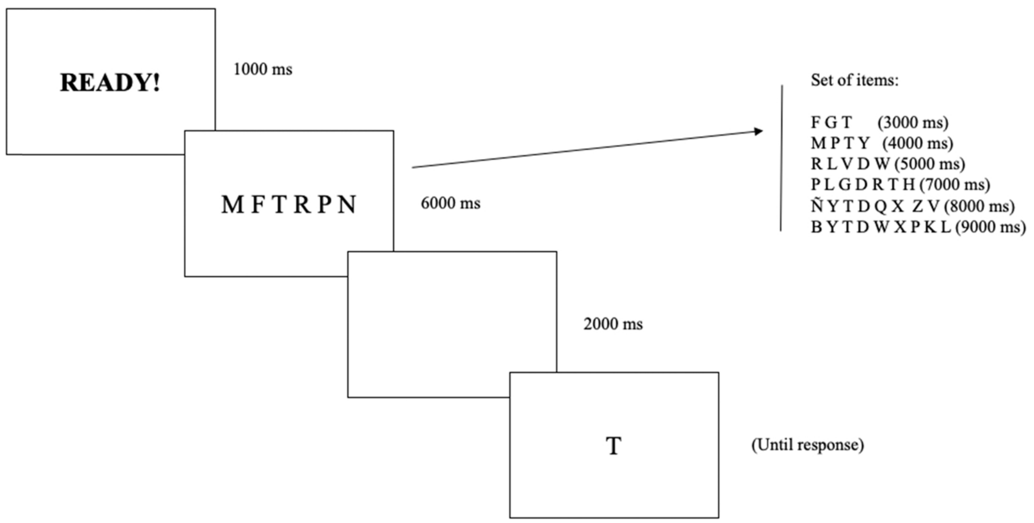

Fig. 1. Schematic illustration of the Sternberg-type Task. A sequence of events on a trial of the medium-load condition. First, a message was displayed for 1000 ms to warn the child of the appearance of the stimulus set. Next, a row of 6 consonants appeared for 6000 ms (in the case of this example), followed by a delay interval of 2000 ms. Finally, a single consonant appeared in the center of the screen. Children must press ''m'' on the keyboard if the stimulus appeared in the previous set of stimuli; and ''c'' if the stimulus had not been presented in the previous set of stimuli.

participants in three conditions: a) Low-load: the memorized set was 3 and 4 consonants; b) Medium-load: 5, 6 and 7 consonants; and c) High-load: 8 and 9 consonants.

6.3.2. 2-back Task (Fletcher & Henson, 2001)

This task evaluates key processes within the WM such as monitoring, updating, and manipulation of remembered information. A continuous stream (sequence) of stimuli is presented. For each stimulus in the sequence, participants are asked whether it matches the one presented two positions previously. Participants must maintain and update a dynamic set of stimuli while responding to each one (Fig. 2). To ensure correct understanding of the task, the participants were required to complete a practice block of 20 trials and achieve a 60% correct response rate. The task is composed of 3 blocks of 30 trials each. Therefore, a total of 90 trials are presented, of which 30 are target trials. The responses were classified as: a) *Hits* (press ''1'' in response to a target stimulus); b) *Misses* (press ''2' to in response to a target stimulus); c) *Correct rejections* (press ''2'' to in response to a non-target stimulus), d) *false alarms* (press ''1'' in response to a non-target stimulus); e) *missed responses* (trials on which the participant does not respond). The sensitivity index (or d'), a

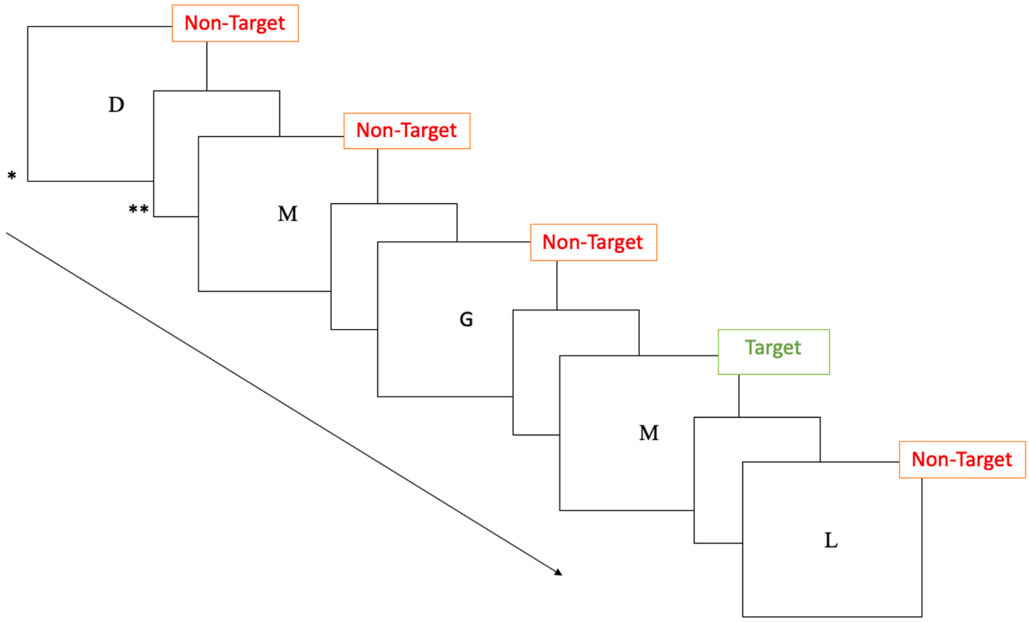

Fig. 2. Schematic illustration of the 2-Back Task. Target and non-Target stimuli are shown. * Each item remains for 500 ms in the center of the screen. * * A delay period (white screen) of 3000 ms is presented between each stimulus. The participant must press the key ''1'' when detecting a stimulus that matches the one presented two positions previously (target stimulus), or key ''2'' if the item does not match (non-target stimulus).

parameter of Signal Detection Theory (Stanislaw & Todorov, 1999), was calculated from the percentage of hits and false alarms.

6.3.3. Child Attention Network Test -ANT- (Rueda et al., 2004)

This study used a short version of the ANT (Child-ANT), originally developed by Rueda et al. (2004), which evaluates the efficiency of the following three attentional networks: alerting, orientating, and executive control. Children were asked to visually fixate on a central cross displayed on the computer screen. The target was a yellow fish which could appear above or below the fixation cross. By pressing a mouse button (right or left), the children had to indicate the direction in which that fish was pointing. This target fish would appear both alone (neutral flanker) or presented in the center of a row of five fish (flanker fish). The flanker fish would point in the same direction (congruent trials) or in the opposite direction (incongruent trials) with respect to the target fish. Before the target fish

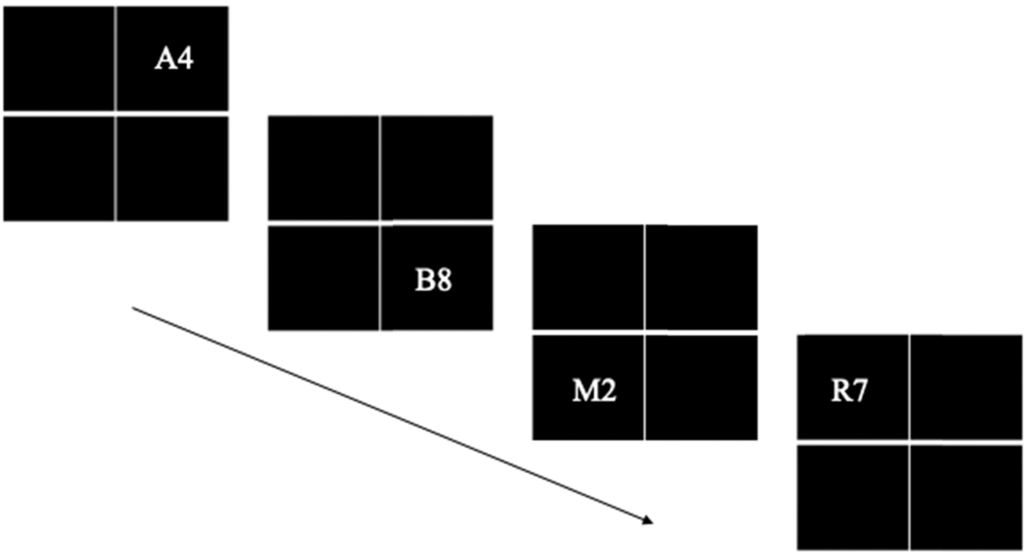

Fig. 3. Examples of Block-3 trials in the Number-Letter task. When a stimulus appears in the upper spaces, the participant must respond by pressing the corresponding key according to whether the number is odd (n) or even (m). When the stimulus appears in the lower spaces, the participant must indicate whether the letter is a vowel (z) or consonant (x). The stimulus remains in each space until the participant responds.

appeared, an attention cue was presented in three different positions: center, top and/or bottom of the screen. Participants completed a practice block of 24 trials and one experimental block of 48 trials (16 neutral, 16 congruent, and 16 incongruent). Of each of these 16 trials, 4 did not include an attentional cue; 4 included a central cue; 4 included a double cue, and 4 a spatial cue. In contrast, Rueda's version consists of 24 practice and 3 experimental blocks of 48 trials in each. Through this task we observed the children's inhibitory control of attention, that is, the capacity to selectively attend to a stimulus whilst suppressing attention to others (interference control). In this task, the interference was introduced by the incongruent flankers (16 incongruent trials). Executive control scores were calculated by subtracting the median score of each flanker condition (congruent and incongruent) from both reaction time (RT) and number of errors.

6.3.4. Number-Letter task (Rogers & Monsell, 1995)

This task measures individual cognitive flexibility, as well as the capacity for rule switching. A symmetrical grid of four spaces is presented. On each space, a single stimulus consisting of a number and a letter will alternately appear. The participant's response varies depending on whether the stimulus appears in the two upper or lower spaces (Fig. 3). The task is divided into three blocks of trials: 1) 32 experimental trials in which the stimulus always appears in the upper spaces; 2) 32 experimental trials in which the stimulus always appears in the lower spaces; and 3) 128 experimental trials in which the stimulus appears in any of the 4 spaces following the sequence from top to bottom and from left to right. Each experimental block is preceded by 12 practice trials to ensure comprehension of the task. The reaction times and the percentage of errors are recorded for the 3 blocks. This task allows us to observe the cost of switching between rules (Cost-change-task or CCT) through both reaction time (CCT^{RT}) and percentage of errors (CCT^{E}). CCT^{RT} was calculated by subtracting the mean RT of Block-1 and Block-2, from the mean RT of Block-3. The CCT^{E} was calculated by subtracting the percentage of errors in Block-1 and Block-2 from the mean percentage of errors in Block-3.

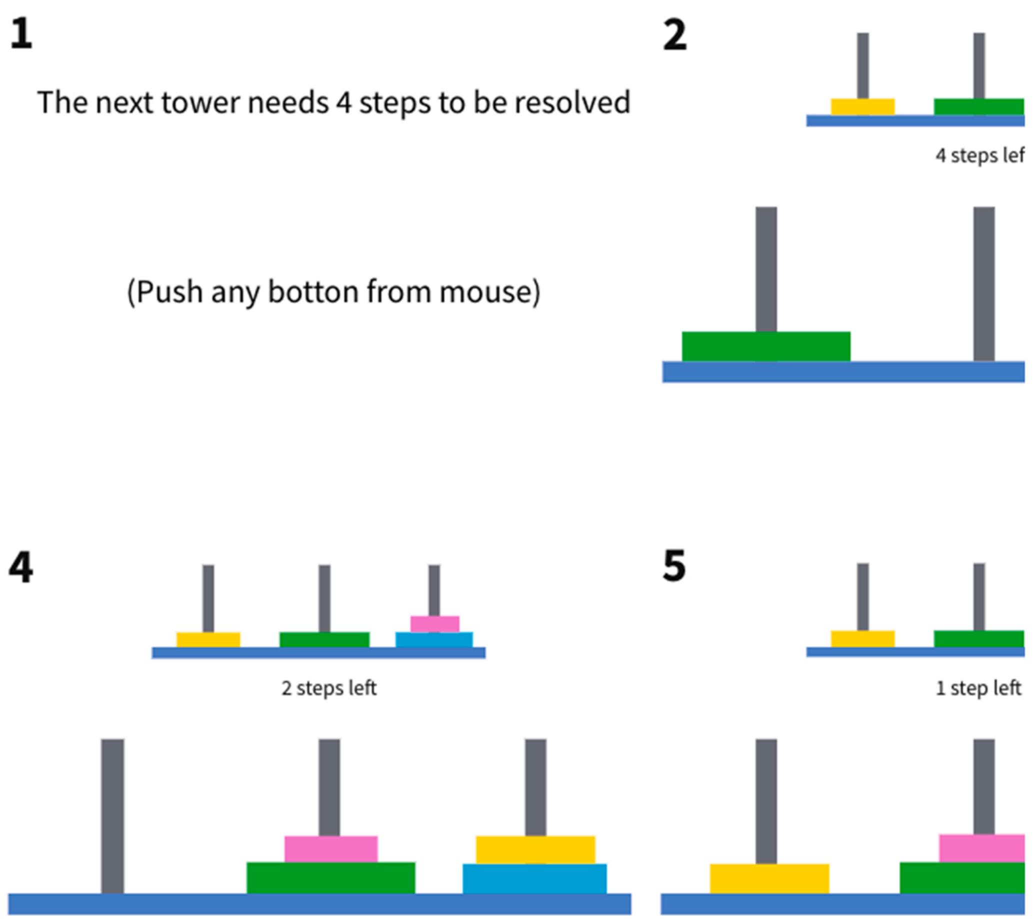

Fig. 4. Tower of Hanoi sequence for a four-step task (low planning condition). A first message (1) appears showing the steps that are necessary to complete the task. An upper model is then presented which must be reproduced in the model at the bottom (2). Participants must use the mouse to move every single piece until completing the model (steps 3, 4, 5 and 6). Basic rules: a) only one disk can be moved at a time; b) one disk cannot be placed on top of a smaller one; and c) Only the disks on top of each rod can be moved. An error message appears if the child makes a mistake, after which they must begin the task again.

6.3.5. Tower of Hanoi (Borys, Spitz, & Dorans, 1982)

This is a computer-based task which evaluates planning capacity. We used a computerized version developed by Groot (2004). The aim of this task is to move three disks of different sizes by three rods (Fig. 4). Children are shown a model which they must create in a certain number of movements (from 2 to 7 movements). The children must perform 2 practice trials to ensure understanding of the rules. Subsequently, the children are given 10 experimental trials divided into two blocks: 5 for short-planning (requiring less than 5 movements) and 5 for long-planning (requiring more than 5 movements). The mean number of errors is recorded for each condition.

6.4. Emotional Intelligence and Empathy measures

6.4.1. Socio-emotional intelligence test (SEIT)

This is a socio-emotional intelligence questionnaire developed by Chiriboga and Franco (2001), which consists of 60 items grouped into five dimensions: *self-awareness*, which is the perception and understanding of one's own emotions; *self-control*, the ability to regulate emotions and adapt behaviors to different contexts; *self-motivation*, the intrinsic motivation to guide efforts towards a goal; *empathy*, the ability to understand and recognize the emotions of others; and *social skills*, a set of abilities that facilitate and allow for adaptation to the group. The children were asked to rate each item on a 4-point Likert-type scale (0 = never, 1 = sometimes, 2 = most of the time, 3 = always). Higher score means better perception and understanding regarding the dimensions evaluated. The estimated time needed to complete the test is 30 min. For this study, we used the partial scores of each scale and the total score obtained by the sum of all items. Concerning the validity of the questionnaire, the authors reported a sensitivity of 45%, and a specificity of 75%; with the positive and negative predictive values being 34% and 83% respectively. The questionnaire showed an adequate internal reliability of 69% (Chiriboga et al., 2001).

6.4.2. Spanish short version of the Basic Empathy Scale (SV-BES)

The 9-item test used in this study was adapted by Oliva et al. (2011) based on an original scale developed by Jolliffe and Farrington (2006). This self-report instrument uses a 5-point Likert-type scale (1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree). Higher score means better perception and understanding regarding the dimensions evaluated. The estimated time needed to complete the scale is 5 min. The items are grouped into two dimensions: affective empathy (Items 1, 2, 3 and 6); and cognitive empathy (Items 4, 5, 7, 8 and 9). The overall score is calculated through the simple sum of all items. The Cronbach`s alpha internal consistency coefficients reported by Merino-Soto and Grimaldo-Muchotrigo (2015) were.77 (affective empathy) and.76

Table 3
Descriptive Statistics and Student's t Test Comparisons of T^1 and T^2 for all Measures.

	T^1				T^2						
	M	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*	*t*	*df*	*Cohen's d*
Age	9.81	.48	9	11	11.35	.52	10	12	-22.41***	52	–
2-Back-Task											
d'	1.31	.72	-.25	2.87	1.73	.87	.13	3.63	-3.25**	52	.58
Sternberg-Task											
Low-load	93.01	11.49	50	100	95.01	10.3	50	100	-1.13	52	.17
Medium-load	82.19	12.15	50	100	88.09	8.99	54.3	100	-3.44**	52	.49
High-load	74.36	14.18	44	100	77.26	11.41	56.5	100	-1.23	52	.20
Number-Letter											
CCT^{RT}	1445.38	1064.23	-2760.55	3275.77	963.81	678.85	-678.68	2892.57	3.64***	49	.45
CCT^{E}	6.7	10.24	-15.5	44	2.87	6.29	-5.5	30	2.78**	49	.37
ANT											
EC^{RT}	79.42	118.17	-162.50	383.50	41.38	85.66	-225	236	1.72	51	.32
EC^{E}	3.09	11.83	-37.00	37.00	2.13	7.93	-25	25	0.47	51	.14
Tower of Hanoi											
Short-Planning	.33	.50	.00	2.4	.24	.32	.00	1.4	1.16	52	.18
Long-Planning	2.63	1.43	.6	7.4	1.44	.8	.4	4	5.72***	52	.83
SEIT											
Self-Awareness	23.72	6.07	2	34	25.17	4.62	15	33	-1.68	52	.23
Self-Control	21.75	5.14	3	31	22.74	4.17	13	31	-1.10	52	.19
Self-Motivation	26.81	5.58	12	35	27.92	4.81	18	36	-1.37	52	.19
Empathy	25.47	6.21	7	35	25.72	5.14	14	34	-.25	52	.04
Social-Skills	26.49	6.53	5	36	27.34	4.55	15	36	-.92	52	.13
Total	125.06	26.38	43	183	128.89	18.09	95	162	-1.03	52	.15
SV-EBS											
Affective	14.4	3.77	7	21	14.04	3.06	4	19	.64	52	.1
Cognitive	20.47	2.98	11	25	19.75	3.42	11	25	1.18	52	.22

Note. CCT^{RT}, switching cost for reaction time; CCT^{E}, switching cost for errors; EC^{RT}, Executive control for reaction time; EC^{E}, Executive control for errors; SEIT, Socio-emotional Intelligence Test; SV-EBS, Short Version of Empathy basic scale.
* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$.

(cognitive empathy).

6.5. Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) v. 23.0 (IBM Corporation, Armonk, NY, USA. Intergroup and intragroup analyses were performed. To identify the differences between T^1 and T^2 in the *cool* and *hot-EF* measures, we used the student's *t* test. In order to identify the possible influence of teaching methodology on the development of *cool* and *hot-EFs,* we conducted a 2 (CL group, IL group) x 2 (T^1, T^2) mixed ANOVA for each variable. Statistical significance was set at $p \leq 0.05$, and trending towards significance was defined as $p \leq 0.08$. When appropriate, post hoc comparisons were made using Sidak's test. One participant was excluded from the analysis of the ANT for being identified as an outlier. Similarly, three students were excluded from the analysis of the Number-Letter task for the same reason.

7. Results

7.1. Development of Executive functions across late childhood

In order to examine the longitudinal development of *cool* and *hot-EFs,* we carried out Student's *t* tests to compare T^1 and T^2 for each variable. As expected, changes in the performance of executive tasks were observed between the two evaluations (Table 3). Regarding WM, we observed significant improvements on the 2-Back task ($p < 0.01$) and Sternberg task medium-load condition (when the stimulus set is 5, 6 and 7 consonants; $p < 0.01$) at T^2 compared with T^1. Significant improvements were also observed on the cognitive flexibility task (Number-Letter Task) for both CCT^{RT} ($p < 0.001$) and CCT^E ($p < 0.01$). The analysis revealed improved performance on the Tower of Hanoi task in the long condition (trials requiring more than 5 movements) but no changes were observed in the short condition (trials requiring less than 5 movements). No statistically significant differences were observed in the ANT.

Regarding EI, we observed no significant changes across T^1 and T^2 in SEIT and SV-EBS (affective and cognitive empathy).

7.2. Methodology: cooperative learning vs individualistic learning

Descriptive statistics of all variables for each group (CL and IL) are described in Table 4, including mean scores and standard

Table 4
Descriptive Statistics of all variables at T^1 and T^2 for each group.

Evaluation	CL group ($n = 25$) T^1 *M (SD)*	CL group ($n = 25$) T^2 *M (SD)*	IL group ($n = 28$) T^1 *M (SD)*	IL group ($n = 28$) T^2 *M (SD)*	*F (Df)*	*p*
Age	9.84 *(.47)*	11.44 *(.51)*	9.79 *(.5)*	11.29 *(.53)*	–	–
2-Back-Task						
d'	1.33 *(0.74)*	1.86 *(0.82)*	1.3 *(0.68)*	1.61 *(0.9)*	.92 *(1,51)*	.38
Sternberg-Task						
Low-load	91.58 *(13.91)*	97.1 *(4.36)* *	94.28 *(8.88)*	93.14 *(13.41)*	3.74 *(1,51)*	.06
Medium-load	84.35 *(13.48)*	88.52 *(6.19)*	80.27 *(10.72)*	87.7 *(11.01)*	.9 *(1,51)*	.39
High-load	71.52 *(13.15)*	80.04 *(10.22)* *	76.89 *(14.8)*	74.78 *(12.01)*	5.43 *(1,51)*	**.024**
Number- Letter						
CCT^{RT}	1338.64 *(905.10)*	937.28 *(586.79)*	1543.92 *(1202.15)*	988.3 *(764.96)*	.34 *(1,48)*	.56
CCT^E	6.79 *(12.94)*	1.9 *(4.6)*	6.61 *(7.16)*	3.77 *(7.5)*	.55 *(1,48)*	.46
ANT						
EC^{RT}	92.48 *(131.13)*	38.23 *(94.19)*	68.23 *(107)*	44.1 *(79.29)*	.45 *(1,50)*	.5
EC^E	6.21 *(12.95)*	2.58 *(7.5)*	0.43 *(10.29)*	1.75 *(8.41)*	1.44 *(1,50)*	.24
Tower of Hanoi						
Short-Planning	0.4 *(0.6)*	0.21 *(0.33)*	0.27 *(0.4)*	0.28 *(0.32)*	1.8 *(1,51)*	.18
Long-Planning	2.57 *(1.45)*	1.29 *(0.66)*	2.69 *(1.44)*	1.58 *(0.89)*	1.4 *(1,51)*	.71
SEIT						
Self-Awareness	23.96 *(4.68)*	24.84 *(4.57)*	23.5 *(7.18)*	25.46 *(4.74)*	.39 *(1,51)*	.54
Self-Control	20.72 *(3.91)*	23.8 (2.99) * *	22.68 *(5.95)*	21.79 *(4.74)*	5.4 *(1,51)*	**.024**
Self-Motivation	26.04 *(5.13)*	27.52 *(5.07)*	27.5 *(5.96)*	28.29 *(4.63)*	.18 *(1,51)*	.67
Empathy	24.84 *(4.17)*	24.6 *(5.78)*	26.03 *(7.62)*	26.71 *(4.35)*	.22 *(1, 51)*	.64
Social Skills	26.76 *(5.26)*	26.4 *(4.31)*	26.25 *(7.58)*	28.18 *(4.67)*	1.54 *(1,51)*	.22
Total	122.32 *(17.71)*	127.16 *(18.37)*	127.5 *(32.38)*	130.43 *(18.04)*	.06 *(1,51)*	.8
SV-EBS						
Affective	13.88 *(3.72)*	13.12 *(2.93)*	14.86 *(3.83)*	14.86 *(2.98)*	.46 *(1,51)*	.5
Cognitive	20.12 *(2.18)*	19.84 *(3.1)*	20.79 *(3.56)*	19.68 *(3.73)*	.46 *(1,51)*	.5

Note: CCT^{RT}, switching cost for reaction time; CCT^E, switching cost for errors; EC^{RT}, Executive control for reaction time; EC^E, Executive control for errors; EBS, Empathy basic scale.
Bold type indicates significant interactions between methodology and EF development.
Differences between T^1 and T^2 in each group: * $p < 0.05$, * * $p < 0.01$

deviations at T^1 and T^2, and significant differences between tests. To detect possible pre-existing differences in the variables between groups at the beginning of this study we conducted an one-factor ANOVA for each variable at T1 in which we observed no differences. We expected this previous data since the methodology structure carried out in the two groups was individualistic prior to starting the study. At the beginning of this study (after T^1), one of the schools implemented the CL methodology over two years while the other one continued applying individualistic learning. Second, a 2 (CL group, IL group) x 2 (T^1, T^2) repeated-measures ANOVA for each variable was conducted to identify the possible influence of teaching methodology on the development of EFs (Cool and Hot), and found an interaction on the Sternberg task. The ANOVA revealed a significant interaction in the high-load condition, and a tendency toward significance in the low-load condition (Table 4). Post-hoc analysis indicated that the CL group showed significant improvement on the Sternberg task (WM) in both low and high-load conditions between T^1 and T^2 ($p < .05$). The difference between evaluations in the IL group was not significant ($p = .504$). However, in both low and high-load conditions, the scores worsened from T^1 to T^2. Both groups showed statistically similar performance scores on the Sternberg task (high-load condition) at T^1 ($p = .171$), although the students in the CL group started from lower levels (m= 71.52) than those in the IL group (m=76.89). It should be noted that at T^2 the CL group reached a similar level (m= 80.04) to that of IL at T^1 (m= 76.89).

We also found a significant interaction between methodology and the self-control subcomponent of the Socio-emotional intelligence test (SEIT). Post-hoc analysis indicated that the CL group showed significant gains in self-control between T^1 and T^2.

($p < .05$) while these improvements were not observed in the IL group ($p = .451$). No interactions were found for the remaining variables.

8. Discussion

The main aim of the present study was to analyze the development of *cool* and *hot-EFs* at two different times between the 5th and 6th grade of Primary School. Our first hypothesis predicted significant changes in *cool* (WM, cognitive flexibility, inhibitory control, and planning) and *hot-EFs* (socio-emotional intelligence and empathy) throughout this period, as well as changes in WM, cognitive flexibility, inhibitory control, and planning measures. Our findings revealed significant age-related improvements between T^1 and T^2 in WM (2-back and Sternberg-type tasks), cognitive flexibility (Number-Letter task) and Planning (Tower of Hanoi task), while no differences were found in Inhibitory control (ANT; Executive control: EC^{RT} and EC^{E}). These results are consistent with those of previous studies suggesting that significant changes can be found in WM task performance throughout middle and late childhood (Conklin et al., 2007; Gathercole et al., 2004; Luna et al., 2004). In particular, these findings are in accordance with studies that indicate an increase in proficiency in maintaining/updating performance as measured through N-Back tasks (e.g., Ciesielski et al., 2006; Vuontela et al., 2003). Pureza et al. (2013), using this general paradigm, employed two different 2-back tasks (both auditory and visual). The authors found significant differences between three age groups: 6–7, 8–9 and 11–12 years. Further, we used a verbal task (Sternberg-type task) to assess the coding and maintenance of information in WM. This task consists of three load conditions in which different components of WM are involved, depending on the extent of the load. Considering that activation of the various WM components (i.e., phonological loop and central executive system) depends on the demands of the task (Rypma & D'Esposito, 1999), these results suggest that performance on the trials in which the phonological loop is engaged (low-load condition: trials of 3–4 items) remains stable across T^1 and T^2 (93.01% and 95.01% correct responses, respectively). In contrast, performance on the two conditions in which the capacity of the phonological loop was exceeded (trials of more than 4 items; medium and High-load condition)— thus recruiting the strategic processes of the central executive system — did not remain stable across the two ages. In fact, we found significant differences between T^1 and T^2 for the medium-load condition (the condition that involves a load of 5, 6, and 7 items). Nevertheless, no changes were found in the high-load condition between T^1 and T^2 (74.36% and 77.26% correct responses respectively), the performance of which could also depend on the central executive system. These findings are congruent with those of other studies indicating that age is positively related to overall performance on verbal WM in middle and late childhood (Brocki & Bohlin, 2004). In a large sample of children aged from 4 to 15 years, Gathercole et al. (2004) found linear increases up to adolescence in scores on WM measures (verbal and non-verbal tasks) associated with the phonological loop, the central executive system, and the visuospatial sketchpad. In our study, the significant improvements in the medium-load condition and no changes in the high-load condition led us to assume that there may be scope for development of the central executive system beyond childhood. It would, however, be necessary to use specific measures to explore the independent developmental changes in the phonological loop and the visuospatial sketchpad.

Our results also suggest age-related changes across T^1 and T^2 in cognitive flexibility (Number-letter-task), as measured by both reaction time (CCT^{RT}) and the percentage of errors (CCT^{E}). Our findings are supported by previous studies in which changes in performance on task-switching paradigms are associated with changes over time (Davidson et al., 2006; Dick, 2014). Similar to our study, Cragg and Nation (2009) conducted a study with a large sample of children aged between 5 and 11 years. They found that the switching cost (both RT and accuracy) improved significantly with age. These findings indicate that the ability to flexibly switch between two task sets develops during this period, with mid-childhood being a transition period where developmental changes occur that persist until adulthood (Crone et al., 2004).

Further, our study has yielded evidence in relation to the development of planning skills. The difference in performance between T^1 and T^2 was significant on those trials that required longer planning strategies, with a large effect size ($r = .67$). Our findings are congruent with those reported in the study by Luciana et al. (2009), which demonstrated significant age-related differences in the performance of planning tasks (e.g., Tower of London) in a sample aged between 9 and 20 years. Their results revealed that younger participants performed worse than adults as the number of moves to complete each problem set increased, although in the lower levels of complexity (2–3 movements; short-planning) the youngsters performed the task at the same level as adults. Planning is considered to be a higher-order skill that develops with core EFs (WM, cognitive flexibility, and inhibition; Miyake et al., 2000). This skill improves significantly throughout the early years and supports other processes such as theory of mind or problem solving (Carlson et al., 2004; Simon, 1975).

We found no changes in inhibitory control between T^1 and T^2 when measured by a short version of the ANT for children (Child-ANT). This finding is in accord with those reported by Rueda et al. (2004), which confirmed that this skill develops from the age of 4–6 or 7 years. However, no significant differences are found in interference control (interference introduced by the incongruent flankers) between the age of 7 years and adulthood. In fact, one of the key findings of this study was the similar effects of flanker interference found in 10-year-old children and adults when the entire sample was assessed using ANT in both its adult and child versions, although the adult version appeared to be more challenging for children. Similarly, Ridderinkhof et al. (1997) found improvements in interference control in a flanker task between the ages of 5 and 10 years but no significant differences between the age of 10 years and adulthood. While these studies support our findings (which appear to be widely documented), more research is needed to determine the standard age at which executive control reaches adult levels.

Finally, no changes were observed in the scores on emotional self-report questionnaires (SEIT and SV-EBS). The EI dimensions assessed in this study imply a broad range of proficiencies, and subjective self-perceptions and self-concept (*awareness*, *control*, *motivation*, *social-skills,* and *empathy*). Our findings are supported by the results of other longitudinal studies which have shown no developmental changes beyond middle and late childhood (Byrne & Shavelson, 1996; Keefer et al., 2013), suggesting that the structure of personality and self-concept related to EI traits already resembles that of adults (Soto et al., 2008). Moreover, empathy is a prosocial behavior-related construct that is influenced by various factors (e.g., the home environment; Thompson & Gullone, 2003). On another hand, in contrast with whose studies that indicate age-related changes throughout late childhood (e.g., Geng et al., 2012), we did not observe changes in measures of empathy (SV-EBS) in either its cognitive or affective dimensions. Based on the results of their meta-analysis, Fabes et al. (1999) claim that age differences in empathy and other prosocial behaviors could vary depending on the design of the studies. Therefore, our results are not conclusive since the magnitude of age differences could be determined by the type of EI measurement used (including the empathy questionnaire) and the sample size. Therefore, further longitudinal studies are needed to understand the development and stability of empathy and EI with the passage of time, and to determine which periods are critical for observing individual differences throughout childhood.

We also predicted that children involved in CL as a classroom methodology would significantly improve in terms of the cognitive and socio-emotional processes related to EFs in comparison with IL children. Our results indicate that there were significant differences associated with CL across ages in certain executive components. On the Sternberg task, the CL group showed significant gains between T^1 and T^2 in both high-load conditions (previous stimulus set composed of 8 and 9 consonants). Significant differences were also found for the self-control sub-component of EI. Previous educational studies have confirmed the efficacy of specific interventions that contribute to social development and cognitive control (Barnett et al., 2008; Diamond, Barnett et al., 2007). Our findings are consistent with these recent studies indicating that curricular differences can have a significant impact on children's EFs. Moreover, these results are in line with those reported by Gabbert et al. (1986), who analyzed the effects of CL in a school context. They observed that cooperative groups performed better than individualistic-learning children on certain cognitive tasks that have been traditionally linked to EFs, particularly WM (reasoning, problem solving; Logie et al., 1994). Although no specific studies have shown associations between CL and Self-control, some authors claim that CL reinforces social skills such as interpersonal trust and positive interdependency, communication, mutual support and attentiveness, more positive self-esteem, and greater acceptance of oneself (Gillies, 2014; Johnson, 1980). The particular features of this methodology such as interaction between teacher and student (e.g., management strategies), student-student interaction (e.g., grouping, role-playing), and the use of specific strategies (e.g., working routines) may be factors that mediate the development of certain cognitive skills or performance on specific cognitive tasks. As shown by our findings, the use of CL as a classroom methodology in Primary School could be a potential strategy for promoting executive processes and could explain the gains in EF experienced by the CL group in terms of WM and self-control. CL places the student at the center of the process (as an active agent who makes his/her own decisions) the purpose of which is to increase motivation towards one's own learning, which is an essential element in the teaching-learning process and EF development (Gottfried, 1990; Zelazo & Carlson, 2012).

Regarding to EI (except self-control) and empathy questionaries, no changes were observed on any groups were found. As we mentioned before, studies in this field have shown no developmental changes beyond middle and late childhood (Byrne & Shavelson, 1996; Keefer et al., 2013), suggesting that the structure of personality and self-concept related to EI traits already resembles that of adults (Soto et al., 2008). Moreover, the emotional and social development occurs across critical period as late childhood which could be influenced by different factors not controlled in this study (e.g., the home environment) (Gee, 2016; Masten & Cicchetti, 2010; Thompson & Gullone, 2003; Zeidner et al., 2003).

Although these findings contribute to our understanding of the development of EFs and their relationship with classroom methodology, this study has certain limitations. First, our measurement of executive functioning related to emotional processes was based on an emotional self-report questionnaire, the responses of which could be affected by subjectivity bias. In accordance with the relational perspective of Main et al. (2017), in which the authors highlight the complex and indivisible relation between individual and context, we suggest that future studies should have a more ecological assessment approach by using tasks which assess individual characteristics in everyday life situations and decision-making scenarios (e.g., Children's Gambling Task; Delay of Gratification tasks), which could contribute towards observing performance on emotionally-charged tasks (e.g., risk taking, quality of decision-making, decision time, risk adjustment, delay aversion, and impulsivity).

Further, use of the emotional self-perception questionnaire could be a limitation for migrant children since self-perception of emotion implies the abstraction of complex ideas, which could depend on a high level of linguistic competence. A questionnaire administered to observer-informants (parents and teachers) could be used to avoid this bias. It would also be useful to gather information on academic performance (Average grades), or family context (socio-economic level, parents' educational level, home-habits) which would extend the possibilities for exploring the various factors that could be involved in the development of EFs. Moreover, the sample size in this study could be regarded as small. Thus, a larger sample would ensure more consistent results and would allow us to make a more accurate diagnosis of the development of EFs throughout late childhood. Another limitation was the partial implementation of CL. The CL group was only involved in cooperative learning activities for the main subjects of Language and Literature, Mathematics and Arts (12 h per week) due to the school timetable, while the individualistic approach was applied most of the time. Therefore, we suppose that further exposure to the CL methodology might have generated more marked results in this group.

9. Conclusion

Our study has revealed developmental changes in *cool* across childhood (the last stage of Primary School) as well as in WM, cognitive flexibility, and planning; whilst no significant changes were found for inhibitory control (interference introduced by the incongruent flankers) and *hot-EFs* (EI and empathy). The CL methodology was found to be associated with developmental changes in WM and self-control. Therefore, classroom methodology could play a crucial role in ensuring the adequate development of some aspect related with cognitive and socio-emotional skills. The findings of this longitudinal study have important implications for psychological, neuroscientific, and educational research. In particular, we have provided novel data regarding the development of *cool* and *hot-EFs* during the last stage of Primary School. Moreover, we have observed how CL could be involved on the development of cognitive and socio-emotional skills, at least in the sample studied here. Consequently, new educational proposals and research based on our findings are necessary to observe changes during this period in which children face very significant and decisive changes at both a cognitive and socio-emotional level.

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Authors’ contributions

All authors have been involved in the design of the study and drafting of the manuscript. All authors have approved the final version.

Consent for publication

All participants gave permission for the publication of their data.

Ethics approval and consent to participate

All procedures were approved by the research ethics board of the University of Almería and by the Provincial authority of Education of the Autonomous Community of Andalucía government. All participants provided informed consent to take part in the experiments.

Competing interest

The authors declare that they have no competing interests.

Data Availability

The data that support the findings of this study are available on request from the corresponding author. The private data are not publicly available due to privacy or ethical restrictions.

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