

# COGNITIVE MODIFICATION IN STUDENTS WITH READING PROBLEMS AND ADHD-CT

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## MODIFICACIÓN COGNITIVA EN ESTUDIANTES CON PROBLEMAS DE LECTURA Y TDAH-CT

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### ABSTRACT

In this exploratory study, the PASS Reading Enhancement Program (PREP) was implemented individually as a cognitive modification program on five Puerto Rican children between 7 and 9 years old with reading difficulties and Attention Deficit Disorder and Hyperactivity - Combined Type. The PREP is based on the Planning, Attention, Simultaneous and Successive processing (PASS) theory and its purpose is to improve reading achievement. Results suggest that cognitive modification was possible, even in children with attention and hyperactivity problems. There was improvement in successive processing, and its relationship with decoding skills was evidenced. The PREP also contributed to optimize children's performance in comprehension skills. The results of this study may improve the academic performance of students with these or similar characteristics and increase their overall academic achievement. This in turn may contribute to advance collaboration between researchers and educators to reduce the gap between scientific research and educational practices.

**KEYWORDS:** Attention Deficit Hyperactivity Disorder, cognitive modification, reading problems.

### RESUMEN

El PASS Reading Enhancement Program (PREP) es un programa de remediación cognitiva, basado en la Teoría de los Procesos de Planificación, Atención, Simultaneidad y Sucesividad (PASS), cuyo propósito es mejorar el aprovechamiento en lectura. En este estudio exploratorio se utilizó el PREP para modificar los procesos cognitivos de cinco niños puertorriqueños entre 7 a 9 años con dificultades de lectura y Trastorno por Déficit de Atención e Hiperactividad - Tipo Combinado. En los resultados de las pruebas cognitivas y de aprovechamiento administradas antes y después de la intervención realizada individualmente, se observaron cambios positivos en el procesamiento sucesivo, así como en la decodificación de palabras. El PREP contribuyó además a optimizar el desempeño de los participantes en las destrezas de comprensión. Los resultados sugieren que la modificación cognitiva es posible, aún en estudiantes con problemas de atención e hiperactividad. Este estudio pretende contribuir a mejorar el desempeño académico de estudiantes con estas características, así como aumentar sus niveles de aprovechamiento escolar, lo cual se espera redunde en la colaboración entre investigadores y educadores para disminuir la brecha entre la investigación científica y las prácticas educativas.

**PALABRAS CLAVE:** Modificación cognitiva, problemas de lectura, Trastorno por déficit de atención con hiperactividad.

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According to the US Department of Education (2017), approximately 47.7% of students enrolled in the Special Education Program of the Puerto Rico Department of Education were diagnosed with Specific Learning Disorders (SLD) in 2015. There is no specific data as to the type (reading, math, writing) or severity of the SLD affecting these specific students. However, many of them may have reading difficulties, since these are one of the most common manifestations of SLD, according to the Fifth Edition of the Diagnostic and Statistical Manual for Psychiatric Disorders (DSM V) of the American Psychiatric Association or APA (2013).

SLD in reading are diagnosed when students show persistent “inaccurate or slow and effortful word reading” or “difficulty understanding the meaning of what is read” for at least 6 months (APA, 2013). This definition was adopted in response to changes made between 2004 and 2006 to the Individuals with Disabilities Education Act (IDEA; 2004) and its regulations regarding the identification of SLD (Cortiella & Horowitz, 2014). That is, in the previous version of this law and the Revised Text of the Fourth Edition of the Diagnostic and Statistical Manual for Psychiatric Disorders or DSM IV-TR (APA, 2000), an individual was said to have an SLD if there was a discrepancy of more than two standard deviations between intelligence and achievement tests in reading, math, and/or writing. This definition was widely criticized because, in practice, it led to exclude children who obtained much lower discrepancies between the mentioned tests yet, continue to show difficulties in one or more achievement areas (Aaron, Joshi, Gooden, & Bentum, 2008).

This new perspective on SLD paved the way to develop innovative approaches to explain the cause or origin of these diagnosis. For instance, it is well-known that SLD are a result of “neurological differences in brain structure and function” and that they “affect a person’s ability to receive, store, process, retrieve or communicate information”

(Cortiella & Horowitz, 2014). However, researchers are still learning more about the nature of these disorders, how are they related to specific areas of the brain and their frequent comorbidity with other neurodevelopmental disorders such as Attention Deficit Hyperactivity Disorder or ADHD (Hendren, Haft, Black, White & Hoeff, 2018).

ADHD is diagnosed when there is “a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development” (APA, 2013). There are different presentations of the disorder depending on the predominance of the symptoms, as well as a combined one, where six or more symptoms of each type have been documented for at least 6 months. According to the DSM V, approximately 5% of children in a given culture may have this disorder; however, in a study conducted in Puerto Rico by Canino et al. (2004), a prevalence of 8% was observed.

The underlying cognitive processes associated with both ADHD and SLD in reading have been documented in recent studies. For instance, children with ADHD show significant difficulties regarding response inhibition, short-term and working memory, processing speed, cognitive flexibility, planning, attention, self-regulation, among other processes (Ahmadi, Mohammadi, Araghi & Zarafshan, 2014; APA, 2013; Barkley, 2011; Li et al., 2008; Willcutt et al., 2012), while students with SLD in reading may also show working memory and attention problems, as well as slow naming speed and poor phonological awareness, among others (APA, 2013; Tannock, 2012). This conceptualization of ADHD and SLD suggests they have common cognitive difficulties that in turn could have similar effects, both at an academic and affective level. Moreover, this emphasis on the cognitive characteristics of these disorders, as opposed to focusing just on their behavioral aspects, may serve researchers and practitioners to develop effective interventions for both diagnoses. As

such, the same intervention could help children with both disorders, in addition to medication and behavior modification programs.

Given the high percentage of Puerto Rican children diagnosed with these disorders (ADHD and SLD), it is imperative to generate new alternatives to help these students. For this reason, the main goal of this exploratory study was to implement a cognitive remediation reading program, the PASS Reading Enhancement Program or PREP (Das, 1999), in a sample of children between 7 to 9 years old that have reading problems and a diagnosis of Attention Deficit Disorder - Combined Type (ADHD-CT). The specific aims of this research were to compare the results of the standardized tests that measure cognitive abilities and reading achievement before and after the implementation of the program and evaluate the changes that occurred in their reading skills after the intervention.

#### PASS Reading Enhancement Program (PREP)

The main goal of the PREP is to improve reading by facilitating the spontaneous acquisition of cognitive processing strategies through an inductive process (Mahapatra, 2016). In this way, children learn through experience as they internalize these strategies. As such, the PREP is theoretically based on the Planning, Attention, Simultaneous, and Successive (PASS) theory of intelligence proposed by Das, Naglieri & Kirby (1994) and emphasizes the zone of proximal development conceptualized by Vygotsky (1978), strategy training, early intervention, as well as aptitude mediated by interaction during training (Das, 2000).

PASS theory is based on information derived from the neuropsychological research of A.R. Luria (1973), together with contemporary information processing and cognitive psychology theories. It conceptualizes intelligence, not as a general ability, but as a group of interrelated,

multidimensional processes: planning, attention, successive processing, and simultaneous processing (Naglieri, Taddei & Williams, 2013). These four basic cognitive processes correspond to specific areas of the brain described by Luria as three functional units or blocks (Naglieri & Otero, 2017). Block 1 is made up of reticular structures (the brain stem, diencephalons, and medial regions of the hemispheres) associated with arousal and attention, while Block 2 consists of the occipital, parietal, and temporal lobes posterior to the central sulcus, which control information processing, and Block 3 encompasses the frontal lobe associated with higher level reasoning and planning (Flanagan et al., 2010). Planning is a mental process in which an individual makes decisions, selects, and implements strategies, as well as evaluates solutions for problems (Iseman & Naglieri, 2011). It provides cognitive control, utilization of processes and knowledge, intentionality, and self-regulation to achieve a desired goal.

Planning is very closely related to attention, which involves concentration on an activity, inhibition of responses to distracting stimuli, as well as resistance to distraction (Lehman, Naglieri & Aquilino, 2009). These characterizations of the process of attention describe higher cognitive functions related to learning and problem solving that facilitate the retrieving, storing, and processing of information. Both the simultaneous and the successive processes are two different ways in which such information is handled (Naglieri, Taddei, & Williams, 2013). Successive processing implies putting information in a specific order, involving both the perception of stimuli in sequence and the formation of sounds and movements in order. In contrast, simultaneous processing implies viewing the relation of separate pieces of information into a group or seeing how parts are related to a whole. It involves the integration of stimuli into an interrelated group. Over two decades of research have provided evidence for the validity of the PASS theory, especially when applied to ethnically diverse populations

(D'Amico, Cardaci, Di Nuovo & Naglieri, 2012; Deng, Liu, Wei, Chan & Das, 2011; Ennis, Reddon, Das & Boudreau, 2008; Janzen, 2000; Moreno Torres, 2003; Naglieri, Rojahn, & Matto, 2007; Naglieri, Otero, DeLauder & Matto, 2007; Naglieri, Taddei, & Williams, 2013; Otero, Gonzales & Naglieri, 2013; Van Luit et al., 2005).

In the PREP, Das (2000) integrates the PASS theory with one of L.S. Vygotsky most known ideas: the zone of proximal development (Rodríguez Arocho, 2015). This concept developed by Vygotsky (1931/1991; 1934/1993), entails the idea that interactions with a more qualified or experienced individual can result in faster than expected cognitive development. This vision of learning presupposes that certain internal developmental processes only operate when interacting with others and once internalized, they become an achievement in their development. Vygotsky made a distinction between the current and the potential levels of development. The former refers to what an individual can do independently, while the latter is what someone can reach with the help of a more qualified individual. That is, the current level refers to mental functions that have been established and can be measured by traditional intelligence tests, while the potential level addresses the dynamic nature of development. The distance between these levels is the zone of proximal development, which defines functions in process of maturation, since what is in the area at this time, may later become the current level. That is, what individuals can do now only with help, in the future, they may be able to do them themselves. Vygotsky's work has been fundamental in the development of PREP, since this program encourages collaborative activity between an adult and a child and underlies the importance of strategies in problem solving.

Strategy training refers to transferring learning by stimulating the development of general learning skills (Das, 2000). Through metacognition the participant is made aware of the strategy used to solve a problem and is

taught other strategies in order to compare and evaluate each one with respect to the problem to solve. Once the participant learns and practices different strategies, then he or she can decide the most appropriate one to solve a problem.

Early intervention has taken renewed interest due to current research on neural plasticity or the process by which the brain changes and reorganizes itself in response to environmental influences (Sharma, Classen & Cohen, 2013). As such, it is thought that the brain is much more malleable, the more synaptic connections available to support developing functions. Recent studies show that neural plasticity may unravel the neurological effects of early negative experiences, as in the case of abuse or illness, as well as positive ones, as in the case of cognitive stimulation (Humphreys et al., 2018).

Finally, the aptitude mediated by interaction refers to the idea that the current abilities of the child should be considered when designing instructional programs. For instance, once a cognitive weakness is detected while using the PREP, the individual is exposed to a series of tasks to try different strategies, monitor their effectiveness and change them, until a successful one is found. This process, based on the participant's abilities, is intended to strengthen their cognitive processing (Mahapatra, 2016).

The ten tasks that make up the PREP vary considerably in content. However, they are designed to strengthen the cognitive processes most related to reading: successive and simultaneous processing (Naglieri & Pickering, 2010). For instance, successive processing is highly involved with blending sounds to form words, as well as the syntax of language, while simultaneous processing requires integration and understanding of word relationships, prepositions, and inflections to derived meaning, which is the basis of reading comprehension.

Each task involves a global and a bridge training component. The global component includes structured tasks that do not imply reading but require the application of cognitive processing strategies. In addition, they provide students with the opportunity to internalize strategies in a personally meaningful manner, which facilitates the transfer. The bridge component links improved cognitive processes to specific tasks whose content is related to word decoding and comprehension. Both the global and bridge components have three levels of difficulty, as to allow the participant to gradually progress in strategy development only after mastering each level. If an individual does not answer correctly 80% of the items in each task, an alternate set is used at the same level of difficulty to provide for additional training. This creates a series of scaffolds that support and guide the participant to ensure that tasks are completed with minimum help and greater success, facilitating the transfer of learned principles so that they can apply the strategies learned in other situations. The effectiveness of PREP as a remedial reading program has been successfully evaluated in several studies (Boden & Kirby, 1995; Carlson & Das, 1997; Churches, Skuy & Das, 2002; Das, Mishra & Pool, 1995; Mahapatra, Das, Stack-Cutler, & Parrila, 2010; Parrilla, Das, Kendrick, Papadopoulos & Kirby, 1999).

The Spanish version of the PREP, Programa para la Reeducción del Aprendizaje o PRDA-PREP (Garrido Laparte, 1999), was used with a group of Spanish students between the ages of 9 and 10 years with Down syndrome. Molina, Garrido and Das (1997) found that these students performed significantly better than the control group in simultaneous and successive processing. In Puerto Rico, an adaptation of the PRDA-PREP to our socio-cultural context was carried out by the author and Dr. María Báez Reyes, with support from the members of the research team of Project EFEL (Study of the Development of Executive Functions and Language). After this process, Dr. Báez Reyes implemented the program with a group

of five participants between the ages of 8 to 12 years with reading difficulties. The results of that study showed an increase in simultaneous and successive processing which suggests the program led to a cognitive reorganization with respect to those processes related to reading (Báez Reyes, In press). However, the PREP had never been implemented with participants with reading difficulties accompanied by problems of inattention and hyperactivity. As previously stated, both ADHD and SLD have common cognitive difficulties, which suggests the same intervention could be effective for both disorders.

## METHOD

### Design

A case study design was used to carry out this exploratory/descriptive study, in which the PREP was used for the first time with participants with ADHD-CT and reading difficulties to improve their achievement in reading. This type of design, widely used successfully in educational and social sciences research, allows greater flexibility in the selection and number of participants (Hernández Sampieri, Fernández Collado, & Baptista Lucio, 2010; Yazan, 2015), especially when the intervention is administered individually, and attendance is required to all sessions to complete the intervention.

### Participants

For this research, five children between the ages of 7 to 9 years were selected according to the following criteria: 1) be between 7 years and 0 months, and 9 years and 11 months, 2) be Spanish speaking, 3) be diagnosed with ADHD – CT, 4) show academic difficulties in reading as reported by teachers, parents or guardians, 5) obtain low average scores in any of the subtests of reading achievement, as well as in any of the cognitive processes, and 6) obtain an intelligence quotient (IQ) of 80 or more. Three of the participants in this research were part of the sample of the

experimental group of Project EFEL. The others were referred to the researcher by the social worker of a public school in the eastern part of Puerto Rico. It is important to note that none of the participants had been diagnosed with SLD in Reading; however, this was deemed not necessary, since PREP has been successfully used with children with reading difficulties and poor readers as well (Báez Reyes, In press, Carlson & Das, 1997; Das, Mishra & Pool, 1995; Mahapatra, Das, Stack-Cutler, & Parrila, 2010; Molina, Garrido & Das, 1997; Parrilla et al., 1999). Moreover, as previously mentioned, the criteria to identify students with SLD has been modified to include children with reading difficulties, even if they obtained much lower discrepancies between intelligence and achievement tests.

#### Instruments

**Cognitive Assessment System (CAS).** The CAS (Naglieri & Das, 1997) measures the four cognitive processes proposed by the PASS theory as the blocks of intelligent behavior. It is individually administered to children from 5 to 17 years. A standard score with a mean of 100 and a standard deviation of 15 is produced for each of the four PASS scales, as well as a Full Scale as a composite of all CAS subtests. Reliability coefficients for each of the four scales and the Full Score are as follows: Planning (.85), Attention (.84), Simultaneous (.90), Successive (.90), and Full Scale (.87). A Spanish version of this test was developed in Puerto Rico by Project EFEL research team in collaboration with Dr. Naglieri, one of the developers of the CAS, following the conceptual and methodological considerations regarding cultural adaptation of psychological instruments aimed at assessing the characteristics of ethnic minorities (Bravo, 2003; Canino & Bravo, 1999). This translated CAS, as well as the original English version, was administered to a sample of bilingual Hispanic children, 5 to 17 years old, in Chicago and they scored consistently similar on both tests regardless of the language difference (Naglieri, Otero, DeLauder & Matto, 2007). The CAS was used

in this study to assess cognitive processing before and after the intervention.

**Batería de Aprovechamiento Woodcock-Muñoz-Revisada (BATERÍA-R).** The BATERÍA-R (Woodcock & Muñoz, 1996), a Spanish version of the Woodcock-Johnson Tests of Achievement Revised (WJ-R), includes 22 subtests to measure academic achievement in reading, math, written language, and oral language. Like CAS, it produces a standard score with a mean of 100 and a standard deviation of 15 for each of the subtests. For this study, two subtests were used to assess participants' reading performance before and after the intervention with the PREP: Identificación de letras y palabras (Letter-Word Identification) and Comprensión de textos (Passage Comprehension). The former examines the ability to read letters and words, while the latter assesses comprehension skills and command of vocabulary. Reliability coefficients for these subtests are as follows: .91 for Letter-Word Identification and .83 for Passage Comprehension.

#### Procedure

The PREP was implemented individually to each participant by the researcher with the assistance of a volunteer graduate student. The duration of the program was approximately 10 to 15 weeks per child, depending on the behavioral characteristics and work style of each participant. Each week, each child completed approximately two sessions of 45 minutes each. Each session was recorded in audio and/or video so that the graduate student could make their own observations and compare them with the researchers. In addition, a qualitative analysis of the participants' performance was made using these observations. This analysis included response patterns, as well as the strategies used by the children. As soon as each participant finished the program, they were retested with the measures mentioned above by another volunteer graduate student who was not involved in the implementation of

the intervention. The results of this reevaluation constitute the post-test of this study, which was reviewed and approved by the Institutional Committee for the Protection of Human Beings in Research (CIPSHI) of the University of Puerto Rico, Rio Piedras Campus (#0203-020).

RESULTS

As shown on Table 1, all participants improved their scores on one or both reading achievement subtests. In addition, four of the

five participants improved one or both cognitive processes that underlie reading: successive or simultaneous processing. In fact, some increased their score in other cognitive processes as well. The most significant changes, in average, were observed in the reading achievement subtests and Successive processing scores (see Table 2). This suggests that cognitive processes were modified after the intervention with the PREP, which may have helped to increase the reading performance of the participants.

TABLE 1.  
Pre and post test results for all participants.

Tests	Subtests	Participants									
		1		2		3		4		5	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
BATERÍA-R	Letter-Word Identification	90	<b>99</b>	89	<b>100</b>	79	<b>119</b>	67	<b>74</b>	61	<b>72</b>
	Passage Comprehension	(24)	<b>(32)</b>	(34)	<b>(41)</b>	(24)	<b>(44)</b>	(9)	<b>(12)</b>	(8)	<b>(11)</b>
		95	<b>98</b>	96	<b>102</b>	46	<b>88</b>	59	58	59	<b>72</b>
CAS	Planning	(13)	<b>(18)</b>	(23)	<b>(27)</b>	(2)	<b>(15)</b>	(0)	(0)	(0)	<b>(2)</b>
	Attention	81	<b>104</b>	85	<b>98</b>	75	75	83	83	89	<b>79</b>
	Successive Processing	80	80	102	<b>115</b>	84	<b>94</b>	108	100	86	84
	Simultaneous Processing	100	<b>106</b>	89	<b>94</b>	110	108	61	<b>92</b>	88	<b>98</b>
	Simultaneous Processing	71	71	100	<b>108</b>	102	102	100	<b>104</b>	102	96

Note. ( ) = Raw scores; Bold = increased scores

TABLE 2.  
Average pre and posttests results.

Tests	Subtests	Average	Average	Difference
		pretest scores	posttest scores	
BATERÍA-R	Letter-Word Identification	77.2	92.8	+ 15.6
	Passage Comprehension	71	83.6	+ 12.6
CAS	Planning	82.6	87.8	+ 5.2
	Attention	92	94.6	+ 2.6
	Successive Processing	89.6	99.6	+ 10
	Simultaneous Processing	95	96.2	+1.2

Table 3 shows changes in the scores of all reading subtests; however, the minimum scores in Planning, Attention and Simultaneous processing remained the same in the pre- and post-tests. Only a small decrease of two points is observed in the maximum scores of Successive processing. These data also support that cognitive modification and improvement in reading skills occurred in these students after the implementation of the program.

Table 4 shows the PREP tasks that the participants completed successfully. According to the PREP procedure manual, Tasks 1 to 6 are more related to successive processing, while 7 to 10 refer to simultaneous processing. Participants in this research performed better in tasks related to successive processing than in those associated with simultaneous processing. This concurs with the results on Table 2 where the most significant changes in the CAS

correspond to the Successive processing scale. This, in turn, is consistent with the

significant increase in the Letter-Word Identification subtest.

TABLE 3.  
Minimum and maximum pre and posttests scores.

Tests	Subtests	Pretest scores		Posttest scores	
		Minimum	Maximum	Minimum	Maximum
BATERÍA-R	Letter-Word Identification	61	90	72	119
	Passage Comprehension	46	96	58	102
CAS	Planning	75	89	75	104
	Attention	80	108	80	115
	Successive Processing	61	110	92	108
	Simultaneous Processing	71	102	71	108

TABLE 4.  
Participants' performance in PREP tasks.

Participants	Tasks																							
	1		2		3		4		5		6			7		8			9		10			
	G	P	G	P	G	P1	G	P	G	P	G	P1	P2	G	P	G	P1	P2	G	P	G	P		
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	■	■							■	
2	X	X	X	X	X	X	X	X		X	X				■							■	■	
3	X	X	X	X	X	X	X	X		X	X				■			■					■	
4	X	X	X	X			X	X		X					■	■							■	■
5	X	X	X	X	X		X	X				X	X		■	■		■	■			■	■	

Note. G = Global Tasks; P = Bridge Tasks; X = Successive Processing tasks completed with 80% or more; ■ = Simultaneous Processing tasks completed with 80% or more

During the implementation of the program, behaviors associated with ADHD-CT were present in the participants. For this reason, the researcher had to invest part of the time of the sessions in regaining their attention, helping them to repeat the instructions in their own words and talk about the task, as well as pay attention to the details and strategies they used to perform the tasks. In addition, when they were reluctant to continue, the researcher resorted to motivational techniques to change their attitude towards tasks, such as reminding them of everything they had achieved so far, everything they could achieve if they continued and what they had to do to finish the program successfully. This is consistent with the literature on children with ADHD that states they benefit

from changes or readjustments in the way others interpret and react to their behavior (Tresco, Lefler & Power, 2010). It is important to note that one of the strengths of PREP is that its implementation can be adjusted to meet the needs of each participant.

DISCUSSION

The specific aims of this research were to compare descriptively the results of cognitive abilities and reading achievement tests before and after the implementation of the PREP and evaluate the changes on reading skills after the intervention. As such, the results of this study show modification of cognitive processes, as well as an increase in the reading performance of the participants

occurred. Considerable changes were observed in both reading achievement subtests, as well as in the Successive processing scale of the CAS. The results suggest the effectiveness of the PREP with this sample. As such, they seem to concur with previous studies regarding the close relationship between successive processing and word decoding. However, although this intervention program is designed to impact both successive and simultaneous processing, the average score of the latter remain almost the same. Yet it is important to note that in cases 3 and 5, the pre-test Simultaneous processing scale scores were already adequate, but they were not reflected particularly in the Passage Comprehension subtest scores until after the PREP, which seemed to help optimize that reading skill, since it increased considerably after the intervention.

The results of this research can also be explained based on the levels of reading development, the interdependence between cognitive processes, the substitution and reorganization of functions, as well as individual variability. According to Dash and Dash (2011), the development of reading consists on hierarchical levels. That is, individuals must master some basic skills that will allow them to access more advanced ones. The results of this study suggest that participants obtained better scores in successive processing and word decoding because they need to master these skills before accessing comprehension skills that will allow them to understand the meaning of words, which is related to simultaneous processing. According to this approach, perhaps on the long-term we may observe the effect of the intervention on comprehension skills, since they may take more time to develop than decoding.

Certainly, the results of this study imply there is an interrelation between cognitive processes, since other processes such as planning and attention, underwent remarkable changes even through the PREP is designed

to impact simultaneous and successive processing. Like the functional units proposed by Luria, the cognitive processes of the PASS are related to each other and it is not possible to modify one without affecting others directly or indirectly (Naglieri & Otero, 2017). This in turn is related to the philosophical foundation of PREP: the substitution and reorganization of cognitive functions.

The substitution and reorganization of cognitive functions refers to the idea originated by Luria (1973) that certain functions normally carried out by a specific region of the brain can be transferred to other areas, reorganizing themselves when learning occurs successfully. This, in turn, concurs with the reconceptualization of the intelligence as a set of dynamic and interrelated cognitive processes proposed by PASS theory.

Furthermore, according to Naglieri and Otero (2017), we can perform the same activity with the same results even when different processes are involved because of individual variability in learning (Meltzer, 2018), since each person will respond to remediation differently according to their stage of development and the level of difficulty related to their specific cognitive weakness. This is evident when we examine the individual results of each participant, since we can see how the program had different effects according to each child's cognitive weaknesses that were present before the intervention. For this reason, it is important to tailor this type of intervention to the needs of the student and not use a "one size fits all" approach.

In addition, this could explain why, in general, the participants performed better in the global tasks. It is possible that the transfer between both types of task will not be carried out completely because the children are still at the word decoding level (Dash & Dash, 2011) where specific sounds are associated with letters or combinations of letters. However, it is expected that, as children apply the strategies related to successive processing,

they will be able to master decoding and concentrate more on high-level processes that lead to reading comprehension.

Moreover, the concept of individual variability takes on greater importance in this study given the behavioral characteristics of the participants. In this case, even children whose reading difficulties were accompanied by problems of inattention and hyperactivity, were able to improve their reading skills after the intervention with the PREP. In fact, during the implementation of the program, the attitude of the children towards the reading tasks changed and, according to the information provided by parents and teachers, lasted even when the intervention was completed. This indicates that the implementation of PREP may have an impact on the psychological dimension of ADHD, since not only was there external motivation on the part of the researcher, but internal motivation also occurred as participants felt more capable of performing the tasks. This is very important because a positive self-concept and sense of self-efficacy may allow them to break the negative cycle that occurs when children facing difficulties in reading, develop negative attitudes towards school work to the point of avoiding any task that requires reading (Lee & Jonson-Reid, 2016), which may harm them even more, since the less they practice reading skills, the less they may develop.

#### Conclusion

The results of this study suggest the intervention with PREP contributed to cognitive modification of the participants, whom in this case had reading difficulties, as well as problems of inattention and hyperactivity. Through this program these children were able to develop and use their own cognitive strategies to improve their reading skills.

Although the Simultaneous processing scores did not undergo any notable changes, the increase in the average scores on the Successive processing scale was

considerable. This increase was reflected in the subtest that measures word decoding, which seems to confirm the close relationship between this skill and successive processing. Moreover, there were notable changes in other cognitive processes not directly related to reading skills.

This research suggests that PASS Theory represents an innovative alternative to explain and contribute to the academic achievement of students with similar characteristics. By reconceptualizing intelligence as a group of interrelated multidimensional processes that can be evaluated through tests such as the Cognitive Assessment System (CAS) and modified by cognitive interventions such as the PREP, this theory serves to showcase and strengthen the link between psychological research and educational practices (Rodríguez Arocho & Bernal, 2016).

#### Recommendations

The main limitation of using a case study design, as in this case, is that the results cannot be generalized to the larger population of Puerto Rican students, even if they have similar characteristics. A longitudinal study using cognitive modification strategies or programs, such as the PREP, in a school setting with a larger sample of children with reading difficulties, as well as problems of inattention and hyperactivity would help characterize a larger number of students and statistically explore short and long-term effects of the intervention. Moreover, a combination of tasks aimed at modifying the cognitive processes of attention and planning may help these children achieve self-regulation, which will contribute to both their academic success, and the body of knowledge about ADHD and how to manage it.

In this study we were able to observe how the cooperation and commitment of the parents of the participants had a positive impact on the progress of the children. For this reason, it would be beneficial to encourage the participation, not only of parents, but also

of teachers, in the program through workshops on cognitive education to offer them the tools that will allow them to develop their own strategies to help children in the classroom. This would also address the social context of these children, which may contribute to increase their sense of self-efficacy regarding academic performance.

Cumplimiento con Estándares de la Ética en la Investigación

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