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INTERVENTIONS IN EXECUTIVE FUNCTIONS IN CHILDREN WITH LEARNING DISORDERS: SYSTEMATIC REVIEW

Intervenciones de la función ejecutiva en niños con dificultades de aprendizaje: revisión Sistemática.

Intervenções em Funções Executiva em Crianças com Dificuldade de Aprendizagem: Revisão Sistemática.

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Palavras-chave: Funções Executivas, Neuropsicologia, Crianças, Deficiências de Aprendizagem, Revisão Sistemática.

A B S T R A C T

Executive functions (EFs) are fundamental attributes in the children's teaching and learning process. The current study presents a systematic review of the literature that describes the model and the effectiveness of the interventions carried out in children with learning disorders. Its primary outcomes include EFs, language, performance and academic skills. In order to do that, PubMed, Scopus, Cochrane Library and LILACS databases were searched. This study identified 177 articles where 7 met the eligibility criteria. The most commonly used instrument for EFs assessment was the "Behavior Rating Inventory of Executive Function (BRIEF)". The proposed interventions in the studies lasted between 5 and 16 weeks. The main problems in assessing the methodological quality of the articles were in relation to randomization, blinding and description of losses/exclusions from the studies. The main features of the studies were discussed and illustrate the importance of interventions to improve the EFs in children.

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R E S U M E N

Las funciones ejecutivas (FE) son atributos fundamentales en el proceso de aprendizaje de los niños. Este estudio presenta una revisión sistemática de la literatura que describe el modelo y la efectividad de las intervenciones realizadas en niños con trastornos del aprendizaje, con la FE como resultado primario, además del lenguaje, el desempeño y las habilidades académicas. Las bases de datos consultadas fueron PubMed, Scopus, Cochrane Library, LILACS. Se identificaron 177 artículos, 7 se incluyeron según los criterios de elegibilidad. El instrumento más utilizado para evaluación es el "Behavior Rating Inventory of Executive Function (BRIEF)". Las intervenciones duraron entre 5 y 16 semanas. Los principales problemas en la evaluación de la calidad metodológica se relacionaron con la aleatorización, el cegamiento y la descripción de pérdidas / exclusiones de los estudios. Se discutieron las principales características de los estudios e ilustran la importancia de las intervenciones y las FE en los niños.

R E S U M O

As funções executivas (FEs) são atributos fundamentais no processo de ensino aprendizagem de crianças. Este estudo apresenta uma revisão sistemática da literatura que descreve o modelo e a efetividade das intervenções realizadas em crianças com distúrbios de aprendizagem tendo como desfecho primário as FEs, além da linguagem, desempenho e habilidades acadêmicas. Foram pesquisadas as bases de dados PubMed, Scopus, Biblioteca Cochrane e LILACS. No total, 177 artigos foram identificados e 7 foram incluídos com base nos critérios de elegibilidade. O instrumento mais utilizado para avaliação das FEs foi o "Behavior Rating Inventory of Executive Function (BRIEF)". As intervenções duravam entre 5 e 16 semanas. Os principais problemas Na avaliação da qualidade metodológica dos artigos foram em relação à randomização, cegamento e descrição das perdas/exclusões dos estudos. As principais características dos estudos foram discutidas e ilustram a importância de intervenções voltadas para fomento de FEs em crianças.

Introduction

Executive functions (FEs) enable people to perform actions which provide them greater autonomy. Thus, they cover a range of interacting cognitive processes related to the frontal lobe, which are particularly relevant to the successful involvement in complex, new and goal-oriented behaviors (Jones et al., 2018; Natale, Teodoro, Barreto, & Haase, 2008; St Clair-Thompson & Gathercole, 2006). Furthermore, EFs are crucial to self-regulation, and embrace several cognitive processes in target-oriented behavior such as attention, problem solving, impulse control, planning, working memory, inhibition, among others (Donadon Germano, Bastos Brito, & Capellini, 2017; Germano, Brito & Capellini, 2017). Therefore, these functions allow the individual to set a route towards a goal, involving the planning of the action, the sequencing of the required steps, the act itself and the monitoring through the goal (Dias, Menezes, & Seabra, 2010).

Currently, the most accepted model in the literature to explain the EFs was presented by Adele Diamond. The author points out that there is a consensus among researchers that there are three central constructs that explain the EFs: inhibition, working memory and cognitive flexibility. Inhibition encompasses the control of attention, behavior, thoughts and emotions aiming to modulate a strong internal or external predisposition for a particular action. The working memory operates holding the information and working with them looking for associations between the contents and problem solving, among others. Finally, cognitive flexibility is understood as the ability to change perspective or focus, seeking for a solution by the adjustment to new tasks, rules or targets (Diamond, 2013).

In literature, EFs are largely related to academic performance, and there are several evidence of their influence on the cognitive and socio affective development (Duncan, McClelland, & Acock, 2017; Germano et al., 2017; Shayer et al., 2015). Likewise, Davis et al. (2010) point out that EFs are essential for the regulation of social, intellectual and emotional skills and that individuals with deviations or deficits in any component of executive functions may have, among other symptoms, delay in school readiness and difficulty in the learning process. Particularly, the working memory (WM) has stood out as an important predictor of all academic domains, especially mathematical skills (Dias et al., 2010; St Clair-Thompson & Gathercole, 2006).

Learning difficulties regarding EFs concern problems in any of the learning domains, which are: listening comprehension (Swanson & Berninger, 2018), oral expression, basic reading skills, reading comprehension, written expression, mathematical calculation or mathematical problem solving (Semrud-Clikeman & Ellison, 2009). Given that, the importance of conducting

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effective interventions in EFs focused on learning processes, mainly regarding literacy (Locascio, Mahone, Eason, & Cutting, 2010) is reinforced.

Diamond and Lee (2011) emphasize that several activities are related to the expansion of skills in executive functions, such as training through the use of the computer, games, martial arts and the revision of school curricula, considering that the practice and the repetition are the foundation of learning. Hence, think creatively making use of working memory and flexibility are key elements to achieve a good performance, especially concerning the competence in school tasks and academic success.

In this regard, early interventions that ought to develop such skills in children are advantageous as they may encourage better academic performance, improvement of socio-affective skills and a healthier development of children with learning disorders. Studies such as Bierman, Nix, Greenberg, Blair and Domitrovich (2008) through the Head Start Redi program, Kenworthy et al. (2014) mattering the autism, and Weiland and Yoshikawa (2013) with children in preschool, have focused on checking the effectiveness of interventions. However, is has not been found in the literature any study which gathers those information and discuss the quality of those interventions. Therefore, the aim of the current study is to review systematically over the literature, the model and effectiveness of interventions in EFs, describing their main characteristics in individuals with learning disorders who were evaluated through a randomized clinical trial.

Method

The current study was carried out according to the Cochrane Collaboration's document (Higgins & Green, 2005, 2011) and Preferred Reporting Items for Systematic Review and Meta-analyses: The PRISMA Statement (Moher et al., 2015).

Search strategy

The following electronic databases searched: MedLine (PubMed), Scopus, Cochrane Library and LILACS. The search was carried out in February 2018 with no filters regarding the date. The terms used in the search were "Executive Function", "Intervention Studies", "Child", "Learning Disorders" and correlated terms, associated with a set of words proposed by Robinson and Dickersin (2002), which increased the search specificity for randomized controlled trials.

Eligibility criteria

The current study included randomized clinical trials in which there was an intervention in executive functions in children (0 to 12 years old) with learning disorders. Articles which were not specific about intervention studies in executive functions, nor having children as a sample were not accepted in the current review. The same is true for non-randomized clinical trial studies and for the ones not written in English, Portuguese or Spanish.

Selection of studies and data extraction

The titles and summaries of all articles found through the search strategy were assessed independently by two investigators who were previously trained and instructed regarding the eligibility criteria. The summaries that did not provide enough information concerning the inclusion and exclusion criteria went through further analysis, in which the texts were fully evaluated by two investigators independently. Eventual disagreements during the evaluation process were sorted out by consensus between two evaluators. The data collected from the articles refer to the following items: authors, journal, language, country, date of publication, goals, sample, used intervention and results. All these data were recorded in files previously prepared for the current study. The main data considered for discussion was the effect of the intervention strategies on executive functions.

Assessment of risk of bias

The quality of the included studies was assessed through the Cochrane assessment tool (Higgins & Green, 2005) of risk of bias, which comprises seven domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcoming report and other sources of bias. The domains and risk of bias have been assessed and classified as low, high or unclear.

Data analysis

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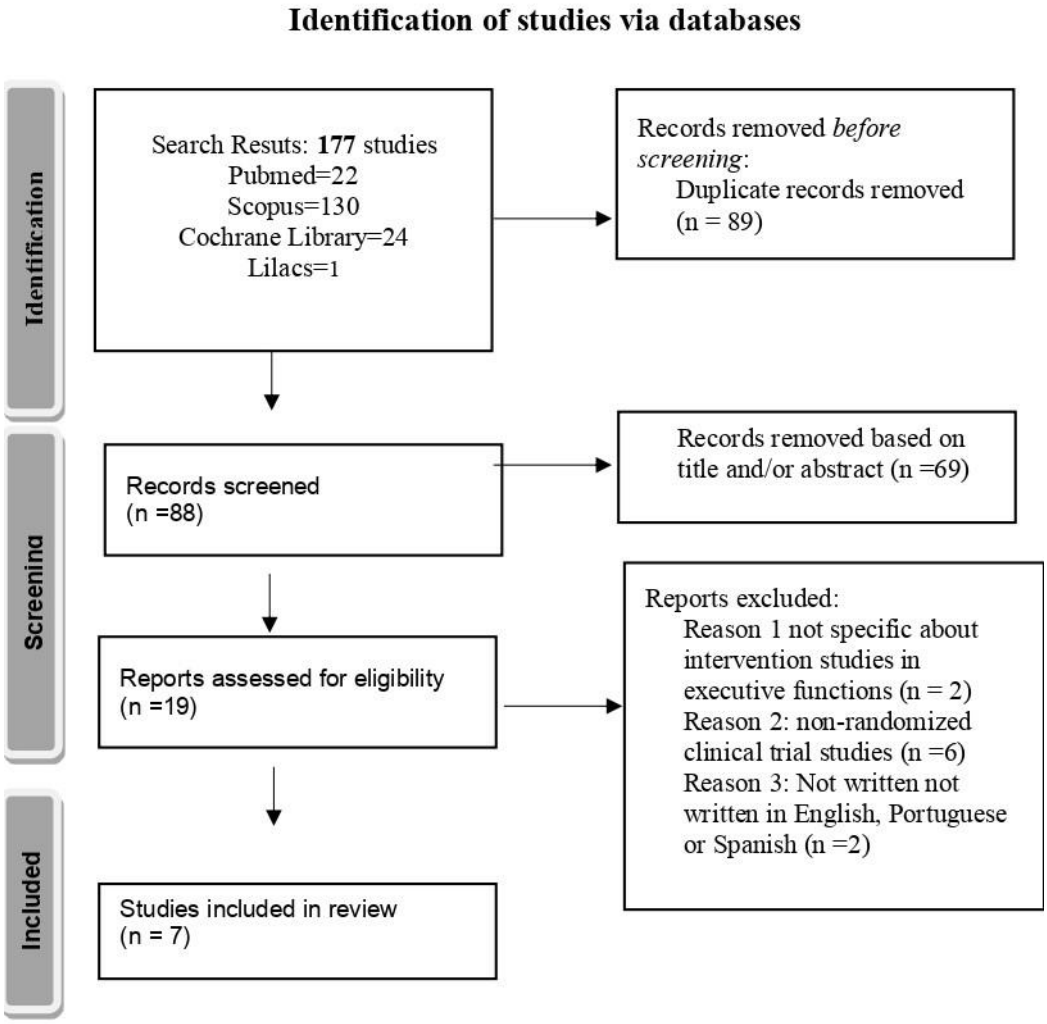
As to the model and effects of interventions on executive functions, language, performance, and academic skills, the current analysis was descriptive. Furthermore, the methodological features as well as the major evidences regarding the aims of the studies were reported.

Results

A total of 177 articles were identified over the databases searched. Of these, 19 met the eligibility criteria of this study, and subsequently were suitable for the complete reading. At the close of a detailed analysis, seven studies met the inclusion criteria and thus relevant for the sample of this work.

Figure 1 displays the flow diagram of the studies included in this review.



All included studies were published in English. As for the year, 71.43% of the studies (n=5) were published over the last five years and 28.57% (n=2) from 2006 to 2010. The United States and Iran were the countries with the highest number of titles, adding up 57.15% of publications. Table 1 displays the identification of the studies included in this review and its features, such as the sample and the main objective.

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Table 1.
Characteristics of the studies included in this review

Articles (authors, year)	Language and Country of Origin	Journal	Goal	Sample
Beck et al. (2010)	English (United States)	Journal of Clinical Child & Adolescent Psychology	Assess the effectiveness of an intensive working memory training on the symptoms of ADHD and/or learning difficulties and executive functions.	52 children and adolescents with ADHD and/or learning difficulties, aged 7 to 17. N=52 (11.75years, SD not found)
Bigorra et al. (2016)	English (Spain)	European Child & Adolescent Psychiatry Journal	Analyze the efficacy of a computerized training through the assessment of executive functions, learning, clinical symptoms, and functional impairment.	66 children and adolescents with ADHD, aged 7 to 12. Control group N=15 (9.0years ± 1.68) Experimental group N=21 (8.7years ± 1.75)
Chenault et al. (2006)	English (United States)	Developmental Neuropsychology Journal	Check the effects of attention training on children with reading difficulties.	20 children who met criteria for dyslexia, aged 6 to 10. N=20 (10.6years ± 0.87)
Esmaili et al. (2017)	English (Iran)	Basic and Clinical Neuroscience	Investigate whether a play-based intervention is effective on metacognitive and behavioral skills of EFs in students with specific learning difficulties.	49 children with learning disability, aged 7 to 11. Control group N=25 (8.5years ± 1.33) Experimental group N=24 (8.7years± 1.03)
Kirk et al. (2017)	English (Australia)	American Journal of Intellectual and Developmental Disabilities	Check the efficacy of a computerized attention training in children with intellectual disabilities and/or developmental problems.	76 children with intellectual disabilities and/or developmental problems, aged 4 to 11. Control group N=37 (8.6years± 1.86) Experimental group N=38 (7.7± 1.62)
Malekpour and Aghababaei (2013)	English (Iran)	International Journal of Developmental Disabilities	Investigate the efficacy of executive functions training on working memory, response inhibition in improving and academic performance of female students with spelling learning disabilities.	45 female students with spelling learning disability, aged 9. N=45 (9.4years, SD not found)
Westendorp et al. (2014)	English (Netherlands)	Medicine & Science in Sports & Exercise Journal	Investigate whether a ball skill intervention has effect on ball skills and executive functions as well.	91 children with learning disorders, aged 7 to 11. Control group N=44 (9.1years± 0.96) Experimental group N=43 (9.4years± 0.83)

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Most of the samples of the included studies (71.43%), are exclusively composed of children. The remaining ones (28.57%) contain mixed samples of children and adolescents. As child we understand individuals aged 0 to 11 years; as a teenager, individuals aged 12 to 18. The age range of the children's samples was extensive (4 to 17). Samples of the studies were comprised by individuals with a learning disorder. Table 2 displays the studies' features regarding the used instruments, the interventions and their effects, as well as the outcomes.

Table 2.
Characteristics of the interventions used in the studies

Authors	Instruments used to measure the EFs	Constructs measured	Summary of the intervention	Effects of the intervention	Results
Beck et al. (2010)	For parents: 1- Behavior Rating Inventory of Executive Function (BRIEF) - Parent Form; 2- Conners' Parent Rating Scale-Revised: Short Form; For teachers: 1- Conners' Teacher Rating Scale-Revised: Short Form; 2- BRIEF Teacher Form	-EF (Working Memory)	"WM Training" is a computerized training program which comprises activities for verbal and visual-spatial working memory. The training consisted of 25 sessions for nearly six weeks. Each session lasted approximately 30 to 40 minutes. The intervention was applied at home under the supervision of a parent or guardian.	1-ADHD Symptoms: After the treatment the experimental group was classified as less inattentive. 2- Executive Functions: The working memory assessment on the experimental group showed 33.3% clinically significant changes and 44.4% presented reliable changes.	Working memory training seemed promising as an intervention in improving the executive functioning and ADHD symptoms.
Bigorra et al. (2016)	1- Behavior Rating Inventory of Executive Function (BRIEF) 2- Digit span backward of the Wechsler Intelligence Scale for Children-IV (WISC-IV) 3- WISC-IV letter-Number Sequencing 4- Spatial span backward of the Wechsler Memory Scale-III (WMS-III) 5- Commission errors of Conners' continuous performance test (CPT II) 6 - Detectability of CPT II 7- Total correct score of the Tower of London 8- Perseverative errors on the Wisconsin card sorting test — 64	-EF (Inhibition, emotional control, initiative, working memory, organization and planning, shifting) -Language -Behavior	CWMT RoboMemo® (2005, Cogmed Cognitive Medical Systems AB, Stock-holm, Sweden) is a program which consisted of visuospatial, auditory and location memory and tracking of moving visual objects as WM tasks. Each training session included 90 trials and had a duration of 30–45 min. articipants attended 5 sessions per week over a 5-week period for a total of 25 sessions.	1- Between T1 (2 weeks) and T2 (6 weeks), the experimental group improved significantly more than the control group according to the Working Memory subscale (t = -2.73, df = 4, p = 0.01) with a large effect size (d' = -0.86, 95% CI -0.17 to -0.35). 2- The difference was also significant in T2-T0 (baseline) (t = -2.56, df = 4, p = 0.01) with a moderate to large effect size d' = -0.61, 95% CI -1.11 to -0.11). 3- Statistically significant results were found between T1 and T2 with regards to the planning/organization	This model of intervention had significant improvements in ADHD symptoms, EF scales and functional impairment.

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	(WCST-64) 9 - Trail making test — part B (TMT B)			subscale (t = -2.02, df = 4, p = 0.05) and the metacognition index (t = -2.25, df = 4, p = 0.03), with moderate to large effect sizes (d'= -0.71, 95% CI -1.21 to -0.21; and d' = -0.78, 95% CI -1.28 to -0,27).	
Chenault et al (2006)	1 - Delis-Kaplan Executive Function System	-EF (Attention/Inhibition) -Language	The intervention had 2 phases of 10 sessions each. In the first phase participants completed 25 minutes sessions, whereas the second one lasted 55 minutes. There were two groups - the intervention group (attention training -Pay Attention! (Thomson et al., 2001) and the control group (training in reading fluency-Read Naturally Ihnot, (1997). Both groups were presented to written lessons with attention bridges. The intervention drew attention to the treatment of multi-sensory language structured for reading deficits.	1-The attention training group did not show greater improvement in attention when compared to the of reading fluency group. Similarly, the reading fluency group did not show any improvement on the reading rate nor on the accuracy when compared to the attention. 2- Both groups showed similar levels of progress in measures of attention and reading tests. 3- The attention training group showed significantly more progress on writing than the reading fluency group.	The "Pay Attention!" training prior to composition instruction coupled by attention bridges activities was the most effective on improving composition writing.
Esmaili et al. (2017)	1 - BRIEF (The Behavior Rating Inventory of Executive Function)	-EF (Inhibition, emotional control, initiative, working memory, organization and planning, shifting)	The protocol was supervised and validated by 5 teachers of Occupational Therapy, Psychology and Neuroscience, who were experts in the Specific Learning Disability field. The intervention was performed in groups of 3 to 5 students, daily, for 9 weeks. In each session, the number of activities	1- The BRI and MCI of BRIEF indices were significantly reduced in the intervention group. The lower scores on BRIEF represents less impairment in EFs. 2-There was little variation in the scores between the pretest and posttest measurements in the control group (BRI = 0.16; MCI = 1.04), but	There was no change in scores regarding the cognitive and behavioral skills on BRIEF scale. The playful therapy was effective on metacognitive and behavioral aspects of EF in students with

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			varied according to the goal. Two therapists (psychologist and occupational therapist) were responsible for implementing the program.	there was a large change in the intervention group (BRI = 8.52; MCI = 15.32). 3- After the pre-test differences the intervention and control groups were significantly different in terms of both BRI (P < 0.05) and MCI (P <0.05) of BRIEF. 4- F values between group variables of BRI and MCI were 11.16 and 6.24, respectively. 5- BRIEF profiles of the groups were significant (THotelling = 0.25; F = 5.51; DF = 2. 44; P < 0.05; η2 = 0.20). The intervention effect size was 0.20 for MCI and 0.12 for BRI - indices considered in the middle to large category.	specific learning difficulties. Professionals can use this therapy as an alternative to traditional educational approaches in clinical practice to improve EF skills.
Kirk et al. (2017)	1 - BRIEF: The Behavior Rating Inventory of Executive Function questionnaire (Gioia, Isquith, Guy, & Kenworthy, 2000) 2 – WMRS The Working Memory Rating Scale (Alloway, Gathercole, & Kirkwood, 2008) 3 - Automated Working Memory Assessment (AWMA; Alloway, 2007). The short form of the AWMA. 4 - Conners 3 Parent Rating Scale (CPRS; Conners, 2008)	- EF (Inhibition, emotional control, initiative, working memory, organization and planning, shifting)	The Training Attention and Learning Initiative (TALI) is an attention training program specifically designed for children with intellectual and development disabilities to be held at home.The sample was divided into 2 groups: Intervention in attention and control group. The sessions were held once a day, 5 days a week for 5 weeks (25 sessions). Each training session lasted approximately 20 minutes.	Average scores were submitted and standard deviations for the outcome measures on each occasion (baseline, post-training, and 3 months follow-up). There was no evidence suggesting that the attention training improved executive functions skills, behavior and/or academic skills, such as vocabulary, phonological skills or cardinality.	The training program was unsuccessful on the improvement of the skills such as literacy, executive functions and behavioral/emotional problems.

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Malekpour and Aghababaei (2013)	1 - NEPSY test	- EF (working memory, response inhibition) - Academic performance (spelling)	The intervention lasted 8 weeks, with 20 sessions of 60 minutes each. Three groups were established (two experimental groups and one control group). Experimental group 1, received working memory training while experimental group 2 received response inhibition training.	1-The posttest scores for EF were higher in the experimental groups. G1 pre -7.33 (4.41) and post 9.73 (2.46). G2 pre -7.13 (1.59) and post 9.66 (1.83). Control pre-7.26 (2.31) and post 7.73 (2.21) 2-The post-test scores for academic achievement were higher in the intervention group compared to the control group. G1 pre-5.53 (2.79) and post 11.66 (2.34). G2 pre -6.43 (4.02) and post 13.63 (3.42). Control pre 7.86 (3.39) and post 8.53 (2.72). 3- The results of Mancova analysis indicated that there was significant difference (P < 0.000) among the three groups on the post-test for EF and academic performance. 4- The training resulted in an improvement of 21% to 51%, considering a proper sample size.	It shows that the executive functions training on working memory and response inhibition can improve executive functions and spelling performance of the students.
Westendorp et al. (2014)	1 - The Tower of London (TOL) 2 - Trail Making Test (TMT)	-Ball skills -EF (cognitive flexibility and problem-solving) -Learning	The intervention consisted of 32 sessions, twice a week, for 16 weeks and focused on the improvement of 6 ball skills (strike, bounce, catch, kick, throw and roll). Each session lasted approximately 40 minutes and was conducted by two teachers for a group of 16 children.	1-The results showed a significant effect of the group (intervention or control) on ball skill performance, favoring the intervention group on the post-test (P < 0.0001) and on the retention test (P = 0.002). 2- No intervention effects were found on the cognitive parameters. 3- In the intervention group it was obtained a positive correlation	The intervention demonstrated to be an effective tool to improve ball skills of children with learning disorders. Additional research is still needed to examine the effect of the intervention of the ball skill on the cognitive parameters in

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	between the change in ball skills from pre-test to posttest and the change in the problem-solving performance from pre-test to retention test (r = 0.41, P = 0.007). This indicated that the larger the improvement in ball skills from pretest to posttest, the larger the improvement in problem-solving performance from pre-test to retention test. 4-No significant correlations were found between the Tower of London performance and the changes in learning (all P values > 0.05) in the intervening period, and 6 months after the intervention.	this population.

Table 2 presents the variety of the constructs regarding the EFs. WM and inhibition were the most frequent constructs and were present in 5 of 7 studies. The interventions made use of different methods. Three models used computerized structured tasks, and CWMT was the only structured intervention in WM, which was used in more than one study (Beck, Hanson, Puffenberger, Benninger, & Benninger, 2010; Bigorra, Garolera, Guijarro, & Hervás, 2016). Other 3 studies presented models using playful activities, which were created by the researchers. Regarding the period the interventions they ranged between 5 (Bigorra et al., 2016; Hannah Kirk, Gray, Ellis, Taffe, & Cornish, 2017) and 16 weeks (Westendorp et al., 2014). Only one study did not report the time of the intervention in weeks.

The studies employed a wide variety of instruments to measure the EFs. Among them, only four instruments were used in more than one study. The most widely used instrument for evaluation of EFs was "The Behavior Rating Inventory of Executive Function (BRIEF)", which was used in four studies (57.14%). Another issue was the variety of diagnoses involving learning disorders sometimes associated to dyslexia, ADHD, intellectual disabilities and developmental problems.

Regarding the quality of the included studies, based on the Cochrane tool, there was an assorted methodological quality. The main problems found were related to the randomization, blinding and description of loss and exclusions, which generated inconsistency of results in some studies. Table 3 shows the detailed results.

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Table 3.
Risk of Bias

Quality of the studies	Generation of random sequence	Allocation concealment	Participants and professionals blinding	Outcome assessor blinding	Incomplete outcomes	Selective outcome report	Other sources of bias
Authors							
Beck et al. (2010)	High	High	High	High	Low	Low	Low
Bigorra et al. (2016)	Low	Low	Low	Low	Low	Low	Low
Chenault et al. (2006)	Unclear	Unclear	Unclear	Unclear	Low	Low	Unclear
Esmaili et al. (2017)	Unclear	Low	Unclear	High	Low	Low	Low
Kirk et al. (2017)	Low	Low	Low	Low	Low	Low	Low
Malekpour and Aghababaei (2013)	Low	Unclear	Unclear	Unclear	Low	Low	Low
Westendorp et al. (2014)	Unclear	Unclear	Low	Unclear	Low	Low	Unclear

Discussion

The importance of the development of executive functions to the improvement of the intellectual skills of children has been well established in the literature (Duncan et al., 2017; Germano et al., 2017; Shayer et al., 2015). Several authors have been conducting studies in this area and have specifically related the working memory as a predictor of school performance in domains as content progress and task complexity increase (Dias et al., 2010; St Clair-Thompson & Gathercole, 2006). In accordance to that, the findings of this review reassert that "WM Training" has been one of the most frequently evaluated constructs used in interventions (Beck et al., 2010; Bigorra et al., 2016; Esmaili et al., 2017; Hannah Kirk et al., 2017; Malekpour & Aghababaei, 2013). Moreover, it is the only one with a specific structured intervention used in more than one study (Beck et al., 2010; Bigorra et al., 2016), which allows it to be reproduced in other populations as well as replicate the studies.

The intervention called "WM Training" is a computerized training program which comprises 25 sessions (around six weeks) of 30 to 40 min each. Each session includes 15 tests for each one of the 8 CWMT RoboMemo® daily exercises for the working memory (2005, Cogmed Cognitive Medical Systems AB, Stockholm, Sweden). The exercises consist of verbal and visuospatial working memory tasks. In the described studies (Beck et al., 2010; Bigorra et al., 2016), the training increased or decreased the difficulty of each exercise according the child's performance. Both studies embraced a population made up of children and adolescents with ADHD diagnosis. The intervention was applied at home under the supervision of a parent or guardian and used, at least, one of the same EF evaluation tools. The results for both studies were significant for the experimental group with emphasis on Bigorra et al. (2016) research group's work due to its well described results and low risk of bias (as presented in tables 2 and 3). The strongest effects were observed in the primary outcome in the long term, through different

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scales of EFs (parents and teachers), as well as through instruments used directly with children and adolescents. The outcomes are in accordance with another review study carried out (Rapport, Orban, Kofler, & Friedman, 2013) which suggests that a rigorous methodological design with long-term follow-up and high intensity training is the key to identify "far-transfer effects".

Regarding the study previously cited (Beck et al., 2010), the results showed an effect (moderate to strong) on the parents' evaluations in relation to the symptoms of ADHD and inattention. Also, a part of the sample (a quarter to half) presented statistically significant changes in measures of EF. Despite of that, the lack of blinding of the evaluators and parents, as well as the lack of information on the form of allocation concealment, are factors that increased the risk of bias and may have compromised the quality of the study. Another significant factor was the use of an instrument that assessed only the parents' perception towards the child, disregarding the possibility to assess the children's EF skills directly. This may have led to different results - as the study did not have the blinding of those parents it could have provided biased results on the intervention group.

The results of the above studies restate other studies regarding the predictor role of the WM in aspects related to language, such as writing. There was a performance improvement in the academic skills of children and adolescents (Altemeier, Abbott, & Berninger, 2008; Jacobson, Williford, & Pianta, 2011; Kellogg, Turner, Whiteford, & Mertens, 2016). Malekpour and Aghababaei (2013) claim that the WM is largely important in the writing process, as it allows the writer to use multiple cognitive tasks at once, such as maintenance of diverse ideas, recovery of memory information, and management of concurrent processes. This ability increases with the growth and is stimulated by means of specific activities (Diamond & Ling, 2016). An example of that are school activities that call for autonomy, attention and organization resources. Activities which demand goals settling and planning for their execution, as well as flexibility to pursue alternative strategies are examples that require a proper EF functioning (German et al., 2017).

On the other hand, when the individual does not feature the expected development according to his/her intellectual potential or if there is any complication that impairs his/her fully development, there may appear learning difficulties (Dias et al., 2010). The literature on learning difficulties, especially regarding neuropsychological aspects, highlights the role of executive functions in the learning process, and hence the deficit of these functions in learning disability, in addition to linking those difficulties with academic performance (Altemeier et al., 2008; Kellogg et al., 2016). As a result, interventions in EF have been increasingly studied in children with various diagnoses associated with low academic performance and/or learning difficulties.

Regarding the other interventions found in the current review, there is a large variability concerning the methodologies. Regarding the computerized intervention, Kirk et al. (2017) published previous studies (Kirk, Gray, Riby, & Cornish, 2015; Kirk, Gray, Ellis, Taffe, & Cornish, 2016) using the program of daily tasks, specifically concerning attention. This program, termed as The Training Attention and Learning Initiative (TALI) is presented in table 2. As opposed to the results found in the studies described (Beck et al., 2010; Bigorra et al., 2016), the TALI training program failed in promoting non-trained skills such as literacy, executive functions and emotional/behavioral problems. This may be related to the type of task and/or construct addressed to population assessment. Taking into account their prior study (Kirk et al., 2016) and a review of interventions carried out by the same group of researchers (Kirk et al., 2015), it can be considered that it is necessary an improvement of the training program in order to promote significant and embracing improvement. Despite the considerable discrepancies regarding the intervention effects reported, these inconsistencies might be attributed to flaws in the program and in the design of the study.

The review published by Kirk et al. (2015) also makes references to the Attention Training - Pay Attention! intervention (Thomson, Kerns, Seidenstrang, Sohlberg, & Mateer, 2005), used by Chenault, Thomson, Abbott and Berninger (2006), in children diagnosed with dyslexia. Although this attention training program used a specific instrument to assess EFs, the focus of the study and description of its results pointed out to the academic skills of reading and writing. The results indicated that students who initially received the Pay Attention! and instructions beforehand, progressed more than those in the control group. However, the training program alone was not enough, as the gains were not observed until additional instructions were introduced. The analyses of the results of different attention training programs indicate improvement on the EFs (Rapport et al., 2013; Steiner, Sheldrick, Gotthelf, & Perrin, 2011) and on the WM (Kray, Karbach, Haenig, & Freitag, 2012). However, despite these effects seem promising, the lack of objective measures hinders the attribution of improvement in cognitive processes.

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Within the scope of seven included studies, three carried out interventions with playful activities (Esmaili et al., 2017; Malekpour & Aghababaei, 2013; Westendorp et al., 2014). Malekpour and Aghababaei (2013) and Esmaili et al. (2017) Iranians studies presented interventions based on more recreational tasks. In both cases the training description was not enough to be properly evaluated and, as there was no protocol available, it could not be reproduced by another research group. That was the case of Malekpour and Aghababaei (2013), who performed a working memory and response inhibition training. The WM training included auditory and visual memory reinforcement tasks, by means of following instructions, movie playback, memorizing and recalling a list of words, and testing and meta-cognitive strategies. Alternatively, the response inhibition training was conducted through specific following instructions tasks, such as playing ball toward a circle and the maze task within settled time. In addition to the training, each student received a set of chores to be done at home (homework). As for the results, scores for EF and the grading for academic performance were significantly better for the intervention group (Table 2).

The study of Esmaili et al. (2017), showed an intervention protocol containing recreational activities, which were selected by reviewing the play history of participants and some books about the children's play. The selected play activities were analyzed in terms of EF components. The protocol was supervised and validated by five teachers of Occupational Therapy, Psychology and Neuroscience who were experts in the field of Specific Learning Difficulty (SLD) and implemented by two therapists (an occupational therapist and a psychologist). There was a rigorous training and monitoring of the evaluators, including recording sessions for later discussion. Daily meetings with them and the therapists who were responsible for the program were held. The results obtained in this study showed a significant difference between the pre-test and post-test of the intervention groups, and between the intervention and the control group. Furthermore, it showed the extent of the intervention effect (moderate to large), as displayed in table 2. That suggests that professionals could use this therapy as a promising alternative to traditional approaches.

In both studies, through the inference of the results, there is a consensus (Diamond, 2013) about EFs being skills that can be improved at any age through training and practice. Likewise, they are important skills to achieve success in all aspects of life, and sometimes they might be more predictive than the IQ or the socioeconomic condition of the individual. However, many issues are still on discussion. It is unclear whether the benefits of training are superficial and/or for how long they can be kept, what are the best methods or to what extent individual features influence the outcomes. Moreover, it is still an undergoing matter whether physical and emotional health conditions, such as stress, sadness, and loneliness influence EFs. It has been inferred that the most successful approaches should encompass the emotional, social and physical demands (Diamond & Ling, 2016; Pesce et al., 2016; Schmidt, Benzing, & Kamer, 2016).

In regard to this discussion, there are other studies which look for associations between physical activity and cognition. That is the case of the systematic review carried out by Donnelly et al. (2016), in which several evidences were found suggesting that there are positive associations between physical activity, fitness, cognitive and academic performance.

Based on the available evidences, the authors concluded that PA has a positive influence on cognition, as well as brain functions and structure. Although it is necessary to carry out more researches to determine the mechanisms and the long-term impact, the category rating is B, thus PA is recommended. Since there was significant evidence in the outcomes, the conclusion is that there is benefit in choosing the action over the eventual damages. Likewise, according to Donnelly et al., 2016; Rosenberg & Donald, 1995, there is reasonable evidence to support the recommendation. Within this context the study of Westendorp et al. (2014), also included in this review, presented results of an intervention involving the development of motor skills to stimulate the development of cognitive abilities. The study comprised tasks with ball in which the teacher served as mediator meaning that this instructor monitored, guided and facilitated the learning process in children, individually, through the manipulation of task constraints. For example, the professor increased the distance to a basket for the children who were successful in scoring goals and vice versa. The intervention focused on teaching ball skills in a structured way, which means that the ball skills were first practiced in more simple and static settings with exercises like throwing and catching. These simple exercises in static scenarios aimed at the automatization of the skills, since it enables children to apply these skills to participate in ball games that require more advanced and cognitive skills (Wall, 2004). Afterwards, the tasks became more complex, such throwing, catching and bouncing during a ball game, respecting the time and game rules. These are skills that entail more cognitive engagement than simple exercises (Valentini & Rudisill, 2004). However, although the study found a positive correlation between the change in ball skills from pre-test to the post-test and the change in problem solving performance from pre-test to retention test, the results obtained were not enough to infer that the suggested approach has an effect on cognitive parameters.

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Another important issue is related to the instruments used to assess the EFs in the included studies. Most of the researches used the "Behavior Rating Inventory of Executive Function (BRIEF)". The procedures are made up of questionnaires - one for parents and another for teachers. Both questionnaires consider their perception regarding the child's performance. That would be just one of the ways of measurement, yet it is also important improving the assessment by instruments which take into account the child's tasks performance. That is the case of the "Wisconsin Card Sorting Test (WCST)", which is considered the "gold standard" test for EF assessment. The preference for other instruments may be justified due to the ages of the samples, which are often under the age of WSCT indication (from 8 years on). However, there are still other instruments such as the Trail Making Test and the Tower of London, which directly assess children in various age groups and that are already well established over the literature (Lezak et al. .2004; Malloy-Diniz et al., 2010). Nevertheless, few studies used these tools and only one of them made use of one of WCST tasks.

It is relevant to mention the method in which the individual's diagnosis was carried out. No standardization in the assessment was noticed. In some cases, the assessment was held through the parents' responses in specific instruments, situation in which the child was not directly evaluated (Beck et al., 2010). In some others cases it was held by querying the diagnostic criteria at the DSM-V for a particular disorder (Bigorra et al., 2016). This kind of assessments undermine the specificity of the sample as well as its generalization. Therefore, the more reliable evaluations and classifications are the ones carried out through standardized instruments and/or by trained professionals. The literature (Primi, 2010) advises a global assessment process for the diagnosis, which includes a clinical observation combined with psychological testing.

Conclusion

In view of the effectiveness of the interventions in EFs and the description of their main features, the current review found a variety of interventions organized as recreational tasks, from which just one was structured and registered as to allow its reproduction. Accordingly, interventions with application protocols which may be used in various contexts and which cover the three integrating constructs of the executive functions are required. We also noted that the configuration of the assessments in the studies was also extremely varied, and it was not standardized.

On the top of that, we bring attention to the fact that some limitations as the diversity of instruments for EF constructs are due to the area, since it is a relatively recent field of study which has been in expansion. Other limiting point was the small number of randomized controlled trials and the lack of detailed information on the methods used, which can affect the internal validity of the study. The intention to perform a meta-analysis was hindered by the heterogeneity of the intervention programs, as well as the evaluation instruments, and the limited number of studies found with the chosen descriptors.

As a conclusion, this review brings the outcomes of a broad search of studies that have already been carried out until the current moment. It is recommended a reading this study especially for presents some important considerations about the effects and the effectiveness of interventions on EFs in children and adolescents with learning difficulties.

All professionals who work or study childhood need to know the importance of EF because they are considered essential for the skills regulation in the social, intellectual and emotional areas. They have a direct influence on academic performance and the learning process.

This study intends to instigate the reader about the need to expand RCT research in the neuropsychology area. They constitute a powerful tool for the assessment of health interventions for health, whether drug or not.

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