Effects of an executive function programme (PEFEN) on preschool children: a pilot study

Authors:

María Nieves Pérez-Marfil [1], Manuel Fernández-Alcántara*[2], Raúl López-Benítez [3], Miguel Pérez-García [1], María Purificación Pérez-García [4] & Francisco Cruz-Quintana [1]

Affiliations:

1. Mind, Brain and Behavior Research Center (CIMCYC), University of Granada, Spain

2. Department of Health Psychology, Faculty of Health Sciences, University of Alicante, Spain

3 Department of Psychology, Faculty of Education and Social Work, University of Valladolid, Valladolid, Spain

4 Department of Didactics and School Organization, University of Granada, Spain

***Correspondig Author:**

Manuel Fernández Alcántara. Dpto. de Psicología de la Salud . Facultad de Ciencias de la Salud. Edificio Departamental de Ciencias Sociales. Universidad de Alicante. Ctra. San Vicente, s/n 03690 – Alicante, Spain

Email: mfernandeza@ua.es

Accepted for publication in Journal for the Study of Education and Development

(17.05.203)

Effects of an executive function programme (PEFEN) on preschool children: a pilot study

Abstract

The objective of this study was to test the effectiveness of a programme for the stimulation of executive functions (*Programa para la Estimulación de las Funciones Ejecutivas* - PEFEN) in preschool children (aged 5 years) with no pathologies. A total of 40 children participated. They were distributed into two groups (intervention and control groups) and were evaluated at two different moments in time (before and after the intervention) using the Child Neuropsychological Maturity Questionnaire (CUMANIN) and the Behavior Rating Instrument of Executive Function-Preschool (BRIEF-P). The programme's duration was three months. The results revealed statistically significant differences between both groups in the subscales of psychomotricity, spatial structuring and visual perception of the CUMANIN as well as in the emotional control subscale of BRIEF-P. In conclusion, the Intervention Group presented higher scores in different neuropsychological domains related to executive functions. This research seems to suggest that programmes such as PEFEN may be useful to improve and stimulate the EFs of normal developing children who do not present any difficulties.

Keywords: intervention programme, executive functions, neuropsychological evaluation.

Introduction

Executive Functions (EFs) are a set of skills involved in the generation, supervision, regulation, execution and readjustment of appropriate behaviours in order to achieve complex goals or develop action plans (Gilbert & Burgess, 2008). They are essential to a person's cognitive development from a very young age. Indeed, they make it easier to adapt to new and complex situations, going beyond usual and automatic behaviours, and they allow establishing objectives, developing action plans, or self-regulate behaviour (García-Molina et al., 2009). They are dependent on three basic types of skills that are already present in the first years of life: inhibitory control (the ability to voluntarily inhibit an automatic response), working memory (monitoring, manipulation and updating of information), and cognitive flexibility (ability to switch between tasks or mental operations) (Diamond et al., 2007). In this sense, EFs contribute to inhibit irrelevant information and to operate both one's sustained and selective attention system, as well as verbal and non-verbal working memory throughout decision-making processes.

EFs are necessary to develop school skills and to perform school activities, such as planning and temporal organisation, identifying key ideas, changing tasks as required, or monitoring the work done. On this matter, several studies have shown that EFs are predictors of academic performance and reduce the occurrence of behavioural problems (Cortés-Pascual et al., 2019). Importantly, disturbance or deficits related to these functions could be associated, among others, with attention difficulties in class, problems with completing tasks, not inhibiting impulsive behaviours, impeded ability to acquire new behavioural repertoires, learning demotivation and struggling to meet school requirements (e.g., Morgan et al., 2019). Therefore, the training of EFs is an

essential aspect to consider in the curriculum and play a role in enhancing school performance and reducing social inequalities (Diamond & Ling, 2016).

Neuropsychological assessment at preschool age is essential to detect neurodevelopmental problems and to be able to assess the effect of intervention programs. There are few tests for the assessment of executive functions in children under 6 years of age. The BRIEF-P assesses EFs behavioural manifestations in preschool children, although it is an indirect measure because it is not completed by the children, but by parents and/or teachers (Gioia et al., 2000). The CUMANIN assesses various areas of neuropsychological functioning, including sensory-motor development, memory, learning and language, which are of great importance for detecting possible neurodevelopmental difficulties (Portellano et al., 2000). The CUMANIN is completed by children and includes tasks to assess areas related to executive functions such as spatial structuring, visuoperception, comprehension language and verbal fluency. Along with the assessment of EFs it is also important to consider other variables that may have a direct influence on them. For example, there are many studies indicating how the educational level of parents (especially of mothers), their intelligence and EFs scores may impact on the stimulation levels of the children and thus affect their EFs development (Muñoz-Vinuesa et al., 2019; Ribner et al., 2022). The role of EFs and psychopathology is also well-known, with recent theoretical proposals suggesting the existence of a relation between EFs, stress and psychopathology due to the role that EFs had in learning and adaptation, as well as in agency and intentional action (Zelazo, 2020).

Nowadays, some specific EFs stimulation programmes for both primary and preschool children have recently been developed (Takacs & Kassai, 2019). Some of these programmes are based on methodologies that include computer tasks, paper and

pencil tasks, or a combination of both. In some cases, they are (or could be) integrated into the school curriculum (Cardoso et al., 2018). These latter programmes are implemented by the teachers themselves and incorporate activities in which students work simultaneously and globally on multiple aspects of EFs (Cardoso et al., 2018). In addition, they seem to be more generalised due to their more ecological mode of implementation (Traverso et al., 2019). Diamond and Lee (2011) identified different classroom curricula interventions that have proven to be effective for the improvement of EFs: (a) the *Tools of the Mind* (Tools) based on the use of games for training inhibition, memory, flexibility and creativity; (b) *Montessori approach*, which includes activities not directly related to EFs as well as active meditation; (c) the *Promoting Alternative Thinking Strategies* (PATHS) focused on self-control, regulation of emotion and interpersonal problem-solving; and (d) the *Chicago School Readiness Project* (CSRP), whose objectives were stress-regulation and behaviour management. However, a recent review highlights how these kinds of interventions are scarce, especially at preschool, due to their relative novelty (Cardoso et al., 2018).

Initial indications of the utility of these interventions in Spain were recently published. For example, Romero-López et al. (2021) showed the efficacy of an EFs stimulation programme (*Programme for the improvement of executive functions in Preschool*; EFE-P) in children aged 5 and 6 years who were evaluated using the Behaviour Rating Inventory of Executive Function-Preschool Version (BRIEF-P). For instance, Cruz-Quintana and colleagues (2014) develop a specific EFs stimulation programme integrated in the school curriculum (*Programa para la Estimulación de las Funciones Ejecutivas* - PEFEN) which has been proven to be useful and effective in preterm infants, aged four and five years, to improve motor, neuropsychological and

behavioural aspects (García-Bermúdez et al., 2019). These types of programmes are highly cost-effective and the teacher training required is simple and intuitive.

The PEFEN Programme is based on the EFs theoretical models of Adele Diamond (Diamond & Lee, 2011) and the rehabilitation model of Shonkoff (2011), according to which not only should children's learning conditions be facilitated, but concrete skills and trainings for children should also be implemented to strengthen development, avoiding the effects of "toxic stress". EFs reach their peak development between 12 and 18 years of age but are present from the earliest years of life (Diamond et al., 2007). Not only do many children start school already deficient in the necessary executive functions skills, but also research has shown that preschool children who are at risk due to economic disadvantage have low executive functions relative to other cognitive functions and relative to children from middle-class homes. These are children who fall progressively further behind in academic achievement over the school years. Early training focused on improving these skills is essential to enhance school performance and reduce social inequalities (Diamond, 2013). PEFEN's approach to stimulate EFs is based on the construction of different types of group and individual activities that integrate several of its components: working memory, inhibition/self-control and flexibility.

Furthermore, the PEFEN programme provides a conceptualisation of the components that require practice (operationalised through demands that become progressively more difficult) and incorporates tasks that involve changes, are dynamic, have to be carried out quickly and /or are novel for children (García-Bermúdez et al., 2019). The program is divided into 5 modules with specific tasks for each one. The activities are programmed to increase in difficulty each month, and group activities and individual activities are scheduled for each child. The characteristics of the program

tasks can be summarized as follows: (a) to make it possible to play with ideas; (b) to take time to think before acting (turns); (c) to make possible a challenge to measure anticipation or inhibitory control; (d) to involve games where children must inhibit their behaviour and thus measure their resistance; (e) to maintain concentration and working memory; (f) to involve creativity activities; (g) to promote cognitive flexibility where the child must adopt different perspectives on objects and/or situations and make changes quickly; (h) to include tasks in which children can make mistakes and thus enable the exercise of recognizing them and restructuring new responses; and (i) to include tasks focused on inhibiting attention/action, thoughts and emotions. *Mindfulness* is included because it has been shown that its practice in school-aged children favours the development of EFs, especially changes in behavioural regulation, metacognition, and overall global executive control (Flook et al., 2010). The exercises proposed within this category are diverse, but they all share the training of attentional functions in the present moment.

The usefulness of this programme has not yet been tested in educational contexts with children without pathologies. The objective of this study was to verify the effectiveness of the PEFEN programme in preschool children without neuropsychological difficulties. Following previous studies (Diamond & Lee, 2011; García-Bermúdez et al., 2019), improvements in core EFs (such as flexibility, inhibition and working memory) and other neuropsychological variables associated with them were generally expected in children who participated in the PEFEN programme (Intervention Group) compared to those who undertook curricular activities (Control Group).

Materials and Methods

Participants

An intentional sampling was conducted in which 46 children from two classes of children aged 5 years in an Early Childhood school in Granada province (Spain) initially took part. As the study unfolded, 3 participants dropped out due to a change of school and another 3 were excluded because they were not native Spanish speakers and had little command of the language (see Figure 1). The final sample was composed of 40 boys and girls aged 5 years who were distributed as follows: 11 boys (61.1%) and 7 girls (38.9%) in the Intervention Group (class 1) and 14 boys (63.6%) and 8 girls (36.4%) in the active Control Group (class 2). No significant differences were observed between the groups in relation to sex ($\chi^2 = 0.870$, $p = .564$).

The inclusion criteria were: (a) to be 5 years of age; (b), to not present any neurological problems nor any previously diagnosed psychological or learning disabilities; and (c), to have the mother's informed consent to participate in the study. The exclusion criteria were: (a) could not speak fluent Spanish; and (b) not being able to complete at least 75% of the programme due to illness, travelling or other similar reasons. In addition, all the mothers of the children in both groups had to participate by completing different questionnaires.

INSERT FIGURE 1

Instruments

Instruments completed by mothers

Sociodemographic and behavioural data relating to executive functions

An *ad hoc* survey was designed in which mothers were asked their age, educational level and occupation, as well as a total of 15 of their child’s behaviours

linked to attention, impulsivity, frustration, patience, tranquillity, anger, capacity for reflections, emotional regulation, task switching and problem solving. Specifically, mothers were asked if in the last 3 months they had observed changes in their children in behaviours related to EFs (examples: *Have you noticed in the last 3 months if your child is more attentive?; Have you noticed in the last 3 months if your child has problems changing activities?*). A final question asked whether the mothers had observed changes in their child's behaviour in general (*Has your child's behaviour improved considerably; has it improved; has there been no change; has it worsened; or has it worsened considerably?*). These items collected examples of the activities that had been trained in the program. The survey had an adequate reliability in the present sample (Cronbach's $\alpha = .70$).

G-Factor Test (Cattell & Cattell, 1990)

This instrument evaluates nonverbal aspects of intelligence in adults based on 4 tests. In the first, participants have to find out the correct figure in a logical series ("Series"); in the second test ("Classification"), individuals have to identify the different figure in a set of 5 figures; in the third sub-test ("Matrix"), they have to complete a figure with the option that matches the rest of the elements; in the last test ("Conditions"), adults choose the figure or drawing that fits the characteristics of an example. Participants had 5 minutes to complete the first two tests and 4 minutes for the remaining two. In the present study, sub-tests were taken as a measure of caregiver intelligence. The reliability of the Spanish version fluctuated between $\alpha = .70$ and .80, with test-retest values of $r = .50–.60$ (Cattell & Cattell, 1990).

Behavior Rating Instrument of Executive Function-Preschool (BRIEF-P; Gioia et al., 2000)

This tool enables to assess EFs behavioural manifestations in preschool children. The measure efficiently collects observations from parents and teachers on their children's self-regulating behaviours in their daily lives in a number of related subdomains, including: difficulties in the ability to inhibit impulses; impediments to changing situation flexibly within a given task or from one task to another; problems in controlling and regulating emotions; struggling to keep information in working memory; difficulties in initiating, planning and organising problem-solving; monitoring their task's execution; and behaviour performance. Lower scores indicate better EFs. Recent research confirms the internal consistency of this instrument across all five subscales with a Cronbach's α between .76 and .95 (Holth et al., 2015).

Child Behaviour Checklist for Children aged 1½-5 (CBCL; Achenbach & Rescorla, 2004)

The CBCL is a self-report instrument that serves to obtain information on aspects related to children's psychopathology through their caregivers. This tool, which can be completed within 25-30 minutes, evaluates a total of eight dimensions that are grouped into Internalising and Externalising Problems. They include: anxiety/depression; isolation; somatic complaints; social problems; thought disturbances; attentional disorders; norm-breaching and aggressive behaviour; as well as Social Competencies through three aspects (activities; social; and school dimensions); as well as various problems referred to in the DSM-5. In the present study, only the values prior to the intervention in the dimensions of Internalising Problems, Externalising Problems and Total Problems were taken into account as control measures and compared between groups in the initial evaluation. The CBCL showed high test-retest reliability (r = .90) (Sardinero-García et al., 1997).

Instruments completed by children

Child Neuropsychological Maturity Questionnaire (CUMANIN; Portellano et al., 2000)

This preschool age neuropsychological maturity test was specifically designed for children aged 3 to 6 years. It includes a total of 13 scales to assess the level of a child's neuropsychological maturity, as well as any signs of possible brain dysfunction, especially in cases in which the scores are significantly lower than those corresponding to the chronological age.

This instrument allows to obtain a developmental quotient formed by the results obtained in 8 main scales and 5 additional ones: 1) Psychomotricity (11 items; e.g., touching the nose with the finger); 2) Language articulation (15 items; e.g., repetition of words with increasing articulatory difficulty); 3) Language expression (4 items; e.g., repetition of 4 sentences of increasing difficulty); 4) Language comprehension (9 items; e.g., answering questions about a story); 5) Spatial structure (15 items; e.g., performing spatial orientation activities with increasing difficulty); 6) Visuoperception (15 items; e.g., reproduction of geometric drawings of increasing complexity; 7) Memory (10 items; e.g., memorizing drawings of simple objects); 8) Rhythm (7 items; e.g., reproduction of rhythmic series of increasing difficulty); 9) Verbal fluency (4 items; e.g., forming sentences from various stimulus words); 10) Attention (20 items; e.g., identification and crossing out of geometric figures); 11) Reading (12 items) Only for children over 5 years old; 12) Dictation (12 items) Only for children over 5 years old; and 13) Laterality (17 items) (assessment of the lateral predominance of the hand, eye and foot). In the present study along with the 8 main scales, the attention scale was also included, given the use of *Mindfulness* techniques in the program. The instrument's authors obtained Cronbach's alpha coefficient values that ranged from .71 to .92. It presents adequate internal consistency, a fact which was also reported in studies

conducted on the Spanish sample and a validation in the Peruvian population, being the α obtained in all studies above .66 (Portellano et al., 2000).

EFs Stimulation Programme (PEFEN; Cruz-Quintana et al., 2014)

This programme focuses on neuropsychological models (Diamond & Lee, 2011; Shonkoff, 2010) and the use of *Mindfulness* techniques (Flook et al., 2010). It stimulates children's EFs through play. The programme is composed of a series of activities that focus on: attentional aspects; working memory; the recognition of errors and restructuring of new responses; the inhibition of attention/action and the inhibition of thoughts or emotions; the continuity of concentration, flexibility, decision-making and creativity; or the ability to adopt different perspectives regarding situations or objects (for a review of the activities, see Cruz-Quintana et al., 2014; García-Bermúdez et al., 2019).

The total duration of the program was 3 months and it is composed of 5 modules, each lasting 30 minutes and containing specific tasks. It was incorporated into the students' classroom curricular activities. Therefore, it did not lead to any overload and did not interrupt the daily rhythm of the classes. The total duration of the intervention was 30 hours, with 20 sessions per month, i.e., a total of 60 sessions.

There were both group activities and individual activities, which were scheduled to increase in difficulty each month. The programme included two different activities each day (one focused on cognitive training and another on *Mindfulness*). These activities varied throughout the 5 weekly days to avoid monotony. Examples of the activities included in the PEFEN are: (a) *Orchestra:* children have to coordinate their actions in order to perform the sound of an instrument; (b) *Uses:* children have to creatively think in possible uses or utilities of certain objects; (c) *The drawing speak*: they have to create a story from a set of drawings following specific instructions; or (d)

Alternate Categories: children have to give examples of certain categories (such as "animal" or "fruit"). A full description of the activities and their difficulty levels can be found in Cruz-Quintana et al. (2014).

Curricular intervention for the control group children

To verify the programme's effects, the children in the control group performed curricular activities, though the tasks did not specifically target the stimulation of EFs. Examples of these tasks included: colouring numbers and letters; reading stories in small groups; and watching videos. The control group children engaged in these types of activities in parallel with the Intervention Group.

Procedure

First, a meeting was held with the mothers of the participating pupils to explain the study's objectives and procedure. The mothers then completed the BRIEF-P and the G-Factor test.

The teachers of both groups subsequently underwent their training. They followed the course simultaneously to become familiar with the programme, learning about its characteristics and how to implement it in the classroom. This training was provided by psychologists specialised in child neuropsychology and stimulation.

To start with, participants were assigned to the Intervention or Control Group and completed the CUMANIN for an initial evaluation. The participants never knew the group to which they belonged. Once the children were evaluated, the intervention programme was conducted with the children in the Intervention Group for three months while the Control Group participants pursued their normal class activities.

Three months later, the children were re-evaluated with CUMANIN. On this occasion, the mothers were asked to refill the BRIEF-P as well as to answer a survey

about their age, educational level, occupation and possible changes in their children's behaviour.

Data Analysis

First, descriptive analyses of means and standard deviations were performed for quantitative variables and frequency analyses for qualitative variables. Differences were analysed using the t-test (for independent samples and quantitative variables) and Chi-squared (for qualitative variables). Second, univariate analyses were carried out in order to check whether there were any differences regarding the measures of interest between the two groups before implementing the intervention. Finally, 2x2 mixed ANOVAs were performed and the differences between the Groups (Intervention vs. Control) and Temporal Moment (Pretest vs. Post-test) were evaluated. To measure the group's effect size, the Cohen delta was used. The data were analysed using the statistical package SPSS 24, being the significance level $p < .05$.

Results

Table 1 presents the descriptive results of both groups with respect to the caregivers' sociodemographic variables and the mothers' scores in the G-Factor test. No significant differences were found for any of the variables.

INSERT TABLE 1

Regarding the ANOVAs performed to check whether any differences existed between both groups with respect to the measures of interest before the intervention, no statistically significant differences were found between the Intervention Group and the Control Group in the dimensions of Internalising Problems, Externalising Problems and Total Problems of the CBCL (see Table 2) or in the dimensions of the CUMANIN or the BRIEF-P ($F < 1$; see Tables 3 and 4).

INSERT TABLE 2

Tables 3 and 4 show the means, standard deviations, effect size and the result of the differences between the groups, the evaluation's moment in time and the interaction of the different variables for the factors collected in the CUMANIN and BRIEF-P.

With respect to CUMANIN, statistically significant interactions (Group x Temporal Moment) were found for the variables of Psychomotricity ($F(1, 37) = 8.93$, $p = .005$), Spatial Structuring ($F(1, 37) = 5.03$, $p = .031$) and Visoperception $F(1, 37) = 8.95$, $p = .005$). These results indicated a greater improvement in the Intervention Group compared to the Control Group as a consequence of the intervention (pre-post conditions), with a moderate-high effect size for the Intervention Group (Psychomotricity: $d = -0.90$; Spatial Structuring: $d = -0.69$; and Visoperception: $d = -1.33$).

In addition, effects were found as a function of the Temporal Moment in Articulatory Language ($F(1, 37) = 7.43$, $p = .010$), Visoperception ($F(1, 37) = 6.58$, $p = .014$), and Attention ($F(1, 35) = 14.70$, $p = .001$), indicating an improvement in these variables when comparing the pre-test with the post-test in both groups. The values of the effect sizes in the Intervention Group ranged from moderate (Articulatory Language $d = -.74$) to high (Visoperception: $d = -1.33$).

With respect to BRIEF-P, statistically significant interactions (Group x Temporal Moment) were found for the Emotional Control dimension *[*$F(1, 34) = 4.67$, $p = .038$)]. These results indicated a decrease in Emotional Control scores in the Intervention Group ($d = .41$), as well as an increase in the Control Group ($d = -.24$). The latter thus indicated improvements in the first versus the second group regarding this variable.

Additionally, differences were found for the Working Memory factor for the Temporal Moment variable [$F(1, 34) = 5.69$, $p = .023$)], reflecting lower scores in the second evaluation with respect to the first one for the Intervention Group ($d = 0.69$). The latter suggests an improvement in this variable.

INSERT TABLE 3 AND 4

Finally, Table 5 shows the survey results for the items linked to changes in children's behaviours observed by mothers over the last three months. The mothers indicated whether they had perceived a behavioural change for each item. Significant differences were found in mothers' perceptions of their children's level of impulsivity between the Intervention Group and the Control Group. The Intervention Group's mothers perceived that their children were less impulsive after the programme.

INSERT TABLE 5

Discussion

The aim of the present study was to examine the effectiveness of an EFs stimulation programme in preschool children with no neuropsychological deficits. Significant improvements were found for the Intervention Group versus the Control Group in variables related to EFs. These results were not affected by the mothers' level of intelligence (Cattell & Cattell, 1990), sociodemographic characteristics of the caregivers or by the children's behaviours (Achenbach & Rescorla, 2004). The results supported the hypothesis that our programme is effective both for the improvement of EFs and other neuropsychological domains in preschool children.

In relation to CUMANIN, results revealed differences depending on the Temporal Moment for the Articulatory Language, Attention, and Visoperception subscales. In line with studies that used the PEFEN programme (García-Bermúdez et

al., 2019), an increase was generally observed for the first two subscales over time, also reflecting the critical period of neuropsychological development proper to the evaluated sample. Importantly, improvements were observed in the Psychomotricity, Spatial Structuring, and Visoperception subscales. These results are in line with Aydmune et al. study (2019), which found how an intervention in children aged 6 to 8 years focused on the inhibitory component of EFs produced transfer effects on tasks involving visuo-spatial aspects. Similarly, in Walk et al.'s programme (2018), improvements in viso-spatial working memory emerged.

Moreover, the results of the BRIEF-P showed an effect depending on the Temporal Moment for the Working Memory subscale. A reduction in difficulty of the Work Memory subscale was observed in both groups (more pronounced in the Intervention Group although no statistically significant). In parallel, more pronounced Emotional Control was found for the Intervention Group. In addition, mothers also reported lower impulsivity after the programme. These results are similar to other previous intervention programmes (e.g., Cardoso et al., 2019; Traverso et al., 2019; Walk et al., 2018). For example, Romero-López et al. (2021) carried out an intervention to enhance EFs in preschool children, finding improvements in both working memory and emotional control as well as inhibition, flexibility and planning/organisation.

Diamond (2013) notes several characteristics of effective neuropsychological stimulation programs: (a) the tasks should present an increasing demand for the child; (b) the practice should be repeated; and (c) that it should be integrated into daily tasks and not presented as isolated modules. The PEFEN has been designed following these recommendations and the tasks presented are aimed at training various EFs relevant to the child's academic and social functioning and adaptation to novel situations. The proposed tasks are attractive for children, favour group work, avoid boredom and allow

training more than one function. Moreover, the *Mindfulness* activities are designed to facilitate emotional regulation and concentration. Children who have participated in the PEFEN program show behavioural changes that reflect these results, specifically in various areas of sensorimotor development (psychomotor, spatial structure, and visuoperception) as reflected in the CUMANIN scales. On the other hand, parental evaluation also shows improvements in emotional regulation and impulsivity.

Our results are also in line with that of programmes based on *Mindfulness*-related techniques. Felver et al. (2013) make a distinction between general *Mindfulness* interventions at schools and more specific ones. Despite the evidence supporting the improvements in cognitive and emotional control after these interventions, there is not much literature in the relation between EFs and *Mindfulness* in preschool children (Semple et al., 2017). After implementing a *Mindfulness* based, improvements were found in children's behaviour regulation, metacognition, and overall executive control (Flook et al., 2010).

The present study has relevant practical implications. In this sense, this initiative represents a step forward because it empowers a Spanish population that presents no deficits at a very young age. Implementing a stimulation programme not only allows children to improve skills that contribute to appropriate cognitive development (Morgan et al., 2019), but it also helps to prevent school failure when starting primary school (Quintanar et al., 2008), improving their academic performance and/or reducing possible behavioural problems (Cortés-Pascual et al., 2019).

In addition, previous research using the PEFEN showed that the program was effective for improving EFs and other neuropsychological domains in preterm children (García-Bermúdez et al., 2019). The results of the present study are in the line, showing that PEFEN may also be useful for children who do not present any neuropsychological

deficits. Moreover, the initiative could help to detect a range of early alterations to executive development. Finally, since the programme is integrated into the curriculum, it is pertinent to work on EFs at these stages (Cardoso et al., 2018) and it could be conducted by the teachers themselves, saving costs and time, making it, in turn, more ecological (Traverso et al., 2019).

The study presents several limitations. First, the sample size was limited and the pupils were selected from a single school. Future studies should apply the PEFEN programme to a larger and more heterogeneous sample. Second, the study did not explore the possible effects of the intervention over time. Given the relevance of these programmes on executive functions, it would be fruitful to evaluate children 3 or 6 months later and to examine the medium/long-term impact. On the other hand, an evaluation of the efficacy of teachers' implementation has not been carried out. It would be necessary to test whether there may be relevant differences in the results due to factors related to teacher differences. Finally, some of the findings were recorded using instruments designed *ad hoc*. Future research should include other standardised measures and/or using complete neuropsychological batteries (e.g., Battery for the Neuropsychological Evaluation of Children: BENCI; Cruz-Quintana et al., 2013).

To conclude, the results of this study are promising and seem to suggest the efficacy of the PEFEN programme to stimulate EFs skills of preschool children presenting no neuropsychological difficulties. However, the results presented should be replicated with a larger sample size from different schools. These findings should be taken into account in future interventions to facilitate the development of executive functions in early children.

Ethical Compliance Section

Funding statement: The present research did not receive any funding.

Compliance with Ethical Standards: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study reported in this paper was subject to APA standards on ethical treatment of participants. The present study was approved by the Delegation of Education of the Regional Government (Reference. SOE/IJ/21497) and the Ethical Research Commission of the local University (Reference: CEUGR-935).

Conflict of interest disclosure: Authors declare no conflict of interest.

Informed Consent: Parents signed a written informed consent prior to the initial evaluations which also enabled their children to complete the intervention programme.

References

Achenbach, T. M. & Rescorla, L.A. (2004). *Manual for the ASEBA preschool forms & profiles.* University of Vermont, Research Center for Children, Youth and Families

Arruabarrena, I. & de Paúl, J. (2012). Early Intervention Programs for Children and Families: Theoretical and Empirical Bases Supporting their Social and Economic Efficiency. *Psychosocial Intervention, 21*(2), 117-127. https://dx.doi.org/10.5093/in2012a18

Aydmune, Y., Introzzi, I., & Lipina, S. (2019). Inhibitory Processes Training for School-age Children: Transfer Effects. *Developmental Neuropsychology, 44*(7), 513-542. https://doi.org/10.1080/87565641.2019.1677667

Cardoso, C. D. O., Dias, N., Senger, J., Colling, A. P. C., Seabra, A. G., & Fonseca, R. P. (2018). Neuropsychological stimulation of executive functions in children with typical development: a systematic review. *Applied Neuropsychology: Child*, *7*(1), 61-81. https://doi.org/10.1080/21622965.2016.1241950

Cardoso, C. D. O., Seabra, A. G., Gomes, C. M. A., & Fonseca, R. P. (2019). Program for the neuropsychological stimulation of cognition in students: Impact, effectiveness, and transfer effects on student cognitive performance. *Frontiers in Psychology*, *10*, 1784. https://doi.org/10.3389/fpsyg.2019.01784

Cattell, R.B. & Cattell, A.K.S. (1990). *Test de factor "G" (escala 2 y 3).* TEA Ediciones

Cortés-Pascual, A., Moyano-Muñoz, N., & Quilez-Robres, A. (2019). The relationship between executive functions and academic performance in primary education: review and meta-analysis. *Frontiers in Psychology*, *10*, 1582. https://doi.org/10.3389/fpsyg.2019.01582

Crépeau, F., Scherzer, B.P., Belleville, S., & Desmarais, G. (1997). A qualitative analisis of central executive disorders in a real-life work situation. *Neuropsychological Rehabilitation, 7*(2), 147-165. https://doi.org/10.1080/713755525

Cruz-Quintana, F., Pérez García, M., Pérez Marfil, M. N., Pérez García, P., Hidalgo-Ruzzante. N., Pérez-Lobato, R., Fernández-Alcántara, M., & García-Bermúdez, O. (2014). *Programa de Estimulación para el Desarrollo de la Función Ejecutiva en Niños y Niñas de 4 Años de Edad (PEFEN).* Ediciones Sider S.C.

Cruz-Quintana, F., Pérez-García, M., Roldan-Vílchez, L.M., Fernández-López, A., &Pérez Marfil, M.N. (2013). *Manual de la Batería de Evaluación Neuropsicológica Infantil* (BENCI). Ediciones Sider S.C.

Diamond, A. (2013). Executive Functions. *The Annual Review of Psychology, 64,* 135-168. https://doi.org/10.1146/annurev-psych-113011-143750

Diamond, A., Barnett, W.S., Thomas, J., & Munro, S. (2007). The early years – Preschool program improves cognitive control. *Scienc*e, *318*(5855), 1387-1388. https://doi.org/10.1126/science.1151148

Diamond, A. & Lee, K. (2011). Interventions and programs demonstrated to aid executive function development in children 4–12 years of age. *Science, 333*(6045), 959–964. https://doi.org/10.1126/science.1204529

Diamond, A. & Ling, D. S. (2016). Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not. *Developmental Cognitive Neuroscience, 18,* 34-48. https://doi.org/10.1016/j.dcn.2015.11.005

García-Bermúdez, O., Cruz-Quintana, F., Pérez-García, M., Hidalgo-Ruzzante, N., Fernández-Alcántara, M., & Pérez-Marfil, M. N. (2019). Improvement of

executive functions after the application of a neuropsychological intervention program (PEFEN) in pre-term children. *Children and Youth Services Review, 98,* 328-336. https://doi.org/10.1016/j.childyouth.2018.10.035

Felver, J. C., Doerner, E., Jones, J., Kaye, N. C., & Merrell, K. W. (2013). Mindfulness in school psychology: Applications for intervention and professional practice. *Psychology in the Schools, 50(*6), 531-547. https://doi.org/10.1002/pits.21695

Flook, L., Smalley, S. L., Kitil, M. J., Galla, B. M., Kaiser-Greenland, S., Locke, J., Ishijima, E., & Kasari, C. (2010). Effects of mindful awareness practices on executive functions in elementary school children. *Journal of Applied School Psychology, 26*(1), 70-95. https://doi.org/10.1080/15377900903379125

García-Molina, A., Enseñat-Cantallops, A., Tirapu-Ustárroz, J., & Roig-Rovira, T. (2009). Maduración de la corteza prefrontal y desarrollo de las funciones ejecutivas durante los primeros cinco años de vida. *Revista Neurología*, *48*(8), 435-440

Gilbert, S.J. & Burgess, P.W. (2008). Executive function. *Current Biology, 18*(3), 110-114. https://doi.org/10.1016/j.cub.2007.12.014

Gioia, G.A., Isquith, P.K., & Guy, S.C. (2000). *Behavior Rating Inventory of Executive Function.* Psychological Assessment Resources

Holth-Skogan, A., Egeland, J., Zeiner, P., Romvig-Øvergaard, K., Oerbeck, B., Reichborn-Kjennerud, T., & Aase, H. (2015): Factor structure of the Behavior Rating Inventory of Executive Functions (BRIEF-P) at age three years, Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence. *Child Neuropsychology, 22*(4), 472-492. https://doi.org/10.1080/09297049.2014.992401

Hughes, C. H. & Ensor, R. A. (2009). How do families help orhinder the emergence of

early executive function? In C. Lewis & J. I. M. Carpendale (Eds.). Social interaction and the development of executive function. *New directions in child and adolescent development* (pp. 35–50). Jossey Bas. https://doi.org/10.1002/cd.234

Kaiser-Greenland, S. (2013). *El niño atento. Mindlfulness para ayudar a tu hijo a ser más feliz, amable y compasivo*. Desclée de Brouwer

Lezak, M. (1983). The problem of assessing executive functions. *International Journal of Psychology*, *17*(1-4), 281-297

Morgan, P. L., Farkas, G., Wang, Y., Hillemeier, M. M., Oh, Y., & Maczuga, S. (2019). Executive function deficits in kindergarten predict repeated academic difficulties across elementary school. *Early Childhood Research Quarterly*, *46*, 20-32. https://doi.org/10.1016/j.ecresq.2018.06.009

Muñoz-Vinuesa, A., Afonso-Martín, A., Cruz-Quintana, F., Pérez-Marfil, M. N., Sotomayor-Morales, E. M., & Fernández-Alcántara, M. (2018). Determinantes sociales de la salud. Estatus socioeconómico, neurodesarrollo y funciones ejecutivas en la infancia. *Índex de enfermería, 27(*3), 143-146.

Portellano, J., Mateos, R., & Martínez, R. (2000). *Cuestionario de Madurez Neuropsicológica Infantil (CUMANIN).* TEA Ediciones

Quintanar, L., Solovieva, Y., & Lázaro, E. (2008). Evaluación neuropsicológica infantil breve para población hispano-parlante. *Acta Neurológica Colombiana*, *24*(2), 31-44

Ribner, A., Devine, R. T., Blair, C., Hughes, C., & NewFAMS Investigators. (2022). Mothers' and fathers' executive function both predict emergent executive function in toddlerhood. *Developmental Science, 25*(6), e13263. https://doi.org/10.1111/desc.13263

Romero-López, M., Pichardo, M. C., Justicia-Arráez, A., & Cano-García, F. (2021). Effect of the EFE-P program on the improvement of executive functions in Early Childhood Education. *Revista de Psicodidáctica, 26*(1), 20-27. https://doi.org/10.1016/j.psicoe.2020.09.001

Sardinero-García, E., Pedreira-Massa, J. L., & Muñiz, J. (1997). El cuestionario CBCL de Achenbach: Adaptación española y aplicaciones clínico-epidemiológicas. *Clínica y Salud, 8*(3), 447–480

Semple, R. J., Droutman, V., & Reid, B. A. (2017). Mindfulness goes to school: Things learned (so far) from research and real-world experiences. *Psychology in the Schools, 54*(1), 29-52. https://doi.org/10.1002/pits.21981

Shonkoff, J.P. (2011). Protecting brains, not simply stimulating minds. *Science, 333*(6045), 982-983.https://doi.org/10.1126/science.1206014

Takacs, Z. K. & Kassai, R. (2019). The efficacy of different interventions to foster children's executive function skills: A series of meta-analyses. *Psychological Bulletin, 145*(7), 653-697. https://dx.doi.org/10.1037/bul0000195

Traverso, L., Viterbori, P., & Usai, M. C. (2019). Effectiveness of an executive function training in Italian preschool educational services and far transfer effects to pre-academic skills. *Frontiers in Psychology, 10*, 2053. https://doi.org/10.3389/fpsyg.2019.02053

Walk, L. M., Evers, W. F., Quante, S., & Hille, K. (2018). Evaluation of a teacher training program to enhance executive functions in preschool children. *PloSone, 13*(5), e0197454. https://doi.org/10.1371/journal.pone.0197454

Zelazo, P. D. (2020). Executive function and psychopathology: A neurodevelopmental perspective. *Annual review of clinical psychology, 16*, 431-454. https://doi.org/10.1146/annurev-clinpsy-072319- 024242

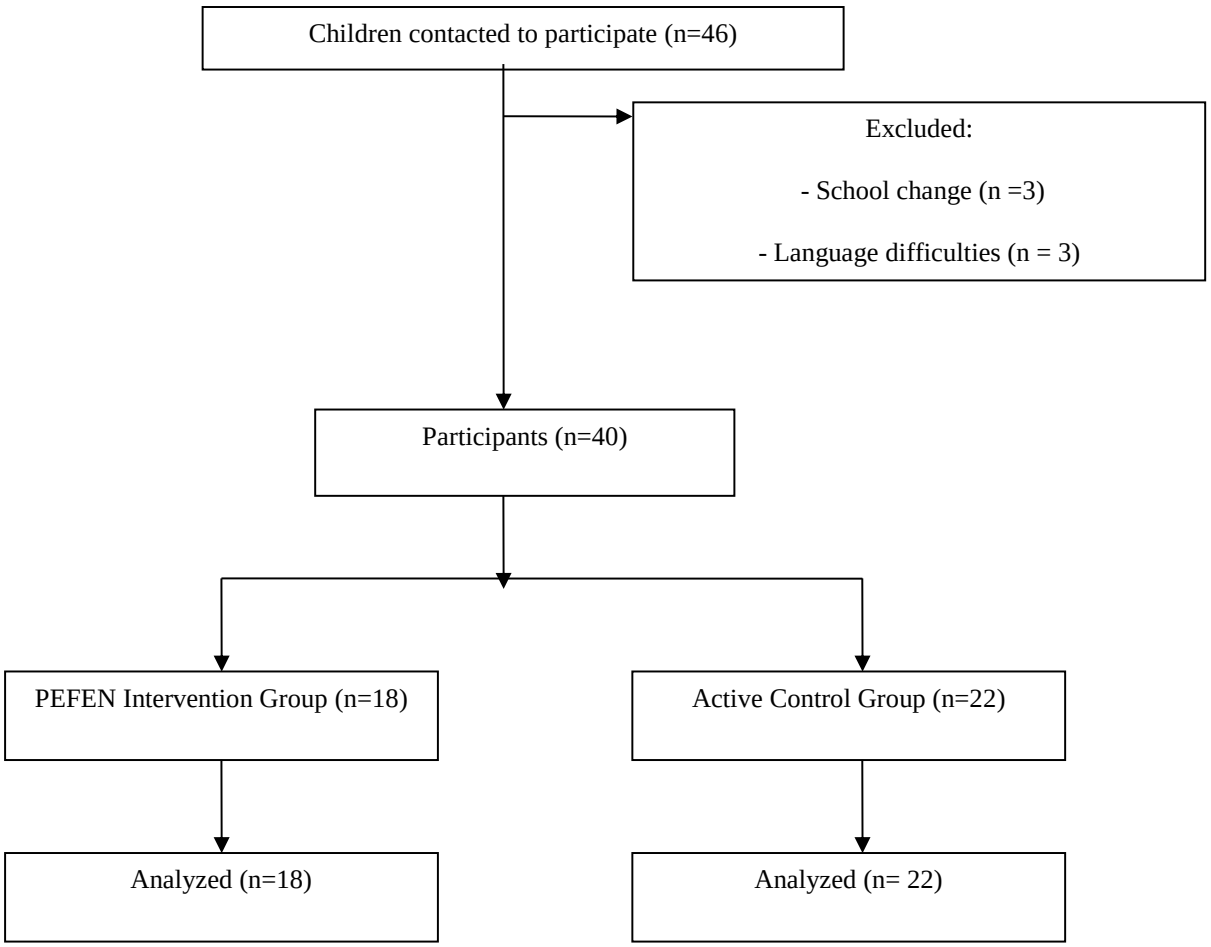

Figure 1. Flow of participants in the Intervention and Control Group

Table 1

Means, standard deviations and analyses of the differences between the Intervention Group and the Control Group regarding sociodemographic variables and G Factor Test.

Variables	Intervention Group *M (SD)*	Control Group *M (SD)*	*t*	*p*
Mother's age (years)	35.06 (6.79)	34.23 (5.93)	.41	.683
Mother's studies (years)	10.00 (3.82)	9.05 (4.40)	.72	.474
Father's age (years)	37.50 (5.71)	36.27 (5.63)	.68	.500
Father's studies (years)	7.89 (3.39)	7.27 (3.40)	.57	.571
G.Factor. Part 1 Series	7.39 (2.38)	8.12 (2.62)	-.86	.395
G.Factor. Part 2 Classification	7.94 (1.86)	8.35 (1.27)	-.75	.457
G.Factor. Part 3 Matrix	6.78 (1.26)	6.12 (1.76)	1.28	.210
G.Factor. Part 4 Conditions	1.44 (.62)	1.24 (.66)	.97	.341

*Note. *p<.05, ** p<.01, *** p<.001*

Table 2

Means, standard deviations, effect sizes and analyses of the pre intervention differences for CBCL factors.

Variables	Group	Pre *M (SD)*	*d*	*F*
Internalising	Intervention	11.58 (7.53)	.08	.81
Problems	Control	11 (6.79)		
Externalising	Intervention	11.21 (8.41)	-.11	.74
Problems	Control	12.13 (8.31)		
Total	Intervention	34.79 (22.61)	-.01	.97
Problems	Control	35.06 (20.63)		

Table 3

Means, standard deviations, effect sizes and differences analyses for CUMANIN factors

Variables	Group	Pre *M (SD)*	Post *M (SD)*	*d*	*F* Moment	*F* Group	*F* Moment X Group
Psychomotricity	Intervention	7.83 (1.47)	9.17 (1.50)	-.90	.99	.70	8.93**
	Control	8.76 (1.18)	8.10 (1.22)	.55			
Language Articulation	Intervention	13.28 (2.52)	14.67 (.84)	-.74	7.43*	.50	.33
	Control	13.24(2.07)	14.14 (1.35)	-.52			
Language Expression	Intervention	2.89 (.68)	3.56 (1.34)	-.63	2.43	2.89	1.02
	Control	2.76 (1.34)	2.90 (.77)	-.13			
Language Comprehension	Intervention	4.61 (2.33)	4.67 (2.03)	-.03	.05	1.43	.01
	Control	4.00 (2.00)	4.14 (1.82)	-.07			
Spatial Structure	Intervention	7.94 (2.80)	10.33 (3.99)	-.69	1.341	1.53	5.023*

	Control	8.67 (2.44)	7.90 (2.95)	.28			
Visuoperception	Intervention	10.17 (2.50)	13.28 (2.16)	-1.33	6.58*	3.14	8.95**
	Control	10.76 (2.84)	10.52 (2.68)	.09			
Memory	Intervention	5.72 (1.45)	6.78 (1.70)	-.67	1.99	.08	1.15
	Control	6.05 (2.46)	6.19 (1.99)	-.06			
Rhythm	Intervention	3.61 (1.65)	3.83 (1.20)	-.15	.00	1.11	.33
	Control	3.43 (1.54)	3.24 (1.89)	.11			
Attention	Intervention	8.56 (3.26)	12.72 (3.51)	-1.23	14.70**	1.93	1.70
	Control	8.32 (3.83)	10.37 (4.31)	-.50			

*Note. *p<.05, ** p<.01, *** p<.001*

Table 4

Means, standard deviations, effect sizes and differences analyses for BRIEF-P factors.

Variables	Group	Pre	Post	*d*	*F* Moment	*F* Group	*F* Moment X Group
		M (SD)	*M (SD)*				
Inhibition	Intervention	26.00 (5.98)	25.17 (6.09)	.14	.36	.30	.28
	Control	26.78 (7.08)	26.72 (7.73)	.01			
Flexibility	Intervention	13.44 (3.22)	12.56 (2.33)	.31	.18	1.48	1.60
	Control	14.06(4.07)	14.50 (4.16)	-.11			
Emotional control	Intervention	16.17 (3.47)	14.78 (3.23)	.41	.09	.19	4.67*
	Control	15.44 (4.15)	16.50 (4.54)	-.24			
Working memory	Intervention	26.33 (4.34)	23.56 (3.65)	.69	5.69*	.88	1.96
	Control	26.89 (7.14)	26.17 (6.25)	.11			
Planning	Intervention	14.50 (2.28)	14.06 (2.60)	0.18	2.80	2.61	.61
	Control	16.50 (3.78)	15.28 (4.30)	0.30			

*Note. *p<.05, ** p<.01, *** p<.001*

Table 5

Intervention versus Control Groups' mother assessment differences on their children behaviors in the last three months

Variables	Intervention Group		Control Group		X^2	*p*
	Yes N (%)	NO N (%)	Yes N (%)	NO N (%)		
More attention	15 (83%)	3 (16%)	16 (72%)	6 (27%)	.64	.424
Less impulsivity	15 (83%)	3 (16%)	8 (36%)	14 (63%)	8.94	.003**
More frustration	7 (50%)	11 (61%)	7 (50%)	15 (65%)	.22	.641
Less impatient	12 (66%)	6 (33%)	13 (59%)	9 (40%)	.24	.622
Change calm	12 (66%)	6 (33%)	14 (63%)	8 (36%)	.04	.842
More demand	8 (44%)	10 (55%)	12 (36%)	10 (45%)	.40	.525
Less anger	10 (55%)	8 (44%)	6 (27%)	16 (72%)	3.30	.069
Shorter anger time	14 (100%)	4 (22%)	14 (100%)	5 (22%)	.00	.970
More reflexive	13 (72%)	5 (27%)	19 (86%)	3 (13%)	1.24	.266
More iniciative	15 (83%)	3 (16%)	15 (68%)	7 (31%)	1.21	.271
More large reactions	4 (22%)	14 (77%)	3 (13%)	19 (57%)	.51	.477
More problems to change	4 (22%)	14 (77%)	20 (90%)	2 (9%)	1.40	.247
More resolution	16 (88%)	2 (11%)	5 (22%)	17 (77%)	.93	.336
Less overwhelm	14 (77%)	4 (22%)	14 (63%)	8 (36%)	.94	.332
More locks	4 (22%)	14 (77%)	4 (18%)	18 (81%)	.10	.751

*Note. *p<.05, ** p<.01, *** p<.001*