

**EFFICACY OF A METACOGNITIVE INTERVENTION
PROGRAMME ON READING COMPREHENSION IN
THIRD GRADE STUDENTS**

**EFICÁCIA DO PROGRAMA METACOGNITIVO DE INTERVENÇÃO
NA COMPREENSÃO DE LEITURA EM ESTUDANTES DO TERCEIRO
ANO**

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Abstract

This study examined the efficacy of a metacognitive intervention programme in a classroom group of 33 third-grade students. Two groups were formed: the intervention group with students in the classroom who showed reading delay and cognitive attention processes (n=8) and the comparison group (n=25). In the intervention group, a planning facilitation programme was implemented that aimed to improve inhibition processes and, correspondingly, overall reading comprehension indices. The Das-Naglieri: Cognitive Assessment System (D.N: CAS; Naglieri & Das, 1997) was used to measure attention processes. For reading processes, the Catalan et al. (2010) Reading Comprehension Assessment (ACL) test was used. The measurements were taken at pre-test, post-test, and follow-up. The results showed that the intervention group equalled the comparison group in reading comprehension and significantly improved in inhibition processes in the post and follow-up measures. It is concluded that the programme has had an impact on improving inhibition processes when facing reading activities.

Keywords: Inhibition, reading comprehension, metacognitive processes, planning facilitation, quasi-experimental study

Resumo

Este estudo analisou a eficácia do programa de intervenção metacognitiva numa turma de 33 alunos do terceiro ano. Foram formados dois grupos: o grupo de intervenção, com estudantes na sala de aula que demonstraram um atraso na leitura e nos processos de atenção cognitiva (n=8), e o grupo de comparação (n=25). No grupo de intervenção, um programa facilitador do planeamento foi implementado, visando melhorar os processos de inibição e, correspondentemente, os índices de leitura e compreensão de um modo geral. O Das-Naglieri: *Cognitive Assessment System* (D.N: CAS; Naglieri & Das, 1997) foi utilizado para medir os processos de atenção. Para os processos de leitura, o teste de *Reading Comprehension Assessment* (ACL) de Catalan et al. (2010) foi utilizado. As análises foram consideradas no pré-teste, pós-teste e *follow-up*. Os resultados demonstraram que a intervenção de grupo igualou o grupo de comparação na compreensão da leitura e melhorou significativamente nos processos de inibição nas análises do pós-teste e do acompanhamento. Conclui-se que o programa teve impacto na melhoria dos processos de inibição quando consideradas as atividades de leitura.

Palavras-chave: Inibição, compreensão de leitura, processos metacognitivos, facilitação de planificação, estudo quase experimental

Introduction

Reading requires the use of complex thinking skills (inference, comprehension, reasoning). The integration of these skills activates the executive functions of cognitive flexibility, inhibition, and working memory updating.

Working memory is the ability to maintain information active for a short period of time, without the stimulus being present, to perform an action or solve problems using information actively, as well as for the development of thinking processes (Baddeley, 2003).

Cognitive flexibility (Shifting) is the ability to change an action or thought scheme in relation to what the evaluation of its results indicates is not efficient, or to changes in the conditions of the environment and/or the conditions in which a specific task is carried out. It also involves the generation and selection of new work strategies within the multiple options available to develop a task (Miller & Cohen, 2001).

Inhibition or inhibitory control is the ability of the human being to inhibit or control impulsive (or automatic) responses and generate responses mediated by attention and reasoning. It allows the suppression of stimuli that compete when a particular task is performed. This would involve suppressing external stimuli that can hinder cognitive functioning, eliminating internal stimuli that can interfere with the operations that take

place in working memory, or avoiding prepotent or automatic responses that are irrelevant to the achievement of the primary task (Diamond, 2013).

Inhibition is one of the main processes of cognitive regulation as it carries out the active control of cognitive contents. This assigns it a key role in reading comprehension (Hasher, et al., 2007; Bizama, Gatica, Aqueveque, Arancibia & Sáez, 2020).

According to Baddeley (2003), when there is an inhibitory deficit, in addition to generating impulsive, hyperactive, and disorganised behaviour, alterations in executive functions occur. This happens because inhibition creates a pause (a fraction of a second) between the stimulus and the response, so that the other executive functions can enter the scene. In that interval, the executive functions help us to analyse the possible consequences of an action and, based on this, we plan and organise ourselves, in order to achieve the set goal. If that pause does not exist, the other executive functions cannot intervene.

Inhibition and attention are two closely related cognitive processes. Attention is the ability to focus the mind on a specific stimulus or task, while inhibition is the ability to suppress irrelevant or inappropriate responses or thoughts. Attention can be sustained or selective. Sustained attention is the ability to maintain attention on a task for a prolonged period of time. Selective attention refers to the child's ability to focus their attention on a relevant stimulus while ignoring irrelevant stimuli. (Rebollo & Montiel, 2006).

The variables of analysis that will be taken into account in this study are inhibition measured through selective attention tests and reading comprehension.

Inhibition and Reading Comprehension

Inhibition seems to have an important influence on reading comprehension tasks (Bizama-Muñoz, et al., 2020). During reading, more information is activated than is necessary for understanding a text, information that can produce interference; suppression is the mechanism responsible for eliminating these interferences (Gernsbacher & Faust, 1991). Good comprehenders would suppress or inhibit inappropriate information better during text processing. According to Cain (2006), poor comprehenders are less skilled at inhibiting or suppressing irrelevant information for the task. The sensitivity to interference of poor comprehenders has been reported in several studies. For example, children with reading difficulties show greater susceptibility to interference on the Stroop test (Kelly, Best & Kirk, 1989). In Cain's (2006) study, good and poor comprehenders were compared using a negative priming sentence processing task adapted from Lorsbach et al., (1996) to determine if good and poor comprehenders differed in their ability to inhibit words that had been generated in a previous task and that were no longer relevant to the task. The results indicated that poor comprehenders were less able to erase information from their working memory that was no longer relevant to the task.

Thus, there are children with problems in the comprehension of texts who do not show deterioration in their decoding skills, but who have specific problems in various skills related to comprehension (Nation & Snowling, 1997). These children show failures

in a wide range of cognitive processes, including deficits in their vocabulary and other higher linguistic skills, such as monitoring (Oakhill, et al., 2005), inference making (Cain & Oakhill, 1999; Cain, et. al, 2004; Savage, 2006, Nation, 2005), working memory (Butterfuss & Kendeou, 2018) and inhibition (Cain, 2006; Georgius & Das, 2016).

Cain's (2006) study examined the relationship between inhibition and reading comprehension in children aged 8 to 10 years. The study tasks of inhibition such as the Stroop task, in which participants had to name the colour of the ink in which a word was written, ignoring the meaning of the word. Reading comprehension tasks included reading texts and answering questions about the texts. The results of the study showed that children with better inhibition skills had better reading comprehension skills. Children who could inhibit their automatic responses were more able to understand the meaning of a text, even when the text was ambiguous or complex. The findings of the study suggest that inhibition is an important skill for reading comprehension. Children with inhibition difficulties may have difficulty understanding the meaning of a text, even if they have a good vocabulary and knowledge.

Inhibition requires automatic and controlled processes produced at the behavioural or cognitive level (for example, Friedman and Miyake, 2004; Nigg, 2000). An individual with weak cognitive inhibitory skills may retain irrelevant information in working memory and not allow relevant information to be acquired because the system is overloaded. In this way, weak inhibitory skills can affect text comprehension.

Studies such as those of Barnes, Faulkner, Wilkinson & Dennis, (2004) and Georgius and Das (2016) show that adults and children with poor reading comprehension have deficient inhibitory mechanisms by being slower to suppress irrelevant meanings of ambiguous words.

In memory tasks, Palladino, et al., (2001) showed that adults with weak reading comprehension are more likely to remember words from previous essays that should have been forgotten than good comprehends. In children, they observed that when they present poor reading comprehension, they similarly experience a greater number of intrusions in their memory of memory tasks and are also more likely than good comprehends to remember irrelevant content. These findings indicate that poor comprehends may suffer from weak inhibitory processes that negatively affect their working memory capacity.

Comprehension is an active process of integrating information. In which, in order to fulfil the objective of creating a coherent mental representation of the text, the reader must hold certain information in the MT while computing the relationships between words and sentences, at the same time, he must be able to inhibit irrelevant information and update the relevant information in his working memory (Cain, 2006).

Metacognitive Strategies and Reading

Metacognitive strategies such as planning, monitoring, or reviewing have been shown to be effective for reading comprehension. Studies such as those by Baker and

Brown (2001) found benefits when using these metacognitive strategies with elementary and secondary students. In another study, Pressley and Harris (2002) examined the effectiveness of a metacognitive strategy-based intervention programme to improve reading comprehension in fourth-grade students with reading difficulties. The intervention group was taught metacognitive strategies of monitoring and guided instruction. The results indicated that the intervention programme was effective in improving reading comprehension in students with difficulties.

Study Aims

This study aims to find significant effects on inhibitory processes and reading comprehension in the intervention group after the application of the planning facilitation programme. It is expected that the intervention group will significantly improve their scores in inhibitory processes measured through the DN attention scale: CAS (Naglieri & Das, 1997), and reading comprehension measured through the ACL scale (Català, et al., 2010).

Research Questions

Do planning facilitation strategies help to improve inhibitory processes in students with reading difficulties? Does the improvement of inhibitory processes directly influence the improvement of reading comprehension?

Method

Participants

The sample consisted of 33 students in a 3rd grade primary education classroom in the city of Ourense, Spain. The socioeconomic status of the families in the area is of a medium level. The types of economic activities developed in the surrounding area belong to the tertiary sector (Instituto Galego de Estatística; IGE, 2018). By gender, 14 were girls and 19 were boys. Their age ranged from 7.5 to 8.4 years, with an average age of 8.05 years.

The classroom group was divided into two. The criteria used for the division of the classroom group were of two types: one the reading delay that some students were acquiring in the judgment of the classroom teacher. Two, the confirmation of the delay in the results obtained in standardised reading tests. The groups formed were different in number. The group with reading difficulties (n=8) and the group of typical development (n=25). This group of typical development formed the comparison group, and the intervention was carried out with the group of difficulties in reading comprehension.

Both groups were equalised in the socioeconomic and cultural level of the parents. They were students of urban origin and from families of medium socioeconomic level. No significant differences were found by gender and group ($\chi^2(1)=.454$; $p=.501$). The sample had homogeneous characteristics in terms of social, economic, and cultural variables.

Instruments

Cognitive Processes. To measure cognitive processes, the Das-Naglieri Cognitive Assessment System (D.N: CAS; Naglieri & Das, 1997) was used in its Spanish adaptation (Deaño, 2005). This battery is composed of four scales: Planning, Attention, Simultaneous, and Successive. In the scales corresponding to 7-9 years old, the minimum score that a student can obtain is 30 and the maximum score is 120. The Attention Scale, corresponding to sustained attention, was used.

Attention Seale. The sub tests comprising the Attention Seale demand that the child resist distraction and maintain appropriately directed attention to the completion of specific tasks. This scale comprises three subtests: (i) For the Expressive Attention subtest, the child must read colour words orally, identify the colour of a series of rectangles, and name the colour of the ink in which words are printed. The distractor is the difference between the word and the colour of the ink (e.g., RED printed in green ink). (ii) Number Detection consists of pages of numbers that are printed in various fonts (e.g., outline). Children are given a stimulus (e.g., 1, 2, and 3 in a normal font) and are required to find all numbers that match the number as well as the font. (iii) Receptive Attention involves underlining pairs of matching letters in multiple rows of stimuli. The first item requires that the letters match physical appearances (e.g., R, R), while the subsequent item demands that they have the same name (e.g., r, R).

Reading Processes. The Avaluación de la Comprensión Lectora (ACL) test by Català, et al., (2010) was used to measure reading processes. The ACL consists of 6 tests, corresponding to each of the six grades of primary education. The tests are designed to assess reading comprehension in a broad manner, with texts of different types (narrative, expository, poetic, interpretation of a graph, and interpretation of data), and with topics related to the different curricular subjects. These tests collect information on four relevant dimensions of reading comprehension: literal, which focuses on the ideas and information that are explicitly stated in the text; reorganising, where the student must analyse, synthesise, and/or organise the explicitly expressed ideas in the text; inferential, which is executed when the student is able to use both the information explicitly stated in the text and the prior knowledge they possess to formulate conjectures and hypotheses; and critical, in which the student must provide answers that indicate that they have made a value judgment, comparing the ideas presented in the text with an internal (personal) or external criterion (the teacher, other sources, etc.). ACL scores range from 0 (minimum) to 10 (maximum). The reliabilities of the test for each one of the levels established from 1st to 6th grade, by means of the KR-20, were, respectively, .80, .83, .80, .83, .82, and .76.

Procedure

Assessment Procedure

Each student was given instructions on what was going to be done before starting the individual administration of the D.N: CAS Battery. The administration was carried out in accordance with the administration and recording guidelines in the manual. The duration was approximately 30 minutes per participant. The evaluator was trained in the administration of this battery. The same evaluator was used for all participants. The test was administered in a suitable room in the school itself and in a relaxed atmosphere. The ACL test was administered collectively and in accordance with the application and recording guidelines. The approximate duration of the test was 30 minutes. The tests were conducted in sessions and on different days in the order described. The necessary permissions were obtained for their implementation, and the collaboration of the teaching staff was sought for their collective and individual administration.

Intervention Programme

The programme consists of texts for reading, of different levels, extracted from the ACL. These texts were used to answer questions asked of the students about each of the texts at a given level. The levels of the texts used for this programme were ACL-1, ACL-2; ACL-4 and ACL-5. The ACL-3 was not used for the intervention as it was used for the evaluation. The programme consists of eight to ten texts per level. Each text has five questions. The level at which the programme for 3rd grade students began was ACL-2, followed by ACL-1, ACL-4 and finally ACL-5. The different levels are used in the intervention so that students can start with texts of less difficulty, which would allow them to acquire the strategies better and then integrate them through more complex texts.

The intervention had the consent of the school administration, the students' parents, and the university research team. It was conducted in a small group system. Each group consisted of 4 participants. The tasks of the text reading programme were implemented using the Planning Facilitation method of Naglieri & Gottling (1997) and the expansion made by Haddad et al. (2003) for reading, which consists of three moments.

Moment 1. The teacher gives the students an ACL text with the five questions to which they have to answer, in ten minutes, individually, after reading it. In this time, the student has to put into place strategies for selecting information, remembering, and organising. To carry out these strategies, the student must reinforce working memory, planning, and inhibition.

Moment 2. With the questions answered by the students in sight, the mediator initiates a debate by asking reflection questions. The mediator does not exhaust the repertoire of questions, but uses them to guide the debate. After ten minutes, the discussion is terminated. At this point, the student puts into place metacognitive processes, through which they will analyse how their classmates have completed the

tasks, evaluate whether their strategies have worked correctly, and plan a new way of working.

Moment 3. The mediator collects the completed sheets from all the students and gives them others with the same text and the same questions to solve the task for ten minutes. In this last moment, they will work on the same strategies as at the beginning, but this time their inhibition processes will have better working strategies, thanks to what they have learned in the previous phase.

The time for completing a text was one session of half an hour, twice a week per group. The number of texts used was 24, which, implemented at 2 sessions per week, makes a total of 12 weeks of intervention, for each group. The total number of intervention sessions was 48 throughout the second school quarter.

The participants in the programme left the classroom to work with the mediator for each session. The exit from the classroom had been scheduled in advance.

Comparison Group

The comparison group learned to read in a conventional way. They read a text with conceptual notions about language, grammar, syntax, and spelling and resolved conceptual questions raised in the text.

Design and Data Analysis

A pre/intervention/post/follow-up design was used, contrasting the intervention and comparison groups on each measure. To evaluate the effectiveness of the training programme in 3rd grade students, a repeated measures multivariate analysis of variance (MANOVA) was conducted for attentional processing (D.N.: CAS) and reading comprehension (ACL).

The Greenhouse-Geisser correction was used for the degrees of freedom, given the violation of the sphericity assumption. The analyses were conducted with the Statistical Package Social Science (SPSS) software package, version 18.0.

Results

The intervention and comparison groups were significantly different on the cognitive variable of attention and its subtests, with the comparison group having a higher mean score than the intervention group [$F(2,62)= 25.286, p=.001$]. The groups also differed initially in their reading comprehension scores [$F(1, 29)= 9.501, p=.005$], with the comparison group having a significantly higher mean score than the intervention group.

Table 1
Cognitive processes (Attention, Scale; D.N.: CAS)

	GE n= 8			GC n= 25			Group x measure N= 33		
	M1	M2	M3	M1	M2	M3	<i>F</i>	<i>p</i>	$\eta^2_{\text{parcial}}^1$
	<i>M</i> (<i>DT</i>)	<i>M</i> (<i>DT</i>)	<i>M</i> (<i>DT</i>)	<i>M</i> (<i>DT</i>)	<i>M</i> (<i>DT</i>)	<i>M</i> (<i>DT</i>)	(<i>gl.</i>)		
Atención	91.00 (11.43)	106.62 (14.22)	109.77 (13.33)	105.60 (12.81)	104.13 (12.61)	105.01 (10.92)	31.077 (2,62)	.000***	.501

Note: * $p < .05$; ** $p < .01$; *** $p < .001$

Note: 1 Small effect size: .01, Medium effect size: .06, Large effect size: .14 (Cohen, 1988)

The results of the analysis of variance for attention cognitive processes, measured with the CAS, showed a main effect for attention processes, $F(2, 62) = 25.286$, $p < .001$, $\eta^2_{\text{parcial}} = .449$.

These main effects indicated that the mean scores of the participants in attention cognitive processes varied significantly when comparing the pairs M1-M3 ($p < .05$). That significant variation of mean scores, in terms of effect size expressed through the value obtained from partial eta squared, was large.

A significant interaction Group x Measure also occurred, indicating that the mean scores of the intervention and comparison groups in attention cognitive processes varied more than what would be attributable to chance in the three measures (Table 1). The effect sizes associated with each interaction were large.

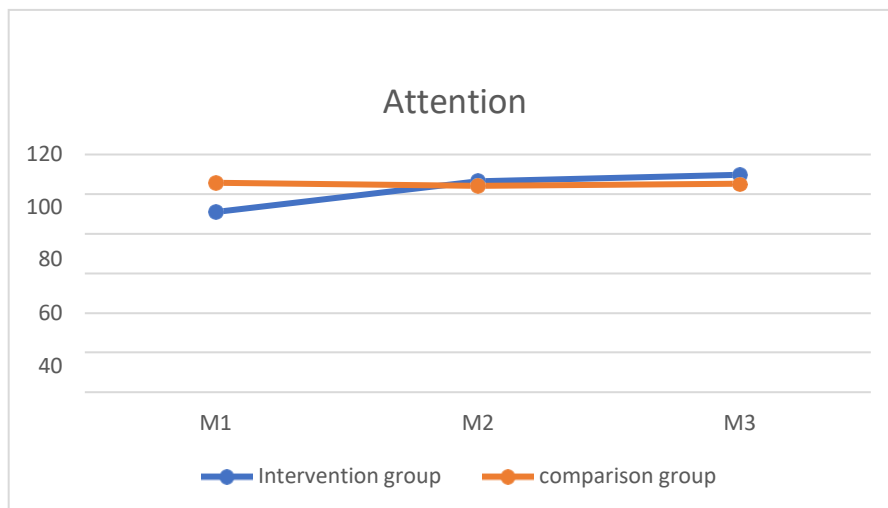


Figure 1. Average scores in cognitive processes for the groups according to the measure

The results of the analysis of variance for reading comprehension, measured with the ACL, showed a main effect for the measure, $F(2, 62) = 60.081$, $p < .001$, $\eta^2_{\text{parcial}} = .660$. This main effect indicates large significant variations in the mean scores of the participants from M1 to M3 ($p < .05$) (Figure 1).

The significant interaction of large size Group x Measure also occurred for reading comprehension.

Table 2
Reading comprehension (ACL)

	GI n= 8			GC n= 25			Group x measure N= 33		
	M1	M2	M3	M1	M2	M3	F (gl.)	p	$\eta^2_{\text{parcial}}^1$
	M	M	M	M	M	M			
ACL	3.20 (1.19)	4.95 (.74)	5.87 (1.10)	5.55 (1.97)	6.22 (1.77)	6.31 (1.70)	17.801 (2,62)	.000***	.365

Note: *** $p < .001$

Note: 1 Small effect size: .01, Medium effect size: .06, Large effect size: .14 (Cohen, 1988)

As shown in Table 2, the intervention group participants had significantly lower mean reading comprehension scores than the comparison group participants at the pre-intervention measure (M1), $F(1, 31) = 10.045$, $p < .01$, $\eta^2_{\text{parcial}} = .245$. However, there were no significant differences between the groups at the post-intervention (M2) or follow-up (M3) measures.

Specifically, the intervention group participants had a mean reading comprehension score of 80.0 at M1, compared to a mean score of 90.0 for the comparison group. The intervention group participants' score increased to 90.0 at M2 and remained at 90.0 at M3. The comparison group participants' score remained at 90.0 at M2 and M3.

These results suggest that the intervention programme was effective in improving reading comprehension in third-grade students, as the intervention group participants' scores were significantly lower at M1 than the comparison group participants' scores, but they were no longer significantly different at M2 or M3.

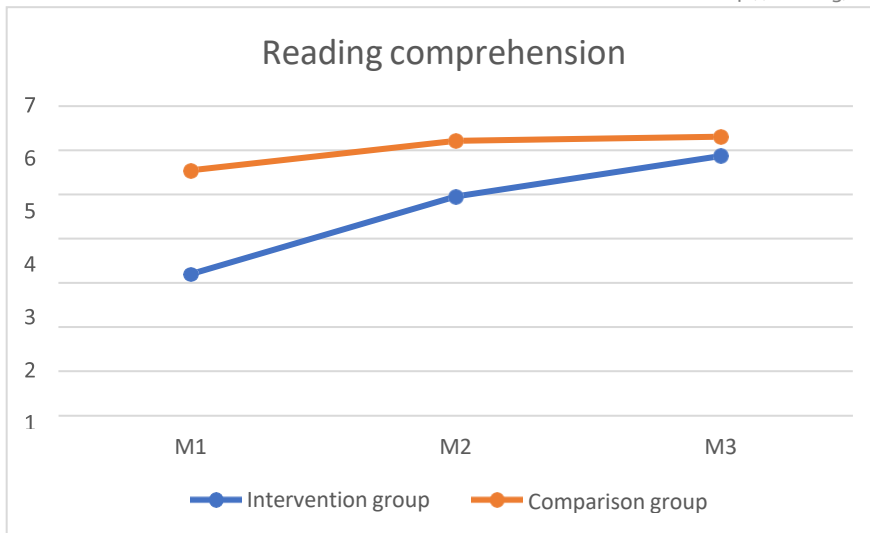


Figure 2. Average scores in reading comprehension for the groups according to the measure

Discussion

The objective of the study was to find a significant effect on the variables of inhibition and reading comprehension in the intervention group compared to the control group. This objective was successfully met.

The intervention produced, as expected, a statistically significant improvement in the scores of the cognitive processes of inhibition, so that the cognitive functioning of the intervention group equalled that of the comparison group, in the processes that differed from the comparison group. The scores of the cognitive processes varied significantly from the pre-intervention mean to the follow-up post-intervention with a large effect size and this variation occurred as a result of the intervention to which the group was subjected and which was reflected in the group x moment of the measure interaction. The analysis of variance showed significant differences for the intervention group in inhibition. This indicates the significant gain in mean score that occurred for the intervention group in the aforementioned processes from the pre-test measure to the follow-up, which, however, did not occur for the comparison group. The group that received the intervention improved its inhibitory measures from pre-intervention to post and to follow-up, producing an interactive effect. Initially, the children/girls in the comparison group had higher mean scores in this process than those in the intervention group, in the post measure and in the follow-up, both groups equalled in the performance of the attention process tasks.

As a result of the intervention, reading performance scores increased from pre-intervention to post-intervention and to follow-up, with reading comprehension performance scores equalizing in the two groups. The significant large variations in the mean scores of the participants were shown from the pre-measure to the follow-up in the intervention group, as indicated by the Group x measure interaction effect for reading comprehension. Initially, the intervention group participants had lower reading

comprehension performance than those in the comparison group, but after the intervention they equalled in reading performance, maintaining similar mean scores in the post measure and in the follow-up (follow-up) measure. Intra-group comparisons made on the three reading comprehension measures indicated statistically significant differences in the mean scores of the intervention group from pre to post and from pre to follow-up, but did not indicate differences in the scores of the comparison group.

As considered by researchers on Planning Facilitation, it promotes reading improvement (Haddad et al., 2003), but at the same time the results of the present study show that it also improves other cognitive processes such as sustained attention. Following research such as Butterfuss and Kendeou (2018) and Georgiou and Das (2016), the improvement in executive attention functions has a significant effect on reading comprehension processes.

The results obtained expand those of Haddad et al. (2003) and Bizama-Muñoz, et al., (2020) in the sense that grade 3 is a good time to address incipient learning difficulties in reading that have not manifested themselves in previous grades, derived from a weakened attentional processing. Its manifestation in grade 3 seems to be presented by the new academic demands (complex reading comprehension) and the participation of complex cognitive skills (thinking, reasoning, inference, comprehension) that require more attentional activity.

To the question "Do planning facilitation strategies help improve inhibitory processes in students with reading comprehension difficulties? Does the improvement of inhibitory processes directly influence the improvement of reading comprehension?" The strategies used in the intervention programme allow to improve inhibitory processes and at the same time improve reading comprehension.

In Cain's (2006) studies, it was shown that there is a relationship between inhibition and reading comprehension. When inhibition skills improve, reading comprehension skills also improve. This relationship is centred on the fact that when students were able to inhibit automatic responses, they could understand better. In this programme, mediated learning with metacognitive questions and the performance of the task at two different times allowed students to create their own strategies to acquire new and more effective skills for reading comprehension. The programme provided students with strategies that they could use long after the intervention. This is demonstrated in the follow-up results where inhibition and reading comprehension improve significantly compared to the post-test results. This study adds to those conducted by Cain (2006) and Georgiou and Das, (2016) that a programme of intervention with metacognitive strategies is applied and that this intervention is carried out with students with reading difficulties with the aim of equalizing it with the control group that from the start did not present any difficulty. This study shows that students with reading difficulties can reach the level of their classmates if we improve their inhibitory processes through metacognitive strategies and mediated learning.

This study presents limitations that should be resolved in future research. It is a study with an intentional sample to address a specific situation in a classroom with students at risk of learning difficulty and in which metacognitive instruction was provided

to the subjects who needed an educational response. This has led to a second limitation, which is the number, balance, and assignment of participants to the groups.

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