



# How to Promote Attentional Efficacy and Cognitive Control Processes: Experience in Argentine School Children

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Research Article

Volume 5 Issue 4

Received Date: November 19, 2020

Published Date: December 16, 2020

DOI: [10.23880/pprij-16000255](https://doi.org/10.23880/pprij-16000255)

## Abstract

Attention is one of the cognitive control processes that are clearly relevant for socio-cognitive performance and young children's school learning. Good attention functioning is one of the important predictors of cognitive level in childhood. Although there is no unified theory of attention, current neurocognitive models have agreed to define it as a cognitive control function responsible for the hierarchical organization of the processes in charge of elaborating information. The capacity of attention can be modified with continuous practice. For this reason, its strengthening in childhood could favour the development of the functioning of cognitive control processes in later years. This article presents two programs for the attention and socio-cognitive strengthening in children of pre-elementary and elementary school level, in the province of Mendoza, Argentina. This study provides empirical evidence of the effectiveness of training programs applied in the school context and of the relevance of the involvement of parents and educators.

**Keywords:** Attentional Efficacy; Cognitive Control Processes; Children; Training programs

## Introduction

Attention plays a central role in the early development of cognitive performance and school learning [1-5]. Although there is no unified theory of attention, current neurocognitive models have agreed to define it as a cognitive control function responsible for the hierarchical organization of the processes responsible for elaborating information [4,6].

It may be defined as a "vertical control" mechanism whose function is to determine which stimuli perceptible resources will be directed to, by activating or inhibiting the processes involved in the processing and organization of information [1,7,4]. More specifically, attention efficiency refers to the child's level of performance in selecting and sustaining attention during the period of time required by the task proposed, in accordance with what is expected for their

developmental age. This involves directing and sustaining voluntary attention towards the task being performed, while inhibiting possible interferences by distracting stimuli [3,6].

Attention is the common denominator on which the three processes of executive functioning are based: working memory, inhibitory control, and set shifting [5,8,9]. In other words, attention plays a key role in boys' and girls' school performance, as it is involved in the selection and sustenance of relevant information, giving place to the manipulation of mental representations and modulating the responses to different stimuli. It also intervenes in both the cognitive flexibility required to correct mistakes or generate new behaviours in response to contextual demands, and the completion of the action once the objectives have been accomplished and the evaluation of results [10-12].

It has been proved, both in children and in adults, that the greater the attentional capacity, the greater the performance in tasks demanding cognitive control [3,13-15]. Various studies have revealed that cognitive control processes such as attentional capacity, flexibility, working memory and inhibitory control are predictors of academic achievements in early and middle childhood [10,16-20]. Meta-analysis studies have highlighted that three periods stand out, in which these processes develop more widely and that coincide with peaks of intense metabolic activation of the frontal lobes: from 4-to-8 years, from 10-to-12 years and from 16-to-19 years [5,21,22]. In turn, the importance of cognitive control processes for obtaining academic achievement in learning contexts is well-documented [2,23-29].

Children's attention development is a gradual, developmental process which has been proven to become more organized, flexible and independent from context over time [1,30]. Thus, attentional performance improves during the schooling period, from the age of 7 to the age of 12, when it reaches its maximum development, as this age period is associated with the maturation of certain areas of the central nervous system which allows for such development [31]. According to gender, the cited authors point out that girls outperform boys in some of the attention and memory tests, such as tasks involving verbal information or requiring a verbal strategy (such as retrieval by keywords), since these would be associated with early language development, which is predominant in girls.

Attentional functioning constitutes a fundamental requirement for cognitive functioning and it is critical to performance in many of the types of learning activities that children participate in, in kindergarten and early elementary school. A large body of research has shown that both attention and executive functioning can be strengthened with practice, through the implementation of stimulation programs. When these interventions are early, intensive, and systematic sustained over time, they generate notable benefits for children. Considering this brief review, the goal of this work is to present two intervention programs carried out in schoolchildren in the province of Mendoza, Argentina.

### General Considerations in both Studies

All the intervention programs were designed and developed by the team conducting research on children's developmental psychology at INCIHUSA-CONICET and the Faculty of Psychology at Aconcagua University. All the intervention programmes implemented by this team were applied with the purpose of optimising and strengthening attentional resources and cognitive control processes in school children in the province of Mendoza. Both experiences

were carried out in public primary schools located in a socially-vulnerable area near Mendoza Capital, Argentina.

The construct of social vulnerability is not limited only to insufficient material resources to get out of the plane of survival, but refers to a set of fragile links that subjects, groups and communities develop in relation to work, social relationships and agency capacities, that is to say the exercise of citizenship through political life [32,33]. Throughout the experience of fieldwork in schools located in socially vulnerable areas, it has been quite common to meet families in situations of psychosocial vulnerability, where boys and girls live daily situations of socio-family stress, in conditions that predispose to greater disorganization in family dynamics and in ambivalent socio-affective communication and bonding patterns. It is worth clarifying that these types of patterns are not exclusive to these schools, since they can occur in other environments [34].

The first of the studies was carried out in pre-elementary children aged 4-5 years, while the second was carried out in elementary children of 7-12 years. In both studies, ethical standards have been performed in accordance with CONICET guidelines on ethical behavior in the Social Sciences and Humanities (2857/06), as well as the code of ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Thus, parents of participating children were informed about the objectives and procedures of the studies before giving their written consent and prior to the administration of any assessment tools on children. Participating children were given verbal information about the procedure, and they could interrupt their participation if they so desired. The privacy and confidentiality of all information will continue to be respected.

### Study with Pre-Elementary Children

A total of 121 children of 4 and 5 years, 56 males and 65 females ( $M_{age}=62\text{months}$ ,  $SD=6.27$ ), from early childhood education public schools from the province of Mendoza, participated in the study. 47.1% were represented by 4-year-old children ( $n=57$ ) and 52.9% by 5-year-old children. Before the application of the stimulation program by the teachers, the following functions were evaluated in children: maturity indicators, attention, visuomotor perception, visuospatial skills, working memory and identification of emotions. Maturity indicators were evaluated through of the Human Figure Drawing (HFD) test [35]. Sustained Attention was evaluated with the CUMANIN figure cancellation test [36]. Visuomotor perception, visuospatial skills and working memory were analysed using the Rey Complex Figure Copy and Memory Reproduction test [37,38]. Finally, Emotion recognition was evaluated through images. This instrument consisted of 6 cards, each of which contains a drawing

of a child's face representing an emotion. The evaluated emotions are: joy, anger, fear, surprise, displeasure and sadness [39]. Once the evaluation stage was completed, the implementation of the *Program for the strengthening of socio-cognitive and emotional skills (PHSCE)* began.

The PHSCE program described has had the purpose of strengthening the socio-cognitive and emotional functioning in children aged 4 and 5 [40], directly involving teachers and indirectly engaging parents. Previous research carried out by our group and the experience of the pre-elementary teachers contributed to its development [3,27,41-43].

This proposal has 3 lines of action: children, teachers and parents, with the purpose of:

- Optimizing the socio-cognitive-affective performance of schoolchildren;
- Promoting cooperative work between classroom, physical education, English and music education teachers in order to articulate activities to promote socio-cognitive and emotional functioning in early childhood; and,
- Promoting teamwork among professionals, teachers and parents in order to foster an interpersonal climate favoring cooperative relationships in the school context.

PHSCE consists of 8 theoretical-practical modules, each of which addresses different themes:

1. Perceptual organization,
2. Attention,
3. Inhibitory Control,
4. Cognitive Flexibility,
5. Working Memory,
6. Recognition of emotions,
7. Resilient attitude and
8. Strengthening socio-emotional resources in school contexts.

Each module has a theoretical foundation that supports a series of practical activities described in a stimulation booklet entitled "Strategies to strengthen cognitive and socio-emotional functioning in initial education" [40]. This booklet works as a work guide for the teacher, in order to stimulate the socio-cognitive and emotional functions in their students through playful activities.

The pre-elementary teachers learned about the development of socio-cognitive and emotional function of children and their importance for social and academic abilities. The program lasted 4 months, and was incorporated as part of the activities of the school curriculum, working on the socio-cognitive and emotional functions daily through recreational activities based on the activities described in the stimulation booklet. For their part, the teachers guided and monitored the development of the activities, by "scaffolding

that knowledge", giving positive feedback, trying to maintain the motivation of the group and promoting emotional self-regulation in their students [44].

Subsequent to the application of the intervention program, the researchers proceeded to the re-evaluation of the socio-cognitive and emotional functions in the children. To analyze whether the PHSCE program contributed to increase the socio-cognitive performance in their students, intra-group comparisons (pre-post assessments) were made. In addition, the teachers' perception of socio-cognitive functioning in their students was analysed.

Analysing of Data to begin, the Kolmogorov-Smirnov (K-S) test was applied. It indicated the studied variables did not adjust to the model of normal distribution. After that, to evaluate the effectiveness of the training program, intragroup comparisons with the Wilcoxon signed rank test for related samples were made, with a significance level of .05. The magnitude of the differences was estimated using the bi-serial correlation index [45], and Cohen's criteria [46] were employed to interpret them.

The main result showed that, in the post-test, children showed improvements in all the analysed variables: Maturity indicators ( $Z=-7.43$ ,  $p=.001$ ,  $r=.71$ ), Attention ( $Z=-4.18$ ,  $p<.001$ ,  $r=.38$ ), Visuomotor perception ( $Z=-5.62$ ,  $p<.001$ ,  $r=.51$ ), Visuospatial skills ( $Z=-3.60$ ,  $p<.001$ ,  $r=.33$ ), Working memory ( $Z=-3.04$ ,  $p=.002$ ,  $r=.28$ ), and Emotion recognition ( $Z=-5.36$ ,  $p<.001$ ,  $r=.53$ ). When analyzing the teachers' perception regarding the cognitive functioning of their students, in the post-test, the teachers observed improvements in Attention ( $Z=-2.61$ ,  $p=.009$ ,  $r=.22$ ) and Working memory ( $Z=-2.88$ ,  $p=.004$ ,  $r=.27$ ).

After the stimulation program, one online survey was carried out for parents, in order to find out if the stimulation program contributed to the strengthening of socio-cognitive and emotional functions in their children. A total of 42 parents responded to the online survey, in which 37 parents (88.09%) considered that the PHSCE program contributed to improving Attentional Efficiency and Cognitive Control Processes performance in their children. They observed positive changes in their children, for example by mentioning that their children paid more attention to daily activities and were more motivated to want to learn. Likewise, they considered it extremely beneficial for their children to continue the stimulation program. However, 5 parents (11.91%) neither agreed nor disagreed as to improvement.

In summary, after the application of the stimulation program, children obtained improvements in the performance of all the variables evaluated, and the magnitude of these improvements ranged from moderate to very large. It is to

be expected that these functions have improved as a result of maturation as well, and not only as a result of the stimulation program. This aspect may be collated in future works when control groups are incorporated.

### Study with Elementary Schoolchildren with Low Attentional Efficacy

A group of 138 schoolchildren (22.8 %) with low attentional efficacy (67 boys and 71 girls), between the ages of 7 and 12 ( $9.25 \pm 1.52$ ) were identified. Then two groups were formed: a) an intervention group (IG), composed of 72 schoolchildren (34 boys and 38 girls); and, b) a control group, formed by 66 schoolchildren (33 boys and 33 girls). The children were randomly assigned to each group by means of the following procedure: once the children with low attentional efficiency were identified, they were assigned a number which was written on a piece of paper; the paper was folded into four and placed in a box; and, then, the pieces of paper were extracted one by one to form the study group and the control group. The same procedure was used in each of the school grades.

Attentional efficacy was evaluated by Magellan's Scale for Visual Attention (Original name in Spanish: EMAV) [47]. This test evaluates the ability to focus and maintain attention, during a period of time by means of a visual search task. For the purposes of this study, it is used as a tool to measure attentional efficacy. It consists of identifying the figures equal to a model among a group of different figures. The test has been customized for students from Mendoza aged 6-12. The test presents high internal consistence for the school population of Greater Mendoza ( $r=0.87$ ) [48]. The EMAV test was administered during school hours, in groups, by specialized psychologists. The classroom teacher committed herself to completing the children's school work during their absence, and it was agreed that the proposed test would not be administered on days when the children had exams, were going to be taught a new topic or during special subjects (such as Music, Drawing and Physical Education).

Once the evaluation stage was completed, the program to stimulate and optimise schoolchildren's attentional control capacity was applied. The intervention program used was the Computer-Based Attention Test for Children 2.0, designed to stimulate focused and sustained attention in children through a series of exercises [2,49]. This program consists of three tests aimed at stimulating focused and sustained attention through visual search tasks. In addition, each test includes training sessions aimed at helping children to understand instructions correctly and become familiar with the program. At this stage, the expert (psychologist) can guide the child and explain to him/her everything that is required for him/her to complete the second phase,

which is the training itself. During the training sessions, the expert explains the instructions of the task to the child and shows him/her what the task consists of on the computer screen. Then, sometime is given to the child to practice, until the expert can make sure that the instructions have been perfectly understood. After that, the child completes the task on his/her own.

Each test presents three levels of difficulty (low, medium and high) and different numbers of stimuli for the child to work with, and it offers the chance to save that information and the reaction and total times. In relation to the total times, the expert may allot a certain time to each task. All these variables can be selected by the expert, who sets the test configuration for each particular case. For all tests, the program keeps record of the right and wrong choices and the omissions, as well as of the total time taken to complete the task. It also keeps a record of the stimuli to which the child was exposed, the number of correct and wrong choices and omissions (stated in raw scores and percentages) and the total time needed for the completion of the task. Finally, a graph showing the performance of each child appears on the right, showing the results of the tests.

The results of this study showed a significant improvement of attentional performance in the intervention group in comparison with the control group ( $t=2.15$ ,  $gI=136$ ,  $p<.03$ ). As a whole, this result would indicate that the implemented stimulation program contributed, to a greater extent, to improving the attentional efficacy in those children that participated in it, compared to those who did not (IG:  $M=45.78$  vs. CG:  $M=37.79$ ;  $d=0.62$ ,  $p<.000$ ). An analysis of the variance (ANOVA) was carried out for each age group (7-9 years and 10-12 years), in order to analyse the effect of the intervention program on the attentional efficacy in relation to the sex variable and ANOVA's interactions between Interventions vs. Control. According to the post-intervention results obtained through the ANOVA procedure in the younger group (7-9 years), the effect of the gender variable was not significant ( $F_{(1,75)}=1.50$ ,  $p<.224$ ,  $\eta^2=0.021$ ); however, significant differences in attentional efficacy were found between the intervention group and the control group. The attentional efficacy of the intervention group was significantly higher than that observed in the control group ( $F_{(1,75)}=9.61$ ,  $p<.003$ ,  $\eta^2=0.119$ ). Similarly, in the older group (10-12 years), the gender variable did not have a significant effect ( $F_{(1,63)}=.08$ ,  $p<.777$ ,  $\eta^2=0.001$ ). The results of the test showed a significant improvement of attentional performance in the intervention group in comparison to the control group ( $F_{(1,63)}=7.59$ ,  $p<.008$ ,  $\eta^2=0.114$ ). This result could indicate that the Computer-Based Attention Program favoured the Attentional Efficacy in children who participated in the intervention program compared to the control group.



## Conclusion

The aim of this work was to present two intervention programs carried out in schoolchildren in the province of Mendoza, Argentina. The first program applied in initial education children was focused on stimulating socio-cognitive and emotional functioning. Results showed that, after the application of the stimulation program by teachers, children obtained improvements in the performance of all the variables evaluated. These results, although it must be tested with a control group, are encouraging, since both teachers and parents observed advances in the socio-cognitive and emotional skills of children after the stimulation program was applied in the classroom. Several studies have shown that programs to stimulate cognitive and socio-emotional functions in children can contribute to favoring the trajectories of academic functioning development, especially when they are applied by their teachers and their content is included within the school curriculum [26,29,50,51].

The training of teachers in strengthening socio-cognitive and emotional skills, curricular adaptations and parental involvement should be a priority in educational settings, in order to strengthen resources in childhood, from a preventive approach and in the framework for promoting children's health. In summary, taking into account the limitations that this study presents, it could be said that the main contribution of this work is to increase the evidence of the importance of teacher training for the development of strategies that can be used to scaffold the socio-cognitive and affective processes in the teaching-learning context.

The second study, applied to elementary school children, was carried out to promote the attentional capacity in children previously identified with attentional dysfunction. The results show that the children identified with attentional dysfunction, in the two age ranges of the elementary children, achieved a significant increase in attention after the intervention program. On the contrary, in the control group (children with attentional dysfunction without intervention), there were no significant differences observed in sustained attention in any of the two age ranges, when comparing the first and second evaluations.

The findings would indicate that the intervention program applied to our sample favoured an increase in sustained attention in the group of children who participated in the intervention, compared to the control group. This program was designed to stimulate focus and attentional support through visual search tasks. Visual search involves the visuospatial processing of information, for which it requires a pattern of organized eye movements for the perception and search of relevant details. In addition, it implies having attentional control, especially for the

maintenance of attentional behaviour.

Therefore, if we understand sustained attention as the ability to maintain attention focus and encode stimuli for a certain time [1,4], neuropsychological activity that requires effort on the part of the subject and persistence in performing a task during a significant time interval, then the results obtained in our work would be encouraging regarding the effectiveness of the intervention program to stimulate sustained attention. In summary, taking into account the limitations that this study presents, it could be said that the main contribution of this work is to increase the evidence of the importance of stimulation programs for the development of attention and socio-cognitive processes in childhoods. In addition, the scaffolding and timely support of parents and teachers is a better condition for achieving greater effectiveness in programs of social-cognitive and emotional strengthening in children.

Although the intervention proposals presented here were effective in improving attentional and socio-cognitive functioning in the schoolchildren in the samples, the question that should be investigated further is as to which types of interventions are the most effective, according to the different profiles of cognitive performance and different developmental contexts, in order to achieve maximum functional results.

## Acknowledgements

This paper has been written within the framework of the PIP 2017-2019, N° 11220170100664, supported by National Council for Scientific and Technical Research (CONICET).

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