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Inhibitory Processes Training for School-age Children: Transfer Effects

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ABSTRACT
Inhibition refers to a basic executive component that can be conceptualized as consisted of different inhibitory processes (i.e., perceptual, cognitive and response inhibition). These processes emerge during the first years of life, and since then are involved in different relevant every day activities. Different individual and contextual factors can modulate their developmental trajectories. The possibility of train in separate ways each inhibitory process is a subject of analysis. In such a context, the aims of this work were: (a) to design, implement and evaluate training of perceptual, cognitive and response inhibition processes, in a sample of school-aged children (6 to 8 years old); and (b) to analyze near, far, short- and long-transfer effects. An experimental design with three training groups (one for each inhibitory process) and an active control group was implemented. Near transfer effects were not observed. We found effects on a visuospatial working memory task in the short term, after the training in the response and cognitive inhibition, and effects on a fluid intelligence task in both the short and long term after the training in cognitive inhibition. The results contribute to a conceptualization of multidimensional inhibitory processes and the plausibility of training them during childhood.

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Introduction

Executive Functions (EF) is a construct defined as a set of cognitive processes involved in voluntary and effortful control of thoughts, actions, and emotions during goal-directed tasks (Blair, 2016; Diamond, 2016; Friedman & Miyake, 2017). Currently, there is general agreement that the three main core EF processes are: (a) inhibition – suppress thoughts, motor behaviors and environmental stimuli that interfere with the achievement of goals (Diamond, 2013; Mann, De Ridder, & Fujita, 2013; Tiego, Testa, Bellgrove, Pantelis, & Whittle, 2018)-; (b) working memory (WM) – hold information in mind and manipulate it to solve a task (Conway, Jarrold, Kane, Miyake, & Towse, 2007)-; and (c) cognitive flexibility (CF) – switch between tasks, perspectives or actions to adjust the performance to new demands, rules, or priorities (Chevalier, 2015; Geurts, Corbett, & Solomon, 2009). These processes are considered the basic components of more complex EF such as reasoning and planning (Best & Miller, 2010; Diamond, 2013, 2016; Miyake et al., 2000; Nigg, 2017). In turn, inhibition and WM are the most basic components (Davidson, Amso, Anderson, & Diamond, 2006; Diamond, 2013, 2016). About the relationship between both, some authors argue

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that inhibition operates in the service of an individual's goal, to constrain the contents in WM to be goal-relevant. They consider that the variation in inhibitory efficiency is a fundamental determinant of the differences observed in WM tasks (Hasher, Lustig, & Zacks, 2007; Lustig, Hasher, & Zacks, 2007).

Inhibition has been associated with skills involved in everyday activities across the life-span. For example, during childhood, it has been linked to impulsivity control in high-calories food intake (Jiang, He, Guan, & He, 2016; Reyes, Peirano, Peigneux, Lozoff, & Algarin, 2015); externalizing behavior problems (Volckaert & Noël, 2015, 2016); reading comprehension (Borella, Carretti, & Pelegrina, 2010; Viterbori, Traverso, & Usai, 2017); mathematics achievement (Gilmore et al., 2013); the development and functioning of fluid intelligence – ability to solve unexpected problems, independent of culturally acquired knowledge (Michel & Anderson, 2009); and the acquisition, development and implementation of behavioral, social and emotional competences (Carlson & Wang, 2007; Riggs, Blair, & Greenberg, 2004; Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006). Currently, there is a debate about the structure and nature of inhibition (Diamond, 2016; Howard, Johnson, & Pascual-Leone, 2014; Introzzi, Canet Juric, Aydmune, & Stelzer, 2016a). This involves several positions, which can be group into two general approaches: the one-dimensional and multi-dimensional approaches. The first one proposes that inhibition is a unique process (e.g., MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003), while the latter considers it as consisting of several processes (Friedman & Miyake, 2004; Howard et al., 2014; Introzzi et al., 2016a). The multi-dimensional approach identifies different inhibitory processes such as: (a) an inhibitory process which would act in a perceptive level by suppressing the activation generated by environmental irrelevant stimuli – called *access function* (Hasher et al., 2007), *resistance to distractor interference* (Friedman & Miyake, 2004), *inhibition of attention* (Diamond, 2013, 2016)-; (b) an inhibitory process devoted to suppress the irrelevant information from WM that interfere with the current activity – called *delete function* (Hasher et al., 2007), *resistance to proactive interference* (Friedman & Miyake, 2004), *cognitive inhibition* (Diamond, 2013, 2016)-; and (c) an inhibitory process which would allow the suppression of prepotent and inappropriate responses for the context and the current aims – called *restraint function* (Hasher et al., 2007), *prepotent response inhibition* (Friedman & Miyake, 2004), *response inhibition* (Diamond, 2013). Even though the terms used can vary according to the model, in this paper the terms *perceptual inhibition, cognitive inhibition* and *response inhibition* are used to refer to the processes described in (a), (b) and (c), respectively. The evidence that supports this approach is based on: confirmatory factorial analyses which identified different inhibitory processes (e.g., Friedman & Miyake, 2004; Gandolfi, Viterbori, Traverso, & Usai, 2014; Stahl et al., 2014; Tiego et al., 2018); studies about the specific developmental trajectories of each process (Introzzi et al., 2016a; Vadaga, Blair, & Li, 2015; Vuillier, Bryce, Szücs, & Whitebread, 2016); and studies on inhibitory processes roles in developmental disorders (e.g., Brocki, Nyberg, Thorell, & Bohlin, 2007; Borella et al., 2010; Mammarella, Caviola, Giofrè, & Borella, 2017; Noël et al., 2012); studies carried out both in children and adults.

As in the case of other EF, inhibitory processes experience improvements in their evolution during childhood, continuing their maturation in adolescence, and show differential trajectories (Introzzi et al., 2016a). Specifically, response inhibition would emerge in the first year of life, with significant changes in the preschool and school years, and continue their development during adolescence (Carlson, 2005; Cragg & Nation, 2008; Garon, Bryson, & Smith, 2008; Kochanska, Tjebkes, & Fortnan, 1998). Some authors suggest that response inhibition may continue its maturation until early adulthood (Bezdjian, Tuvblad, Wang, Raine, & Baker, 2014; Van Gerven, Hurks, Bovend´Eerdt, & Adam, 2016; Vara, Pang, Vidal, Anagnostou, & Taylor, 2014). Perceptual and response inhibition developmental trajectory would be similar from the first years of life to adolescence (Introzzi et al., 2016a, 2016b; Ruff & Capozzoli, 2003). Cognitive inhibition would emerge during the pre-school period; it would experience considerable improvements in school period, and continuing its maturation during adolescence (Aslan, Staudigl, Samenieh, & Bäuml, 2010; Harnishfeger & Pope, 1996; Kail, 2002; Zellner & Baüml, 2004).

Respect to the differentiation of these processes, Gandolfi et al. (2014) distinguished response inhibition and perceptual inhibition in toddlers aged 36–48 months, but not in toddlers aged 24–32 months, suggesting increased functional segregation of inhibitory processes with ongoing development. In line with these results, Traverso, Fontana, Usai, and Passolunghi (2018) fund that response inhibition and perceptual inhibition were independent constructs in children aged 5 and 6 years; while Tiego et al. (2018) fund it in a sample of children aged 11 and 12 years. In these studies, confirmatory factor analysis was used, and a factor for each construct was funded. We did not register similar studies in which cognitive inhibition has been included in the analysis, but the authors of a revision (which contains development studies of inhibitory processes) suggest that three inhibitory processes are differentiated in the first years of school period (Introzzi et al., 2016a). During late adulthood, a decrease in these three inhibitory processes would occur, being stronger the inhibition response, followed by the cognitive inhibition (Vadaga et al., 2015).

In summary, it is during childhood when the inhibitory processes would experience considerable changes, integrating into different processes and skills, which are essential for children's cognitive and academic performances. For example and especially in the school period, when the inhibitory processes would be differentiated (Introzzi et al., 2016a) different studies (in which these processes were simultaneously observed) identified associations between perceptual inhibition, response inhibition and WM (Canet Juric, Andrés, Demagistri, Mascarello, & Burin, 2015; Zhao, Chen, & Maes, 2016); response inhibition and fluid intelligence (Zhao et al., 2016); cognitive inhibition and perceptual inhibition and comprehension reading (Borella et al., 2010; Borella & De Ribaupierre, 2014; Demagistri, Canet, Naveira, & Richard's, 2012). Also, some inhibitory processes impaired were observed in several problems and disorders, e.g., perceptual inhibition in children with Autism Spectrum Disorder (Christ, Holt, White, & Green, 2006) and cognitive inhibition in children with severe mathematics anxiety (Mammarella, Caviola, Giofrê, & Borella, 2017).

However, based on the evidence regarding associations between inhibitory processes and relevant skills for children's cognitive and academic performances (such as WM, fluid intelligence and comprehension reading), several studies have explored the plasticity of inhibitory processes through interventions aimed at optimizing or reducing the disparities in inhibitory performance and other related skills, in typical development samples (Diamond, 2012, 2013; McCoy, 2019; Zelazo & Carlson, 2012). In such intervention efforts – and in executive training in general – researchers analyze their efficiency, and different types of transfer effects (Green et al., 2019; Jolles & Crone, 2012; Karbach & Unger, 2014): (a) *near transfer* involves the generalization of the training effects on the performance to other tasks which demand the same EF which were the target of the intervention; and (b) *far transfer* refers to the effects achieved through the intervention which are transferred to other domains and abilities which involve only partly the trained functions. At the same time, both types of transfer can be analyzed in terms of (a) the short term – *short-term transfer*-, which refers to the effects of the training that are observed immediately after the end of the intervention-; or (b) the long term – *long-term transfer*-, which refers to maintaining of effects over time (Green et al., 2019; Karbach & Unger, 2014; Rapport, Orban, Kofler, & Friedman, 2013; Sala & Gobet, 2017; von Bastian & Oberauer, 2014).

In this area of research, the training of the main executive components in the context of a *processes-based* approach prevails. It involves activities that demand the processes which are intended to train, adjusting the difficulty level in function of the performance of the participants (Cardoso et al., 2016; Jolles & Crone, 2012; Karbach & Unger, 2014; Rueda, Cómbita, & Pozuelos, 2016). Even though there are studies in which diverse EF are trained, the available ones oriented to train particularly the inhibition in children with a typical development are still insufficient to understand the efficacy of the interventions. These studies are fundamental because they allow us to improve our understanding of which are the specific effects that are derived from the inhibitory training (Aydmune, Lipina, & Introzzi, 2017; Karbach & Unger, 2014; Kray & Ferdinand, 2013; von Bastian & Oberauer, 2014).

About studies oriented to train particularly the inhibition, following aspects are observed: (a) a significant amount of studies based on the non-unitary perspective propose the training of response inhibition (e.g., Liu, Zhu, Ziegler, & Shi, 2015; Zhao, Chen, Fu, & Maes, 2015; Zhao et al., 2016). In some studies with preschoolers, the training of perceptual inhibition is considered, but it is not trained exclusively (e.g., Thorell, Lindqvist, Bergman, Bohlin, & Klingberg, 2009; Volckaert & Noël, 2015). In these last studies, it is difficult to understand what the specific effects derive from the training of each inhibitory process (i.e., perceptual, cognitive, response inhibition). Besides, there are no studies based on the non-unitary perspective which communicated the train of cognitive inhibition – whether in a particular way or with other inhibitory processes (Aydmune et al., 2017). (b) In general, in the child population, near transfer effects on response inhibition and perceptual inhibition are evaluated. When only response inhibition was trained, there were effects on this process (e.g., Dowsett & Livesey, 2000; Jiang et al., 2016; Zhao et al., 2015, 2016); while effects on the perceptual inhibition have not been observed (Liu et al., 2015; Zhao et al., 2015). Effects on perceptual inhibition were observed in some cases where this process was trained – but simultaneously with response inhibition and in preschooler (Volckaert & Noël, 2015). There are no studies based on the non-unitary perspective which evaluate near transfer effects on cognitive inhibition (Aydmune et al., 2017). Based on these findings, it is possible to expect transfer effects on the inhibitory process trained and the absence of transfer to other inhibitory processes. (c) In some cases, far transfer is not analyzed (Dowsett & Livesey, 2000; Zhao et al., 2015). In the cases in which it is evaluated, different cognitive processes and behaviors were analyzed. In general, the transfer effects on other EF – specifically on WM and CF (Liu et al., 2015; Thorell et al., 2009; Volckaert & Noël, 2015; Zhao et al., 2016)-; fluid intelligence (Liu et al., 2015; Thorell et al., 2009; Zhao et al., 2016); attention (Thorell et al., 2009; Volckaert & Noël, 2015); externalizing behaviors (Volckaert & Noël, 2015) and highly caloric food intake (Jiang et al., 2016) are analyzed. Respect to EF, fluid intelligence and attention, the results are contradictory. For example, in preschoolers, after implementing inhibitory control (perceptual and response inhibition) training, Thorell et al. (2009) did not find changes in the performance of WM, fluid intelligence, and attention tasks; while Volckaert and Noël (2015) observed effects on WM, attention and externalizing behavior. In turn, Liu et al. (2015) found the effects of response inhibition training on fluid intelligence. In school children, after response inhibition training, Zhao et al. (2016) funded transfer effects on WM and cognitive flexibility; while Jiang et al. (2016) observed transfer effects on highly caloric food intake. Based on these findings, in general, it is possible to expect some sort of far transfer effect of inhibitory training, especially in school-aged children. (d) Short-term transfer is analyzed in all the mentioned studies, even though (e) the evaluation of the long-term transfer is observed in few studies. Of all the studies, only one (Zhao et al., 2016) evaluated and observed effects in the long term on the performance of the participants in response inhibition and WM tasks. The analysis of the long-term transfer can be hard because it implies longitudinal designs and the risk of increased sample attrition (Green et al., 2019).

Therefore, the goals of this work are: (a) to design, implement and evaluate the training of perceptual, cognitive and response inhibition processes (applying its different groups of participants, i.e., three experimental groups) for school-aged children (6 to 8 years old), through computerized activities and applying a processes-based approach. All this, to understand the specific effects derived from the training of each inhibitory process, considering processes that do not constitute the usual target of the intervention in the child population, as the cognitive inhibition (Aydmune et al., 2017). The age of the children was selected based the literature on the development and the differentiation of inhibitory processes (Gandolfi et al., 2014; Introzzi et al., 2016a; Tiego et al., 2018); the findings about the relations between inhibitory processes and relevant skills for children's performance in different areas; and the transfer effects of inhibitory training observed in school children. (b) To analyze near transfer effects of each type of inhibitory training. (c) To analyze far transfer effects on WM, CF and fluid intelligence tasks. And (d), to analyze short- (i.e., immediate) and long-term (6 months after training end) transfer effects.

Materials and methods

Design

An experimental design with control active group, pretest, posttest, and follow-up stages was implemented (Campbell & Stanley, 1995; Hernández, Fernández Collado, & Baptista Lucio, 2015).

Participants

An intentional sample of 110 children (62 girls and 48 boys, 6 to 8 years old, first to third graders) from two elementary schools of the city of Mar del Plata, was included. They were predominantly from middle socioeconomic (SES) homes according to Hollingshead (2011) index used in different studies with similar sample (e.g., Andrés, Castañeiras, & Richaud, 2014; Andrés, Espínola, & Cáceres, 2017; Andrés, Richaud de Minzi, Castañeiras, Canet-Juric, & RodríguezCarvajal, 2016; Demagistri, 2017; Pascual, Galperín, & Bornstein, 1993). Table 2 shows descriptive statistics for age and SES. For analytical purposes, participants were included according to the following criteria: non-repeating students; absence of developmental, psychological and/or psychiatric disorders; and with normal or corrected vision and hearing. The information was collected through a sanitary card that children's parents/caregivers completed. We obtained 185 informed consents from children's parents/caregivers, but 33 cases were excluded because they did not meet with the inclusion criteria and 31 children participated in a prior pilot study to test the procedure. Finally, participants who left the study or who did not complete one or more tasks in the pretest and posttest 1 instances (11 cases) were excluded.

Ethical considerations and procedure

All the procedures were evaluated and approved by an ethics committee – Comité de Ética del Programa Temático Interdisciplinario en Bioética, Secretaría de Ciencia y Técnica del Rectorado de la Universidad Nacional de Mar del Plata (UNMdP)- and two institutional review boards – Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET); Comité del Doctorado en Psicología, Facultad de Psicología, UNMdP. Then, it was also approved by the authorities of the two schools. Children's parents/caregivers signed an informed consent and the students gave their assent to participate in the study. Participants were randomly assigned to the following conditions: (a) response inhibition-training group (TG; $n = 30$); (b) perceptual inhibition-TG ($n = 25$); (c) cognitive inhibition-TG ($n = 24$); (d) Control active group (GC; $n = 31$). Table 1 shows the characteristics of the total sample and the groups, while Figure 1 shows the procedure.

Sample size was calculated using G*Power. Planned data analysis was selected (F test; ANOVA repeated measures, within–between interactions), and the estimation was based on the following data: n2p = .25 (average from reviewed studies); alpha error probability = .05; power = .80; number of groups = 4; number of measurements (repeated) = 3; with nonsphericity correction. A minimum of 72 participants (groups of 18 participants) was determined. Second, because in these designs usually there are missing data, we identified the biggest group size in the reviewed studies (n = 24). Thus, at the beginning of this research, each group had at least 24 participants.

During the experimental conditions (training and control), children performed on individual sessions of 10–15 min each one, once or twice a week for 2 months. On average, participants in the TG completed 12 sessions ($M = 11.7$, $SD = 1.9$), while those in the CG completed 6 sessions ($M = 6.32$, $SD = 3.04$). Originally, 12 sessions, twice a week were planned. However, different factors – such as suspension of school classes (e.g., strikes, meteorological warnings), special school activities (e.g., school excursion and events), and

Table 1. Sample description according to group, age, and gender.

		Response inhibition EG		Perceptual inhibition EG		Cognitive inhibition EG		CG	
		n	%	*n*	%	*n*	%	*n*	%
Gender	Girls	17	56.7	13	52	18	75	14	45.2
	Boys	13	43.3	12	48	6	25	17	54.8
Age	6	14	46.7	11	44	11	45.8	11	35.5
(M = 6.8,	7	8	26.7	9	36	8	33.3	13	41.9
SD = 0.788)	8	8	26.7	5	20	5	20.8	7	22.6
		(Age M = 6.8, SD = 0.847)		(Age M = 6.76, SD = 0.779)		(Age M = 6.75, SD = 0.794)		(Age M = 6.87, SD = 0.763)	

EG = experimental group; CG = control group; n = number of cases; % = percentage; M = mean; SD = standard deviation.

Table 2. Performance indices: mean and standard deviation for each test instance and group.

	Response inhibition EG		Perceptual inhibition EG		Cognitive inhibition EG		CG	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
SSRT pretest	522.659	102.971	529.736	114.641	507.219	117.624	476.222	160.980
SSRT posttest1	478.628	94.526	510.242	78.016	481.597	125.169	484.323	139.452
SSRT posttest2	475.997	103.581	497.605	96.870	478.049	96.790	501.111	107.955
NH ds pretest	17.13	8.063	16.36	8.543	15.42	8.140	17.32	9.206
NH ds posttest	20.90	8.062	19.08	8.485	20.58	8.954	20.35	8.890
NH ds posttest2	25.62	7.248	20.95	9.766	27.41	8.924	26.50	10.275
NH pc pretest	57.90	27.516	53.00	27.927	53.29	29.953	55.19	34.193
NH pc posttest1	70.23	26.393	63.40	26.822	70.58	24.399	66.48	27.200
NH pc posttest2	78.00	20.995	58.68	29.701	82.82	18.908	72.97	27.980
PI Intrusions pretest	0.517	0.748	0.480	0.586	0.479	0.499	0.435	0.528
PI Intrusions posttest1	0.333	0.547	0.360	0.445	0.542	0.721	0.419	0.467
PI Intrusions posttest2	0.346	0.505	0.318	0.424	0.353	0.492	0.357	0.591
PI pretest	1.650	0.744	2.020	1.122	2.062	1.548	1.984	1.235
PI posttest1	1.917	1.232	2.180	1.171	1.750	1.207	2.290	1.340
PI posttest2	2.115	1.602	2.409	1.260	2.323	1.103	1.964	1.146
BD ds pretest	5.20	1.297	5.28	1.137	4.67	1.880	4.94	1.914
BD ds posttest1	5.27	1.311	5.20	1.190	5.17	1.204	4.55	1.823
BD ds posttest2	5.39	1.166	5.24	1.091	5.47	1.463	5.50	1.137
BD ss pretest	10.07	2.803	10.28	2.227	9.46	3.189	9.35	3.147
BD ss posttest1	9.87	2.474	9.76	2.488	9.88	2.490	8.32	3.059
BD ss posttest2	9.21	2.299	9.05	2.269	9.88	3.295	9.50	2.374
vsWM pretest	2.07	1.484	1.88	1.691	1.88	1.702	2.42	1.523
vsWM postes1	2.80	1.243	2.48	1.610	2.75	1.675	2.26	1.653
vsWM posttest2	2.46	1.666	2.41	1.593	3.41	1.661	2.83	1.464
CFaccuracy pretest	68.23	19.181	64.56	27.819	62.04	27.071	60.39	19.812
CFaccuracy posttest1	69.80	21.775	67.52	20.516	75.42	23.305	68.87	23.171
CFaccuracy posttest2	75.39	18.522	72.27	18.066	73.41	11.732	70.52	14.725
FI ds pretest	23.03	4.937	23.72	5.136	23.25	4.532	22.10	6.920
FI ds posttest1	24.30	5.344	23.76	5.600	25.58	5.941	23.48	5.773
FI ds posttest2	26.31	4.878	25.55	5.934	28.24	4.236	25.59	5.288
FI pc pretest	51.63	31.933	54.20	23.965	57.92	26.082	41.61	28.413
FI pc posttest1	53.20	32.468	50.80	28.383	66.79	28.674	42.90	27.012
FI pc posttest2	50.52	29.621	50.64	32.232	72.41	27.146	42.76	26.342
SES	39.315	12.849	35.636	14.541	36.454	12.002	34.768	12.876
Age	6.8	0.847	6.76	0.779	6.75	0.794	6.87	0.763

EG = experimental group; CG = control group; *n* = number of cases; % = percentage; *M* = mean; *SD* = standard deviation; SSRT = stop-signal reaction time; NH = net hits; ds = direct score; pc = percentile; PI Intrusions = proactive interference index, intrusions-based; PI = proactive interference index, correct responses-based; BD = backward digit span; ss = scalar score; vsWM = visuospatial working memory (span); CFaccuracy = general accuracy in mixed block; FI = fluid intelligence; SES = socio-economic status.

children with repeated absence – impeded to reschedule for the same week some sessions. In turn, training sessions were prioritized. Each TG worked with a training task (perceptual inhibition training task, cognitive inhibition training task or response inhibition training task); the participants in CG performed the first levels of the training tasks (see Materials).

Before and after experimental conditions, inhibitory, WM (verbal and visuospatial), a cognitive flexibility and a fluid intelligence tasks, were administrated to all children (see Materials). Specifically, one pretest and two posttests – *posttest1*, immediately after training or control procedures were completed, and *posttest2*, 6 months after them. All activities were carried out by the authors of this work, at school, in an appropriate room.[1]

Materials

Pre and posttest tasks

Perceptual inhibition task. Perception of Similarities and Differences test (*Test de Percepción de Diferencias*-revisado, CARAS-R; Thurstone & Yela, 2012). This is a paper and pencil task with 60

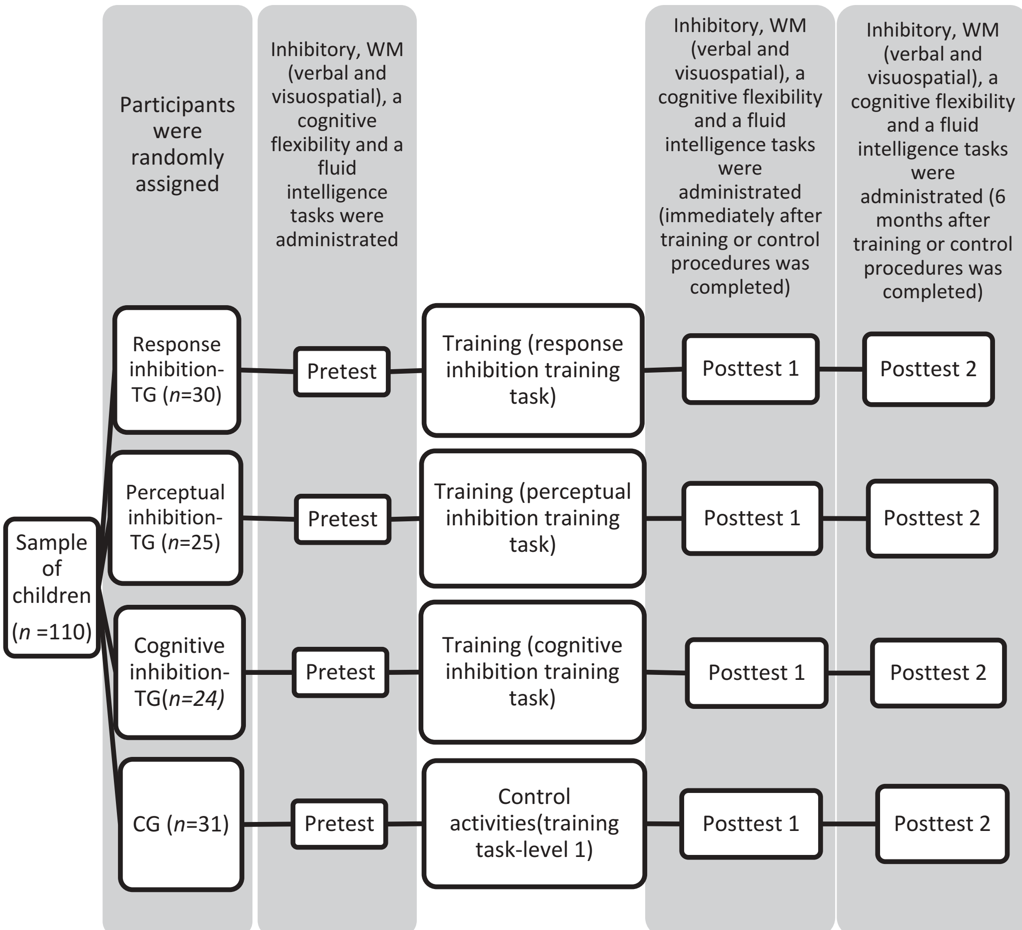

Figure 1. Procedure. This horizontal organization chart shows the procedure in the study.

boxes each of which contains three faces (simple drawings with elementary strokes). Two faces are identical while the third is different. The participant is required to indicate with a cross, as quickly and accurately as possible, the different face in each box (for 3 min). In other words, the participants must find relevant stimulus in a larger set of stimuli that can operate as distracters. Thus, this task allows us to asses selective attention involving perceptual inhibition of the distracting information (Stelzer, 2014). Hits net -(HN) number of hits minus the number of errors, including direct scores (HN ds) and percentiles (HN pc) – were employed as dependent variables. This test has normative data sample-appropriate (Ison & Carrada, 2012) and adequate levels of reliability – internal consistency α = 0.91-; convergent validity – correlation with intelligence measures $r = .45$, $p < .05$-; and divergent validity -no correlations with personality and adjustment variables (Thurstone & Yela, 2012).

Cognitive inhibition task. This is a variant of the proactive interference task by Brown (1958) and Peterson and Peterson (1959). The activity employed here is an adaptation of the tasks designed by Borella, Carretti, and Lanfranchi (2013) and Christ, Kester, Bodner, and Miles (2011). In each of two blocks of this task, participants view four lists of four words each (images with their corresponding verbal labels presented at a rate of one image every 2 s). The first three lists were taken from the same category, and the last list, which served as the "release from proactive interference" list, was taken from a different category. Between

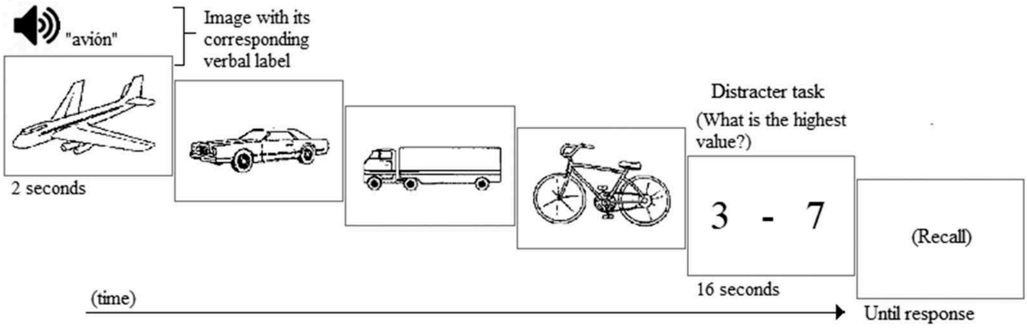

Figure 2. Example of trial in the cognitive inhibition task (proactive interference task). Participants view a list of four words (images with their corresponding verbal labels at a rate of one image every 2 s). Then, he or she completes a distracting task and finally, must verbally recall as many of the four to-be-remembered items as possible.

the presentation of each list and recall, participants completed a distracting task (to tell which of the two numbers is the highest, during 16 s). After the distracter task, participants must verbally recall as many of the four to-be-remembered items as possible (see Figure 2). The words recalled are registered. The task runs on a PowerPoint presentation. The images are standardized pictures designed specifically to be used with children. Familiar semantic categories for children were employed (e.g., animals and eating utensils). Also, familiarity and length of words were considered (Cycowicz, Friedman, Rothstein, & Snodgrass, 1997; Goikoetxea, 2000).

On trails (lists) 2 and 3, participants had to overcome proactive interference associated with the semantically similar items from the previous trial. Inhibitory control was assessed by comparing memory performance on these “interference” trials with performance on trials 1 and 4 (which were not preceded by trials with semantically similar items). The performance was evaluated based on a participant’s accuracy for items on the list (% correct) and the number of false-positive (intrusion) errors (we named these indices as IP and IP Intrusions, respectively). We use both variables as dependent variables. The activity fulfills the expected internal criteria according to the paradigm on which it was built (Aydmune, Introzzi, Zamora, & Lipina, 2018).

Response inhibition task. This task is part of the Cognitive Self-Regulation Tasks computerized battery (*Tareas de Autorregulación Cognitiva* – TAC-; Introzzi & Canet Juric, 2012). It was built based on a Stop-signal paradigm (Logan, Schachar, & Tannock, 1997; Verbruggen & Logan, 2009) and has two blocks. First block has 32 *go trials*, each trial start with a fixation point (a cross during 500 ms) in the center of the screen, followed by an arrow pointing left or right (for 1,000 ms). Participants must press a key according to the orientation of the arrow as quickly as possible. Second block has 72 trials, which the 75% are go trials, and the 25% are *stop trials*. Stop trials contain the same stimulus as go trials, and a stop signal (audio signal) that indicate the participant that must inhibit the response. The stop-signal delay (the interval between the presentation of the go signal and the stop signal) was changed dynamically after every stop trial according to the participant’s performance. Stop-signal delay was set at 250 ms initially and then adjusted dynamically depending on the subject’s responses. The delay increased by 50 ms if the subject inhibited successfully and decreased by 50 ms if failed to inhibit (Figure 3). Response in stop trials might indicate that the participant – through inhibition – did not stop an ongoing response (Logan et al., 1997). The main performance index is *Stop-signal reaction time* (SSTR), which represents the latency of the response to the stop signal. SSTR can be calculated subtracting stop-signal delay from mean go reaction time (Schachar & Logan, 1990; Schachar, Tannock, Marriott, & Logan, 1995). The activity fulfills the

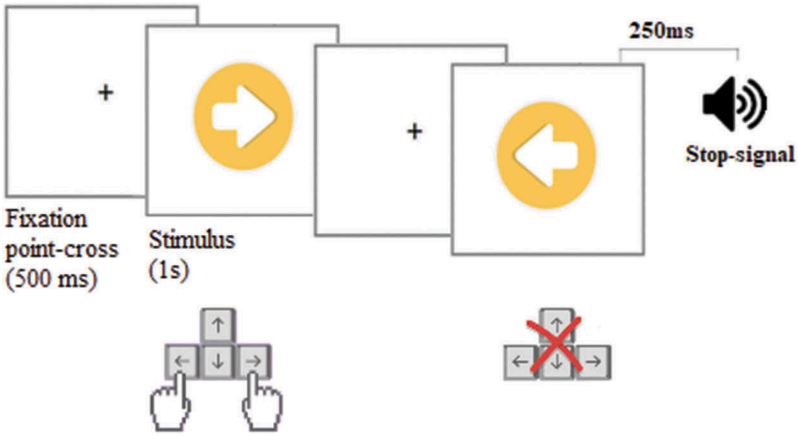

Figure 3. Example of two trials of the response inhibition task. The first one corresponds to a go trial, and the second to a stop trial. Both start with a fixation point (a cross exposed during 500 ms) in the center of the screen, followed by an arrow pointing left or right (exposed for 1,000 ms). In the go trials, participants must press a key according to the orientation of the arrow as fast as possible. The stop trials also contain a stop signal (audio) that indicates to the participant that he/she must inhibit the response. The stop-signal delay (the interval between the presentation of the go signal and the stop signal) was changed dynamically after every stop trial according to the participant's performance. Stop-signal delay was set at 250 ms initially and then adjusted dynamically depending on the participant's behavior.

expected internal criteria according to the paradigm on which it was built and shows adequate levels of convergent and divergent validity (e.g., Richard's et al., 2017a, 2017b).

Visuospatial working memory task. This is a dual task (Hale, Bronik, & Fry, 1997), part of the TAC computerized battery (Introzzi & Canet Juric, 2012) that requires carrying out two tasks simultaneously: a primary task and a secondary task. The primary task requires recalling the locations of crosses (X) that appeared one at a time, in individual cells of a 4 × 4 grid (6.5 x 6.5 cm) centered in the left half of the screen. Series of X are followed for a recall signal (audio signal), and the participant must indicate (by pointing the mouse in a grid) the location of each X in the displayed order on the screen. Secondary task (interference visuospatial task) requires reporting the color of the stimuli (pointing mouse in a palette of colors centered in the right half of the screen) as they were presented (Figure 4). Series are increased by one if the participant's response is accuracy. If not, series of next trial will have the same length. If participant's

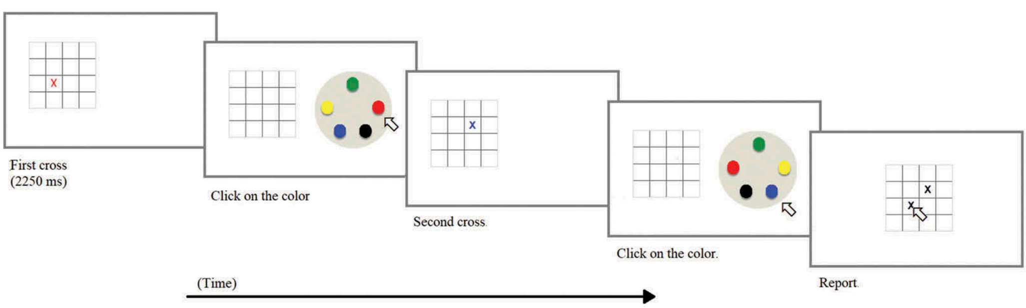

Figure 4. Example of a trial of the visuospatial working memory task (dual task). This task requires carrying out two tasks simultaneously. The primary task requires recalling the locations of crosses (X) that appeared one at a time in individual cells of a grid centered in the left half of the screen. Series of X are followed for a recall signal (audio), and the participant must indicate (by pointing the mouse in a grid) the location of each X in the order displayed on the screen. Secondary task (interference visuospatial task) requires reporting the color of the stimuli as they are presented (pointing the mouse to a palette of colors centered in the right half of the screen).

performance is not accuracy in two consecutive trials with the same length, the task end. The dependent variable, *span*, was determined to be the number of items in the last correctly recalled series. The activity fulfills the expected internal criteria according to the paradigm on which it was built (Canet Juric, Introzzi, & Burin, 2015).

Verbal working memory task. Digit Span Backward that is part of the digit span subtests of the Scale of Intelligence for children WISC IV (Wechsler, 2010). In this task, the experimenter read a list of numbers and the child had to repeat the numbers back immediately, in the correct order. Trials began with lists of single numbers and were given in blocks of two trials. The list length was increased one by one from one block to another until the child made errors in two trails of a block. Total trials correct were scored – direct score (DBds) and scalar score (DBss). Task shows levels adequate of reliability, e.g., internal consistency r = .74 (Taborda, Brenlla, & Barbenza, 2011).

Cognitive flexibility task. This is a task-switching included in the TAC (Introzzi & Canet Juric, 2012) that consists of three experimental blocks that are presented in the following sequence: Congruent Block, Incongruent Block, and Mixed Block. Only performance on the mixed block allows to obtain a measure of cognitive flexibility. The mixed block contains a practice block of eight trials and an experimental block of 32 trials. In both cases, congruent trials and incongruent trials appear distributed randomly. A fixation point (a cross) in the center of the screen remains fixed throughout the block. Next, the stimuli begin to appear sequentially on the left or right side of the cross at an equidistant distance. Each stimulus remains on the screen for 750 ms, during which the participant must give his or her response. On congruent trials, stimulus is a hand that appears with a finger pointing straight down, and the participant must press the key ipsilateral to the site where the stimulus is presented. Therefore, when the stimulus appears on the left side, the participant must press the “Z” key and when it appears on the right side, the “M” key. On incongruent trials, the stimulus consists of a hand with its index finger pointing in a diagonal direction to the opposite side in which it is presented. Thus, if the hand appears on the right side of the screen, it points to the contralateral response site and the participant must, therefore, press the letter “Z”; conversely, if it appears on the left side, the finger points to the contralateral response site and the participant must press the “M” key (Figure 5). The participant must switch quickly and effectively between two incompatible rules (pressing on the same side or on the opposite side). For this reason, execution in the mixed block demands cognitive flexibility (Davidson et al., 2006; Monsell, 2003). Accuracy on the mixed block was employed as the dependent variable. Task fulfills the expected internal criteria according to the paradigm on which it was built and shows levels of adequate discriminate validity (Richard’s et al., 2017a).

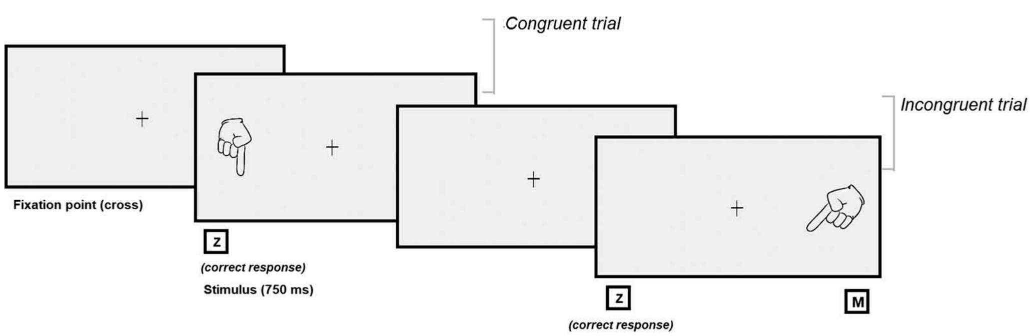

Figure 5. Example of two trials of the cognitive flexibility task (task switching). The first one corresponds to a congruent trial, and the second to an incongruent one. On congruent trials, the participant must press the key corresponding to the same site where the stimulus is presented on the keyboard (“Z” or “M” keys for left and right directions, respectively). In this case, the stimulus appears on the left side and the participant must press the “Z” key. On incongruent trials, the participant must press the contralateral key to the site where the stimulus is presented. In this case, the participant must press the “Z” key.

Fluid intelligence task. Raven's Colored Progressive Matrices Test (Raven, Court, & Raven, 1993). This test is made up of a series of diagrams or designs (36 designs, one per page) with a missing piece. The participant is given six choices to pick from and fill in the missing piece. The dependent variable was the number of correctly solved problems – direct score (IFds) and percentiles (Ifpc). Test has normative data sample-appropriate and levels adequate of reliability -α = .898 (Cayssials et al., 1993).

Training activities

These activities have rules and stimuli appropriate for 6 to 8-year-old children. In this sense, a character called "*Verdecito*" ("Little green") introduces and is present during all the activities. Tasks are process-based and have different levels of difficulty. Six levels of difficulty were designed according to the criteria of the paradigm on which were built and contemplated the conditions in which the inhibitory processes are demanded to a greater or lesser extent. We carry out pilot studies; they show that the first levels are easier than final levels and near transfer effects of inhibitory training tasks (Aydmune et al., 2018; Aydmune & Introzzi, 2018a, 2018b). During the training process, the percentages of correct responses were taken as the criterion of level change. Initially, 80% ≤ of correct responses in two consecutive blocks of the same level, gave rise to a greater difficulty level, while <80% of correct responses in two consecutive blocks of the same level involved the work at a lower level. On the cases in which the participants completed the six levels and they did not finish the planned 12 sessions, the activities were presented again, though taking as criterion 90% of correct responses.

Perceptual inhibition training task. It is a computerized task based on the Flanker paradigm, which is usually used to evaluate and train perceptual inhibition (e.g., Blakey & Carroll, 2015; Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002; Thorell et al., 2009; Traverso, Viterbori, & Usai, 2015; Viterbori, Gandolfi, & Usai, 2012). Each trial of the task starts with a fixation point (a cross) in the center of the computer screen (during 500 ms); then, in the same location, a line of five stimuli (fishes) appears. The participant has to press a key on the keyboard as quickly as possible, according to the direction of the main fish (target). If this fish looks left, the participant has to press the "Z" key and if it looks right, the "M" key (see Figure 6). In the instructions "Verdecito" suggests playing this game with his friend the fish (target). The task has three types of trials: (a) *Congruent*, in which the fish that surrounds the main fish look toward the same direction as this one (congruent distracting stimuli). This condition facilitates the response (Kopp, Rist, & Mattler, 1996; Lavie, 1995). (b) *Neutral*, in which the fishes look up or down (neutral distractors). Some authors raise that this condition generates some interference that the participant has to control through perceptual inhibition, to be able to respond to the target (Eriksen, 1995; Kopp et al., 1996). (c) *Incongruent*, where the fishes look in the opposite direction of the main one (incongruent distractors). This is the greater interference condition (Eriksen, 1995). With this in mind, the increase in the difficulty level mainly contemplates the type of trial presented. On the lowest level only congruent trials are presented; in the next one, neutral trials; and from the third level on, the three types of trials, increasing the percentage of incongruent trials as the difficulty increases. On the first three levels, the presentation time of stimuli (including the response window) is 1500 ms, and then it decreases to 300 ms per level. Each level has blocks of 20 trails each.

Cognitive inhibition training task. This activity was designed based on a modification of the experimental paradigm used by Oberauer (2001, 2005a, 2005b), which combines characteristics of proactive interference and directed forgetting tasks. Each trial is divided into three stages: *learning*, *signal*, and *probe*. In the learning phase, after the presentation of a fixation cross (during 500 ms), the participant is requested to remember two lines of stimuli; one of them is on a red background, and the other one on a blue background.

The length (number of elements) of the lists must not exceed the capacity of WM of the participants (since the objective of the task is to train cognitive inhibition more than WM). In this case, it was considered the average amount of elements that 6 to 8-year-old children can keep active in the WM while they operate with them, considering the normative data of the subtest Digit Span Backward from

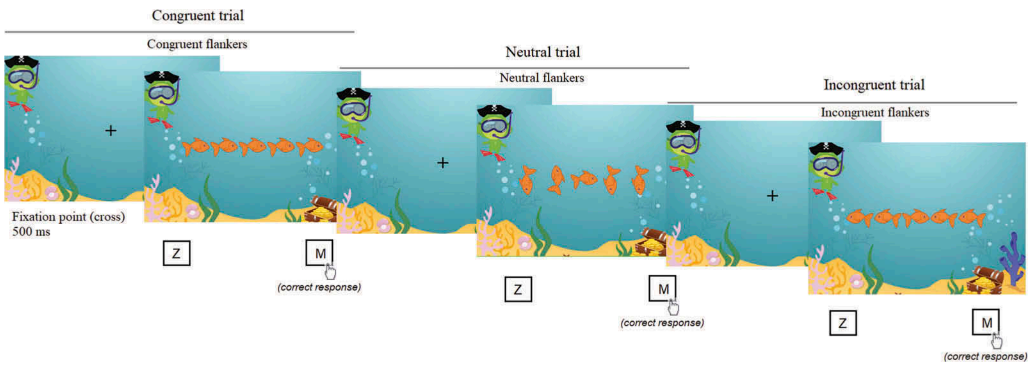

Figure 6. Examples of congruent, neutral and incongruent trials of the perceptual inhibition training task. All trials start with a fixation point (a cross) in the center of the screen exposed during 500 ms. Then, at the same location, a row of five stimulus (fishes) appears. The participant must press a key according to the orientation of the central fish (target) as fast as possible. Therefore, when central fish is looking at the right, the participant must press the "M" key and when the target is looking at left, the participant must press the "Z" key. The first corresponds to a congruent trial, since the flankers are looking at the same site where the target is looking at. The second corresponds to a neutral trial since flankers are looking at up and down. Finally, the third corresponds to an incongruent trial, in which flankers are looking at the opposite side with respect to the target.

WISC IV (Taborda et al., 2011). Thus, the number of elements in the list ranged from one to two, but more than three elements were not presented in each learning phase. For the construction of the lists it was contemplated: the familiarity of the stimuli (Cycowicz et al., 1997); the length of the words; and the ownership of the words in different semantic categories (to avoid the interference in the recognition of the requested probe, at a subsequent phase, see recognition phase). Then, the lists disappear and the signal phase takes place (forgetting phase). Here, after a blank screen (during 1 s), it is shown a signal that informs which of the two lists will have to be remembered – since it will be relevant for a subsequent task of recognition- and which one will have to be forgotten – since it will be irrelevant at a subsequent phase. The signal has two rectangles, one of them is red and the other one is blue (which represents the two lists), and on them a checkmark (in the list which has to be remembered) and a cross (in the list which has to be forgotten). Finally, the probe phase takes place, where a stimulus is presented and the participant has to indicate if it was in the relevant list or not – saying "yes" or "no", respectively (Figure 7). The probes are of three types: (a) *relevant probes*, which are in the list which has to be remembered; (b) *irrelevant probes* that are in the list which has to be forgotten or "deleted"; and (c) *new probes*, which are not in either of the two lists. It is supposed that at the sign, the participant has to forget the irrelevant list, that is to say, to inhibit or suppress it actively (demanding cognitive inhibition). If he/she does not achieve it, when an irrelevant probe is presented, instead of being compared only with the stimuli of the relevant list and being rejected, it could be compared with the irrelevant list which has not been eliminated and it could be considered as a part of the relevant one. Consequently, it is probable to make more mistakes in the trials with an irrelevant probe. So, the increase in the difficulty was generated through two main factors:

(1) The time between the signal and the probe presentations. The fewer the interval, the fewer the time that the participant has to "delete" the elements in the irrelevant list, so it is assumed that the task becomes more difficult as the interval decreases.
(2) The percentage of stimuli types presented in the probe phase. It is understood that the higher the percentage of trails with irrelevant probes are presented, the greater will be the difficulty of the task since the participant is more likely to make mistakes. This percentage increased progressively from 30% to 60% through the difficulty levels. Each level has blocks of 10 trails. In the instructions, it is explained that "Verdecito" and his friends have created two teams -the red one and the blue one- to play different games, but they have forgotten

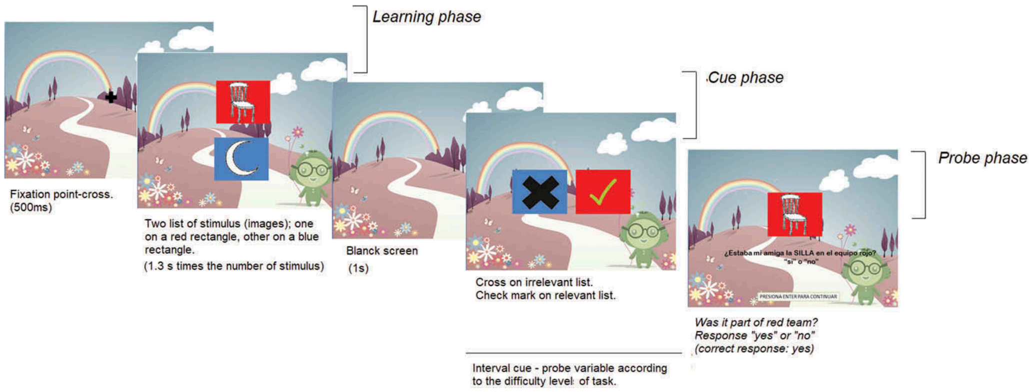

Figure 7. Example of a trial of the cognitive inhibition training task. Each trial is divided into three stages: learning, signal, and probe. In the learning phase, after the presentation of a fixation cross (during 500 ms), the participant is requested to remember two lines of stimuli; one of them is on a red background, and the other one on a blue background. Then, the lists disappear and the signal phase takes place (forgetting phase). After a blank screen presented during 1 s, it is shown a signal that informs which of the two lists will have to be remembered – since it will be relevant for a subsequent task of recognition – and which one will have to be forgotten – since it will be irrelevant at a subsequent phase. The signal has two rectangles, one of them is red and the other blue (which represents the two lists), and on them, there is a checkmark (in the list which has to be remembered) and a cross (in the list which has to be forgotten). Finally, the probe phase takes place, where a stimulus is presented and the participant has to indicate if it was in the relevant list or not – saying "yes" or "no", respectively.

which team they belong to. So, it is proposed to the participant to help them find which team they belong to, through this activity. The administrator registers the verbal responses.

Response inhibition training task. This computerized task was constructed based on the go/no-go paradigm used frequently to evaluate and train response inhibition in the child population (e.g. Cragg & Nation, 2008; Reyes et al., 2015; Thorell et al., 2009; Zhao et al., 2016). The tasks based on this paradigm require that a response takes place when a go stimulus appears frequently and that the response was not generated or held, when a no-go stimulus is presented, which is less frequent. The relative frequency of the go trails compared with the no-go creates a tendency to respond on all the trials (prepotent response), which has to be inhibited in the no-go trials (Bezdjian et al., 2014; Casey et al., 1997). In this case, the go stimulus is "a green ball" in which the participant has to press the space bar on the computer keyboard, while the no-go stimulus is "a violet ball", in this case, he/she must not press any key. The stimuli are presented in the center of the screen (Figure 8). In the instructions "Verdecito" explains that he wants to build a place full of balls with only green balls (it is his favorite color). To achieve it, he needs the child's help, the participant has to catch the green balls, letting pass the violet balls. The increase in the difficulty of the task is related to two factors.

1. The decrease in the time between stimuli (Lindqvist & Thorell, 2008) – inter-stimuli interval (ISI), interval from the presentation of the stimulus of a trial to the appearance of the stimulus in the next trial (Alvarez-Linera Prado, Ríos Lago, Hernández Tamames, Bargalló Alabart, & Calvo Merino, 2007), which includes the response window. The reduction of ISI contributes to the prepotency of the response, because the participant has to answer quickly, generating a tendency to respond in all the trials.

Besides this, the time he/she has to give a response is reduced. Different studies show that the less the time, the less probability the participants have to inhibit a prepotent behavior (Simpson et al., 2012). In this way, during the training, the ISI was reduced 300 ms from a level to the other when the difficulty was increased – being the fewest ISI of 30 ms (Zhao et al., 2016).

2. The increase in the amount of go trials that precede the no-go increases the tendency to respond in all the trials and consistently, it will be harder to stop it in a no-go trial (Ciesielski, Harris, & Cofer, 2004; Durston et al., 2002). Thus, there were sequences of one and two go trials previous to the no-go essay in

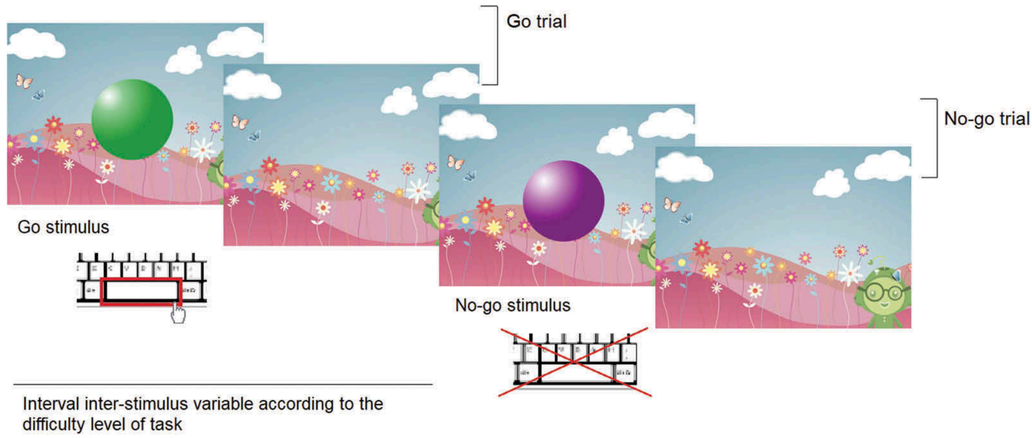

Figure 8. Example of two consecutive trials of the response inhibition training task. The first is a go trial and the second, a no-go trial. The go stimulus is "a green ball" in which the participant has to press the space bar on the computer keyboard, while the no-go stimulus is "a violet ball", in this case, he/she must not press any key.

the level of lesser difficulty; sequences of three and four go trials previous to the no-go trail in the next level; and so on. At least two sequences of trials of lesser difficulty levels were placed to avoid the inference of logic which underlines the stimuli presentation. Each level has blocks from 30 to 40 trials.

Control activities

The participants in CG performed the first level of the training tasks (see *Training activities*) – i.e., level 1 of perceptual inhibition training task (congruent trials; presentation time of stimuli: 1500 ms); level 1 of cognitive inhibition training task (with 30% of trails with irrelevant probes); and level 1 of response inhibition training task (sequences of one and two go trials previous to the no-go trial). In these levels, inhibitory processes are not significantly involved.

Results

Data preparation and analysis

Table 2 shows the group's mean and standard deviations of the pre and posttest (posttest1 and posttest2) scores on dependent measures. Six atypical cases were identified according to criteria of 3,29 standard deviations below the mean (Tabachnick & Fidell, 2013). However, they were considered in the analysis because results are not different if atypical cases are deleted. Twelve participants did not perform tasks at posttest2 (response inhibition-TG, n =2; perceptual inhibition-TG, n = 3; cognitive inhibition-TG, n = 6; CG, n = 1). Additionally, six participants did not complete one cognitive task (two cases of response inhibition-TG; one case of perceptual inhibition-TG; and three cases of GC). The training process was described briefly. In order to check basal homogeneity between groups regarding socio-demographic variables (age and SES) and performance indices, we conducted one-way ANOVAs (Table 3). To evaluate the effects of the three interventions, we ran a mixed ANOVA with Time (pretest, posttest1, and posttest2) as the within factor and Experimental condition (response inhibition-TG; perceptual inhibition-TG; cognitive inhibition-TG; CG) as the between-subjects factor. One analysis for each performance index (dependent variable) was carried out. Previously, the assumptions that are required for one-way ANOVA and mixed ANOVA were analyzed. In both cases, we evaluated *normal distribution and homogeneity of variances* of dependent variables, for each combination of the groups of two factors. First assumption was analyzed using Shapiro–Wilk test and the results show normal distributions, except in a few cases. In these cases, the distribution shape was evaluated. We observed symmetry, except in only

Table 3. Analysis of basal homogeneity between groups regarding age, SES and performance indices.

	One-way ANOVA	
Dependent variables	*F*	*p*
SSRT pretest	1.019	.387
NH ds pretest	0.273	.844
NH pc pretest	0.155	.926
PI Intrusions pretest	0.092	.964
PI pretest	0.732	.535
BD ds pretest	0.766	.516
BD ss pretest	0.676	.569
vsWM pretest	0.734	.534
CFaccuracy pretest	0.634	.594
FI ds pretest	0.432	.731
FI pc pretest	1.758	.160
Age	0.134	.939
SES	0.612	.609

SSRT = stop-signal reaction time; NH = net hits; ds = direct score; pc = percentile; PI Intrusions = proactive interference index, intrusions-based; PI = proactive interference index, correct responses-based; BD = backward digit span; ss = scalar score; vsWM = visuospatial working memory (span); CFaccuracy = general accuracy in mixed block; FI = fluid intelligence; SES = socioeconomic status.

one variable – at pretest, posttest1, and posttest2 (George & Mallery, 2011), which coincides with the presence of atypical cases. Therefore, these variables were transformed (using square root) and the variance analysis was carried out on variables with and without transformation (in both cases, results coincide; consequently here we report analysis without transformation). The second assumption was evaluated using Levene's test. In general, homogeneity of variance is observed, and in these cases, p*ost hoc* comparisons were performed using the Tukey method (Tukey, 1953). *When the variables did not show equivalent variances between the groups*, the Games-Howell method (Games & Howell, 1976) was applied for this comparison. Additionally, for mixed ANOVA we analyzed equivalence of variance/covariance matrices for between-group factors, using *M* de Box test (Box, 1950) and the assumption of sphericity of variance/covariance matrix, using Mauchly's test (Mauchly, 1940). In general, this assumption was checked, and when this did not happen, *epsilon* corrector Greenhouse-Geisser (Greenhouse & Geisser, 1959) was used. All this, according to literature about the topic (Gardner, 2003; Tabachnick & Fidell, 2013). Here, we followed a conservative protocol about the fulfillment of these assumptions; however, it is important to point that the analyses are quite "robust" to violations of them (Gardner, 2003; Tabachnick & Fidell, 2013). This procedure is used in most studies with similar aims (Schmiedek, 2016), because the primary purpose of a mixed ANOVA is to understand if there is an interaction between the Experimental condition and the Time (between-subjects factor and within-subjects factor) on the dependent variable (in addition, it allows to determine whether there are any simple main effects). Once statistically significant effects were established, *post hoc* comparisons were explored to identify the interactions and groups between which eventual differences were found. In addition to graphs, one-way ANOVA and ANOVA Repeated Measures were run to explore the eventual differences between groups and the performance of the groups over time, respectively. Since there were missing data at posttest2, and considering that the analyses involve only complete cases, we ran tests including data of pretest and posttest1 (for assessment of short-transfer effects), and complete cases (with data of pretest, posttest1 and posttes2, for assessment of long-term transfer), according to the procedure followed in studies with similar aims (e.g., Zhao et al., 2016). Finally, since not all children in the CG completed 12 sessions, we analyzed whether the number of sessions of work was related with these participants' performance at dependent variables where an Experimental condition effect or an interaction effect between Time and Experiment condition was observed. Here, the cases were re-grouped in three groups according to the number of sessions that the participants completed, based on terciles (high-exposure, medium-exposure, low-exposure). Considering groups size, in this latter case, we decide to use Kruskal–Wallis test.

Table 4. Level reached at the last training session for each TG.

Percentage of correct responses	Level	Response inhibition-TG *n*	Perceptual inhibition-TG *n*	Cognitive inhibition-TG *n*
80%	Level 1	0	0	0
	Level 2	3	0	0
	Level 3	5	1	2
	Level 4	8	2	0
	Level 5	11	4	3
	Level 6	3	1	13
90%	Level 1		2	0
	Level 2		4	2
	Level 3		3	1
	Level 4		4	2
	Level 5		3	1
	Level 6		1	0
Total		30	25	24

TG = training group; n = number of cases

Training process

As mentioned in the subsection *Training activities*, during the training process the percentages of correct responses were taken as a criterion of level change: initially, 80% and then 90% on the cases in which the participants completed the six levels and they did not finish the planned 12 sessions. This was not observed in response to inhibition-TG. Seventeen participants in perceptual inhibition-TG and six in cognitive inhibition-TG completed the six levels of difficulty before the end of the intervention. Table 4 shows levels reached at the last training session, for each TG. During the training process, no child remained in the level 1, they advanced to more difficult levels. In turn, considering that percentages of correct responses were taken as the criterion of level change (80%≤), it is possible to posit that children increase their performance in training tasks. However, the improvements on the trained tasks may merely reflect task-specific practice effects (Rapport et al., 2013). Also, researchers often look for positive correlations between gains in the training tasks and in the transfer tasks, and interpret such effects as evidence supporting the effectiveness of an intervention. However, some authors suggest that correlated gain scores would be neither an indication nor a necessity for transfer (Moreau, Kirk, & Waldie, 2016). For these reasons, transfer effects are analyzed in the following sections, using a mixed ANOVA (according to literature about the topic, e.g., Diamond & Ling, 2016; Moreau et al., 2016; Schmiedek, 2016; see Data preparation and analysis).

Near, short- and long-term transfer effects

Response inhibition

Short-term transfer. With regard to TF, no effect of Time -$F(1,106) = 1.955$, $p = .165$, $n^2p = .018$- or Experimental condition -$F(1,106) = 0.850$, $p = .470$, $n^2p = .023$- were observed. The interaction between Time and Experimental condition was not significant -$F(3,106) = 0.622$, $p = .602$, $n^2p = .017$.

Long-term transfer. No effect of Time -$F(1.8,174.5) = 1.939$, $p = .150$, $n^2p = .020$- or Experimental Condition – $F(3,94) = .397$, $p = .755$, $n^2p = .013$ were observed. The interaction between Time and Experimental condition was not significant -$F(5.6,174.5) = 0.625$, $p = .699$, $n^2p = .020$.

Perceptual inhibition

Short-term transfer. For both indices of perceptual inhibition task significant effect of Time was observed – HN ds, $F(1,106) = 38.765$, $p < .001$, $n^2p = .268$; HN pc, $F(1,106) = 27.301$, $p < .001$, $n^2p = .205$

(Table 2 shows descriptive statistics). Analysis did not show effect of Experimental condition – HN ds, $F(3,106) = .170$, $p = .917$, $n^2p = .005$; HN pc, $F(3,106) = 0.254$, $p = .858$, $n^2p = .007$- and nor interaction between Time and Experimental condition – HN ds, $F(3,106) = 0.785$, $p = .505$, $n^2p = .022$; HN pc, $F(3,106) = 0.358$, $p = .786$, $n^2p = .010$.

Long-term transfer. For both measures, the significant effect of Time was observed – HN ds, $F(2,190) = 76.555$, $p < .001$, $n^2p = .446$; HN pc, $F(2,190) = 21.465$, $p < .001$, $n^2p = .184$ (Table 2 shows descriptive statistics). Analysis did not show the effect of Experimental condition – HN ds, $F(3,95) = 1.183$, $p = .320$, $n^2p = .036$; HN pc, $F(3,95) = 2.029$, $p = .115$, $n^2p = .060$- nor the interaction between Time and Experimental condition – HN ds, $F(6,190) = .358$, $p = .456$, $n^2p = .195$. HN pc, $F(6,190) = .796$, $p = .574$, $n^2p = .025$.

Cognitive inhibition

Short-term transfer. With regard to measures of cognitive inhibition task (IP and IP Intrusions) no effect of Time – IP, $F(1,106) = 0.50$, $p = .481$, $n^2p = .005$; IP Intrusions, $F(1,106) = .868$, $p = .354$, $n^2p = .008$-, or Experimental condition – IP, $F(3,106) = 0.926$, $p = .431$, $n^2p = .026$; IP Intrusions, $F(3,106) = 0.229$, $p = .876$, $n^2p = .006$- were observed. The interaction effect between Time and Experimental condition was not significant – IP, $F(3,106) = 0.867$, $p = .461$, $n^2p = .024$; IP Intrusions, $F(3,106) = 0.618$, $p = .605$, $n^2p = .017$.

Long-term transfer. Non-significant effect of Time – IP, $F(2,180) = 1.695$, $p = .187$, $n^2p = .018$; IP Intrusions, $F(1.56, 140.2) = 2.247$, $p = .122$, $n^2p = .024$-, nor Experimental condition – IP, $F(3,90) = .694$, $p = .558$, $n^2p = .023$; IP Intrusions, $F(3,90) = 0.126$, $p = .945$, $n^2p = .004$- were observed. There were no interactions between Time and Experimental condition -IP, $F(6,180) = 0.505$, $p = .804$, $n^2p = .017$; IP Intrusions, $F(4.67, 140.2) = 0.607$, $p = .684$, $n^2p = .020$.

Far, short- and long-term transfer effects

Verbal working memory

Short-term transfer. The analysis did not show effects of Time – DBds, $F(1,106) = 0.041$, $p = .839$, $n^2p = .000$; DBss, $F(1,106) = 1.483$, $p = .226$, $n^2p = .014$-, Experimental condition – DBds, $F(3,106) = 0.919$, $p = .434$, $n^2p = .025$; DBss, $F(3,106) = 1.569$, $p = .201$, $n^2p = .043$- nor the interaction between Time and Experimental condition – DBds, $F(3,106) = 2.233$, $p = .089$, $n^2p = .059$; DBss, $F(3,106) = 1.219$, $p = .306$, $n^2p = .033$.

Long-term transfer. Similarly, no significant effect of Time – DBds, $F(2,186) = 2.039$, $p = .133$, $n^2p = .021$; DBss, $F(2,186) = 2.558$, $p = .080$, $n^2p = .027$-, or Experimental condition – DBds $F(3,93) = .406$, $p = .749$, $n^2p = .013$; DBss, $F(3,93) = 1.001$, $p = .396$, $n^2p = .031$- were observed. There was no interaction between Time and Experimental condition -DBds, $F(6,186) = 1.619$, $p = .144$, $n^2p = .050$; DBss, $F(6,186) = 1.641$, $p = .138$, $n^2p = .050$.

Visuospatial working memory

Short-term transfer. No significant effect of Experimental condition was observed – $F(3,106) = 0.156$, $p = .926$, $n^2p = .004$. The analysis revealed a significant effect of Time – $F(1,106) = 12.637$, $p = .001$, $n^2p = .107$ (Table 2 shows descriptive statistics)- and the significant interaction effect between Time and Experimental condition -$F(3,106) = 2.78$, $p = .045$, $n^2p = .073$ (Figure 9). Multiple comparations were no significant (Table 5). Repeated measures ANOVAs (for each group) revealed that cognitive inhibition-TG and response inhibition-TG change significantly yours performance – cognitive inhibition TG, $F(1,23) = 8.692$, $p = .007$, $n^2p = .264$; response inhibition TG, $F(1,29) = 7.563$, $p = .010$, $n^2p = .207$-; while this does not apply to the other groups – perceptual inhibition-TG, $F(1,24) = 2.769$, $p = .109$, $n^2p = .103$; GC, $F(1,30) = 0.482$, $p = .493$, $n^2p = .016$.

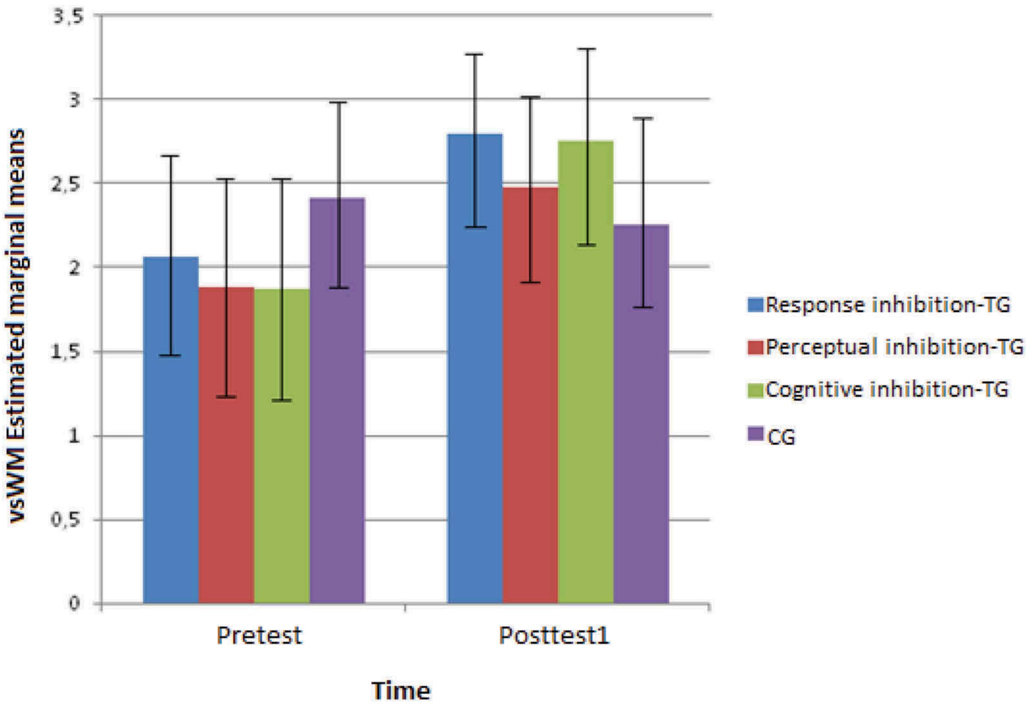

Figure 9. Performance of training and control groups on visuospatial working memory task, at pretest and posttest1. Groups are organized according to different evaluation instances (pretest and posttest1). The height of the bars represents estimated marginal means, which were obtained through a mixed ANOVA. Error bars represent 95% confidence intervals. Note: vsWM = visuospatial working memory; TG = training group; CG = control group.

Long-term transfer. In this case, an effect of Time was observed -$F(2,188) = 7.303$, $p = .001$, $n^2p = .072$ (Table 2 shows descriptive statistics). The analysis did not reveal a significant effect of Experimental condition -$F(3,94) = 1.412$, $p = .244$, $n^2p = .043$- or interaction between Time and Experimental condition -$F(6,188) = 1.613$, $p = .146$, $n^2p = .049$.

Cognitive flexibility

Short-term transfer. The analysis revealed a significant effect of Time – $F(1,106) = 5.768$, $p = .018$, $n^2p = .052$ (Table 2 shows descriptive statistics). No significant effect of Experimental condition – $F(3,106) = 0.413$, $p = .744$, $n^2p = .012$ – was observed. The interaction between Time and Experimental condition was not significant – $F(3,106) = 0.935$, $p = .427$, $n^2p = .026$.

Long-term transfer. In this case, the analysis also revealed a significant effect of Time – $F(2,186) = 5.162$, $p= .007$, $n^2p = .026$ (Table 2 shows descriptive statistics). No significant effect of Experimental condition was observed – $F(3,93) = 1.133$, $p = .340$, $n^2p = .035$. Finally, the interaction between Time and Experimental condition was not significant -$F(6,186) = 0.797$, $p = .573$, $n^2p = .025$.

Fluid intelligence

Short-term transfer. With regard to FIds, the effect of Time was observed – $F(1,106) = 16.636$, $p < .001$, $n^2p = .136$ (Table 2 shows descriptive statistics). The analysis did not reveal the effect of Experimental condition – $F(3,106) = 0.428$, $p = .733$, $n^2p = .012$- or interaction between Time and Experimental condition – $F(3,106) = 2.112$, $p= .103$, $n^2p = .056$. For IFpc, no effect of Time was observed – $F(1,106) = 1.072$, $p = .303$, $n^2p = .010$. Results suggest a marginal effect of Experimental condition

Table 5. Far, short- and long-term transfer analysis: Comparisons between groups.

		Visuospatial WM Short term transfer			Fluid Intelligence											
					Short term transfer						Long term transfer					
		Mixed ANOVA[a]			Mixed ANOVA[b]			One-way ANOVA[c]			Mixed ANOVA[b]			One-way ANOVA[d]		
Comparisons between groups		Differences of means	Standard error	*p*	Differences of means	Standard error	*p*	Differences of means	Standard error	*p*	Differences of means	Standard error	*p*	Differences of means	Standard error	*p*
EG RI	EG PI	0.320	0.419	1	−.08	7.218	1	2.400	7.922	.990	−0.41	6.932	1	−0.119	8.127	1
	EG CI	0.050	0.423	1	−9.94	7.299	.526	−13.592	8.011	.331	−19.31	7.357	.049*	−22.316	8.625	.054
	CG	0.542	0.396	1	10.16	6.826	.448	10.297	7.492	.518	9.37	6.439	.469	7.759	7.548	.734
EG PI	EG CI	−0.270	0.442	1	−9.85	7.617	.569	−15.992	8.360	.229	−18.90	7.793	.079	−22.197	9.135	.078
	CG	0.222	0.416	1	10.24	7.165	.484	7.897	7.863	.747	9.77	6.932	.496	7.878	8.127	.767
GE IC	GC	0.492	0.420	1	20.10	7.247	.033*	23.888	7.953	.017*	28.68	7.357	.001*	30.075	8.625	.004*

GE = experimental group; RI = response inhibition; PI = perceptual inhibition; CI = Cognitive Inhibition; CG = control group.
*Significant difference of means < .05.
[a] Interaction effect between Time and Experimental condition: Comparisons between groups in posttest 1.
[b] Experimental condition effect: comparisons between groups.
[c] Comparisons between groups in posttest 1.
[d] Comparisons between groups in posttest2.
TG = training group. GC = active control group. WM = working memory. n = participants

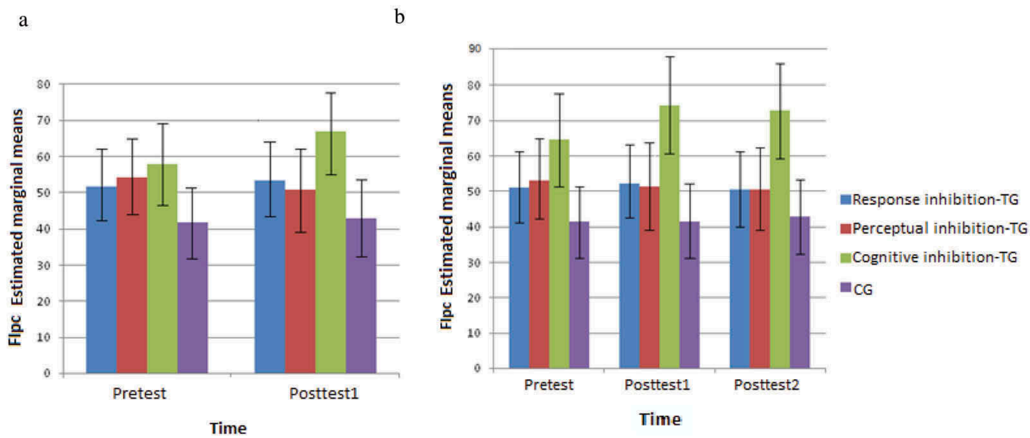

Figure 10. Performance of groups on the fluid intelligence task (percentile score), at pretest, posttest1, and posttest2. The groups are organized according to different evaluation instances (pretest and posttest 1 in panel A; pretest, posttest1 and posttest 2 in panel B). The height of the bars represents estimated marginal means, which were obtained through mixed ANOVAs. Error bars represent 95% confidence intervals. Note: FIpc = fluid intelligence, percentile; TG = training group; CG = control group.

-$F(3,106) = 2.590$, $p= .057$, $n^2p = .068$, and no interaction between Time and Experimental condition – $F(3,106) = 1.428$, $p= .239$, $n^2p = .039$. With regard to the marginal effect of Experimental condition, pair comparisons reveal a significant difference between the cognitive inhibition-TG and CG. We proposed that this difference might occur mainly at posttest1, because no significant differences between the groups were observed at pretest. Thus, a one-way ANOVA was applied and results indicate significant difference – $F(3,109) = 3.054$, $p = .032$. *Post hoc* tests indicate that the difference is between cognitive inhibition – TG and the GC (Table 5, Figure 10).

Long-term transfer. For FIds, the effect of Time was observed – $F(2,188) = 32.808$, $p < .001$, $n^2p = .259$ (Table 2 shows descriptive statistics). The analysis did not reveal a significant effect of Experimental condition – $F(3,94) = 1.450$, $p = .233$, $n^2p = .044$- nor the interaction between Time and Experimental condition – $F(6,188) = 0.976$, $p = .443$, $n^2p = .030$. With regard to FIpc, no significant effect of Time was observed – $F(1.82, 171.05) = 0.365$, $p = .675$, $n^2p = .004$. The analysis revealed a significant effect of Experimental condition – $F(3, 94) = 5.093$, $p = .003$, $n^2p = .140$-; and no interaction between Time and Experimental condition – $F(5.46, 171.05) = 0.483$, $p= .804$, $n^2p = .015$. Related to the effect of Experimental condition, pair comparisons revealed significant differences between the cognitive inhibition-TG with respect to the response inhibition-TG and the CG (Table 5). In this case, we proposed that this difference might occur mainly at posttest2. Thus, in order to compare the performance of the groups at posttest2, we ran a one-way ANOVA. Results indicate significant differences – $F(3, 97) = 4.189$, $p= .008$- between the cognitive inhibition-TG and the CG. Also, a marginal difference between cognitive inhibition-TG and response inhibition-TG was observed (Table 5, Figure 10).

Analysis of the relationship between numbers of sessions and participants in GC's performance

This analysis was carried out with the dependent variables on which significant effect of Experimental condition (FIpc short- and long-term transfer) or interaction between Time and Experimental condition (v-sWM, short-term transfer) was observed. The cases were re-grouped in: high-exposure ($n = 9$), medium-exposure ($n = 11$) and low-exposure ($n = 11$). Kruskal–Wallis test did not reveal a significant difference between the groups -v-sWM posttest1, $X^2(2) = 1.250$, $p= .535$; FIpc posttest1, $X^2(2) = .498$, $p = .779$; FIpc posttest2 $X^2(2) = 2.901$, $p = .234$.

Discussion

The aims of this study were to design, implement, and evaluate training activities of response inhibition, perceptual inhibition, and cognitive inhibition, in a sample of 6 to 8-year-old-children (elementary school student) with typical development. It was also proposed to analyze the efficacy of the interventions on the performance in tasks which demand the three inhibitory processes (near transfer), other EF tasks (verbal and visuospatial WM, CF) and fluid intelligence (far transfer); close to the end of the training (short-term transfer) and 6 months later (long-term transfer).

Regarding near transfer, in both short and long terms, results showed an absence of effects of the different training activities. These results coincide partly with results reported by Thorell et al. (2009) in preschoolers. These authors did not find changes in the performance of the inhibitory tasks after implementing different trainings of inhibitory control. Our results could be raised that the tasks used to measure the different inhibitory processes were not sensitive enough to capture changes. Also, it is possible that the training tasks and transfer tasks did not measure the same ability. For example, respect to response inhibition some authors argue that go/no-go and stop-signal are not equivalent paradigms because they allow different kinds of response inhibition (Verbruggen & Logan, 2008). In turn, different presentation formats of the training tasks and the transfer tasks could have influenced this result (e.g., regarding to perceptual inhibition, computerized training task, and paper-pencil transfer task were used). These arguments are partly applied to Thorell et al.'s study, whereby respect to the training and assessment of perceptual inhibition, different formats and paradigms were used. However, it is important to note that the differences between the training activities and the tasks adopted in the assessment allow to distinguish real improvements from mere task-training effect (Traverso et al., 2015). Finally, also it is possible that the training did not cause effects on these processes. However, far transfer effects were found. Specifically, we found effects on the performance in the visuospatial WM task in the short term, after the training in the response and cognitive inhibition, and effects on the performance in the fluid intelligence task in both the short and long term after the training in cognitive inhibition. Even though caution is needed to interpret far transfer effects in the absence of near transfer effects, it is important to consider these results for future directions. Regarding the visuospatial WM task, it was observed that the achievements of the cognitive inhibition-TG and the response inhibition-TG were modified from the pre to the posttest1, unlike Thorell et al.'s study, that did not find such effects. The results of our study could be associated with the characteristics of the training tasks: in the cognitive inhibition activity, lists of stimuli in different areas of the screen are presented. Consequently, during its execution, the children could have implemented some sort of strategy based on the spatial localization of the lists that in some way had an effect on their later performance in the visuospatial WM task. However, it is not applied to the response inhibition training task, since the stimuli appear one at a time, always in the same screen area. For this reason, the effects observed could not be explained by the characteristics of training tasks. Although it is difficult to interpret far transfer effects when near transfer effects are missing, this is probably due to inhibitory tasks used in pre and posttest instances. Thus, another possible explanation for these far transfer effects would be the relation between the inhibition and the WM (which raised the different postures of the inhibition); and their participation in the resolution of complex tasks (Diamond, 2013; Miyake et al., 2000). In this respect, non-unitary postures of the inhibition hold that cognitive inhibition would remove irrelevant information – verbal and visuospatial (Cyr et al., 2017) – of the WM, contributing with the relevant information processing (Diamond, 2013; Friedman & Miyake, 2004; Hasher et al., 2007). In this context, it might be thought that an improvement in the cognitive inhibition was linked to a better performance in the visuospatial WM task, since the participants could have operated mainly with the relevant information (i.e., with the localization of the crosses), removing the interfering and accessory information (for example, the colors of the crosses). Similarly, the optimization of the response inhibition might improve the control of prepotent and inappropriate responses during the execution of the visuospatial WM task. For example, it was observed that some children pressed quickly the mouse button without checking the right position of the cross. A greater control of this sort of behavior could give rise to more precise responses in this task. It is important to say that the training effects are observed only in the short term. Perhaps with more intense interventions longer effects could be observed, such as the literature of cognitive intervention suggests (Arán-Filippetti & Richaud de Minzi, 2011; Diamond, 2012; Korzeniowski & Ison, 2017; Sheese & Lipina, 2011). This might explain the absence of inhibitory training effects on the performance in verbal WM and CF tasks, in both the short and long term, and the general absence of perceptual inhibition training effects. In fact, during perceptual inhibition training 17 participants completed the six levels of difficulty before the end of the intervention (while six participants completed them in cognitive inhibition-TG and no cases in response inhibition-TG). These data suggest that, in general, the six levels in perceptual inhibition training task would be easier than the levels of response inhibition and cognitive inhibition training tasks. In turn, the characteristics of the training activities could explain the absence of changes: Although the executive tasks are *impure* – they demand other cognitive processes (Miyake et al., 2000; Miyake & Friedman, 2012)-, the design of the training tasks considered the low demand of other EF. On the one hand, simple rules were raised and the amount of information that the participants had to hold in mind when they operated, the activities were reduced. That could partly explain the absence of effects on the performance of the verbal WM task, which also agrees with the results reported by Thorell et al. (2009). Other authors that trained specifically inhibition in preschoolers and elementary students have found effects on the execution in WM tasks (Volckaert & Noël, 2015; Zhao et al., 2016, respectively). Nevertheless, comparing these results is difficult because the different studies administered distinct tasks. Volckaert and Noël (2015) used short-term memory measurements combined with verbal WM measurements in the same factor (through a factorial analysis). Then, training effects were analyzed on the factor as a whole, which does not make possible to examine the effects on the performance in each task individually. Zhao et al. (2016) used a WM updating task based on a different paradigm than the one used in this study. Regarding the CF, the results were the opposite of the ones reported by Zhao et al. (2016), in which after response inhibition training, effects on the CF in the short term were found. The authors explain these results using the characteristics of the training task that involved rule changes on which the participants had to operate. As mentioned, we tried to demand to a lesser extent other executive components during the trainings what could be related to the absence of effects. Another argument to these results is related to the CF measure, which could not have detected changes in the performance of the participants.

Finally, transfer of training effects to performance on fluid intelligence task was found, in both the short and long term. Immediately after concluding the training, the cognitive inhibition-TG differed from the CG. Cognitive inhibition-TG presented higher marks than the CG. After 6 months, this difference remained, and the cognitive inhibition-TG was different from the response inhibition-TG. In this way, Liu et al. (2015) reported transfer of response inhibition training effects to performance on fluid intelligence task, in preschoolers; while Zhao et al. (2016) – who trained the same inhibitory process – and Thorell et al. (2009) – that intervened on perceptual and response inhibition – did not find such changes.

Different authors hold that the inhibition plays an important role in the fluid intelligence (Dempster, 1991; Dempster & Corkhill, 1999; Diamond, 2013, 2016; Liu et al., 2015; Michel & Anderson, 2009). In general, it is raised that inhibition constitutes one of the main executive components which are useful for its development (Diamond, 2013, 2016; Michel & Anderson, 2009). In turn, it is understood that the inhibition could contribute to the resolution of tasks that demand this skill, in different ways: (a) at perceptual level, suppressing the interference generated by irrelevant stimuli, which hinder the focus on the relevant ones; (b) at a cognitive level, suppressing irrelevant information of the WM, to contribute to the processing of relevant information to the task, such as rules or patterns of relations; and (c) at a behavioral level, suppressing prepotent and inappropriate behaviors to the activity (Dempster & Corkhill, 1999; Liu et al., 2015; Sala & Gobet, 2017). It is also possible that the relation of each inhibitory process with this ability may be distinguishing. That is to say that perhaps some of these are linked to a greater extent to the other ones. Considering the results of this study, it could be raised that the cognitive inhibition is related to the fluid intelligence, because of the training of the first one generated effects on the performance in an activity that the second one demands. A better functioning of this inhibitory process could imply a decrease in the WM demands when it is released of irrelevant information, contributing to the processing of important information for the activity (Au et al., 2015; Brewin & Beaton, 2002; Dempster & Corkhill, 1999; Hasher et al., 2007; Sala & Gobet, 2017). In fact, cognitive inhibition training effects on performance on visuospatial WM task were observed. Since changes in the performance on a fluid intelligence task were observed only after cognitive inhibition training, it is possible to raise a particular relation between them. However, it is important to consider three questions: First that the effects observed were low, because the analysis did not reveal effect of interaction between group and time (Diamond & Ling, 2016). Second, Liu et al. (2015) reported transfer effects of response inhibition training to fluid intelligence in preschoolers. Perhaps perceptual and response inhibition training activities used in this research, as well as its implementation, were not enough to generate effects; and/or the relations between inhibitory processes and fluid intelligence change with ongoing development.

Considering the above, limits of the study from which are derived different ideas for future works can be formulated:

(1) In general, here it was used only one task to measure each construct. Future studies should use different tasks to measure each construct with the aim of having more information about near and far transfer effects, contributing to the analysis of its limits and the trust in the efficiency of the intervention (Sheese & Lipina, 2011). Likewise, the analysis of different levels of organization could be incorporated – for example, neural and cognitive (e.g., Liu et al., 2015) – which would contribute to the understanding of the dynamic of changes and underlying mechanisms.

(2) The activities and the structure of the training might not have been appropriate to generate observable effects. Future studies could test interventions with a greater amount and longer sessions, and/or with different intervals between sessions. Besides this, the training tasks used here could be modified, having higher levels of difficulty and variability regarding their stimuli and rules. All this would allow to demand through different situations the processes target of the intervention and to develop training sessions of a duration longer than 10 min, avoiding the loss of motivation by the novelty. The literature suggests that more intense interventions and those which involve different modalities can generate greater benefits (Arán-Filippetti & Richaud de Minzi, 2011; Diamond, 2012; Diamond & Ling, 2016; Korzeniowski & Ison, 2017; Korzeniowski, Ison, & Difabio, 2017; Sheese & Lipina, 2011).

(3) The number of sessions of the CG might have affected the results. Here, an analysis of the relationship between numbers of sessions and the GC's performance was carried out. However, future studies should test interventions with the same number of sessions in experimental and control groups.

(4) The use of pre and posttest measures derived from experimental paradigms or standardized tests, away from the children's everyday life (McCoy, 2019). This is a common characteristic to different inhibitory training processes-based studies (e.g., Dowsett & Livesey, 2000; Liu et al., 2015; Zhao et al., 2015, 2016) and few studies include measures as the frequency of externalizing behaviors at school and home (e.g., Volckaert & Noël, 2015). For this reason, it is still insufficient the knowledge about the training transfer in the daily life of children and it is fundamental to the development and incorporation of these measures.

(5) The sample of this study imposes limitations for generalization of results. It is important to work with samples which come from different contexts.

In summary, even considering the mentioned limitations this study makes contributions in the following ways: (a) It applies computerized activities for inhibitory training processes-based in child population, and it reports data about their administration. (b) It provides information related to the transfer effects on processes and cognitive skills which are vital for childhood and they are in developing. (c) These activities and results have been obtained in a different cultural context to those from which the main evidence in this subject come. With this study it is expected to have contributed to the field of knowledge about inhibition training during childhood, encouraging the development of new works which allow to understand, to a larger extent, the dynamic of the inhibitory functioning, to generate benefits in other processes and skills, as well as in the children's daily performance, in the short and long term.

Note

1. This work is based on the first author's doctoral dissertation. Only she was not blind to the children condition. The rest of the research assistants were blind.

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Disclosure of interest

The authors report no conflict of interest.

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