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Abstract

The Autism Spectrum Disorders (ASD) encompasses a group of neurodevelopmental illnesses that involve communication, social interaction and behavior changes. Motor aspects are still poorly investigated in this population. The aim of this study was to evaluate the manual dexterity of adolescents with ASD through three different tests, correlating them with the cognitive assessment and the handgrip strength and checking which one is shown to be more sensitive to this population. We evaluated 20 participants with ASD among 10 and 14 years, 18 boys and two girls. The WASI test was used to evaluate the intelligence quotient, the Van Strien test verified the lateral dominance and the Jamar dynamometer measured the handgrip strength. The manual dexterity was evaluated by three instruments: Box and Block Test (BBT), Jebsen-Taylor Hand Function Test (JTHFT) and the Minnesota Test. Statistical analysis found a high correlation for dynamometry, BBT and JTHFT indicating that when there is a good performance with the dominant hand, there will be also with the non-dominant hand. No correlation was found between handgrip strength and manual dexterity in any of the tests. The only one to show significant result when correlated to WASI scores was Minnesota ($p \leq 0.02$), indicating that the higher the IQ, the shorter the time of task execution. It was found that it is possible to assess teenagers with ASD with instruments validated in the literature, and the most sensitive to this population was the JTHFT, followed by the BBT test.

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SUMMARY

The Autism Spectrum Disorders (ASD) encompasses a group of neurodevelopmental illnesses that involve communication, social interaction and behavior changes. Motor aspects are still poorly investigated in this population. The aim of this study was to evaluate the manual dexterity of adolescents with ASD through three different tests, correlating them with the cognitive assessment and the handgrip strength and checking which one is shown to be more sensitive to this population. We evaluated 20 participants with ASD among 10 and 14 years, 18 boys and two girls. The WASI test was used to evaluate the intelligence quotient, the Van Strien test verified the lateral dominance and the Jamar dynamometer measured the handgrip strength. The manual dexterity was evaluated by three instruments: Box and Block Test (BBT), Jebsen-Taylor Hand Function Test (JTHFT) and the Minnesota Test. Statistical analysis found a high correlation for dynamometry, BBT and JTHFT indicating that when there is a good performance with the dominant hand, there will be also with the non-dominant hand. No correlation was found between handgrip strength and manual dexterity in any of the tests. The only one to show significant result when correlated to WASI scores was Minnesota ($p \leq 0.02$), indicating that the higher the IQ, the shorter the time of task execution. It was found that it is possible to assess teenagers with ASD with instruments validated in the literature, and the most sensitive to this population was the JTHFT, followed by the BBT test.

Keywords: Autistic Spectrum Disorder. Motor Dexterity. Evaluation studies.

INTRODUCTION

Autistic Spectrum Disorder (ASD) is a term that encompasses a group of neurodevelopmental illnesses (APA, 2014), characterized by qualitative and quantitative alterations of communication, whether in verbal or non-verbal, social interaction and behavior characteristically stereotyped, repetitive and with restricted range of interests. In the case of a spectrum, the degree of difficulty differs from people who have a mild picture, with complete independence and discrete problems of adaptation to those people who are dependent for activities of daily living (ADLs), throughout life (SÃO PAULO, 2013).

ASD is multifactorial, that is, both its etiology is constituted by genetic as well as environmental components. For this, some aspects are: exposure to chemical agents, vitamin D and folic acid deficiency, maternal infections, use of certain drugs such as valproic acid during pregnancy, prematurity (below 35 weeks) and low birth weight (<2500 g). The risk factors that involve genetic components are: having a

first-degree family affected, congenital abnormalities and either maternal or paternal age over 40 years old. There are cases of ASD that are associated with genetic syndromes and others that this association does not exist (FUENTES et al., 2012).

The estimate of the Centers for Disease Control and Prevention (CDC), in the United States, was 1in68 or 14.7/1,000 for children up to eight years (CDC, 2014). In a new survey released recently (CDC, 2018), this index increased to 1in59. According to a study by Baxter (2015), changes in diagnostic criteria and methods for determining the ASD in recent decades have contributed to this increase, generating the need for better understanding of the impairments presented in ASD and their repercussions throughout their lives.

Given the increasing prevalence of ASD in the world, recent researches are looking for evidence that can contribute to better understand the functioning of these people (MIERES et al., 2012) , as well as the reports on the unusual sensory functioning and motor difficulties, apparently due to voluntary or involuntary disorders which vary widely among individuals (SCHWARTZMAN AND ARAUJO, 2011). These deficits can influence the global developing and can also cause impact on education, socialization and communication of these people (VAN WAELVELDE et al., 2010).

People with ASD may experience sensory hypersensitivity reaching the extreme irritation or getting pleasure from stimulation or sensations perceived as unpleasant or indifferent to most people. These characteristics can produce behaviors such as: side view display in order to reduce this excess of stimulation; handing objects repeatedly; having fixing by water, both in the bathing and tactile stimulation, in the visual stimulation or the assessment of its movement; having dietary restrictions based on textures, flavors, colors and present agitation crises in public transport or noisy environments, presenting auto or hetero-aggressive behavior when upset or disappointed.

Aspects of the motor performance of individuals with ASD are not used as diagnostic criteria, but some authors (LIU et al., 2013) discuss on the integration of these deficit motors standards in these criteria. The purpose of this insertion is to characterize the impaired motor dexterity at an early stage, increasing the possibility of earlier intervention and so, some cognitive and social problems could be minimized (LLOYD, MACDONALD AND LORD 2013). For these authors, fine and global motor activities may have implications and deficits in social and communication skills (CATELLI; D'ANTINO; ASSIS, 2016).

The motor impairment could be characterized as neurological comorbidity along with epilepsy and sleep disorder, common in ASD and associated with the most severe phenotype of the disease. The motor impairment includes delays and deficits, stereotypes, dyspraxia, incoordination and ride deficiency, and they are often associated with cognitive impairment (JESTE et al., 2011).

Regardless of age or level of commitment, people with ASD have limited mobility in all their skills compared to their typically developing peers. Among the motor performance differences are the manual functions that are few explored in some researches as well as the relationship between manual and functional laterality activity (MILER et al., 2014).

The evaluation of motor behavior in a given individual is performed from a process of analysis and observations by means of instruments such tests or scales which assess the motor skill assuming a reference pattern previously constructed in these materials (SOARES; CAVALCANTE NETO, 2015).

The motors impairments are present throughout the life of these individuals and assessments and interventions could contribute to the understanding of the limitations and to the acquisition and maintenance of motor dexterity, meeting the needs of families and improving their long-term development (QUINTAS et al., 2014).

The motor behavior analysis allows measuring and comparing the motor performance of an individual with their typically developing peers, making possible, by analyzing the results, specific guidance for each case (REIS et al., 2012).

To measure the motor performance is necessary to use a test or a battery of tests to be validated and appropriated for the population studied (GORLA; ARAÚJO; RODRIGUES, 2009; ROSA NETO, 2002), which does not always happen when it comes to evaluate people with ASD.

Considering this need and observing the lack of literature on the subject, the aim of this study was to evaluate the manual dexterity of adolescents with ASD by using three different tests, correlating them with the cognitive assessment and handgrip strength in order to check which of them is shown to be more sensitive and appropriate for this population.

METHOD

20 adolescents participated in this study, aged among 10 and 14 years (18 boys and 2 girls). They are with a diagnosis of ASD and go to a school specialized in the care of these people

The study included adolescents who could understand the verbal commands, a necessary criterium for using rating scales, and whose guardians authorize the volunteer participation in this research, being excluded from the study people displaying neurological or orthopedic problems already diagnosed, or who do not conclude the tests during the evaluation period.

Data collection was carried out in an attendance room granted by the institution itself, in a suitable environment, as recommended by the manuals of the instruments used. For evaluation, we used the Wechsler Abbreviated Scale of Intelligence test - WASI, Van-Strien questionnaire, Jamar dynamometer, Box and Block Test (BBT), Minnesota test (only the placing-test, due to the complexity of the tasks of this instrument) and Jebsen-Taylor Hand Function Test (JTHFT). The application of the instruments was carried out individually in four sessions, lasting about 40 to 60 minutes.

Data were recorded in a standard protocol and analyzed with the help of statistical tests. These understood the descriptive analysis of the data (mean, standard deviation, maximum and minimum), sample normality test and the comparison of results by T-test. The correlation between the handgrip strength and the performance in each of the tests were investigated. The project was approved by the Mackenzie Presbyterian University Ethics Committee under number 1,717,700.

INSTRUMENTS

- ✓ Wechsler Abbreviated Scale of Intelligence - WASI: applicable scale in people from six years old up to 89 years old, which provides information about the Total Intelligence Quotient

(IQ). The scale provides the possibility of evaluating the Total IQ with only two subtests (Vocabulary and Matrix Reasoning) (TRENTINI, YATES, BATES, 2014).

✓ Tests such as Van Strien: questionnaire with 10 tasks to run through mimes, such as: pick up the pencil when drawing; holding the brush; brushing the teeth; unscrew the cap of a bottle; throw a ball; dealing cards from a deck; pick up a racket; open the lid of a box; grab a spoon when eating soup; erasing with a rubber; open a door with a key. The evaluated individual is classified as right-handers when he presents a score among 8 and 10, or left-hander, if he gets results among -10 and -8 (FREITAS; BOTELHO; VASCONCELOS, 2014).

✓ Jamar dynamometer is widely used in the clinic by professionals from the rehabilitation field. The instrument has two parallel handles, one fixed and one mobile. The latter is adjusted into five different positions, according to the hand size of the assessed individual. The handgrip strength is recorded in kilograms or pounds. As the participant presses the bars, they bend, causing a change in the resistance of the gauges, occurring a corresponding change in the output voltage that is directly proportional to the force exerted on the bars (FIGUEIREDO et al., 2007; PRIOSTI et al., 2013).

✓ Box and Block Tests (BBT): is designed to measure the ability and manual dexterity, these functions are often underestimated in assessing patients, and it is also presented as a pre-vocational test for people with physical disabilities. The BBT consists of transporting small pieces of wood from one side to the other for one minute. These blocks must be taken from end to end from a wooden box with partition. The number of blocks has to be recorded for the upper dominant and non-dominant member upon three attempts for each member (MATHIOWETZ et al., 1985; MENDES et al., 2011).

✓ Minnesota Manual Dexterity Test (MMDT): evaluates the gross motor skill of the assessed individual, considering the unilateral and bilateral manual dexterity. It is used for various purposes, including the measuring of the degree of disability and/ or the patient evolution in specific training programs or manual activities of interest in practical life, as to handgrip strength (LOURENÇÃO et al., 2007; INSTRUMENT, 1998).

✓ Jebsen-Taylor Hand Function Test (JTHFT): is similar to those manipulative tasks performed daily, divided into seven subtests: 1) writing; 2) simulation of a task of turning letters; 3) lifting of small objects; 4) simulation using spoon for food; 5) stacking blocks (checkers pieces); 6) lifting of large and light objects; and 7) lifting of large and heavy objects. In the case of wider manipulative tasks, this test appears to be related to the various aspects involved in the operation of the hands and upper limbs (JEBSEN; TAYLOR, 1969; LIMA et al., 2012).

RESULTS

The results are related to 20 adolescents with ASD in the study. In the application of Van Strien Hand Preference Test (HP), 18 participants were presented as right-handers (90%) and two (10%) were left-handers. From the HP defining the tests for strength and manual dexterity were applied considering dominant hand (DH) and non-dominant hand (NDH).

The participants' performance is described in Table 1 for the manual dexterity tests, considering the units of measurement for each test, that is: to dynamometry, in kilogram-force (kgf); BBT, quantity of blocks transported per minute; Minnesota, in seconds required for placement of the discs on the board; JTHFT, in seconds required to perform each of the seven tasks. It is also shown in the Table, the score for the Intelligence Quotient (WASI) and the age of the participants.

Table 1: Descriptive statistics of the tests used for the assessed group (n = 20).

		Average Group	Median	Min/Max[5]	SD[6]
Dynamometry	**DH[3]**	15.07	14.5	8/29	6.15
	NDH[4]	15.55	13.5	5.5/29	5.18
BBT[1]	**DH[3]**	46.9	41.5	15/65	11.18
	NDH[4]	42.1	42.5	12/66	13.31
JTHFT[2]	**DH[3]**	24.43	148	69/282	56.98
	NDH[4]	28.1	160	88/338	66.18
Minnesota		139.75	126	93/260	50.64
WASI		68.95	70.5	44/95	15.96
Age		11.62	11	10/14	1.32

[1]Box and Blocks Test, [2]Jebsen-Taylor Hand Function Test, [3]Dominant Hand, [4]Non-Dominant Hand, [5]Minimum/Maximum,[6] Standard Deviation.

The Shapiro-Wilk and Kolmogorov-Smirnov tests were used to verify the normality of the sample for all analyzed variables, not being found normality for most of them. It was decided, therefore, by using the Spearman non-parametric test.

The parameters used to measure and interpret this correlation were based on values from 0 to 0.30 / -0 to -0.30 being insignificant, from 0.30 to 0.50 / -0.30 to -0.50 being low, from 0.50 to 0.70 / -0.50 to -0.70 being moderate: from 0.70 to 0.90 / -0.70 to -0.90 being high and from 0.90 to 1.00 / -0, 90 to -1.00 being too high (MUKAKA, 2012).

Table 2: Correlation among the studied variables in relation to the assessed group(n=20)

Variables	DIN.[1] (DH)[4]	DIN.[1] (NDH)[5]	Minnesota	BBT[2] (DH)[4]	BBT[2] (NDH)[5]	JTHFT[3] (DH)[4]	JTHFT[3] (NDH)[5]
DIN.[1] (NDH)	.755** (.000)						
Minnesota	-.292 (.212)	-.276 (.238)					
BBT[2] (DH)	.002 (.995)	-.159 (.504)	-.477 (.034)				

BBT[2] (NDH)	.155 (.513)	-.074 (.755)	-.462 (.041)	.882** (.000)			
JTHFT[3] (DH)	-.313 (.179)	-.108 (.650)	.537* (.015)	-.638* (.002)	-.716** (.000)		
JTHFT [3] (NDH)	-.224 (.343)	-.034 (.888)	.344 (.138)	-.481 (.032)	-.599* (.005)	.939*** (.000)	
WASI	.008 (.972)	.063 (.793)	-.642* (.002)	.552* (.012)	.325 (.161)	-.361 (.118)	-.207 (.382)

[1]Dynametry, [2]Box and Blocks Test, [3]Jebsen-Taylor Hand Function Test, [4]Dominant Hand, [5]Non-Dominant Hand. **Moderate *, High**, Very High *** Correlation**

The assessed group was divided into two groups, group 1 (G1) showing IQ≥70 and group 2 (G2), IQ <70. Each group is made up of 10 subjects.

To assess the difference between the groups G1 and G2 in relation to Minnesota tests, BBT and JTHFT, the Mann-Whitney test was carried out. There was no statistical significance for G1 and G2 in relation to BBT ($p = 0.26$) and JTHFT ($p = 0.13$), considering the value of $p \leq 0.05$. However, in Minnesota test was found statistical significance with the value of $p \leq 0.02$, indicating that if the IQ is greater than 70, the better the test result will be. The Descriptive statistics of the tests used in relation to the manual dexterity in G1 and G2 are shown in Tables 3 and 4, respectively.

Table 3: Descriptive statistics of the tests used in relation to the manual dexterity of G1 (IQ≥70).

			Mean	Median	Min/Max[5]	SD[6]	DH[7]	NDH[8]
G1	Dynamometry	R[3]	15.65	15	8/35	7.32	15.55	15.30
		L[4]	15.30	13.5	11/29	5.42		
	BBT[1]	R[3]	46.40	44	31/65	10.29	46	45.7
		L[4]	45.35	46.5	29/66	12.17		
	JTHFT[2]	R[3]	124.3	99.5	69/208	54.9	174.5	173.89
		L[4]	149.2	118	88/258	61.3		
	Minnesota		112.40	109	93/139	16.08	-	-
	IQ		82.40	80	75-95	7.75	-	-

[1]Box and Blocks Test, [2]Jebsen-Taylor Hand Function Test, [3]Right, [4]Left, [5]Minimum/Maximum,[6] Standard Deviation, [7]Dominant Hand, [8]Non-Dominant Hand

Table 4: Descriptive statistics of the tests used in relation to the manual dexterity of G2 (IQ <70).

			Mean	Median	Min/Max[5]	SD[6]	DH[7]	NDH[8]
	Dynamometry	R[3]	14.6	13.25	9.5/27	5.07	14.6	13.7
		L[4]	13.7	13.5	5.5/24	5.09		
	BBT[1]	R[3]	38.4	38.5	15/58	11.06	39.1	38.5

G2		**L[4]**	39.4	39	12/65	14.37		
	JTHFT[2]	**R[3]**	167.1	163.5	84/282	53.16	147.9	163.6
		L[4]	189.8	171	90/338	67.64		
	Minnesota		167.1	135	102/260	59.10	-	-
	IQ		55.5	55	44-66	8.71	-	-

[1]Box and Blocks Test, [2]Jebsen-Taylor Hand Function Test, [3]Right, [4]Left, [5]Minimum/Maximum,[6] Standard Deviation, [7]Dominant Hand, [8]Non-Dominant Hand

DISCUSSION

The aim of the study was to assess the manual dexterity of adolescents with ASD by using three different tests, correlating with cognitive assessment and strength of the handgrip strength, besides checking which of them seems to be more sensitive and appropriate for this population.

One of the objectives of this study was to analyze the relationship between handgrip strength and its influence on the performance of the manual dexterity tests. Then, the dynamometer was correlated with the Minnesota (p = 0.21) BBT (p = 0.66) and JTHFT (p =017), using the Spearman non-parametric test. Considering the normal standards, the association among the variables is not statistically significant, indicating that either the handgrip strength is greater or not, people with ASD did not perform better in the ratings.

In relation to JTHFT a very high correlation was found and for handgrip strength (DIN) and BBT, it was found a high one, indicating that when the participant has good performance with DH, he also performs well with NDH. A moderate correlation among JTHFT, Minnesota test and BBT test was obtained, indicating that if the individual can successfully run the JTHFT possibly he will go well in the other two tests. Moreover, a moderate negative linear correlation was found among the scores of the intelligence test (WASI) and the runtime in Minnesota and BBT tests test, pointing out that the lower the IQ, the greater the run time of the tests. This finding suggests that although the BBT and Minnesota are tests of only one task, they demand more persistence and concentration.

The literature points out disadvantage of this population in researches with a focus on motor evaluation. Quintas et al. (2014) observed that people with typical movement show a superior motor performance to people with ASD in all areas: manual dexterity, ball skills, balance and global motor performance, analyzed by Movement Assessment Battery for Children (MABC-2) scale, and manual dexterity was ranked as the second-worst analyzed skill.

Researches suggest that the difficulties in motor skills in people with ASD would be directly related to sensory processing. This relationship was observed by researchers who evaluated 32 children with ASD in order to examine the processing performance and motor-sensory skills through Short Sensory Profile (SSP) and the MABC-2 tests. Descriptive data show that all people with typical development were classified in the green zone, which represents motor performance without impairment, and 80% of people with ASD were classified in the red zone, suggesting significant motor impairment (LIU et al. 2013).

Motor skill deficits are present and persist in school children with ASD (SOARES et al., 2010; VAN WAELVEDE et al., 2010). These researches have been reported through a review of the literature which presented studies from different regions, indicating the motor disadvantages for people with ASD from different age groups and, consequently, the need for intervention researches in this area. (CATELLI et al., 2016)

In this study, the assessment of handgrip strength was carried out smoothly, with good understanding and cooperation from the participants. During the Box and Blocks Test, some of the assessed individuals reported that they were tired, or did not have the persistence to complete it. Sometimes the blocks were organized by color, or they demonstrated their preference since the test has blocks in the blue, red and yellow colors. As it is a speed test, perhaps these factors did not allow the participants to run as fast as they could.

The Minnesota test has been performed with some difficulty, since participants were dispersed at some point, not completing the placement of the discs on the board (placing test) quickly. But the Jebsen-Taylor test was of good understanding and participation. Being quick tests, the execution of the tasks was as requested. However, this study did not consider the item "write" to the final result because some participants did not write, as they still meet the literacy process.

The importance of knowing what is the best assessment is essential to the success of therapeutic programs, because only by knowing the dysfunctions an effective intervention is possible. Thus, these findings indicate that three tests are able to assess the group with ASD, however, considering its particularities, the JTHFT is the best for application, perhaps in an adapted form in relation to writing or to the application process, depending on the age category.

Due to the difficulty of people with ASD and the difficulty of understanding in relation to the instructions provided in the various evaluation tools, some research suggests that there would be the need to adapt the instruments or the way in which the instructions should be provided to these people so that this process could facilitate the understanding of the instructions and impact on the standard scale scores. (QUINTAS et al.,2018; LUI et al., 2013).

Motor deficits could be directly related to socialization and communication (VAN WAELVELDE et al., 2010). In order to determine whether the functional motor abilities predict success on standardized social communication skills, 35 people with high-performance TEA were evaluated, among 6 and 15 years old. The results indicated that children with motor skills below that expected for age are more likely to have deficits in social communication (MACDONALD et al., 2013).

Thus, stimulation programs for people with ASD aimed at the improvement of manual skills and of attention can contribute to better school performance and promote greater independence, autonomy and greater chances of social inclusion.

The concepts and more comprehensive analyses of the motor and sensory evaluation could contribute, in a multidisciplinary context, to understand and to map out the best clinical procedures and more efficient treatment protocols (MIERES et al., 2012; RINEHART et al., 2010).

Some points in this study should be considered with caution and may be indicative of possible limitations of the study, such as the small number of people assessed and the evaluation procedures being

performed by a single evaluator. All these descriptions could impact in the generalization of the results presented. New researches could help to better understand the assessment processes that are needed to understand the impairment of people with ASD and their repercussions throughout life.

CONCLUSIONS

The specialized literature highlights the relevance of studies focusing on motor aspects for people with ASD since several authors point out disadvantages compared to typically developing peers. The instruments that are used for assessment of hand function are not validated for people with ASD, and studies like this will help to demonstrate what is the most effective for this analysis.

Based on the results, it was found that it was possible to apply the suggested tests in adolescents with ASD and that the most sensitive to this population was the JTHFT, followed by BBT. Moreover, it was observed that the Minnesota test is best performed by those who have higher cognitive scores. It is suggested continuing research with a larger number of participants in order to be noted the results in a greater proportion.

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