ORIGINAL ARTICLE

EFFECTS OF A GAME THERAPY PROGRAM WITH LEAP MOTION SENSOR ON THE MANUAL FUNCTION IN ADULTS WITH CEREBRAL PALSY

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Highlights: 1. Stimulation strategies for adults with cerebral palsy should be developed. 2. Game therapy can be an effective strategy for developing manual function. 3. Video games are motivating in rehabilitation programs.

PRE-PROOF

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ABSTRACT

Hand motor rehabilitation programs require long-term therapy and they are generally uninteresting and repetitive for the patient who is not always motivated to achieve them. The literature shows that Virtual Reality (VR) can increase motivation and engagement in motor rehabilitation programs. The aim of this study was to evaluate the effects of game therapy program for adults with cerebral palsy. The study included five adults with CP, levels 3 and 4 from Manual Ability Classification System (MACS). The manual function was evaluated before and after the game programs by the Box and Blocks and Jebsen-Taylor tests. The program was offered in 15 sessions, twice a week, in a care association for people with CP. The results indicated the stability of the condition, which can be expected for the adult population. Some games were more motivating and through testimonials, participants demonstrated satisfaction and suggested technical changes for better usability of the games. Motivators therapeutic resources should be considered in adult therapy with CP.

Keywords: physiotherapy; cerebral palsy; manual function; virtual reality; leap motion.

EFEITOS DE UM PROGRAMA DE GAMETERAPIA COM LEAP MOTION SENSOR NA FUNÇÃO MANUAL EM ADULTOS COM PARALISIA CEREBRAL

RESUMO

Programas de reabilitação motora da mão requerem terapia de longo prazo e geralmente são desinteressantes e repetitivos para o paciente que nem sempre está motivado para realizá-los. A literatura mostra que a Realidade Virtual (RV) pode aumentar a motivação e o engajamento em programas de reabilitação motora. O objetivo deste estudo foi avaliar os efeitos de um programa de gameterapia para a reabilitação da função manual em adultos com Paralisia Cerebral (PC). O estudo incluiu cinco adultos com PC, níveis 3 e 4 do Manual Ability Classification System (MACS). A função manual foi avaliada antes e após os programas de jogo pelos testes Box and Blocks e Jebsen-Taylor. O programa foi oferecido em 15 sessões, duas vezes por semana, em uma associação de assistência a pessoas com PC. Os resultados indicaram a estabilidade do quadro, o que pode ser esperado para a população adulta. Alguns jogos foram mais motivadores e por meio de depoimentos, os participantes demonstraram

satisfação e sugeriram alterações técnicas para melhor usabilidade dos jogos. Os recursos terapêuticos motivadores devem ser considerados na terapia de adultos com PC.
palavras-chave: fisioterapia; paralisia cerebral; função manual; realidade virtual; leap motion.

INTRODUCTION

Cerebral palsy (CP) is a condition characterized by movement and posture disorders, causing limitations in motor activities that are attributed to disorders that occur in the developing encephalon[1].

Technological advancement can be a relevant resource to increase social participation and quality of life that promotes the interaction between the individual and the environment. Changes in individual and social attitudes must occur to recognize that individuals with CP have the right not only to the inclusion, but also to participate fully in society[1-2].

Motivation is fundamental for patients to accept and persist in the program, enabling the achievement of better results[3]. However, hand therapy exercise programs are generally uninteresting and repetitive, and the patient is not always motivated to perform them[4-5]. Moreover, it sometimes requires long-term therapy to restore the functionality of the hand, which, in many cases, becomes a tedious and exhausting process[6].

The aim of this study was to evaluate the effects of game therapy program for adults with cerebral palsy.

MATERIALS AND METHODS

The study was a cross-sectional, descriptive, case series, approved by the Research Ethics Committee, included five adults with CP aged over 18 years, both genders, with the ability to understand the rules of the proposed games and visual acuity that would allow the identification of the graphics elements and the virtual interaction with the environment of immersive games, with manual and segmental function enough for active movement of the upper limbs to perform the proposed tasks classified at levels 3 and 4 from Manual Ability Classification System (MACS). The procedures occurred in sequential stages:

1. **Development of the games:** three VR games was developed to flexion and extension finger exercises. All games have been implemented with immersive (headset version) and non-immersive (desktop version) modes of use with Leap Motion.
2. **Usability Tests:** aimed investigate the usability of the games, accurately capture of the movements by Leap Motion, adapting to the use of VR glasses (Gear VR), positioning of users and symptomatological issues like nausea, visual discomfort, headaches, physical fatigue, among others. The usability test was applied in two sessions of using the games for a period of 20 minutes in immersive and non-immersive modes. In addition to the observations, a satisfaction questionnaire was applied to collect the participants' opinions.
3. **Intervention:** The intervention program occurred after the usability study. The meetings took place twice a week for two months, totaling 15 sessions. Up to two absences were admitted, and to participate in, at least, 13 sessions was mandatory. Each session lasted about 15 to 20 minutes and performed two games a day, one day in an immersive way (headset version) and the other in a non-immersive way (desktop version). Assessments took place over a period of 2 months. An initial individual assessment was performed using Jebsen-Taylor Hand Function Test (JTHFT)[7:] based on the seven subtests: writing with pen and paper a sequence of 24 letters; flip a set of cards sequentially; pick up small objects (paper clips, bottle caps and coins), simulate feeding with a spoon and beans, stack wooden checker pieces, move large and light objects (empty cans), move large and heavy objects (heavy cans) and Box and Block Test (BBT)[8]: the BBT was used to count the number of blocks transferred per minute between two divisions of a standardized box. At least two sequential assessments were performed for the dominant hand and two for the non-dominant hand. After the stipulated period related to the use of the games, totaling three evaluations, the participants were reevaluated, following the same initial assessment protocol.

The equipment necessary for the practice of the games consists of a kit with Gear VR glasses and smartphone Galaxy S8, notebook and installed software.

The following table has the characterization of the study participants:

Participant	Sex	Age	GMFCS	MACS	March
P1	F	41	IV	III	Wheelchair
P2	M	36	III	IV	wandering
P3	F	37	IV	II	wandering
P4	F	26	IV	II	wandering
P5	F	38	IV	IV	Wheelchair

Table 1: Profile of study participants

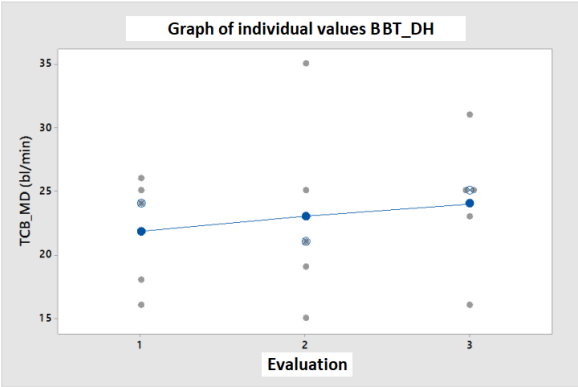
RESULTS AND DISCUSSION

Manual dexterity by the Box and Blocks Test: This assessment of manual dexterity was performed for dominant hand (DH) and non-dominant hand (NDH) and all participants were able to accomplish the task (n = 5). Table 1 shows the results of the averages obtained from blocks per minute (bl / min) and the p value in the three evaluations performed for DH and NDH.

	Evaluation 1	Evaluation 2	Evaluation 3	P-value
BBT/ DH	23,66	24,33	25	0,692
BBT/ NDH	19,66	22,33	25	0,030*

Table 2: Medians for BBT DH and NDH/ P-value

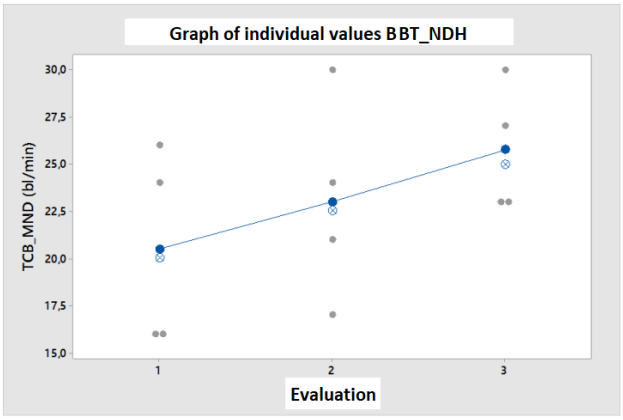
The results indicated that for DH in BBT, there was no significant difference among the three assessments (p = 0.692). The median obtained by them, however, even without statistical confirmation, showed a tendency with increasing values in the three medians evaluations (23,66; 24,33 and 25) blocks per minute (bl / min), respectively (Graphic 1).



Graphic 1. Medians for BBT / DH (Individual values)

Graphic 1. Medians for BBT / DH (Individual values)

For the NDH, the BBT task was not performed by a participant due to his motor difficulties (n = 4). Statistically, significant results were found (p = 0.030) showing evolution in the transport of bl / min (19,66; 22,33; and 25) in the initial, intermediate and final assessments, respectively (Graphic 2). It was also found, by contrast made after analysis of variance, that evaluation 1 was lower than 2 which was lower than 3, which demonstrates the evolution of the performance of the participants.



Graphic 2. Medians for BBT / NDH (Individual values)

Graphic 2. Medians for BBT / NDH (Individual values)

In the case of CP, the determination of the DH and NDH is related to the degree of impairment caused by the lesion, i.e., the preferred hand is the one that has fewer sequela and acts in a more functional way. Manual activities require the cooperation of both hands, where

the DH performs fine and gross manipulations, and the NDH is used to stabilize objects. People with CP develop their capacity for action on the least affected side[5].

In a study carried out[9] with Wii video games and CP, the results were surprising because no improvement was found in the coordination and function of the hand. However, the report given by the parents showed an increase in the amount of hand function and the onset of the use of the affected hand for the first time. For an individual with a CP to pick up a virtual object in the virtual environment, he does not need to have a full range of finger flexions, for example. Instead, a small interval can easily allow him to take the object, which reduces the perceived difficulty of the task[10].

Int the study[11] in which the interventions were directed to the distal upper extremity, it was found that rehabilitation based on VR had beneficial effects on both extremities (proximal and distal). These results were unexpected because it was believed that rehabilitation based on VR would only influence the distal upper extremity because the system used (GS smart glove) was focused on it. One possible explanation for the results is that the distal part plays an important role at the upper extremity, functioning as a final effector, thus, the high activity of the distal part during the rehabilitation promoted the active use of the affected upper extremity, which has been neglected or unused, surpassing learned disuse.

Function Manual by JTHFT: The assessment of hand function was carried out for DH and NDH in each of the seven tasks proposed by JTHFT. Due to the complexity of some test tasks, not all participants were able to perform them with both hands. Thus, the number of participants ranged from 3 to 5, disregarding the tasks not performed by at least three people.

The first task is writing. It was performed by four participants with DH and it was not possible to apply the statistical test with NDH. There was no statistical difference among the three assessments, with $p = 0.368$. The average time for this task was 50,92 seconds (mean of medians).

Task 2 corresponds to the movement of turning cards. To DH ($n = 5$) and NDH ($n = 4$). For both hands no significant difference (DH and NDH $p = 0.247$, $p = 0.779$).

Task 3, represented by the movement of picking up small objects (clips, coin and bottle cap) was performed with DH ($n = 4$) and NDH ($n = 4$). Significant results were obtained for DH ($p = 0.039$), but the contrast after variance analysis showed that the measurements were not

increasing, i.e., assessment 1 was lower than 2, which was larger than 3, which shows irregularity in the performance of the participants. For NDH, no difference was found ($p = 0.368$).

Task 4, equivalent to simulating feeding, showed an irregularity in its execution, and in the initial and in the final assessment only two participants with the DH performed it, making to statistical analysis impossible. For NDH ($n = 3$) there was no statistically significant difference ($p = 0.368$).

Task 5, stacking checkers was performed with DH ($n = 3$) and NDH ($n = 3$). In both cases there was no statistically significant difference (DH $p = 0.717$ and NDH, $p = 0.717$).

Task 6, represented by moving large and light objects, was conducted with DH ($n = 5$) and the NDH ($n = 4$). For both hands, no statistically significant results were found (DH $p = 0.247$ and NDH, $p = 0.472$).

Task 7, moving large and heavy objects was carried out by DH ($n = 5$) and NDH ($n = 4$). For DH, there was a statistically significant result ($p = 0.074$) if one considers $p \leq 0.10$, which can be justified by the reduced sample size to obtain better test power. There were no statistically significant results for NDH ($p = 0.174$).

The absence of significant results may be related to several factors, such as the age of the studied group, session time and intervention time, which vary greatly. The choice for the number of sessions and time allocated to practice exercises was based on previous studies[10-12-9] focusing on the rehabilitation of people with CP, which vary the intervention time among 4 and 20 weeks. The time spent on VR also varies among 20 to 90 minutes and may be practiced from one to seven days per week. These data are probably influenced by the severity of the CP, the more severe, the less tolerance time to play.

The heterogeneity of the group in relation to the presence of four women and only one man was not considered in the analyses, since in a recent review of published literature it was found that differences between the sexes for people with CP are minimal[13].

In a meta-analysis study[10], the results show that young children who received intervention with VR at home or in the laboratory and who used a VR system built by an engineer had a better effect on the performance of motor skills. This study shows that the VR effect had a negative linear correlation with the age of the subjects in arm function. The younger the participants are, the better the effect. This is consistent with the early intervention idea, because

younger people may have more brain plasticity and adaptability to improve their motor function than patients at older ages.

All participants felt challenged to improve their performance in achieving the games, which may be a consequence of the scores being visible during the practice of each one of them. In addition, the games provided auditory feedback when the proposed task was performed with hits or errors, leading the participants to create their own challenges and also in the group. Motivation has been recognized as an important reason to explain why VR works, positive feedback can optimize learning through increased motivation[10]. Moreover, the manual capacity and the performance of motor tasks may be influenced by the motivation and cognition[5].

CONCLUSIONS

The study results indicate that, although no significant differences were found in the assessed skills, the intervention program had a beneficial effect on the maintenance of the participants' motor condition, with some improvement trends not statistically confirmed. However, the innovative nature of the proposal must be considered, knowing that the population of adults with CP needs motivation and stimulation strategies for adherence to therapies and that these results should be analyzed by scientific and social relevance to be applied in future research. It is suggested the continuity of studies with VR, focusing on groups of people with CP diversified by age, the severity of the condition and intervention time.

This study had some limitations, such as: small number of the population and different particularities and severities among the participants.

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