The Role of Small Robots in Designed Play Workshops in Centers of Adults with Cerebral Palsy

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Abstract. An experience that took place in ASPACE (Association of People with Cerebral Palsy in Seville) showed that the intervention with games based on tangible devices like small robots is a good alternative in the case of people with cerebral palsy (CP). The aim is to develop skills in three facets: cognitive, motor and social. From three to six sessions with seven subjects allowed obtaining information on the evolution of them and their involvement in the activity.

Keywords: Small robots · Cerebral palsy · Games therapy · Access to technology · Social skills improvement

1 The R&D or Application Idea

In this paper an event that took place in a center of adults with CP is described. In this center a game workshop made up one of several activities that they organized. The aim was studying new possibilities that can help to develop new skills in their users. In this workshop different alternatives for gaming are analyzed. The main idea is to study game accessibility for different user profiles and to familiarize them with technological solutions which can later be applied to communication, learning, etc. Videogames and little robots are used. The paper is focused on the robot alternative. Two options are tested. One of them is a ball robot called SPHERO manufactured by Orbortix [1]. The other one is homemade and is called CUBOT which consists of a vehicle manipulated by a cube. The origin of the name is a mixture of cube and robot.

2 The State of the Art in This Area

CP is a general term for a group of permanent, non-progressive movement disorders that cause physical disability in development, mainly in the areas of body movement. It is a central motor dysfunction affecting muscle tone, posture (and movement) resulting from a permanent, non-progressive defect or lesion of the immature brain but it might also affect intellectual capabilities. This causes a lack of independence that diminishes self-esteem, entertainment opportunities and involvement in tasks. Since childhood, they get used to events happen without their participation and influence, the reason is that it is complicated they may have independent experiences. The access to technology improves the quality of life of people suffering from CP. It favors communication, integration and entertainment.

A European project which reveals two important aspects in the use of robots in game-based therapies for people with disabilities is described in [2]. The first is the lack of measurement scales for evaluating scenarios and game devices as well as its design. The second is the term Socially Assistive Robots, as intersection between Assistive Robots used in rehabilitation therapies and Social Interactive Robots, robots used like companion. Unlike in the case of Assistive Robotics, the social robots impact on quality of life is still unexplored due to the fact that social robots are still expensive and not largely widespread yet in educational or therapeutic settings; for these purposes, when developing new robot toys, a consistent framework should be anyway found and used.

In [3] the effects that the robot has on CP children s ability to participate in play were analyzed. The main types of play that can be observed in children younger than 8 years old are functional play and pretend play. Functional play is characterized by repetitive movements or actions that the child performs for the pleasure of exerting an impact on the toys (for example building a tower of blocks and then knocking them down). On the other hand, pretend play is make-believe play where children use toys in imaginative ways. The pretend level of play was not achieved with the robot, contradicting expectations.

In [4], a robotic arm system was used in the children s school. Children with disabilities will engage in play if the stimulus is adequate (i.e., the toy is interesting to the child) and the toy is physically accessible to them. Adapted robotic devices meet both of these criteria. Twelve children with severe physical disabilities, ranging in ages from 6 to 14, participated in this study. All of the children reacted positively to the robot. The robot generated tasks were more motivational for the children, and generated more interest and excitement than single switch tasks such as toys, appliances or computer-based activities.

In [5], the object of case study was to investigate the effect of a home-based robot intervention. The participant was a 4 year old girl using Lego Mindstorm robots. The results showed that playfulness increased a little more than in a play situation without robot.

In [6], SPHERO was proposed as the main device in the game. Several concepts arise in this paper. The first one emphasizes the idea of interactive technologies such as tools which have the ability to enhance the perception of individuals. Interaction can be done with physical objects. Those are tangible interfaces. The gameability concept is related to the quality of the user interaction with the game. A user centered approach is used. The disabled person takes an active part contributing to the adaptations of interfaces according to their needs.

In [7, 8] the goals are different because a robot therapy environment is used to perform physical rehabilitation.

As far as we could investigate, no studies were found based on using robots for therapies with CP adults. It is difficult too, the measure of the effect of interventions, there are not proper scales to do this. In this paper, our experience is described. An alternative based on low-cost robots to encourage and measure skills in this population. This is a preliminary study showing that the work on this line is promising and can be formalized and expanded in the future.

3 The Methodology Used

3.1 Participants

A group of seven users ranging from 24 to 43 (mean 33,8 ± 5,7) attending the day center of ASPACE took part in three to six sessions. In general these users have movement problems and very poor oral communication. Among them, there are varying social interactions and access to technology. The workshop s objective was to improve their shortcomings in these areas.

The sessions were led by an ASPACE therapist and a member of our team.

3.2 Materials

SPHERO and CUBOT are used.

SPHERO is a robotic ball with various internal motors to roll in any direction. It has lights and sounds too. There are several applications for mobile devices that allow one to control it. There are different kinds of games including augmented reality. Mobile devices communicate with SPHERO using Bluetooth (Fig. 1a).

Fig. 1. Left: SPHERO [1]. Right: CUBOT

CUBOT is a prototype we have built. It is formed by two devices, a little robot in the form of a motorized vehicle and a cube shaped control device. Controlling CUBOT is quite simple. Each face of the cube has a carved arrow on its surface that illustrates each action of the robot, turning the cube and therefore the face that is on the top. This changes the movement of the vehicle. Two Arduino Leonardo boards are in charge of controlling both devices. A three-axis accelerometer is installed in the cube to know its position. The LEDs provide lighting to each of the five arrows indications and the vehicle, different colors have been used, when cube and vehicle are connected the same colors appears in both, constituting a good feedback for the user. In addition, in the inside of the cube a little vibrator motor and a buzzer module are installed, these two components endow the cube with capacity to alert and inform the user of certain situations, for instance the proximity of an obstacle. The robot is based on a Rover 5 chassis by Dagu Electronics. On this chassis the Arduino Leonardo, a dual motor controller and an ultrasonic distance sensor were mounted. Cube and robot are connected using Bluetooth modules (Fig. 2).

Fig. 2. Left: a user holds the cube in order to control the robot. Right: playing with SPHERO

3.3 Intervention

The planified Activities were different for CUBOT and SPHERO. The reason for this is due to the fact that the systems are controlled in different ways and not all the users are able to play with both.

CUBOT is controlled by turning the cube in five different positions. Motor skills can be improved in those cases where its use is possible (Fig. 2a). The subject is asked that turn the cube in several positions. Only spot tests could be performed with some users.

The activities with SPHERO were based on different circuits drawn on the floor that the robot had to follow. First the aim was that users were familiarized with the system and they had fun. Bottles were filled with sand to emphasize more the path to be followed in the circuit. The last goal was to pull the pins placed at the end of the circuit (Fig. 2b). In the following sessions a circuit with three items was used (Fig. 3). The users had to pass the items without crossing the lines of the circuit. If the lines were past, this was considered an error and counted then for the results. The time was also measured. Different sessions with this last circuit are done in order to notice the evolution in the skill to manipulate the robot.

SPHERO can be controlled through an application that was installed in a tablet or IPAD, so the access method was the touch screen or any other adaptation that can be used with the tablet. For instance one of the users controlled it with a licornio, but any other adaptation that allows simulating one touch in the screen would be possible.

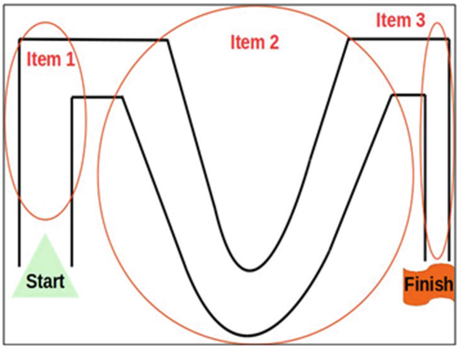

Fig. 3. SPHERO circuit

Additional goals to the main one, access to technology, can be obtained in this workshop:

- Motor skills. Controlling the robot by turning the cube in five different positions makes CUBOT an excellent tool to improve fine motor skills.
- Dissociation. In some cases CP people have problems in the perception of their environment. They should be able to increase their external attention focus (on the movements of the robot). In the case of CUBOT the robot lights up with the same color as the face of the cube when varying the action that is active, increasing the link between action and reaction between cube and robot.
- Coordination and orientation. Understanding and distinguishing concepts like left/right or forward/backward. Robots help to treat these orientation disorders while working with visual memory and the perception of spatial relationships.
- Temporal concepts. Working with robots, the educator can help to develop the temporal perception of the patient by marking certain guidelines in the control of the robot. He can ask the user to combine movements into a determined sequence, varying the time between actions or asking the user to do it at different speeds.
- Learning colors. In the case of CUBOT, the symbol in each face of the cube is light up with different colors, depending on the action that is being executed. SPHERO has different games related to colors

4 Results

The game workshop was well accepted in the center. The game using robots increase user enjoyment and motivation more than when they only engage video games. In general all participants showed a high interest to participate in games with CUBOT and SPHERO, but SPHERO was funnier for them.

Trials with CUBOT couldn t be formalized because in general people with CP have many difficulties in hand manipulation and only two of the users had enough skill to control CUBOT but with help. It can be observed, in any case, the high potential of CUBOT design for training the attention and orientation capabilities in the user. The original idea of doing control by turning the cube or the feedback that the user has due to the use of the same color in the cube and the vehicle to connect the different arrows symbols and the type of movement are very interesting and show great usefulness.

Tables 1 and 2 shows results in the sessions with SPHERO. In this case, at least three sessions could be realized with each user. Numbers of errors and time to complete the circuit were measured. Data show that the session 1 is clearly different from the rest. In general more time was required and more errors were committed in this session while in the rest of them the numbers are stabilized. User 6 accessed to the tablet with a licornio (Fig. 4), but this did not worsen the results. User 5 and 6 were in the group with great interest in took part in the activity, they did with too much errors, but the observation showed us that they acquired more control and security in the in subsequent replays, more sessions with them are needed in order to quantify their evolution.

Table 1. Numbers of errors for session with SPHERO

User	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
1	2	1	3	1	0	0
2	1	0	2	2	1	1
3	5	3	2			
4	5	2	3	1	3	1
5	Too many errors	Too much but less that in session 1	More security in the control and less errors			
6	2	2	1	0		
7	Need help but wants to do more sessions	Improve a little with help	Does it alone but with too much errors			

Table 2. Time for session with SPHERO

User	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
1	1 m 35 s	50 s	1 m 11 s	58 s	1 m 38 s	1 m
2	1 m 13 s	42 s	1 m 3 s	39 s	39 s	46 s
3	2 m 6 s	40 s	48 s			
4	1 m 12 s	50 s	38 s	1 m 11 s	55 s	44 s
5	1 m 30 s	52 s	52 s			
6	1 m 14 s	1 m 25 s	1 m 53 s	50 s		

Other aspects to be into account are the joy and willingness of users because they were accomplishing the proposed challenge. The feeling of being able to bowl without help was very fulfilling for them. They challenged each other and compare their results.

Fig. 4. An user control SPHERO with a licornio

5 Conclusion and Planned Activities

In the CP population, the use of small robots is a good option in activities using for develop skills related with technologies familiarization. Improvement in motor skill, coordination, temporal concepts is also reached. Games with family and friends enhance social relationships.

User acquire security and understand the control of this kind of robots in a short time, so they don t bored during the learning time and don t feel frustrated with the new technology. For people with CP, CUBOT has difficulties due to the needed control with the cube; an alternative can be adding another kinds of control it. An application for tablet expands the range of users. The use of color and vibration could be added to the application as reinforcement techniques in the same way as it is done with the cube.

More sessions must be developed in order to reach the initial objectives. On the other hand, therapist evaluation must be supported by objective scales that measure changes in users skills.

This kind of robots could be a good alternative for other kind of population; one clear case is the group with Autism Spectrum Disorder or ASD. These disorders have in common a significant alteration in three development areas: social-emotional skills, communication and interaction with people and restricted repertoire of interests and behaviors, usually accompanied by sensorimotor impairments. Working with a robot encouraged the patient to unfold with more simple rules than the reality ones; this reduces the confusion and the different sensory distractions of the real world that may be able to cause insecurity and anxiety. Exist several studies in this area of work between children with ASD and robots, most of them are centered in social-emotional skills [9, 10] and using high cost robots.

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