Dance Mat Fun - A Participatory Design of Exergames for Children with Disabilities

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Abstract. Physiotherapy can lead to a long and tedious process where the progress of rehabilitation is usually not immediately visible. Exergames introduce a fun factor to the therapy while keeping rehabilitation as the primary goal, promoting patient engagement to foster adherence to therapy. This paper presents a participatory design of exergames for children with disabilities. We intended to explore the interaction with dance mats as a means of promoting rehabilitation and therapy adherence using a fun and low-cost off-the-shelf device for interaction. The games are designed to be adaptable, with different degrees of speed, difficulty and modality. Using the mat, the children can play standing up, seated or laying down. We worked with a rehabilitation clinic center for children to create a suite of exergames following a design thinking methodology, benefiting from the collaboration between developers, therapists, and patients. Therapists and children participated actively in the process design to help us create games suited to their needs. We present the participatory design process with focus on the user study that provides important insights on what works for certain groups of children with disabilities.

Keywords: Exergames · Physiotherapy · Children with special needs · Participatory design · Low-cost controllers · Dance mat

1 Introduction

Traditional therapy must be repeated for long periods, leading to patients that may become demotivated and lose focus on the therapy program [9]. Therapists are always in need of tools that can help them mask this repetitiveness, making it important to research ways of keeping the patients motivated and engaged in

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the therapy. It is known that motivated patients spend more time and effort into promoting their recovery [14].

By combining video games with physiotherapy, therapy sessions can be more motivating [12] and accessible without a significant increase in healthcare costs. Al-Nasri and Salim [1] describe two main issues with physiotherapy adherence: (1) the barriers patients face that lead to non-adherence, from low levels of physical activity before physiotherapy to depression and poor social support; (2) the lack of adoption of new technologies that could encourage intrinsic motivation for adherence in patients. Al-Nasri and Salim [1] claim the lack of adoption of new technologies for physiotherapy is more apparent than in other health sectors since the nature of rehabilitation requires hands-on applications, where clinicians need to be able to control parameters such as speed, duration, and difficulty.

Creating games for children with disabilities may generate particular challenges that are easier to address by employing a participatory design approach. Since typical interaction designers do not usually have a deep understanding of the children's needs, the process should always be multidisciplinary, where experts in the rehabilitation area should be involved, as much as possible, to work with the system developers to find the requirements needed and design the solution to achieve the therapy goals [10,13]. A participatory design provides three main benefits [15]: 1) a better understanding of problems, 2) the building of realistic expectations in target groups, 3) the empowerment of marginalized groups by giving them a stake in the technology design, giving them with a sense of ownership and control over shaping one's own environment.

In this paper, we present research work focused on exploring the creation of therapy-oriented games under a participatory design setting, as a research goal. We enlisted the collaboration of therapists from a clinic with deep experience and expertise on developmental disabilities - a group of lifelong conditions caused by an impairment in the physical, learning, speech, or behavior areas. Children diagnosed with such disabilities typically require therapy, or other services, to address behavioral and developmental challenges [30].

As a second research goal, the team decided to explore the use of simple, yet motivating, interaction devices like a dance mat (similar to the one from Dance Dance Revolution[1]). The mat has distinct characteristics that make its usage very flexible, as it can be displaced horizontally on the floor (Fig. 1 (left)), where it can be used with feet, hands, and even the body, or vertically on a wall (Fig. 1 (right)), to be used with the hands, for instance.

Therefore, we have applied a design thinking [8] process in which the therapists participated actively in the define, ideate and test stages. The partnership produced four exergame prototypes that can be played with the dance mat and have several adjustable parameters to be more adaptable.

The paper is organized as follows. Section 2 contextualizes the background and related work. Afterwards, we present our participatory design approach in Sect. 3. A first user study appears in Sect. 4 and results are discussed in Sect. 5. Finally, conclusions and Future Work are summarized in Sect. 6.

[1] https://www.konami.com/amusement/products/am_ddr/ (last access: sep 2022).

Fig. 1. Physiotherapists testing the prototypes and exploring the mat in different ways, using: (**left**) lower limbs; (**right**) upper limbs.

2 Background and Related Work

We focused mainly on the subject of therapy for children and on how others approached the task of developing serious games.

Therapy can be habilitative when the goal is to develop new skills or rehabilitative if the patient had the skills previously. Its goals are, among others, to help the patient achieve an appropriate level of functional skills for their development; lower the impact of body part impairments, and ensure that families are supplied with support and training to carry over the therapy into other settings [17].

Traditional physiotherapy programs in children with Cerebral Palsy (CP) have been shown to improve muscle strength, local muscular endurance, and overall joint range of motion. A program [25] of progressive resistive exercises is used to improve muscle strength, while a program that uses low resistance and more repetitions will enhance local muscle endurance. To maintain and improve joint mobility, patients need to repeat several passive range of motion exercises, and to prevent joint contracture, patients also need to stretch. Traditional occupational therapy has also been used to improve fine motor skills and the use of the upper limbs to increase the ability to perform daily living tasks. Occupational therapy also empowers children with the knowledge and skills they need for self-care and information processing [25].

Despite its benefits, low motivation and engagement with therapy are very common problems. Pervasive computing technologies can make play-based occupational therapy more effective by embedding digital technology into playful activity [22]. In occupational therapy, an effective means to motivate a change in a child's behavior is by designing playful activities that leverage the child's desire to play. Video games designed specifically for rehabilitation can do the work without adding significant costs to both the healthcare system and patients [5].

Moreover, the use of participatory design [4,18] is important to have a wider discussion about different aspects and perspectives on what a solution should be. The integration of experts in the design team can be used to leverage their knowledge to create a more meaningful experience to the players, as Thompson et al. [28] report in their article about how behavioral science guided the design of a serious video game to prevent Type 2 diabetes and obesity. The final solution should be the result of an iterative process involving different actors, such as, therapists, children, parents, designers and developers.

Exergames can be an important component for the rehabilitation process, but aspects, such as, Fun vs Effectiveness, Variations of Exercise, Goals, Positive Feedback and how to present Negative Outcomes should be considered [2]. Burke et al. [9] identified two main principles of game design to be very important in the development of serious games: meaningful play and challenge.

Meaningful play stems from the relationship between players' actions and the system's outcome. The actions must have feedback when performed to give players the awareness they need regarding their choices. In rehabilitation games, the feedback [29] should take into account the difficulties patients playing the game might have. Failure should be handled more conservatively with an initial focus on increasing engagement and then rewarding players with success. Correct identification of failure can also be used to teach players by making them reconsider strategies [27].

Challenge is closely related to the difficulty of the game objectives. Generally, starting with a lower level and gradually increasing throughout the game according to the player's ability. A balanced experience has shown increased motivation and higher perceived levels of fun and fairness, even when players compete against each other [19,20].

A study [11] comparing exergames designed for individuals with autism spectrum disorder (ASD) with commercially available ones, on their performance as a tool for supporting visual-motor coordination training, showed exergames designed for individuals with ASD excel in many aspects when compared to commercial games and provide an overall better experience for the players. Another study [21] developed two games using the dance mat and reported balance improvement on patients with CP.

Games for rehabilitation have to be prepared to adjust their parameters according to the patients' difficulties. After an evaluation from the therapist, the game speed could be adjusted to set its pace [6]. The position of objects could also be adjusted to account for different ranges of motion, making the game's difficulty more appropriate for a specific patient. It is always better to have a conservative starting difficulty when the user is being introduced to the system to minimize the risks of failure.

Despite their limited motor capacity, children with cerebral palsy still want to play action-oriented games similar to the ones played by their peers without motor disabilities [16]. Through a year-long participatory design process with children with CP, researchers have found that it is, indeed, possible to develop such games for children with disabilities. However, they also recognize that using what they call "traditional guidelines" can still be the correct choice for some kinds of games, such as those focusing on stretching and balancing actions where the goal is not to encourage cardio-vascular exercise. Following those guidelines will also make the user group that can benefit from the games as large as possible. The guidelines are as follow: avoid fast pace, do not require precise timing, provide a simple control scheme, do not require multiple simultaneous actions, avoid repeated inputs (button mashing), and automate the player's input.

3 Participatory Design of Rehabilitation Exergames

We employed a design thinking approach consisting of five different stages: Empathize, Define, Ideate, Prototype and Test [8]. We had the active collaboration of therapists (experts) from a clinic with deep experience working with children with different disabilities. Their integration in our design team allowed us to leverage their therapy expertise to create more meaningful experiences.

The **Empathy** stage of the process was already taken through previous collaboration on different projects, mainly "just Physio kidding" [23], which is a solution based on the use of serious games with Kinect-based natural user interfaces and personalisation. In the **Define** stage, the team focused on discussing and selecting the therapeutic exercises that needed motivational support to be executed by children, like repetitive reaching exercises or the ones that require moving to different positions to train mobility and balance while standing. It was established that therapists sometimes used commercial games in their sessions, but these were often hard to adapt to their patients' capabilities and did not allow them to collect relevant data to measure progress. Therefore, they would like to see exergames where they could still use off-the-shelf controllers but have more control over the game parameters. They considered the dance mat a great controller to explore due to its possibilities regarding different therapeutic exercises' dimensions, because of its ability to, not only, be used as a stepping mat, but also be folded or hung on a wall, for example.

Reaching the **Ideate** stage, we had brainstorming sessions with the therapists to understand how we could build games that benefit the therapy of children followed by the clinic. When possible, we also asked children what themes they enjoyed to make the games more appealing. We settled on a game suite where children would have to use body movements to control the games so it would be possible to train balance and mobility. The idea of having different games would also allow us to test which kind would be more suitable for the children at the clinic and their characteristics. If games had an element of symbol/pattern recognition, they could also be used to train focus and stimulate cognitive function. Again, we found the dance mat could satisfy these requirements while being very affordable, easy to use, and requiring no calibration, unlike other sensors like the Microsoft Kinect.

With the suggestions and ideas collected in the define and ideate steps, we initiated the development (**Prototype** stage) of four prototype games. They were called "Matchmat", "Left or Right?", "Crazy Car" and "Fishing". With the dance mat being a simple interaction device, all games follow the same interaction principles with varying degrees of complexity. We tried to integrate different

Fig. 2. Top Left: Depiction of *Matchmat*; **Top Right:** Depiction of *Left or Right?*; **Bottom Left:** Depiction of *Crazy Car*; **Bottom Right:** Depiction of *Fishing*

game modes and input layouts that would allow the games to be more suited to a higher number of patients depending on their physical and cognitive strengths. In every game, it is also possible to adjust parameters, such as, speed, button and obstacle placement, a.o., as required by the therapists. The games had a first iteration as proof of concept, with simple 2D visuals to allow the therapists to see the dance mat interaction in person and test it with two children. After this small test session and getting their approval, a more developed version of the games was created (Fig. 2) with updated 3D graphics, and better visual and audio feedback because the children had found the previous design boring.

Matchmat (G1): Matchmat shows a representation of the dance mat on-screen with a human character in the middle that the children can recognize as a reference. Buttons will show up on the screen for a limited time, with their virtual positioning matching the one in the real world. There are two modes in this game, one where only the correct button is displayed and another where all the buttons are always shown on the screen, with the correct one being highlighted with a red animated square. This way, children will have an easier time identifying which button to press and can train the matching between real-world positioning and the visual representation of the buttons, as well as having to use real-life movements to reach each button. ***Goal:*** Improve equilibrium, Real-virtual visual matching, Mobility.

Left or Right? (G2): Left or Right? Is a more complex variation of Matchmat. There are two colored squares on the screen with a symbol representing the left and right feet below them. When a button appears on the red square, the patient must press it using their left foot. When it appears on the yellow button, it must be pressed with the right foot. In this game, the children no longer see the whole

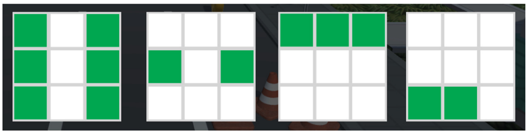

Fig. 3. Dance mat controller layout options for *Crazy Car*. Highlighted squares represent the buttons used to play the game (from left to right: V1, V2, V3, V4).

representation of the mat in the virtual space. They must not only recognize the symbol and find its position on the mat but also decide which is the correct foot to use. ***Goal:*** Improve Equilibrium, Real-virtual visual matching, Mobility, Limb laterality recognition.

Crazy Car (G3): Instead of having to match symbols shown on the screen, this game is an "endless runner" style game where a car continuously moves forward. The patients must use the buttons on the mat to dodge obstacles placed on the road. For more adaptability, this game offers four controller layouts that allow the game to be played while standing, sitting, or possibly, laying down. The control layouts (Fig. 3) use button presses to make the car switch lanes, with variations V1, V2, and V4 using the buttons on the left and right sides of their layout to move the car in the respective direction. Variation V3 matches each button from the first row of the mat to each of the three lanes the car can occupy, allowing to move instantly between lanes. ***Goal:*** Improve Equilibrium, Real-virtual visual matching, Mobility, Reflexes, Decision making.

Fishing (G4): Fishing is harder to play because it requires a higher cognitive capacity. The grid representation of the mat is not visible on the screen, and no buttons appear in this game. Instead, a fish will appear in a around the player character in a zone that represents a position on the mat. The patients must then understand in which position the fish is in relation to them without the help of any other visual cues, like they had in the previous games, and press the correct button. Once they press the correct button, a mini-game is triggered where they must counter the movement of the fish by going left or right on the mat to catch it. ***Goal:*** Improve equilibrium, Real-virtual visual matching, Mobility, Situational awareness.

4 User Study

In the **Test** stage of the design, we ended-up conducting a user study focused on testing the usability of mat-controlled games and how children with different disabilities would be able to interact with them. The therapists did a pre-selection of children they considered able to use the system at the clinic. We were able to achieve a sample size of ten participants with varied diagnostics and abilities, which allowed us to test the mat in different ways. In Table 1, we can see these characteristics which include, for the patients with cerebral palsy, the Gross

Table 1. Diagnosis and Characteristics of the patients that tested our system.

ID	Diagnosis	Characteristics
P1	Spinal Muscular Atrophy - Type I	General muscle weakness. Restricted amplitude of movement (mainly elbows, knees, and hip)
P2	Articulation and Phonological Disorders	Neurotypical development
P3	CP - Spastic Diplegia	GMFCS II. Able to walk, run, and climb stairs with the support of a railing. Difficulty jumping and balancing on one foot
P4	CP- Spastic Tetraparesis	GMFCS IV. Higher function with the upper left limb. Limited amplitude of movement of knees and hip. Able to roll independently. Slight cognitive deficit
P5	CP- Spastic Tetraparesis	GMFCS IV. Able to roll with assistance and remain seated with the support of the upper limbs. Difficulty dissociating lower limbs. Cognitive deficit
P6	CP - Spastic Diplegia	GMFCS III. Lower limb constraints and difficulty maintaining balance while standing without support. Can perform all posture transfers but with a higher risk of falling. Prefers to stand with flexed knees and hip. Slight cognitive deficit
P7	CP - Left Hemiparesis	GMFCS I. Bigger upper limb constraints and difficulty maintaining balance while standing on one foot. Able to walk, run and climb stairs without assistance
P8	Global Developmental Delay	Lack of motor coordination and planning
P9	Autism Spectrum Disorder	Difficulties with information processing and motor planning. Difficulty performing the same activity for long periods
P10	Autism Spectrum Disorder	Difficulty focusing and managing frustration. Slight trouble with motor planning

Motor Function Classification System (GMFCS) [24] level. This is a I to V scale where V means less mobility. Participant P6 was a female, and the other nine were males. The ages ranged between three and eleven with a median of 7.5. All tests were performed with parental consent. Before each session, the children were asked if they wanted to participate and the therapist assessed how comfortable they were in the process. Testing was done over the course of two weeks, and we only had limited time with each patient. Our testing sessions had to be done during small time windows that coincided with the time patients went to the clinic for their regular therapy sessions without disrupting their treatments.

Fig. 4. Left: The mat can be folded to allow children with very limited mobility to play using elbows; **Right:** Child using Pilates ball to play a game while laying down.

Children with severely limited mobility could only play the endless-runner game while sitting down (Fig. 4, Left), supported by the therapist. The mat was placed over a table to allow them play using the elbows. Another option for children with trouble standing and maintaining balance was laying over a Pilates ball (Fig. 4, Right). That allowed them to roll with it and reach every button with the help of a therapist.

At this stage, our main concern with this first evaluation was to assess the children's acceptance of the system and the therapists' enthusiasm for using it in their therapy sessions. Due to the many different ways in which the children at the clinic were affected by their respective disabilities, the studies can not be as standardized as when working with neurotypical children with normal motor function. We decided our approach with this study would be to test the usability of mat-controlled games and how children with different symptoms would be able to interact with them. We also wanted to assess the degree of success they would have in their interactions and if we could establish some kind of patient profile that could benefit more from these games.

We found that the Fishing game was not adequate to use with the children because it was hard for them to recognize the place of the fish and press the correct button. Also, in some cases, since the character used for reference, at the center of the screen, always turns to face the fish, some children were inclined to always press the button representing the "front" position. For these reasons, we focused only on the first three games when moving forward with testing.

Therapists showed interest in the system from the start and looked forward to seeing the potential of its integration into the children's therapy sessions.

5 Results and Discussion

Given the nature of our users and their very different characteristics, we believe achieving a sample size of ten was good and allowed us to test the mat in different ways. Each child went through each game, and we logged which ones they were able to play and which variations did they play. We also registered if they needed active support to play the game and collected data, sent in real-time to an external platform [3], from each game execution.

Fig. 5. Visual Likert scale used to help children answer the questions.

A questionnaire was set up to be answered by both the therapists, and, when possible, by the children after each session to assess their thoughts and suggestions about the proposed solution. The first set of questions was directed at the children, using a simplified System Usability Scale (SUS) [7] where the questions were adapted to a younger audience [26] to get their direct opinion about the games and their overall experience with the system using the support of a visual representation of the Likert scale (Fig. 5).

The second set of questions, also using SUS, was directed at the therapist that accompanied the child during the game session. The SUS questions were directed to the specific interaction of each child with the system from the therapist's point of view. Since the therapists were always involved in the development process of the system and given the many variable patient characteristics, our goal with this questionnaire was not necessarily to attain a high score with the SUS. Our interest was in using the SUS structure to understand how children with different disabilities would interact with the mat and their motivation to do so. Then, on the side of the therapists, we wanted to see if exergames designed to be controlled with a dance mat could have a role in the therapy regimes of their patients.

Regarding the first set of questions, out of the ten children, only two didn't manage to answer the questions at all. We had SUS scores ranging from 25 to 100, averaging 68.75. It makes sense that the children that were not able to play the games as intended or didn't understand them produced a lower score on the questionnaire. But we were optimistic when seeing that the children that can play gave the system very high scores. Although it is important to note that in their enthusiasm, most children tended to rate every question with the highest score, we believe that same enthusiasm shows that they were motivated to use the system and wanted to keep playing the games.

On the therapist side the system got an average SUS score of 77.5. But we would like to focus on the statement: "I think that I would like to use this system frequently with this patient." In the context of this study, the answer to this question is the most important since even when a therapist understood the system and the child had no trouble playing the games, the therapist can consider that the system does not meet the therapy goals set for a given patient, as happened with patient P2. P2 is only enrolled in speech therapy and does not need to practice the kind of movements required by our games, so their expected usage in therapy sessions was "Unlikely", as seen in Table 2, where we grouped every child based on the therapist's answer to that statement. The table also shows each child's main constraints, GMFCS level, when applicable, if they needed support to play the game, and the results for each game played.

Table 2. Expected usage of the system by each patient in their therapy sessions with their respective game results. Total error Manhattan Distance (MD) for game G1 and G2, and play time for G3.

Expected Usage	ID	Main Constraints	GMFCS	Needs Support ?	G1 MD #	G2 MD #	G3 Time (s)
Frequent	P6	Lower limb movement & balance	III	Yes	80	-	26
	P7	Balance & right upper limb	I	No	2	4	17.6
	P8	Motor coordination & planning	-	Yes	44	-	12.3
	P10	Autism Spectrum Disorder	-	No	0.5	8	29
Occasional	P3	Balancing & jumping	II	No	3	4	27
	P9	Autism Spectrum Disorder	-	Yes	49	-	18.5
Unlikely	P1	General weakness & joint movement	V	Yes	-	-	53.25
	P2	Neurotypical development	-	No	2.6	6	42.8
	P4	Severe lower limb limitations	IV	Yes	-	-	54.2
	P5	Severe lower limb limitations	IV	Yes	-	-	25.3

We observed that children with a higher GMFCS level and, therefore, less mobility are less likely to be able to play the games using the dance mat and, as expected, require more active support from the therapists. Especially when they also suffer from cognitive disabilities. For the patients on the autism spectrum, the bigger challenges were having them interested in the games for long periods and the abstract perception of the connection between the button pressed on the mat and the movement of the car, but the therapist accompanying them believed these were all aspects that could improve in subsequent sessions as the children got more used to the games, and that the style of the games developed could be useful to train their focus.

For each game we collected data that was considered to be relevant to evaluate patient performance. For "Matchmat" (G1) and "Left or Right?" (G2), for each button that the child presses we save which button was pressed and the timestamp for that action, how much time the button was held, if it was the correct button, and we also calculate the Manhattan Distance (MD) of the button pressed to the target button. For the purpose of this paper we focused on the last stat as our success measure, the shorter the total Manhattan distance is, the better the child performed at the game. For the "Crazy Car" (G3) game, since the goal is to dodge obstacles for as long as possible the metric for success is the game play Time (s), the longer the better, but we also save each button pressed with an associated timestamp.

Because of the size of our sample, it is hard to make general assumptions about the collected data. Even so, taking another look at Table 2, we can see the average results each patient got in the games they played. In the column for Manhattan Distance (G1 MD#) of the "Matchmat", we can see that the values vary greatly from patient to patient and that the ones with more mobility constraints could not play it. Each of the abnormally high values are justified for a different reason for each patient. For P6 it was her slight cognitive deficit and even when she recognized the correct button, since she was playing while laying on a Pilates ball, she preferred to press the buttons closer to her because she didn't feel like stretching to reach buttons further away - this was one the aspects of her condition that therapist felt could be improved with the games. When his session started, Patient P8 was not very interested in playing the games and wanted to be held by the therapist leading to poor cooperation in the "Matchmat" game. Patient P9 was someone who had trouble processing new information and had trouble making the connection between the mat and computer screen. He was also much more interested in playing with the computer.

Only the four patients that managed to play "Matchmat" correctly were able to play "Left or Right?". We can see in the G2 MD# column that the Manhattan distance remained within understandable values, despite raising slightly. This was the result we expected since the interaction method is practically the same but the visual representation is a little more complex.

Finally, the last column of Table 2 (G3 Time (s)) present the time each patient managed to play the "Crazy Car" game without hitting an obstacle. The reason we some patients with less mobility achieving better results is because the patients with less mobility were playing the games, sitting down, with excessive help from the therapists accompanying them, which to a certain degree would nullify the benefits of having the child play the game. That is also one of the big reasons therapists said it is unlikely that they would be interested in integrating the games in the therapy sessions of these patients. Regardless of that, both the development and the expert team are optimistic with the obtained results and look forward to continue exploring this co-design process.

Analyzing patients P6, P7, P8, and P10, we observe the system was more suited for children that retained some mobility in at least one group of limbs. These children can harness more potential from the mat because they do not require a level of assistance that would essentially have therapists playing the games for them. It is obvious that children with typical cognitive development understand the games faster and better, but patient P6 shows that having a slight cognitive deficit is not an obstacle to interact with the games, as long as they can understand and recognize shapes, which is something they might even train while playing by having to recognize the symbols on screen repeatedly.

The different ways the children interacted with the dance mat also showed us it is a versatile game controller capable of adapting to the different needs of patients. The dance mat can act as a very flexible controller that can be used in a myriad of ways at a very affordable price, which would allow the parents to easily get one and help their children play the games at home. This expands the places where the system can be used, which can only benefit the end-user.

The participatory design based on a design thinking approach gave us valuable insights on the creation of exergames for children with disabilities using a dance mat, which can be summarized in the following main guidelines:

- Usability: The games can be used by children, who find the experience positive, and the therapists identify they might be mostly useful for children with motor and balance constraints. Therapists also consider the game to be able to potentially train focus in occupational therapy.
- Flexibility: The dance mat is a very robust and flexible controller, being important that the games can be highly configurable for each child's needs.
- Feedback: Whether positive or negative, it is one of the most important parts of the game. The patients must understand if they are performing the actions correctly and feel they are progressing.
- Tracing: Therapists want to register the progress and observe the history of the patient. It is also important to have an online platform to offload the burden of managing records from the game designers.

6 Conclusions and Future Work

In conclusion, throughout every stage, the therapists were very interested in this collaborative process. The participatory design allowed the developers to create a product that may prove to be useful to therapy in further studies. Going forward, patient selection must be done in a careful way to make sure children are not frustrated when playing the exergames. In general, every child seemed enthusiastic to play the games using the dance mat, but therapists believe the potential therapy benefits could only be harvested by children with a GMFCS level III, or lower, or with other children that retain some level of independence of movement in the upper and/or lower limbs.

The integration with an external framework [3] will be further explored to make use of the provided tools allowing real-time update of game settings and managing game result recordings. Finally, we must conduct a thorough evaluation with children from the clinic, but also with therapists and children from other clinics, who did not participate in the design.

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