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Neurocognitive Aspects of Dyscalculia in the Williams-Beuren Syndrome

Aspectos Neurocognitivos de la Discalculia em el Síndrome de Williams-Beuren

Aspectos Neurocognitivos da Discalculia na Síndrome de Williams-Beuren

FABIO COLINS

Universidade Federal do Pará

ABSTRACT: *This work aims to analyze the damage caused by dyscalculia in a student with Williams-Beuren Syndrome about skills related to numerical processing. For that, an evaluation of the numerical cognition domains was carried out using the triple code model proposed by Dehaene and collaborators. This is a case study type qualitative research. The participant is a student who was in the 9th grade of elementary school and who received specialized educational assistance. Their mathematical skills were analyzed using a protocol for screening for dyscalculia, PROMAT. The reports and records generated information that was analyzed using the content analysis methodology. The research results showed that several mathematical skills were impaired due to the syndrome, such as numerical counting, oral counting, numerical transcoding, numerical magnitude and mental numerical line.*
COGNITIVE NEUROSCIENCE. MATHEMATICAL LEARNING. DYSCALCULIA. WILLIAMS-BEUREN SYNDROME.

RESUMEN: *Este trabajo tiene como objetivo analizar el daño causado por la discalculia en un estudiante con síndrome de Williams-Beuren con respecto a las habilidades relacionadas con el procesamiento numérico. Para ello, se realizó una evaluación de los dominios de cognición numérica utilizando el modelo de código triple propuesto por Dehaene y sus colaboradores. Este es un estudio de caso tipo investigación cualitativa. El participante es un estudiante que estaba en el noveno grado de la escuela primaria y que recibió asistencia educativa especializada. Sus habilidades matemáticas se analizaron utilizando un protocolo para la detección de discalculia, PROMAT. Los informes y registros generaron información que se analizó utilizando la metodología de análisis de contenido. Los resultados de la investigación mostraron que varias habilidades matemáticas se vieron afectadas debido al síndrome, como el conteo numérico, el conteo oral, la transcodificación numérica, la magnitud numérica y la línea numérica mental.*
NEUROCIENCIA COGNITIVA. APRENDIZAJE MATEMÁTICA. DISCALCULIA. SÍNDROME DE WILLIAMS-BEUREN.

RESUMO: *Este trabalho tem como objetivo analisar os prejuízos causados pela discalculia em um estudante com Síndrome de Williams-Beuren no que se refere às habilidades relacionadas ao processamento numérico. Para isso, foi realizada uma avaliação dos domínios da cognição numérica a partir do modelo do código triplo proposto por Dehaene e colaboradores. Trata-se de uma pesquisa de abordagem qualitativa do tipo estudo de caso. O participante é um estudante que cursava o 9º ano do Ensino Fundamental e que recebia atendimento educacional especializado. Suas habilidades matemáticas foram analisadas por meio de um protocolo de rastreio da discalculia, o PROMAT. Os relatórios e registros geraram informações que foram analisadas por meio da metodologia de análise de conteúdo. Os resultados da pesquisa apontaram que diversas habilidades matemáticas foram prejudicadas em decorrência da síndrome, tais como contagem numérica, contagem oral, transcodificação numérica, magnitude numérica e linha numérica mental.*
NEUROCIÊNCIA COGNITIVA. APRENDIZAGEM MATEMÁTICA. DISCALCULIA. SÍNDROME DE WILLIAMS-BEUREN.

Introducion

The learning process can be considered (Bridi-Filho & Bridi, 2016) the central element between the studies of Cognitive Neuroscience and the studies of Inclusive Mathematical Education. In this sense, what happens when after years of schooling a student fails to develop mathematical skills? What factors contribute to this lack of learning? These and other questions run through this investigation, however, there are several terminologies given to refer to people with low arithmetic performance and there is still no universal classification, although there are several proposals in the literature. Thus, this work uses the term dyscalculia as a synonym for Arithmetic Difficulty (AD).

This article, an excerpt from a doctoral research in Science and Mathematics Education, aims to analyze the damage caused by dyscalculia in a student with Williams-Beuren Syndrome with regard to skills related to numerical processing. The theoretical discussion on the neurodevelopment of Numerical Cognition (CogN) is based mainly on the Model of the Triple Code of Dehaene and his collaborators (1995; 1999, 2009, 2011). In addition, dyscalculia in Williams-Beuren Syndrome (Haase; Júlio-Costa & Santos, 2015) is discussed, above all, the difficulties in numerical processing.

The research methodology was organized based on a qualitative approach. The research deals with a case study (Yin, 2015) developed with a student with Williams-Beuren Syndrome. This syndrome is a rare disease that compromises the neurocognitive development of mathematical learning and occurs in an estimated 1/20,000 children born alive (Robinson & Temple, 2015).

The information was constructed from a neurocognitive evaluation process using the PROMAT evaluation protocol, that is, a performance test of mathematical skills for use not restricted to psychologists or neuroscientists. The empirical material was analyzed using the Content Analysis methodology (Bardin, 2011). The results showed that the investigated student has severe losses in mathematical skills regarding the domain of numerical processing.

The text is organized into five sections. In the first (introduction), the initial considerations about the research were presented; in the second, the neurocognitive aspects of mathematical learning in Williams-Beuren syndrome and the brain regions affected by the syndrome and the type of dyscalculia are addressed; the third describes the methodological aspects and the PROMAT instrument; the fourth discusses the results of the neurocognitive assessment and the fifth brings the final considerations and the research contributions to the field of Mathematics Education and Special Education.

1 Neurocognitive Bases of Dyscalculia in Williams-Beuren Syndrome

Williams Syndrome (SW) is a rare genetic disorder caused by a microdeletion, a small loss of DNA in the long arm of chromosome 7, resulting in the interruption of the elastin gene, which leads to changes in the vascular walls, in the lung, in intestine and skin (Bastos, 2016). Its incidence, which varies in several countries, is 1 child for every 20 thousand live births (Robinson & Temple, 2015).

The person with SW can be recognized by facial examination, as they are also known as the Elf face for having distinct facial morphology. In addition, it develops heart problems, kidney problems and impaired dentition. According to studies by Heinze *et al.* (2005), this syndrome was clinically discovered in 1962 by the geneticist physician J.C.P. Williams. In his research he noticed that the subjects affected by this syndrome had a genetic dysfunction in the pair 7 of chromosomes affected by the absence of about 21 genes. Among them were the genes responsible for the production of elastin (elastic fibers).

This syndrome compromises the superior executive functions related to lectowriting and mathematics, such as aspects related to motor, linguistic, visuospatial and numerical development. Heinze *et al* (2005) state that an important clinical aspect is related to cerebral morphology, as the brain in SW is different, it is generally smaller.

A study developed by Heinze *et al.* (2005) with people with SW, showed, through neuroimaging exams, that less developed parietal brain areas, while others are more disproportionately developed. The regions of the parietal lobe stand out as one of the most important, as they are areas of integration where much of the information from the rest of the brain regions pass. It is there that the inferior parietal cortex is located, constituted by the angular gyrus (Brodmann's area 39) and the supramarginal gyrus (Brodmann's area 40) that, in the context of mathematical learning, play roles related to the rescue of arithmetic facts and symbolic numerical representation , as shown in figure 1.

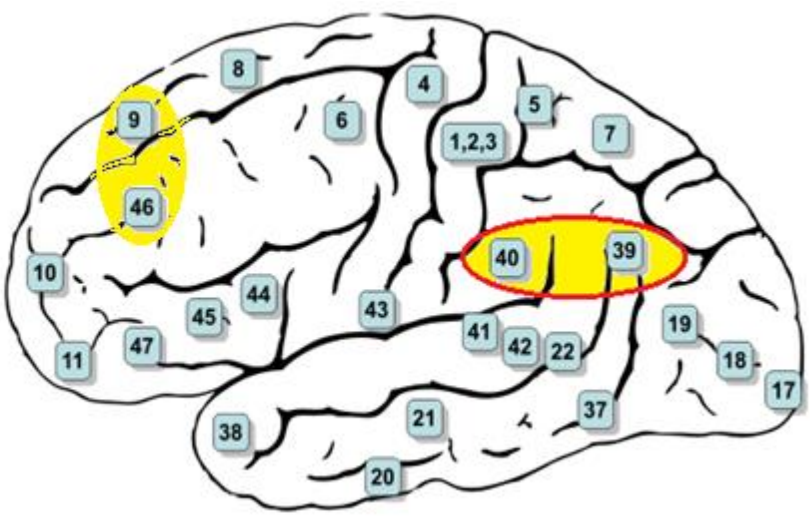


Figure 1 - Areas of the inferior parietal cortex *
Source: Carter and Gray, 2008.
* Lateral surface of the left cerebral hemisphere, lateral view.

These areas of Brodmann (fig. 1) are also involved in the processing of numerical magnitude, in the recognition of Arabic numbers and in the development of spatial sense skills. Other areas of the dorsolateral prefrontal cortex (Brodmann areas 9 and 46), which are located in the frontal lobe, play an important role in the "emergence of symbolic numerical representations, that is, the association of representations of numeracy with symbolic systems" (Haase & Dorneles, 2018, p. 157). It can be inferred that people with SW may have difficulties in recognizing Arabic numerals.

In this context, students who have dyscalculia characteristics may have cognitive impairment in specific mathematical skills, such as numerical sense, numerical processing and calculation. Each loss of CogN depends on the brain region affected.

A study developed by O'Hearn and Landau (2008) with elementary school students diagnosed with Williams-Beuren Syndrome pointed out, with regard to cognitive aspects, that language seems to be the least affected skill than arithmetic-related skills. With this, the research made it possible to infer, through neuroimaging exams, which areas of the temporal lobe are less affected, since it is in the temporal regions that the components of language formation are located.

The same study indicated that areas of the frontal lobe are most affected, for example, neurocognitive dysfunctions in areas of the prefrontal cortex imply low performance in the following tasks: evocation of arithmetic facts, verbal symbolic representation, calculation strategies, numerical estimation and comparison of quantities.

O'Hearn & Landau (2008) claim that little research has been carried out to verify the mathematical skills conserved and impaired in SW. The study concluded that people with SW had success in the skills related to reading numbers and failure in tasks related to the mental numerical line. For the authors, the results suggest that subjects with SW have particular difficulties in tasks that require numerical skills, a loss that probably reflects dysfunctions of the CogN in the parietal areas.

According to O'Hearn & Landau (2008), low performance in mental numerical line tasks results from dysfunctions in the structures of the dorsal flow of the upper parietal lobe and the occipital lobe (Brodmann areas 17, 18 and 19), but this The damage can be compensated through interventions that seek different strategies, including verbal ones, that support the understanding of the numerical line.

In this sense, an investigation carried out by Landau & Hoffman (2012), with young people aged between 19 and 21 years, showed that people with SW have a gradual and slow development in linguistic and mathematical aspects and that it becomes a peculiar characteristic of this syndrome. Thus, the cognitive structures that should have been developed during childhood occur only during adolescence and adulthood.

For the authors, other cognitive functions that normally need more time to develop (due to the slow neurocognitive maturation process in SW) never reach the expected maturity because of the stabilization of all learning during adolescence. This hypothesis pointed out by the researchers allowed to affirm that the approximate numerical system is severely compromised in the SW caused by the slow development, because adult people have cognitive age in mathematics compared to that of a child with typical behavior of seven years of age (Landau & Hoffman, 2012).

Landau & Hoffman (2012) conclude the research by stating that the impairment of cognitive functions related to the approximate numerical system can impair the construction of basic arithmetic facts (addition, subtraction, multiplication and division). This characteristic is not exclusive to the SW, as people without SW who have conducts of developmental dyscalculia have low precision of the approximate numerical system. As well as can be applied to other specific disorders of mathematical learning, for example: Turner's syndrome and the fragile X syndrome. Based on these findings, the authors state that "for all these cases, a key question for prospective studies is whether basic cognitive functions (including representations of the approximate numerical system) can be improved by early training" (Landau & Hoffman, 2012, p. 237).

For researchers in Cognitive Neuroscience (Heinze *et al*, 2005; O'hearn & Landau, 2008; Landau & Hoffman, 2012; Dehaene, 2011; Robinson & Temple, 2015; Haase & Dorneles, 2018), know the brain regions activated in tasks of numerical magnitude can help to understand other arithmetic skills related to the acquisition of counting and cardinality in people with SW. In addition, check to what extent they are related to the most advanced mathematical skills such as numerical and non-numerical acuity. Therefore, these researches can help to understand the typical behaviors of dyscalculia manifested in people with SW.

About dyscalculia in the SW, Brazilian researchers have developed studies on this topic in cases of genetic disorders. For Haase, Júlio-Costa & Santos (2015, p. 164),

> [...] the investigations with structural neuroimaging show bilateral involvement of the parietal areas involved in the numerical processing in several genetic syndromes, such as the fragile site syndrome on the X chromosome, the Williams syndrome, the Turner syndrome and the velocardiofacial syndrome.

These genetic syndromes carry dyscalculia as one of the characteristics of the compromised cognitive aspects. For Kaufmann (2012), dyscalculia is a severe calculation difficulty, although the subject has average intellectual capacity and a good level of schooling. However, dyscalculia is not a unique CogN dysfunction, but it can present different mathematical performance profiles. For the author, the processing dysfunction of numerical magnitude may be the main cognitive deficit of dyscalculia.

Dyscalculia in the SW compromises the parietal structures where the bilateral intraparietal grooves and the left angular gyrus are located. These brain regions are related to the processing of numbers, the numerical magnitude, the mental numerical line, the comparison of non-symbolic quantities, the verbal processing of numbers and the recovery of basic arithmetic facts (Kaufmann, 2012). These brain areas affected by dyscalculia can be seen in figure 2.

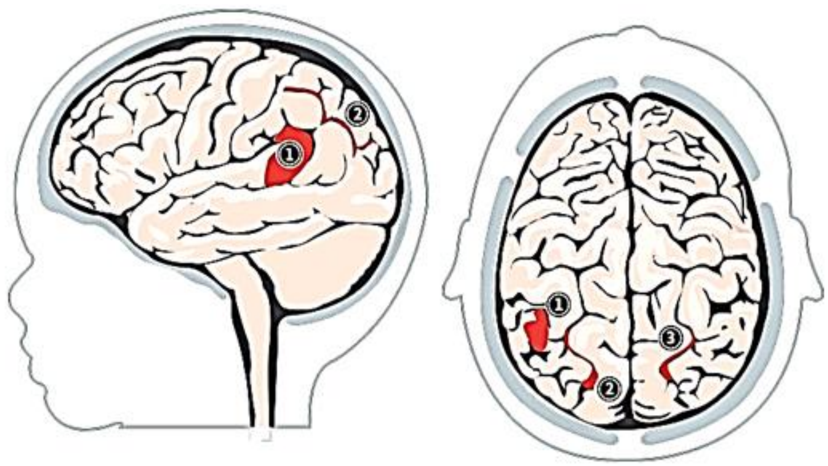


Figure 2 - Parietal lobe responsible for processing numbers.
Source: adapted from Haase and Dorneles, 2018.

The left angular gyrus (1) is usually affected by dyscalculia. So, a simple question like: Who is bigger 2 or 3? can generate difficulty for a person with SW. Other skills can be impaired, such as quickly retrieving arithmetic facts and mapping quantities of objects.

The left intraparietal groove (2) and the right intraparietal groove (3) that are responsible for the execution of arithmetic algorithms are related to the damage caused due to the SW. Calculation tasks and comparison of quantities of elements belonging to two different sets are difficult to be performed by people diagnosed with dyscalculia.

Haase, Júlio-Costa & Santos (2015) state that the calculation tasks (addition, subtraction and multiplication) recruit different areas of the parietal (upper and lower) and prefrontal lobes. For example, for addition are the regions of the left hemisphere; for subtraction, both left and bilateral activations can occur; and for multiplication, right hemispheric activation prevails. In the case of people with SW, these areas are affected by the syndrome, so they have difficulties in calculations.

For Iuculano *et al* (2015), dyscalculia affects other brain areas other than the parietal cortex, for example, difficulties in visual judgment and recognition of Arabic symbols are affected because of neurocognitive dysfunctions in regions of the ventral temporal-occipital cortex, as well as those attention functions and working memory recruited in regions of frontoparietal control.

Kaufmann (2012) classified dyscalculia into three types: procedural dyscalculia due to an executive dysfunction and characterized by a delay in the development of the acquisition of counting procedures and strategies to solve simple arithmetic problems; semantic memory dyscalculia caused by verbal memory dysfunction and characterized by errors in the recovery of basic arithmetic facts. This type of dyscalculia (semantic memory) is directly related to the specific learning disorder of lectowriting (dyslexia); finally, visuospatial dyscalculia.

In a review study, Santos (2017) classifies dyscalculia into two groups: primary dyscalculia and secondary dyscalculia. For the author, primary or pure dyscalculia is characterized by an exclusive deficit in the numerical cognition system, even if the student has regular cognitive development in other areas of knowledge and has received appropriate education for his chronological age. "Primary developmental dyscalculia (DD), sometimes referred to as pure or isolated, is a minority of cases of DD, with a prevalence between 1% and 2% in school children" (Santos, 2017, p. 75). Thus, from Bastos (2016), we could say that pure dyscalculia is associated with neurological factors of primary aspects, such as acalculias.

In the case of secondary dyscalculia it is "when the dysfunctions in numbers are severe enough to constitute a diagnosis of DD and, however, they are accompanied by non-numerical cognitive deficits equally serious or other disorders" (Santos, 2017, p. 76). In this case, secondary disorders such as Williams-Beuren syndrome can be included in the secondary dyscalculia.

Santos (2017) reports a case of dyscalculia associated with dyslexia. In this study, children with dyslexia presented dysfunctions in the verbal numeric code, in contrast, the skills related to arithmetic comprehension were not impaired showing the strong relationship between reading and mathematics.

A typical characteristic of dyscalculia in Williams-Beuren syndrome is related to the processing of numerical facts or evocation of basic arithmetic facts. Thus, they have an inability to recover arithmetic facts between two factors less than ten, as they were unable to develop efficient and accurate methods for calculating and resort to counting on fingers and scribbling on a sheet of paper (Dehaene, 2011).

In a neuroimaging study conducted by Cho (2011) and his collaborators, they showed that areas of the prefrontal cortex (evocation of information) of the hippocampus (formation of long-term memory) and the parietal cortex (representation of numerical magnitude) are recruited when subjects are faced with simple addition problems. This shows that there may be different evocations of arithmetic facts and that different brain areas can be activated to compensate for the others compromised by dyscalculia.

Dyscalculia researchers (Geary, 2000; Bastos, 2016; Cho, 2011; Kaufmann, 2012; Weinstein, 2016; Santos, 2017;) state that arithmetic difficulty and the difficulty of writing are common disorders that affect children in principle of schooling. This reality makes students have negative attitudes towards mathematics, which in turn, may develop anxiety to mathematics or generalized school phobia. Dyscalculia accompanies a person throughout his life and can permanently impair the development of personality and professional life.

2 Research Methodology

This research is a qualitative investigation that sought to analyze the damage caused by dyscalculia in a student with Williams-Beuren Syndrome with regard to the skills related to numerical processing. The production of scientific knowledge took place at the interface of the studies of Cognitive Neuroscience, Mathematics Education and Special Education, as it was in the confrontation between these areas of investigation that new information emerged that was articulated so that it was possible to better understand the neurocognitive aspects of mathematics learning process in Williams-Beuren syndrome.

Theoretical discussions were based on studies in the area of Cognitive Neuroscience located on medical literature research platforms, such as Medline (Medical Literature Analysis and Retrieval System Online) and Pubmed (Medical Publications). Medline is a search engine for medical literature and its bibliographic database is linked to the national medical library of the United States of America. Pubmed is a platform that makes it possible to research studies of biomedical literature cited in magazines and books. It covers topics related to Cognitive Neuroscience, Behavioral Neuroscience, Biochemistry and Bioengineering.

Regarding the method, this is a case study research, that is, "an empirical investigation that investigates a phenomenon (the case) in depth and in its real-world context, especially when the boundaries between the phenomenon and the context may not be clearly evident" (Yin, 2015, p. 17). This method made it easier to better understand the damage caused by the Williams-Beuren syndrome in the development of numerical processing in a student with SW.

All the methodological procedures of the study were approved by the Ethics Committee of the Institute of Health Sciences of the Federal University of Pará, according to opinion nº. 2,624,998. In addition to Ethics Committee approval, a Free and Informed Consent Form was signed by the person responsible for the investigated student.

The context of the investigation was a school in the state teaching network of Castanhal-PA. One of the pedagogical spaces, the multifunctional resource room, was used as the locus of the research. The choice of this context was due to the researcher exercising the role of teacher of Special Education in this educational establishment and acting as a teacher of the research participant in the multifunctional resources room.

The research participant was a student with SW enrolled in the 9th grade of elementary school and who attended the Special Education space since March 2016, when the first contacts with the researcher were made. He regularly received specialized educational assistance (AEE-acronym in Portuguese), a service offered in the multifunctional resource rooms. This contact with the AEE made it possible to assess the neurodevelopment of his mathematical skills related to numerical processing.

The evaluation instrument used was the PROMAT protocol, it is a script designed to probe the development of mathematical skills related to CogN. This protocol is considered as a screening tool for numerical skills compromised by dyscalculia (Santos, 2017). It allows to verify the lag of the neurocognitive development of the numerical sense, of the numerical processing and of the calculation, that is, the functional structures that make up the domains of mathematical learning.

The PROMAT presents tasks that make it possible to analyze neurocognitive performance related to the mental numerical line. For example, inserting digits in a mental numeric line from 0 to 100 and writing them from smallest to largest, as shown in figure 3.

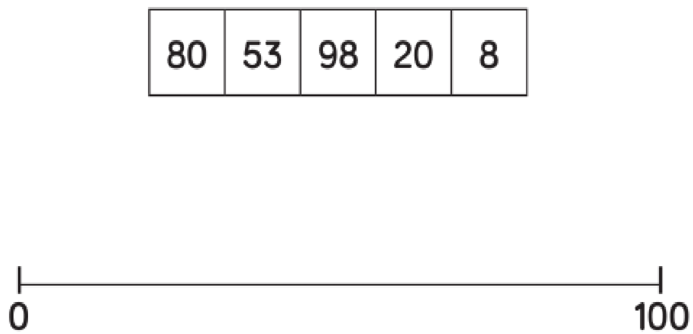


Figure 3 - Numeric Line Task.
Source: Weinstein, 2016.

Therefore, the PROMAT is composed of an application manual that provides a presentation of the instrument and the theoretical assumptions on which it is based and which helps in the interpretation of results. A stimulus notebook with forms and slips presented to the participant. A student notebook with sheets for recording the answers to the proposed items. The evaluator also has a notebook to record the responses of the evaluated student.

Among the mathematical domains evaluated by PROMAT, there is numerical processing that involves the processing of non-symbolic and symbolic quantities and numerical understanding (Deahene, 2009). This domain involves skills related to numerical counting, the development of oral counting, symbolic representation of magnitude, mental numerical line, positional value and numerical transcoding.

According to Weinstein (2016), the classification of the participant in PROMAT is given with the following categorizations: presents dyscalculia or specific learning disorder of mathematics; presents Low Performance in Mathematics; presents Typical Performance. When the student has a performance of up to 10% in the standardized test for at least two consecutive school years, he can be classified as dyscalculia or arithmetic difficulty.

The information constructed during the research was analyzed using the Content Analysis methodology (Bardin, 2011). Therefore, the data were treated in a way that would qualitatively express the research results, which are presented in the next section.

3 Results and Discussions of the Neurocognitive Assessment

The participant's evaluation using of the PROMAT was carried out in two sessions due to the extensive number of items. This evaluation procedure refers to the mathematical skills corresponding to the numerical processing domain. The meetings took place in the space of the AEE and twice a week the participant was recruited to carry out the evaluations, according to the organization in chart 1.

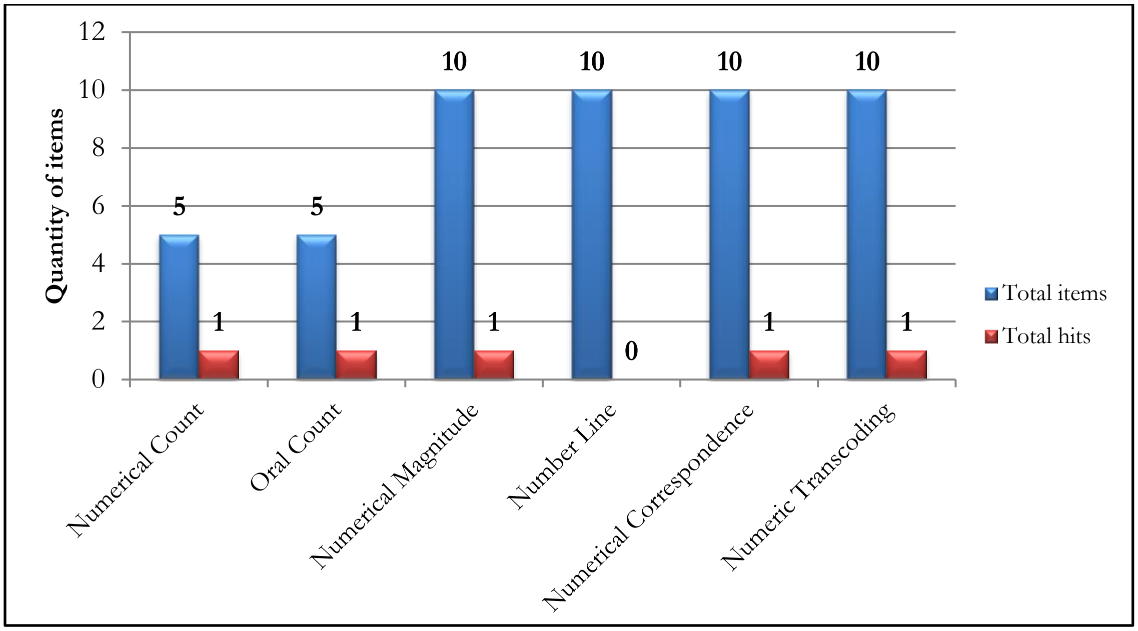
Domains of Numerical Cognition	**Numerical Cognition Skills**	**Nº items**	**Sessions**	**Time**
Numerical Processing	Numeric Count	5	Session 1	30 minutes
	Oral Count	5		
	Numerical Magnitude	10		
	Number Line	10	Session 2	40 minutes
	Numerical Correspondence	10		
	Numeric Transcoding	10		
Total		**50**	**2**	**1h:10**

Board 1 - Organization of Neurocognitive Assessment sessions.
Source: Weinstein, 2016.

In each session the participant was seated in a chair with the support of a table. In each meeting, it was explained how it should be done, that is, trying to solve all the items and those that were not possible to answer could be left blank. At the end of each session, the student's answer sheet was collected and the points were counted in the applicator's results sheet.

The mathematical skills survey script made it possible to verify the CogN skills most affected by the SW and to prioritize the areas that demand more attention during the intervention process. The evaluation carried out can contribute for the teacher who teaches mathematics to have a better understanding that learning mathematics is a cumulative process that takes place throughout school life, but for these changes to happen there are demands on the performance in basic skills fundamental, that is, there are prerequisites.

According to the information produced from the test, it is clear that the evaluated student had a total performance of 10% considering the different domains of Numerical Cognition. This result, according to the PROMAT parameters, makes it possible to infer that the referred student presents signs of the specific disorder of mathematical learning, dyscalculia. Thus, it was possible to categorize the participant's performance by numerical processing skills, as shown in Graph 1.



Graph 1 - Participant's Yield in the Numerical Processing Test
Source: PROMAT Test, 2018.

According to Graph 1, the student has dysfunction in several domains of the CogN, more specifically in the domain of Numerical Processing. These signs, therefore, are more evident when evaluated by specific skills, for example, in the test of representation of the numerals in the numerical line, the participant presented a 0% yield. He was subjected to ten items in this category, but was unable to arrange the numerals on a number line from 0 to 100.

The task related to the numerical line consisted of inserting the numbers 8, 20, 53, 80 and 98, with proportional spacing, in a numerical line from 0 to 100. The student did not have the determined time, so he could use the time necessary to execute the task, even so, failed to place the numbers in a proportional increasing order, as shown in figure 4.

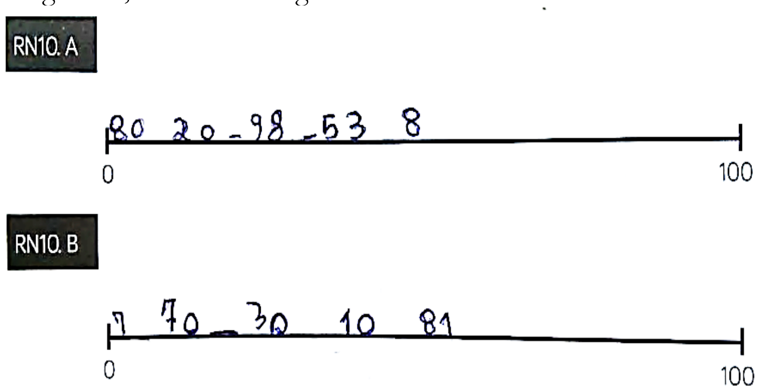


Figure 4 - Numeric Line Test.
Source: PROMAT Test, 2018.

The evaluation showed that the numerical distance effect was compromised by the SW and that means that the ability to discriminate the proportional space between two numbers on a number line was impaired. Thus, it can be inferred that the number is represented in the form of a numerical mental line, where numerically similar values occupy approximately the same position in the numerical continuum, preventing the recovery of appropriate representations for close numbers (Dehaene, 2011). Thus, for a person with SW, it becomes more difficult to compare or place closer numbers in a numerical line.

Numerical transcoding was another skill related to numerical representation in which the student had insufficient performance. He was subjected to 10 tasks which were only correct 1. One dysfunction observed in this skill refers to the fact that the student writes the numbers omitting figures or writing them in a staggered way, that is, without considering the positional numerical system, according to the figure 5.

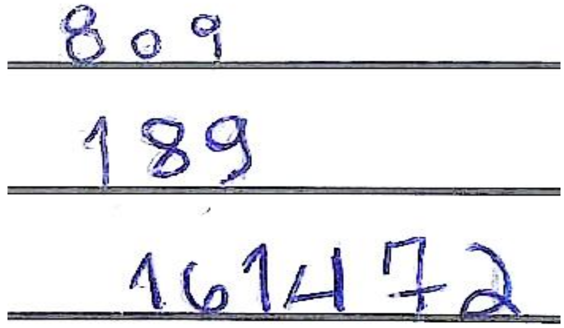


Figure 5 - Numeric Transcoding Test.
Source: PROMAT Test, 2018.

In this task (fig.5), the student had to represent numerals spoken in Arabic numerals. Numerals 371, 889, 1089 and 16472 were dictated. Therefore, the item included third, fourth and fifth order numerals. The task execution time was unlimited. According to the student's response, it is clear that in addition to omitting numerals, he presented an error pattern that consisted of adding digits to the dictated numeral.

Another aspect present in the answer is the fact of writing the numeral in the order that was dictated, for example, 809 instead of 889. This same pattern of response was observed by researchers in different countries (Geary, 2000; O'hearn & Landau, 2008; Dehaene, 2009; Robinson & Temple, 2015). Based on the results, different terms were adopted for this error pattern, but the expanded written expression was the most used in the research reports, which we call staggered writing.

Another task related to numerical transcoding that deserves mentioning refers to the writing in full of numerals. Figure 6 addresses aspects of the syntax and semantics of numerals.

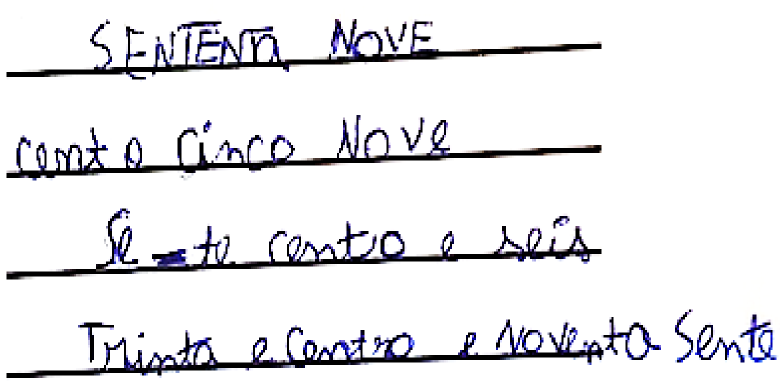


Figure 6 - Numeric Transcoding Test.
Source: PROMAT Test, 2018.

The task (fig. 6) consisted of representing Arabic numerals in written numerals. The student read the figure and wrote it using words. Numerals 79, 159, 706 and 3097 were presented. The task execution time was also unlimited. Figure 6 showed that the student wrote the name of the numerals in the same way as he read, for example, “cent” for the figure 1, “five” for the figure 5 and “nine” for the figure 9. He shows knowledge about the house of the hundred and the house of units, however, the position regarding the order of tens is unknown.

The mathematical learning disorders related to Numerical Processing presented by the student with SW are recurrent damage in the intraparietal groove (Kaufmann, 2012; Jolle, 2016), since it is in this brain area that the primary numerical information is processed. The intraparietal groove acts as a kind of semantic decoder of symbolic numerical representation, for example, Arabic digits and written numerals. In this way, it can be inferred that an impairment in this brain region can affect mechanisms of learning mathematics, such as the combination of symbolic mathematical skills and non-symbolic skills that make up the basis of typical numerical representation capabilities.

Dehaene (2009; 2011) states that the low development of skills related to the counting procedure can compromise the learning of basic arithmetic facts. Therefore, the results of the neurocognitive assessment showed that the participant has neurocognitive dysfunctions in the domain of numerical processing, but that the student during specialized educational assistance may be able, even if slowly, to learn numerical production and comprehension. For this, the teacher needs to use the practice of exercises to make him fluent in the processing of numbers and, consequently, in the evocation of basic arithmetic facts.

Final Considerations

The results of the research made it possible to establish reflections on the importance of understanding the teaching and learning process of Mathematics of students with SW from evidence of research in neurosciences, as the study also provoked reflection on the contributions of Cognitive Neuroscience to Mathematics Education Inclusive and the construction of tasks that can be used in the ESA.

A relevant aspect is the fact that teaching cognitive strategies to students with dyscalculia can improve their school performance in Mathematics and, consequently, several skills related to Numerical Cognition. Among these strategies are oral counting, numerical counting, the mental numerical line, numerical correspondence and numerical transcoding. These skills are crucial for improving mathematical performance related to the domain of numerical processing.

Another factor worth mentioning refers to the identification of the main disorders of mathematical learning caused by SW. Among them, the difficulty in understanding the symbolic and non-symbolic numerical magnitude was highlighted, as well as naming terms and symbols related to mathematical language, as well as the reading and writing of numbers and the evocation of basic arithmetic facts.

The research identified a strong relationship between language skills and mathematical skills retained in the student with SW. This indicator suggests studies on the resolution of mathematical problems presented orally and in writing. This relationship between lectowriting and mathematics is evident because the person with SW has characteristics of dyslexia. Thus, the study made it possible to infer that the brain areas associated with reading that are impaired by dyslexia, for example the angular gyrus or Brodmann's area 39, are also related to mathematical learning. Therefore, it implies the development of symbolic representations such as language and numbers.

In this context, one of the biggest challenges of primary school is to be able to refer a child with SW to a neurocognitive evaluation that can track characteristics of dyscalculia, however if educational programs and education professionals start to consider the scientific evidence resulting from research in Neuroscience Cognitive as an instrument for understanding learning problems, a bridge can be established between Neurosciences, Mathematics Education and Special Education.

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About the Author

FABIO COLINS
ORCID: https://orcid.org/0000-0002-9138-1712
Doutor e Mestre em Educação em Ciências e Matemáticas pela Universidade Federal do Pará (UFPA/IEMCI/PPGECM). Especialista em Educação Especial (UCDB-MT) e em Língua Brasileira de Sinais (UCAM-MG). Licenciado em Matemática (UFPA) e Licenciado em Letras (UEPA). Professor Colaborador da Faculdade de Matemática da Universidade Federal do Pará, Campus Universitário de Cametá-PA (UFPA). Professor de Matemática e da Educação Especial da Secretaria de Estado de Educação do Pará (SEDUC-PA). Coordenador da Educação Especial da Secretaria Municipal de Educação de São Francisco do Pará (SEMED). Membro do Grupo de Estudos e Pesquisas (Trans)Formação vinculado ao Programa de Pós-Graduação em Educação em Ciências e Matemáticas da Universidade Federal do Pará (PPGECM/UFPA). Membro do Grupo de Estudos e Pesquisas em Linguística, Educação e Literatura (LELIT) vinculado à Faculdade de Letras da Universidade do Estado do Pará (UEPA). Atuou como Professor Formador do Plano Nacional de Formação de Professores da Educação Básica (PARFOR/UFPA). Atuou, pelo Ministério da Educação, como Avaliador de livros didáticos de Matemática no Programa Nacional do Livro Didático (PNLD/FNDE/MEC). Atualmente, desenvolve pesquisas e orienta Trabalhos de Conclusão de Curso nas áreas de Educação Matemática, Formação de Professores, Neurociência Cognitiva, Educação Especial, Educação de Surdos e Ensino de Língua Portuguesa.
formador.ufpa@gmail.com

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