Neuropsychological assessment of executive functions in autistic patients: a case study

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1 INTRODUCTION

Neuropsychology is the science that studies the behavior of brain dysfunctions; it is a science that studies the Nervous System, more precisely the brain functions in their relationship between structure and performance (LEZAK, 1995). The theoretical bases of Neuropsychology are concerned with the correlations of brain changes with changes in behavioral functions. Among the cognitive functions are attention, memory, executive functions, visuospatial processing and language (MOSS, KILLIANY (1994).

Cognitive functions can be verified through Neuropsychological Assessment (NA), which is a systematic evaluation of the relationships between brain and behavior. For Weinstein and Seidman (1994) it is an approach that can complement other assessments and systematically address specific diagnostic and treatment issues. AN is not limited to the application of psychometric and neuropsychological tests organized in batteries, but aims to consider the relationship of these findings with neurological and/or behavioral pathology and, from there, establish the possible brain area involved (COSTA et al., 2004).

According to Kluwe-Schiavon et al. (2012), executive functions can be defined as a complex and integrated set of cognitive skills that allow the individual to perform behaviors directed to previously established purposes. According to Barros and Hazin (2013) the EF are considered higher mental functions and responsible for the ability of self-regulation or self-management, relating to several components, such as selective attention, inhibitory control, planning, organization, cognitive flexibility and working memory or operational memory. Such abilities are strongly related to the activity of the prefrontal cortex region. There are several theoretical models that address the theme of EF and several definitions related to these skills, as well as different forms of evaluation (CORBETT, CARMEAN, FEIN, 2009; KLUWE-SCHIAVON et al., 2012).

Autism Spectrum Disorder (ASD) is characterized as a developmental disorder with onset in early childhood and chronic evolutionary course. According to the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), the diagnostic criteria for ASD encompass a dyad of qualitative impairments in the domains of social interaction/communication and behavioral patterns (APA, 2014).

Epidemiological data point to an increase in the prevalence of ASD over the years. Consequently, many studies have been conducted to understand how the cognitive aspects of this population are presented. Due to the heterogeneity of clinical pictures, different theories have been proposed to try to account for the cognitive impairments presented by these individuals, and among them we can mention the deficit of the Theory of Mind, the impairment in Central Coherence and the deficit in Executive Functions (FOMBONNE, 2009; HAPPÉ, FRITH, 1996).

Individuals with autism have impairments in several cognitive domains. In 1985, Rumsey described the first findings regarding EF deficits in individuals with ASD, where he investigated ten men diagnosed with autism and observed impairments in the performance of tasks associated with the integrity of the functioning of the frontal lobes. According to Eigsti (2011), after Rumsey's findings, research results have generated discussions about the fact that EF may be the central deficit in ASD.

Hill (2004) states that activities involving planning require a sequence of actions that must be constantly monitored, reassessed and updated. The deficit in mental flexibility is perceived by perseverative, stereotyped behaviors and difficulties in the regulation and modulation of motor acts. This entails limitations to change strategies and behaviors according to changes in the context. Thus, behavioral rigidity has been associated with lack of planning and cognitive flexibility in ASD. In addition, studies show that individuals with ASD have impaired mental control capacity necessary to maintain strategies and solve problems to achieve a future goal (LOPEZ, LINCOLN, OZONOFF, 2005).

Recent studies are contributing to the understanding of the neuropsychological profile of ASD. However, controversies and gaps are still identified, notably in terms of the severity of autistic symptoms regarding the level of language development and global intellectual capacity, as well as the impact of such impairments on the dimension of social relationships. The present research aims to contribute to the study of neuropsychological assessment of executive functions in patients with ASD.

2 OBJECTIVE

Describe the main aspects of the executive functions of the patient inserted in the Autism Spectrum.

3 METHODOLOGY

Participant

In this case study, the participant was an 8-year-old male child, who goes by the name S. The patient in question received a diagnosis of autism from his neurologist and was referred for Neuropsychological Assessment. In 2020, he was attending the second year of elementary school at a public school in Goiânia. He is the third child of an offspring of six. He currently lives with his adoptive parents and siblings. He arrived in the foster family at eleven months of age. The mother used drugs and alcohol during and after pregnancy. Born by normal delivery, without complications during or after birth. He has developmental impairments, such as speech, motor skills, learning, physiological needs, social interaction and behavior. He had difficulty adapting to school at the beginning of his studies. S is a restless child who likes to run, spin around, easily loses focus and has difficulty maintaining eye contact. Despite his agitated, impulsive behavior and his difficulty in dealing with frustrations, he has the ability to learn through stimuli and repetition. He is currently being monitored by a speech therapist and a psychologist at the State Center for Disability Support (CEAD). During the testing meetings, he formed a bond with the psychologist, showing enthusiasm and willingness to perform the proposed activities; however, if the activities required greater mental effort, he dispersed and needed a new stimulus to complete it.

Instruments

2.2.1 Rey's Complex Figures: Copying and Memory Reproduction Test of Complex Geometric Figures - 2nd Edition. The test was idealized by André Rey in 1942, having its publication in Brazil in 1999 with Brazilian normative tables. Today it is in its second edition adapted by Margareth da S. Oliveria and Maisa dos S. Rigoni. The figure "A" is intended for the evaluation of people between 5 and 88 years, which allows to evaluate the visual perception and immediate memory of the subject (OLIVEIRA, 2014). According to Caffarra et al (2002), the Rey Complex Figures test (FCR) was described as a neuropsychological test, widely used to investigate visual memory and some functions of planning and execution of actions. The test also assesses constructive praxis skills. It is composed of a complex and abstract geometric figure, without evident meaning, of easy graphic realization, and with a complicated set structure with the objective of requesting an analytical and organizing perceptual activity (REY, 1959/2014).

2.2.2 FDT: Five Digit Test. The test was developed by Manuel Sedó and adapted by Jonas J. de Paula and Leandro F. Malloy-Diniz in 2015. It aims to measure processing speed, attentional processes and executive functions, more specifically inhibitory control and cognitive flexibility. It evaluates in any language the speed and mental efficiency of the individual, identifies the decrease in speed and efficiency, characteristic of individuals with neurological or psychiatric disorders (D' PAULA, 2015).

It is intended for children from 6 years old, adolescents, adults and the elderly up to 92 years old. The application is individual, lasting five to ten minutes. It is a multilingual test of cognitive functions, based on minimal multilingual knowledge: reading digits from 1 to 5 and counting quantities from 1 to 5. It has four stages: reading, counting, choosing and alternating.

2.2.3 WCST: Wisconsin Card Sorting Test: Revised and expanded manual. Created by Robert et al. and adapted by Margareth et al. in 2019. The Wisconsin is an excellent instrument for the assessment of executive functions. Its target audience is individuals aged 6.5 years to 89 years. It was originally developed to assess abstract reasoning ability and the ability to adapt cognitive strategies in response to changes in the environment. The instrument can still be considered a measure of executive functions, as it requires the ability to develop and maintain an appropriate problem-solving strategy to achieve a future goal. It evaluates strategic planning, organized search, the use of environmental feedback to change cognitive strategies, the direction of behavior to achieve goals and the modulation of impulsive responses (OLIVEIRA, 2019).

2.2.4 Tower of Hanoi: used as a complementary activity. The puzzle was invented by the French mathematician Édouard Lucas, who was inspired by a legend to build the Towers of Hanoi game in 1883. It is used to assess executive functions, more specifically planning, motor act organization, flexibility of thought and implicit memory. It aims to move the discs (with different sizes and colors) from pin "A" to "C", being able to use pin "B" as a support. The game has two rules: a) the largest disk can never be on top of a smaller disk; b) you have to move one disk at a time. The minimum number of disks required to start the game is three, with seven moves expected for three disks. The subject is asked to perform the attempt 5 times (with time counting). If the subject manages to perform the activity within the 5 attempts in a maximum of seven movements, another disk is added. Fifteen movements are expected for four disks.

Procedures

The patient described in this research was part of the evaluative work of neuropsychological evaluation, carried out by one of the psychologists described in the research production. For the development of this research, initially, a detailed anamnesis was carried out with the person responsible for the patient. Subsequently, testing with the aid of validated instruments according to the Psychological Test Evaluation System (SATEPSI), through which it was possible to perceive the preserved and compromised cognitive abilities, as well as their level of impairment.

No impaired cognitive abilities were perceived, to the point of making the application of neuropsychological tests unfeasible. Thus, it was possible to administer the following instruments for the assessment of Executive Functions: Rey's Complex Figures, Five Digit Test (FDT), Wisconsin Card Sorting Test (WCST) and the complementary activity with the Tower of Hanoi. Other tests were

administered to assess the patient's performance in general (Memory, Attention and Processing Speed, Cognitive Efficiency, Written and Spoken Language, Visuoperception, Visuoconstruction and Behavior); however, the data shown in this study will only be in relation to his executive functioning, according to the proposal of this study.

The testing took place between August and October 2020, with the consent of the child's legal guardian and also the child himself, so that they signed the Informed Consent Form (ICF) and the Assent Form (attached). A total of eight sessions of forty minutes each were held at Clínica Sante in Goiânia - Goiás, where it was possible to evaluate and give feedback to the guardian and the child.

One of the principles of Resolution 466/2012 is that the participant must consent to their participation or, in the case of a child or adolescent, the consent of their legal representative. In the Informed Consent Form (ICF), the researcher reports the main objectives and procedures of the study, enabling the person to make a free and informed decision about their participation, since the ethical principles of research aim to protect the rights, dignity and well-being of the participants (Goldim, Fleck, 2010; Barker, et al., 1995).

4 DEVELOPMENT

In this study, the analysis of the results was performed using the qualitative method. In conjunction with the quantitative results, a qualitative analysis of the patient's responses, as well as the recognition and interpretation of their own errors, was performed.

In Rey's Complex Figures test - copying test of figure "A", the patient obtained a gross result of 17.5 with a 10th percentile, demonstrating that he has difficulties in relation to activities that require planning, organization and perception skills. He presented a result well below the expected for his age group. He showed significant damage in the creation of the whole from the sum of the parts.

The model of copying carried out by the patient was of the "IV" type (juxtaposition of details), where the subject juxtaposes the details to each other, proceeding, little by little, as if he were assembling a puzzle. There is no directing element in the reproduction. The whole, finished more or less well, is globally recognizable and may even be perfectly realized. According to Osterrieth, quoted by André Rey (1959/2014), this model of drawing is considered dominant in the 5-10 age group, reaching its maximum at the age of 8 (70%).

Regarding the patient's result in the FDT test, referring to the processes that present responses considered as automatic, such as "reading" and "counting," and that neither operation requires a great intentional effort on the part of the individual, the patient showed significant damage both related to the process of time and the process of errors made. As for the processes that use more executive skills, because they require greater attention capacity, flexibility and impulse control, which are the processes

of "choice" and "alternation", he showed lower than expected performance both in the process of time and errors committed.

In the "flexibility" process, he also presented a deficient performance, which indicates that he has important limitations regarding his EF evaluated by the FDT. Despite having presented average performance with regard to the "inhibition" process, the inhibitory process was analyzed as a whole (and not in isolation), including in clinical analysis during the consultations, which showed little capacity for inhibitory control.

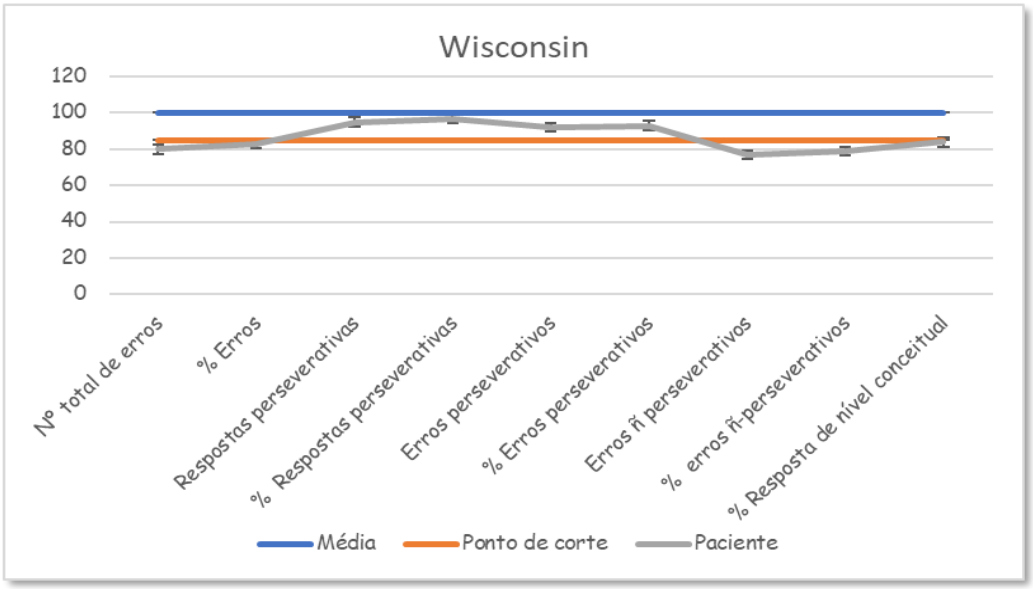
Table 1- Instruments administered and interpretation of results.

Instruments	Referring	Expected score	Score obtained	Percentile	Interpretation
Complex Figures of Rey	Copy	21 a 33	17,5	10	Difficulty
FDT	Reading - Time	29 a 39	84	< 5	Deficit
	Reading - Error	0	5	< 5	Deficit
	Counting - Time	40 a 56	102	< 5	Deficit
	Counting - Error	0	6	< 5	Deficit
	Choice - Time	66 a 94	113	< 5	Deficit
	Choice - Error	0 a 4	6	25	Difficulty
	Alternation - Time	75 a 113	176	< 5	Deficit
	Alternation - Error	1 a 5	7	25	Difficulty
	Inhibition	31 a 55	29	75	Medium
	Flexibility	41 a 75	92	5	Deficit
Wisconsin	Total number of errors	31 a 69	86	9	Borderline
	Percentage of errors	26 a 57	67	13	Lower Middle
	Perseverative responses	8 a 53	43	37	Medium
	Percentage of Perseverative R.	13 a 43	33	42	Medium
	Perseverative errors	8 a 43	40	30	Medium
	Percentage of perseverative errors	13 a 34	31	33	Medium
	Non-perseverative errors	11 a 32	46	7	Borderline
	Percentage of non-perseverative errors	9 a 27	36	8	Borderline
	Percentage of conceptual level response	66 a 31	20	14	Lower Middle
Tower of Hanoi (three pins)	Attempt 1	Placed the larger disk on top of the smaller one. Picked up two disks at once.			Error
	Attempt 2	He took two disks at once.			Error
	Attempt 3	He held two disks at once.			Error
	Attempt 4	Turned the game upside down. Held two records at once.			Error
	Attempt 5	He took a disk from the pin and left it on the table.			Error

Interpretation of symbols: (<)=less than; (>)=greater than; (≤)=less than or equal to.

The Wisconsin Test of Letter Classification is one of the "gold standard" tests we have today for assessing executive functions, and is one of the most widely used instruments for assessing cognitive flexibility. The patient was administered 128 trials (letters); he was able to successfully complete 2 categories; he performed 14 trials to complete the first category; his failure to maintain context was 0; and it was not possible to calculate his learning to learn, due to the amount of categories completed which was less than three. There is evidence that the performance of people with ASD, compared to people with typical development in this instrument, presents changes regarding the type of responses characterized as perseverative and the number of categories completed, the latter being the case of the patient evaluated.

Graph 1 - Wisconsin test



The patient presented a 9th percentile (borderline) in relation to the "total number of errors" committed during the test, demonstrating that he was not benefiting from the feedback given by the psychologist. He had a 37th percentile (medium) for "perseverative responses" and a 30th percentile (medium) for responses given as "perseverative errors". He obtained percentile 7 (borderline) for the answers given as "non-perseverative errors", and percentile 14 (lower middle) for the "percentage of conceptual level answers", which shows that the patient is in the executive impairment range.

After completing the first category "color" with 14 trials administered, he completed the second category "shape" with 30 trials administered. Thereafter, the category in which the patient made the most errors and perseverated throughout the remainder of the test was the "shape" category; and although the patient scored in the average range with respect to perseverative errors, such findings demonstrate his lack of ability to create alternative problem-solving solutions. This is confirmed by the borderline percentile of the total number of errors.

The complementary activity performed by the Tower of Hanoi was administered in this research to better assess the patient's executive abilities. As shown in the spreadsheet above, he presented difficulty in relation to the control of impulses which made him persevere in the act of picking up two pins at once, failing to perform the proposed activity with three disks. This also shows little capacity for cognitive flexibility. However, it was possible to observe that after the correct reproduction so that he could observe, he was able to perform the activity with trial and error. It was noticed that he remained calmer when he realized that he had a way to perform the activity, without necessarily taking two pins at once. This demonstrates his ability to learn through the act of repetition.

5 FINAL CONSIDERATIONS

Taking into account the specificity of the theme of executive dysfunction in patients with ASD, it is considered that the Neuropsychological Assessment is of extreme and fundamental importance to evaluate in general the preserved skills of the individual, as well as their impairments. The assessment should be planned according to the needs of each patient, and the instruments should be sensitive to the clinical characteristics and specificities of each case. Thus, one of the objectives of the Child Neuropsychological Assessment is to help the patient, their parents and the school in the formation of an adapted curriculum, so that the child can be better accompanied and their difficulties are seen in a clear and facilitating way for educators and family members.

Autism Spectrum Disorder is characterized as a Developmental Disorder with onset in early childhood and chronic evolutionary course. This shows us the importance of early diagnosis, and the importance of the professional being able to meet such demand according to the specificity of each family and patient to be evaluated.

According to the data acquired through the instruments administered, it is possible to perceive that the patient is impaired in relation to his Executive Functions. When analyzing his evaluation process in general, he presented unsatisfactory results both in relation to his Executive Functions and in the other areas evaluated. Thus, specific referrals were made so that he could acquire gains in relation to the losses presented, being important to consider his capacity for learning through stimulation.

Scholars claim that deficits in EF have often been associated with people with ASD, according to Eigsti (2011), we can see exactly this in the results obtained from the patient in question. It is important to mention that the patient presented in this study received his diagnosis at a late age and it is believed that the earlier the diagnosis, the greater the chances of the patient having a good prognosis.

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