Change in Manual Dexterity of Student with Cerebral Palsy With the Use of Adequate School Furniture[1]

Mudança na Destreza Manual do Aluno com Paralisia Cerebral Frente ao Mobiliário Escolar Adequado

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ABSTRACT: A proper sitting posture, especially when it comes to students with cerebral palsy, seems to favor a functional improvement of upper limbs and, consequently, an improvement in motor performance during school activities and learning. In this context, the aim of this study was to verify the influence of furniture on the manual dexterity of the child with cerebral palsy during a tracing activity. Six students with a diagnosis of cerebral palsy participated in the study. For data collection the participants were positioned in adapted furniture and performed a previously elaborated tracing activity. This activity was repeated 10 times on each item of furniture used: 1) on furniture without initial adjustment (WIA); 2) on furniture with adjustment (WA); and 3) again on furniture without final adjustment (WFA). The tracing analysis was performed by using the *MovAlyzeR* 6.1 software. For the analysis of the data, the average of the performance for each variable in each item of furniture used was conducted. The data was then treated statistically and the variables analyzed: vertical velocity peak, vertical acceleration peak, jerk, stroke, activity execution time, pen pressure on paper, linear error and absolute size of the tracing activity. The results indicated that all participants presented difficulties in performing the tracing, however, the furniture adapted to the needs of the user influenced the variables vertical velocity peak and activity execution time. It is concluded that adequate furniture may influence the manual dexterity of students with cerebral palsy.

KEYWORDS: Cerebral palsy. Assistive technology. Furniture.

RESUMO: Uma postura sentada adequada, principalmente quando se trata de alunos com paralisia cerebral, parece favorecer uma melhora funcional de membros superiores e, consequentemente, uma melhora no desempenho motor durante as atividades escolares e na aprendizagem. Nesse contexto, este estudo teve como objetivo verificar a influência do mobiliário na destreza manual da criança com paralisia cerebral durante uma atividade de traçado. Participaram seis alunos com diagnóstico de paralisia cerebral. Para a coleta de dados, os participantes foram posicionados em mobiliário adaptado e realizaram uma atividade previamente elaborada de traçado. Essa atividade foi repetida 10 vezes em cada mobiliário utilizado: 1) no mobiliário sem adequação inicial (SAI); 2) no mobiliário com adequação (CA); e 3) novamente no mobiliário sem adequação final (SAF). A análise do traçado foi realizada por meio do programa *MovAlyzeR* 6.1. Para a análise dos dados, foi realizada a média do desempenho para cada variável em cada mobiliário utilizado. Em seguida, os dados foram tratados estatisticamente e analisadas as variáveis: pico de velocidade vertical, pico de aceleração vertical, *jerk*, *stroke*, tempo de execução da atividade, pressão da caneta no papel, erro linear e tamanho absoluto da atividade de traçado. Os resultados indicaram que todos os participantes apresentaram dificuldades na realização do traçado; no entanto, o mobiliário adequado às necessidades do usuário influenciou nas variáveis pico de velocidade vertical e tempo de execução da atividade. Conclui-se que o mobiliário adequado pode influenciar na destreza manual de alunos com paralisia cerebral.

PALAVRAS-CHAVE: Paralisia cerebral. Tecnologia assistiva. Mobiliário.

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1 Introduction

Students with cerebral palsy (CP) present changes in tone, posture and persistence of reflexes that result in functional difficulties. Lack of postural control may be considered one of the most limiting factors in CP, as it results in the restriction of the reach ability with upper limbs, which, in turn, reduces participation in activities of daily living (Santamaria, Rachwani, Saavedra, & Woollacott, 2016). Qualified manual actions and manipulation involve a combination of reaching, grabbing, carrying, and dropping objects during daily tasks (Coluccini, Maini, Martelloni, Sgandurra, & Cioni, G, 2007; Klingels, Jaspers, Van de Winckel, De Cock, Molenaers, & Feys, 2010).

It has been identified that children with CP, even those with a diagnosis of diplegia and hemiplegia, present bilateral difficulties in the use of their hands with the prevalence of losses in finger dexterity (Arnould, Penta, & Thonnard, 2007).

The ability and performance of individuals with cerebral palsy can be altered, depending on the proposed task. If the task is more relevant or important for the child with cerebral palsy, manual motor performance will be more precise and less variable (Volman, Wijnroks, & Vermeer, 2002). Capacity refers to an individual's ability to perform a task or an action. It indicates the likely maximum level of functionality a person can achieve for a given domain at any given time. The quality of movement (active movement, fluency and accuracy), dexterity and speed of movement are components of ability. Performance describes what the individual does in his/her usual living environment. Since this environment includes a social context, performance can also be understood as involvement in a life situation, or the experience of people in the real context in which they live. This context includes environmental factors in all aspects of the physical, social, and attitudinal world (World Health Organization [WHO], 2003).

Boyd, Morris, and Graham (2001) have indicated that the effective or non-effective use of upper limbs may impact educational outcomes, participation in life activities, and career options for individuals with cerebral palsy. Writing-related motor activities account for 30-60% of the academic day for school-age children. Although many school-aged children with spastic cerebral palsy have the ability to write, a high percentage of them find it difficult to keep up with the school demands (Cheng et al., 2013).

According to the report of parents and teachers of children with spastic hemiplegia, handwriting is an important occupational activity for these students. However, parents reported that 75% of children have writing difficulties, whereas for teachers 69% of students have problems. The difficulties cited by teachers were the ability to write from dictation, and the ability to maintain speed for long periods of time. They also indicated that children with right hemiplegia, boys and those who had associated alterations had more generalized problems. Study participants reported that their children or students had difficulty holding a pencil, maintaining posture, and the presence of pain during activities. However, despite the high prevalence of writing difficulties, this is not consistent with their reading and spelling skills, suggesting that writing skills are not an indicator of academic ability (DuBois, Klemm, Murchland, & Ozols, 2004).

Children with cerebral palsy, quadriplegia type, need a longer time to perform the drawing activity, in addition to putting more pressure on the pen, when compared to children without motor alterations (Van Roon, Steenbergen, & Meulenbroek, 2005).

Individuals with motor difficulties have greater variability when pressuring the pen on the table and may show improvement in writing fluency with practice. However, there seems to be no indication that the practice could lead to a major change in spatial error and average execution speed (Gimenez, 2006).

Restrictions in manual writing, presented by children with CP, are related to the difficulties of motor coordination and postural control due to damages of the central nervous system and the persistence of involuntary movements (Kim, 2016).

Children with cerebral palsy generally exhibit instability in the sitting posture, and maintenance of postural stability is essential for the performance of most motor actions, especially of upper limbs. Therefore, it is fundamental to understand the parameters associated with the postural instability of children with cerebral palsy (Lacoste, Therrien, & Prince, 2009). Efficient postural control can be favored by adequate furniture that promotes stability and facilitates control of upper limb movements (Braccialli, Sankako, Braccialli, Oliveira, & Lucareli, 2011; Cheng et al., 2013). Thus, this study intends to verify the influence of furniture in the manual dexterity of the child with cerebral palsy during a tracing activity.

2 Method

This study was characterized as quasi-experimental, which, according to Portney and Watkins (2008), is a research design suitable for heterogeneous groups, in which the sample can be selected for convenience and that there is no need for a control group.

2.1 Ethical procedures

The project was approved under Opinion No. 0454/2009 on the Research Ethics Committee of the *Faculdade de Filosofia e Ciências* - UNESP – Marília, state of São Paulo, Brazil.

2.2 Participants

A convenience sample comprised of six students with spastic cerebral palsy, aged between seven and fourteen years, being one of the female gender and five of the male gender (Table 1). The inclusion criteria were: to have diagnosis of spastic cerebral palsy, to be enrolled in Elementary School, to be able to perform the tracing activity and to understand simple commands. Students with cerebral palsy who had other associated alterations were excluded from the study: low vision, blindness, alterations in visual and auditory perception, intellectual deficit that interfered in the understanding of the tasks. The legal guardians signed the Informed Consent Form and the participants agreed verbally to participate in the study after reading the Assent Form.

Partici-pants	Age (years old)	Gender	Topographical distribution	GMFCS	MACS	Grade at Elementary school
P1	10	Female	Spastic quadriplegia	IV	II	Third grade
P2	11	Male	Spastic diplegia	III	II	Fourth grade
P3	7	Male	Spastic quadriplegia	IV	III	First grade
P4	8	Male	Spastic diplegia	III	II	Second grade
P5	14	Male	Spastic diplegia	II	I	Seventh grade
P6	12	Male	Spastic diplegia	III	I	Fifth grade

Table 1. Characterization of study participants regarding age, gender, topographical distribution of cerebral palsy, grade in the Gross Motor Function Classification System (GMFCS), level in the Manual Ability Classification System (MACS) and seriation
Source: Elaborated by the authors.

2.3 Location

The study was carried out at the *Laboratório de Análise do Desempenho Motor* (LADEMO) - Laboratory of Motor Performance Analysis – located at the *Faculdade de Filosofia e Ciências* - UNESP - Marília-SP.

2.4 Data collection procedures

At first, the State and Municipal Departments of education were contacted in order to request the authorization to carry out the study and to identify the students with a diagnosis of cerebral palsy that met the inclusion criteria of the study.

After the identification of the children with a diagnosis of cerebral palsy enrolled in Elementary School, a visit to the school was made to evaluate if they met the other inclusion criteria of the study. During the visit to the school environment, the following activities were carried out with students diagnosed with cerebral palsy: 1) evaluation and classification of gross motor abilities through GMFCS and manual abilities with MACS; 2) verification of being able to carry out the tracing activity and if they understood simple commands.

For those who met the inclusion criteria, meetings were held with legal guardians to explain the purpose of the study and request authorization for participation. After signing the Consent Form and the students' agreement, the researcher made a second visit to the school to analyze the furniture used during the activities in the school environment and to carry out the anthropometric measurements of the participants. At this stage, it was found that the furniture used by the students with CP were not adequate to the anthropometric needs and obtained the parameters to make the adjustments and adjustments of the furniture for the data collection in the laboratory.

On the day arranged for individual collection, the laboratory was previously prepared, in relation to the furniture, equipment and activities that would be performed.

2.5 Experimental environment

For data collection, the performance of each participant with two different items of furniture were analyzed, with the piece of furniture routinely used by the participant and with a piece of furniture suitable for anthropometric measurements. The furniture used for the data collection of each participant was adjusted to the anthropometric measurements and, on the table with a semicircular cut, a digitizing table connected to a computer was placed. The participant was positioned with his/her back to the computer during collection so that his/her attention was not diverted.

The digitizing table used was Wacom, Intuos3, model PTZ-930, with a total height of 25.5 centimeters (cm) and a total length of 34 cm, with a writing area of 16.1 cm in height and 21 cm in length, referring to sheet A4, normal (Figure 1). This type of digitizing table has been considered an instrument with objective parameters for the evaluation of the movements of the fingers and the readability of the writing (Yu, Van Gemmert, & Chang, 2017; Caligiuri, Teulings, Dean, & Lohr, 2015; Piovezanni, Rocha, & Bracciali, 2014; Van Roon et al., 2005). It was set according to the manufacturer standards so that the computer could record pen pressure data, even if the child had difficulty in pressing force on the pen. An Ink Pen with the sensitivity of the pen configured in the program of the digitizing table installed on the computer was used (Figure 1). The data was captured and recorded on the computer through the *MovAlyseR* software.

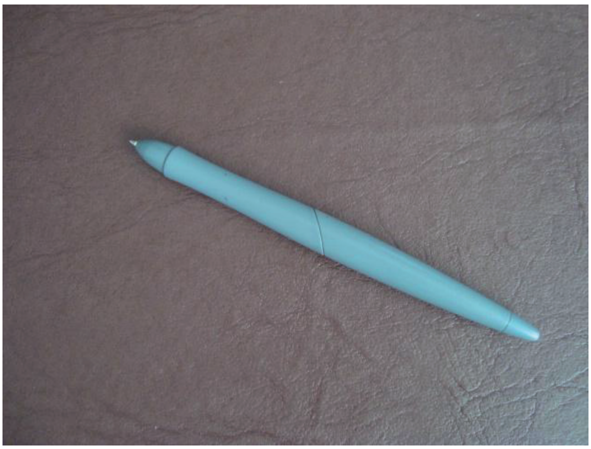

Figure 1. Digitizing table and *Ink Pen*
Source: The authors.

An A4 sulphite sheet which had imprinted a tracing activity was attached to the digitizing table (Figure 2).

Figure 2. Tracing activity that the participants performed for the study
Source: Elaborated by the authors.

2.6 Experimental situation

Upon arriving at the laboratory, the participant was advised about the activity that would be performed, then was positioned in his/her furniture of routine use. Then he/she was guided to carry out the tracing activity that consisted in following the dots in the direction of the arrows. This activity was performed twice on a sheet of paper before it began to be recorded on the computer.

For data collection of each participant, the software *MovAlyseR* was configured and between one activity and another an interval of about 15 seconds was programmed. A research assistant monitored the software during the collection; in the event of an error, a new collection session was scheduled for that participant.

Throughout the time of the collection, the researcher remained in front of the participant, in order to provide the necessary information for the execution of the activity. The participants carried out the activities on the piece of furniture they routinely used in the school environment (WIA), then on the furniture adapted to their needs (WA) and again on the furniture without adaptation (WFA). Participants performed the tracing activities 10 times on the furniture used in the school; then 10 times on the furniture suited to their needs; and then again 10 times on the school furniture. The data collection with repeated measures allows to evaluate if there were changes in the answers during data collection. It was chosen to work with the performance average because it can minimize differences due to external factors that were not controlled.

2.7 Procedures for data analysis

For the data analysis, the performance average of the ten activities carried out for each variable studied in each piece of furniture was performed. For the analysis of manual dexterity, the following variables were examined:

- Time: the time spent for the participant to perform the task, between the first touch of the pen tip on the table until its final suspension - it is the execution time (Calvo, 2007).
- Vertical Velocity Peak: Velocity indicates the ability to move the pen in space-time. Due to the ballistic characteristic of writing, rapid displacements of the pen are important for a proficient writing (Calvo, 2007). Therefore, the peak of the vertical velocity is the maximum value of the vertical velocity (Caligiuri, Teulings, Dean, Niculescu, & Lohr, 2011).
- Vertical acceleration peak: acceleration peak indicates the individual's ability to change the speed of pen movement. Acceleration peaks are the highest absolute acceleration values within the segment. Since a segment is formed by points at which the vertical velocity crosses the zero, the ideal would be that the number of acceleration peaks would be twice the number of segments. This means that the closer this value is, the more fluent is the tracing (Calvo, 2007).
- Normalized Jerk: it can be considered an acceleration variable in relation to time, which is analyzed at any displacement. To Caligiuri et al. (2011), the normalized jerk is a measure of disfluency in the movement of the pen, it is the third derivative of time in the displacement. It can be calculated by time and duration of each stroke (Codogno, 2011). Other authors have studied the disfluency of exchanges in the direction of speed and acceleration, which may also mean the automation of writing.
- Strokes: they can be defined as the segments in which an individual fragments a graphic pattern. The separation between the strokes of a graphical reproduction would be made from inflections in the speed of execution. Strokes emerge through different subsystems of neuromuscular works that control flexion and extension (Codogno, 2011). Other authors define the stroke as a half cycle of a continuous motion, defined by two extreme sequential points (maximum/minimum) of the curve position. These points correspond to changes in the direction and the zero speed point (Tindle & Longstaff, 2016). The number of strokes can be used as an indication of the formation of representation for the cursive writing or even the stability of the graphic pattern.
- Pressure of the pen on the table: pressure is equal to the force exerted with the tip of the pen on the table during the production of the traces (Calvo, 2007).
- Linear error: it is also called the standard deviation of a straight line. The linear error is calculated by the length of a straight line in centimeters. The linear spatial error is calculated by the linear size difference in centimeters between the model figure and the actual drawing performed (Gimenez, Santos, Ojeda, Makida-Dionísio, & Manoel, 2016). It is like putting the drawing or activity on a straight line and calculating the errors, that is, the parts that protrude from that straight line (Codogno, 2011).
- Absolute size: it is the sum of the size of all segments of a graphic pattern, calculated by the horizontal and vertical sizes (Neuroscript, 2010).

2.8 Statistical treatment

Statistical analysis was performed with specific tests to verify the efficiency of the activities in each piece of furniture. Previously the analysis was done using the Shapiro Wilk normality test, and the comparison between the moments, Without Initial Adjustment (WIA), With Adjustment (WA) and Without Final Adjustment (WFA), for each studied variable was done through Friedman's non-parametric analysis of variance. When there was a significant difference, the two by two comparison was performed; through Dunn's Multiple Comparison Test. The significance level $p \leq 0.05$ was adopted.

3 Results

In Table 1, the values of the Vertical Velocity Peak (VEL) (in cm/s) in the different evaluation moments are presented: with the furniture without initial adjustment (WIA), with adjustment (WA) and without final adjustment (WFA). Analysis using the Friedman test indicated that there was a significant difference ($p = 0.0081$) between the evaluations.

Variable VELOCITY	WIA	WA	WFA
P1	3.27	2.75	4.26
P2	2.92	1.99	2.88
P3	2.87	2.64	3.66
P4	2.48	1.78	2.23
P5	9.66	6.34	9.64
P6	8.89	6.39	9.46

Table 2. Data related to the Vertical Velocity Peak variable (in cm/s) at the different moments of the activity execution
* Friedman test p = 0.0081
Source: Elaborated by the authors.

The pair analyses through Dunn's Multiple Comparison Test showed a significant difference for the comparison between the moment without initial adjustment (WIA) and with adjustment (WA) and the moments without initial adjustment (WIA) and without final adjustment (WFA) (Table 2).

Comparison	p
WIA - WA	<0.05*
WIA – WFA	<0.05*
WA- WFA	>0.05

Table 3. Comparison of Peak Vertical Velocity through Dunn's Multiple Comparison Test
* significant
Source: Elaborated by the authors.

Table 3 shows the descriptive characteristics of the Vertical Acceleration Peak (ACCEL). The analysis using the Friedman test did not indicate a significant difference ($p = 0.2522$).

Variable ACCELERATION	WIA	WA	WFA
P1	6.47	16.28	56.08
P2	3.14	5.19	2.88
P3	4.6	5.01	8.3
P4	8.07	4.94	5.05
P5	13.71	31.15	37.68
P6	14.31	28.83	34.02

Table 4. Data of the variable Peak of the vertical acceleration (in cm/s^2) in the different moments of execution of the activity
Source: Elaborated by the authors.

In Table 4, the results regarding the performance of the participants for the Stroke variable are presented for the activities proposed in the moments Without Initial Adjustment (WIA), With Adjustment (WA) and Without Final Adjustment (WFA). Statistical analysis indicated that there was no significant difference (p = 0.1188).

Variable STROKE	WIA	WA	WFA
P1	8.6	9.10	9.00
P2	6.89	7.44	6.89
P3	5.78	6.00	6.56
P4	8.00	6.56	8.33
P5	6.00	6.33	6.89
P6	6.44	6.33	6.56

Table 5. Stroke (in units), statistical significance and comments
Source: Elaborated by the authors.

In relation to Time (TIM) spent by the participants for the execution of the activities at different times, Without initial adjustment (WIA), with adjustment (WA) and Without final adjustment (SAF), the data indicated a significant difference (Table 5).

Variable TIME	WIA	WA	WFA
P1	18.59	13.63	17.74
P2	30.08	22.38	22.96
P3	41.46	39.42	40.16
P4	23.81	20.89	21.65
P5	10.28	6.36	5.69
P6	13.57	7.58	6.51

Table 6. Statistic for the variable Time(s) in the different moments of execution of the activity
* Friedman test p = 0.0055
Source: Elaborated by the authors.

The pair analyses through Dunn's Multiple Comparison Test showed a significant difference for the comparison between the moment Without Initial Adjustment (WIA) and With Adjustment (WA) (Table 6).

Comparison	p
WIA - WA	<0.05*
WIA – WFA	>0.05
WA - WFA	>0.05

Table 7. Comparison of the variable Time (in s) at the different moments of execution of the activity through the Dunn Test
* significant
Source: Elaborated by the authors.

In Table 7, the data for the normalized Jerk variable (JERK) are presented during the activities at the different moments Without Initial Adjustment (WIA), With Adjustment (WA) and Without Final Adjustment (WFA). The analysis using the Friedman test showed no significant difference (p = 0.2522).

Variable JERK	WIA	WA	WFA
P1	64.6	17.4	32.58
P2	92.74	56.17	74.12
P3	449.58	478.11	401.73
P4	61.88	72.26	70.92
P5	12.21	9.86	9.62
P6	24.55	13.45	10.98

Table 8. Data of the variable Jerk (in cm/s3) at the different moments of the activity
Source: Elaborated by the authors.

In relation to the linear Error (ERROR) variable, it was observed that there was no statistical difference (p = 0.8102) at the different moments, Without Initial Adjustment (WIA), With Adjustment (WA) and Without Final Adjustment (WFA), of the activity (Table 8).

Variable ERROR	WIA	WA	WFA
P1	0.03	0.02	0.03
P2	0.04	0.04	0.05
P3	0.06	0.06	0.05
P4	0.04	0.05	0.05
P5	0.05	0.04	0.03
P6	0.05	0.05	0.04

Table 9. Data of the variable Linear Error (in cm) in the different moments of the activity
Source: Elaborated by the authors.

For the variable Paper Pressure (PRES), there was no significant difference (p = 0.5705) for performing the activity in the different moments, Without Initial Adjustment (WIA), With Adjustment (WA) and Without Final Adjustment (WFA) (Table 9).

Variable PRESSURE	**WIA**	**WA**	**WFA**
P1	856.58	665.14	831.38
P2	897.55	930.23	952.05
P3	956.07	903.67	898.04
P4	577.6	726.86	566.89
P5	820.8	820.04	854.31
P6	889.11	768.96	772.69

Table 10. Data of the variable Pressure of the pen in the paper (in N) in the different moments of the realization of the activity
Source: Elaborated by the authors.

The data showed that there was no significant difference (p = 0.9563) for the variable Absolute Size (ABS) in the different moments, Without Initial Adjustment (WIA), With Adjustment (WA) and Without Final Adjustment (WFA), during the execution of the activity (Table 10).

Variable ABSOLUTE SIZE	**WIA**	**WA**	**WFA**
P1	37.24	36.27	50.68
P2	39.52	40.94	39.22
P3	39.92	38.61	41.5
P4	27.79	30.52	30.96
P5	41.52	40.63	38.84
P6	47.76	41.61	40.2

Table 11. Data of the variable Absolute size (in cm) at different times of the activity
Source: Elaborated by the authors.

4 Discussion

Students with cerebral palsy have difficulties in performing movements that depend on the accuracy of upper limbs (Van Roon et al., 2005), which justifies the difficulties that the study participants presented in order to perform the proposed tracing activity in this work.

The data indicated a significant difference in the activity execution time and in the Vertical Velocity Peak when the participants used appropriate furniture to their anthropometric measurements, but there was no significant difference in the performance in relation to the vertical acceleration. The use of a table with a 20º slope has been efficient in the parameters of speed and calligraphy size of children with CP and in speed for healthy children, since this furniture can offer a better visuomotor organization (Kavak & Bumin, 2009).

Increased speed in writing or drawing means improvement or automatism of the motor act; however, it does not mean improvement in fluency because the student can automate his/her writing and worsen readability (Gimenez, 2006). A study carried out with children with hemiparetic cerebral palsy indicated that the speed of calligraphy was similar to that of peers with no disabilities, but with a poor readability (Kavak & Eliasson, 2011). Lateral deviation of the wrist, associated with decreased muscle strength and upper extremity velocity, appears to have a major impact on writing as the wrist muscles stabilize and prevent unwanted movements, and allow the finger muscles to maintain a length suitable for producing tension and hold during writing activity (Kim, 2016).

Acceleration is a measure of the maximum speed change rate (Johnson et al., 2010); points to the individual's ability to change the speed of pen movement (Calvo, 2007). In this sense, Van Roon et al. (2005) verified in their study that, without visual feedback, children with cerebral palsy slowed the acceleration and increased the task execution time. Therefore, the adequacy of the furniture assists in the oculo-manual coordination, which will facilitate in increasing the acceleration, decrease in the time of execution and, consequently, in the improvement of the motor performance of the activity. According to Calvo (2007), the practice of fine motor coordination influences the speed, acceleration and fluency of manual activities such as writing, for example. Thus, there is not only the influence of the furniture in the execution of the activities, but the motor practice, the learning also interferes in the manual dexterity of students with CP.

Ideally, as with speed, acceleration would also increase when participants were in the chair with adjustments. With increased acceleration and speed, students would perform the proposed activities in a shorter time and therefore improve their motor performance.

The results of the variable stroke showed that there was no significant difference regardless of the suitability of the furniture used. Stroke is a measure that indicates fluency in writing, so that the more strokes in the activity, the less fluency. When there is little fluency, the quality of the drawing or writing is compromised (Calvo, 2007). In a study conducted by Almeida, Codogno, Braccialli and Tibério (2015), children with typical development presented a much superior performance regarding the stroke variable in graphical activity similar to that used in this study by children with cerebral palsy. A number of major strokes during graphic activities may be warranted because of poor movement control and coordination of upper limbs of children with cerebral palsy (Volman, 2005).

For the jerk variable, no statistical significance was observed at the different moments evaluated. The variable jerk indicates the disfluency in fine motor coordination, that is, the amount of tremor during the activity performed (Caligiuri et al., 2011). Some authors have reported that slower movements tend to be more disfluent, hence the value of jerk tends to be higher (Tindle & Longstaff, 2016). The study participants due to cerebral palsy have a tendency to perform slower movements with the upper limbs regardless of the furniture used, tending to be more disfluent. In Teulings and Romero's (2003) study, the jerk increased according to the activities performed, the more curves and complex the activities, the higher jerk value the individuals presented. Thus, in this work, the students performed an activity with curves, which corroborates the findings of these authors.

In this work, it was verified that there were no significant differences in the linear error according to the WIA, WA and WFA moments. Linear error is the standard deviation of a straight line; it is like stretching the drawing and checking what got out of the straight line, that is, the mistakes. In a study carried out by Gimenez (2006), there was also no decrease in linear error, along the blocks of attempts performed by children with motor difficulties. However, there was a slight tendency to increase this error, from the initial blocks to the final ones, that is, the author inferred that, faced with a greater amount of practice, the children erred more the dimensions of the proposed figure. With the use of adequate furniture, it was expected that the linear error would decrease, since it improves the postural alignment and, consequently, the functionality of the upper limbs.

For the variables pressure of the pen in the paper and absolute size of the figure, there was no significant difference between the evaluated moments, thus, the furniture does not seem to have influenced the performance. In Gimenez's (2006) study, the participants maintained mean levels of pen pressure on the table throughout the trials. In Van Roon et al. (2005) study, the students with CP also maintained pressure levels, even without looking at the member that was performing the activity. However, the higher the pressure, the greater the physical exhaustion of the student when performing the tracing activity, since it requires greater coordination and finger dissociation. In this sense, Gordon, Charles and Duff (1999) observed that there is a loss of anticipatory control of the force in children with cerebral palsy in the limbs that are compromised. The authors report that this is probably due to the sensory and perceptual dysfunction of these children.

Children with cerebral palsy have coordination deficits and difficulties both to start and stop a movement (Ricken, Bennett, & Savelsbergh, 2005), this justifies the size of the tracing to have changed in the three moments - WIA, WA and WFA. However, the results found here do not invalidate the use of the appropriate chair by students with CP, which should provide safety, comfort and stability, contributing to improving the performance of upper limbs to perform activities, whether they are school activities or not. According to Calvo (2007), the size of writing or drawing varies according to the increase of finger strength in children with motor difficulties. Proper stabilization of the lower limbs by using appropriate furniture associated with the use of a pencil of adequate width improves the inclination of the trunk, head, shoulder and visual focus during handwriting. Although these factors are beneficial for body posture, they did not alter the muscular effort of the upper extremity to a statistically significant level (Cheng et al., 2013).

Adequate furniture should be recommended to improve the manual performance of this population with PC, even though the results found in this study did not show significant difference in some variables, since adequate seated posture favors postural control, postural stabilization allows normalization of tone and accommodation and also increases the individual's potential (Braccialli, Oliveira, Braccialli, & Sankako, 2008).

According to Araújo (2003), the furniture, as well as the pedagogical material, is pointed out as fundamental to enable the presence of the student in the school and in the classroom. When it comes to students with disabilities, this factor is of significant importance, since, because they present some limitations, such students have their autonomy aided by the equipment and objects available for their use.

Good manual dexterity is important for performance in school activities. As it was observed in the results, not only the adequate furniture is important, but also it is necessary to know the degree of commitment of the student and the degree of complexity of the activity that is intended to be used. All of these items need to be well evaluated so that the student with cerebral palsy can achieve maximum motor performance with as little fatigue as possible during school activities.

The limitations of the study must be considered with regard to sample size and heterogeneity in relation to manual motor skills. There is a need to conduct further studies to verify how manual and motor skills can interfere with performance and relate to the type of furniture used.

5 Conclusion

The furniture adapted to the user influenced the execution time of the task and the peak of the vertical acceleration, but it was not significant for the other variables studied.

There is evidence that furniture suitable for students with cerebral palsy favors visual motor control and has a positive impact on performance during school activities. Thus, the school should be concerned with providing school furniture appropriate to the student's individual needs with cerebral palsy in order to facilitate the realization of activities in this environment.

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