Mobile Activation Games for Rehabilitation and Recreational Activities

Exergames for the Intellectually Disabled and Older Adults

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***Abstract*- Social isolation and lack of exercise have become serious problems that people face in assisted living conditions. One of the reasons is a lack of resources - funds and professional staff. In this paper, a new recreation and self-rehabilitation tool – a mobile exergame - is developed to provide a partial solution to the problem. Mobile exergames are played with a mobile phone by body movements, thus providing both physical and mental exercise. The games were tested with groups of older adults and people with intellectual disabilities, and tailored for these particular user groups. The gaming situations were followed by the researchers and members of the professional staff. After the gaming events, the test groups and the members of the professional staff concerned were interviewed in order to obtain background information on the participants and their experiences with the games.**

Both user groups responded well to the games. The results of the test event for persons with learning disabilities imply that the game events provided a new recreation session: a social event with light exercise and cognitive stimuli. Likewise, the older adults' overall experiences of mobile phone controlled gaming appeared to be a successful experiment, offering a potential tool for self-motivated rehabilitation and recreation. However, further development of the exergame concept will require dedicated collaboration with game designers, health care professionals and the user groups.

Keywords- Recreation; Rehabilitation; Older Adults; Intellectually Disabled; Exergames; Mobile Technology

I. INTRODUCTION

Obesity has become a serious problem in modern welfare states due to unhealthy diet and lack of exercise. The problem occurs among healthy adults who could control their eating habits and physical exercise. The situation is even more difficult in the case of intellectually disabled people who might not be able to motivate themselves or understand the benefits of healthy eating and regular physical exercise, or might be due to a general lack of opportunity to be physically active. In addition, they might have physical disabilities that prevent hard physical exercise. Similarly, older adults may suffer from mental and physical impairments that may impede physical exercise [3, 4].

Social isolation is another serious problem for these groups of people. Older adults as well as the intellectually disabled may require increased health care for both mental and physical problems, many of which derive from social isolation and lack of activity. Participation in various activities helps older adults feel better and healthier as they recognise their ability to move and create something significant in the way of health [3]. According to a recent report, moderate but regular exercise may be just as helpful in combating serious depression in older people as antidepressant medication [4]. On average, compared with someone with the lowest activity level, the risk of Alzheimer's disease is relatively lower for those whose frequency of activity is highest [5]. Despite knowing the positive effects of cognitive stimuli and exercise, the human resources for rehabilitation and recreation are limited. On the other hand, this creates opportunities in assistive technological innovations. Because intrinsic motivation is heavily influenced by hope for success and fear of failure, appropriate challenges will be most likely to result in appreciation of the technology [1, 2, 4].

Research on developing and evaluating virtual reality systems among adults with systemic disabling conditions has been increasing [5, 6]. The studies involve research subjects (e.g., stroke survivors) engaging in therapeutic exercises, sports and leisure activities and/or functional tasks within a virtual environment. This line of research has shown potential in improving health and functional capacities. However, high costs and the required expertise in operating virtual reality systems have impeded its distribution in clinical rehabilitation practices [7, 8, 11].

Simple video games may offer a solution to the cost problem. Findings from scientific research studies show that playing general video games can improve an individual's level of pleasure, alertness, dominance and, therefore, generic state of experienced well-being [1]. Older adults and the intellectually disabled could also enjoy a computer gaming experience [2, 13, 4, 14, 15, 16]. It is reported [15] that robotics, interactive devices and computer games, as well as interactive collaborative environments, may represent a unique opportunity for physically, visually or hearing impaired children, and for emotionally and mentally handicapped children to get fully engaged in playing and having fun. Similarly, in the case of older adults, video

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games that are simple and easy to play are well accepted and have been found to create positive feelings and enjoyment [4, 16, 23].

On the other hand, a fairly strong relationship between the time spent playing electronic games and people's weight status has been found [12, 13, 24]. This is why exercise games (=exergames) combining gaming and physical exercise are being developed. Game console manufacturers provide exergames and special game controllers or additional equipment to control the games. However, the situation with the elderly is that game consoles and commercial games may feel childish and the threshold for buying such equipment is rather high. In addition, the commercial game versions are overly visualised and fast-paced, and, therefore, might be seen as distracting and too challenging by elderly or intellectually challenged people. In this study, another approach of using a game platform without any special game consoles, designed with simple graphics, adjustable game intensity and levels of difficulty was developed for these user groups. It is also known that acute cognitive benefits, such as temporary improvements in concentration, can result from as few as ten minutes of exercise [21]. Gao et al [22] discovered the acute cognitive benefits of a casual exergame that were demonstrated in significantly improved performance on two cognitive tests that required focus and concentration. Therefore, it is reasonable to believe that exergames could help in preventing and delaying cognitive impairment in older people, and in preventing impairment of motor skills. In the case of mentally challenged people, the games may offer tools for entertainment, improve motor and perception skills, and encourage participation in social activities [1-5, 13].

In general, the games should correlate with the physical condition of the player as well as their skills to achieve the so-called "flow feeling".

Games are designed to generate a positive effect in players and are most successful and engaging when they facilitate the flow experience [18, 20, 26, 27]. Csikszentmihalyi [9] introduced the flow state through the study of people involved in activities such as rock climbing, playing music, chess and dancing. 'Flow' describes a state of complete absorption or engagement in an activity and refers to the optimal experience [10]. During the optimal experience, a person is in a psychological state where he or she is so involved with the goal-driven activity that nothing else seems to matter. The activity producing such experiences is so pleasant that a person may be willing to do something for its own sake, without being concerned about what to get out of it. Theoretically, the flow consists of nine dimensions, but immediate feedback, sense of control, loss of self-consciousness, clear goals and the challenge-skill balance dimension in particular provide a meaningful approach with which to embody engaging elements into exergames used in activation.

In exergames, the challenge-skill balance and sense of control dimensions need to be considered from both the cognitive and physical perspectives. The dual flow model forms the foundation for this consideration [24] and provides the theoretical basis on which to optimise the engagement and effectiveness of exergames. Recently, Kiili and Perttula [26] argued that the team-based gameplay facilitates flow attainment in exergames, and they added a team flow aspect into the dual flow model (Fig. 1).

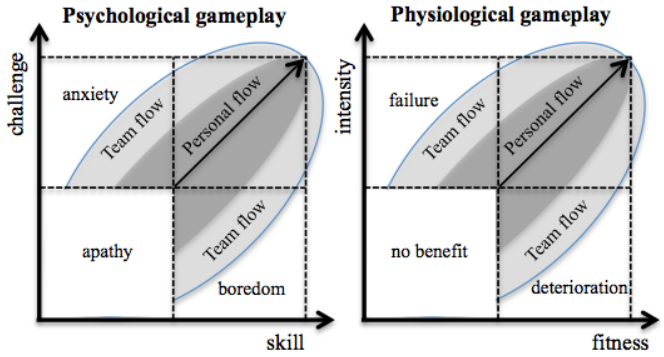

Fig. 1 An extended dual flow model for exertion games (modified from Kiili & Perttula, in press [26])

According to the extended dual flow model, if the cognitive challenge is too low, a player tends to feel boredom, and when the cognitive challenge is too high, a player tends to feel anxiety. Neither of these states is stable since every time the player tends to feel either boredom or anxiety it motivates him or her to strive for the flow state in order to regain the feeling of enjoyment. Similarly, the intensity-fitness balance determines the effectiveness of the exertion. If the game is too intensive, a player will fail to play the game and be unable to continue exercising. On the other hand, if the intensity is too low compared with the player's fitness level, the player will enter a state of deterioration. This dynamic feature explains why flow activities lead to growth and discovery. In general, the challenge of the game design is to keep the player in a flow state by balancing the cognitive and physiological aspects of the game: the optimal exergaming experience can be achieved when both the psychological and physiological aspects are in balance and the player is in the flow zone.

The balancing of workloads and adaptation to the player's characteristics are very challenging because, for example, the cognitive workload (psychological game play) is composed of several factors, such as the number of game elements, the number of players, the number of possible movements, the complexity of the rules, the type of audio-visual implementation,

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the game tempo, etc. [25]. Furthermore, the fitness and sensomotor aspects create more challenges for the designers. It is evident that the balancing of cognitively demanding exergames is not as straightforward as the balancing of traditional computer games. The basic balancing principle suggests that the difficulty level of a game can be gradually increased because it is assumed that a player's skill level increases with playing time. Such an approach does not work properly in cognitively demanding exergames. Even though a player's skills may increase during playing, the gradually increasing intensity will finally lead to exhaustion and failure in lengthy playing sessions. To overcome this problem, Sinclair, Hingston & Masek [24] suggested that exergames should adapt dynamically to a player's performance, or they should be based on simple mechanics that focus more on input devices and exercise movements than on complex game play.

Two exergames that utilize the personal flow experience are discussed in this article. One (the red-cube-chase game) is targeted at older adults and is presented in more detail in the article by Sirkka et al [4]. The other (the catch-the-cheese game) is targeted at intellectually disabled people and is only introduced in this article. The main purpose of these games is to activate physically, to give cognitive stimuli, to activate socially and to entertain people with restricted physical activities. The focus is especially set on user experiences and game designing for these user groups with special needs [4, 15, 17, 19]. The purpose is to investigate the game design challenges related to the two different user groups, to compare their adaptation to the games (attractiveness and usability), and to analyse the user groups' attitudes to mobile activation games. The ultimate goal of this kind of game design is to create tools for recreation and rehabilitation of the elderly and intellectually disabled, and through this to improve their sense of wellbeing.

II. GAME PLATFORM AND PROTOTYPE GAMES

The equipment required is a cell phone with integrated acceleration sensors and a computer. Communication between the cell phone and the computer is handled over the Internet (Fig. 2).

When designing the games, one of the goals was to produce a multiplatform game that would make playing possible. HTML5 markup language was used in the game construction. To be precise, the game was built purely using JavaScript, enabling the application to become as light to play as possible; all major browsers support JavaScript and its HTML5 canvas element. The canvas element allows the drawing of any desired shapes and importing of any eligible images, and it is fairly easy to build the collision detection that is important in all games.

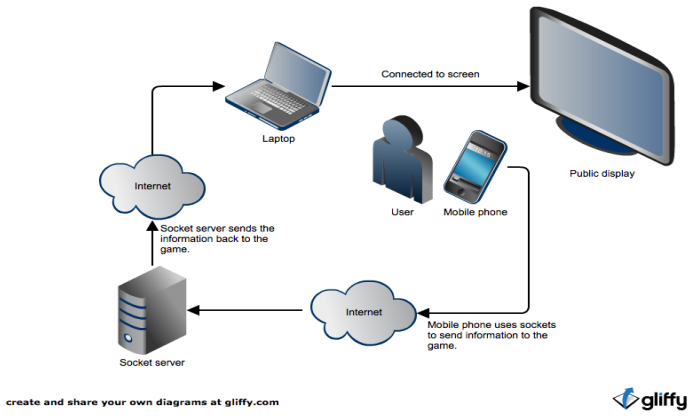

Fig. 2 Game platform and communication between the game and the controller (Image is made with Gliffy)

The game controller to the cell phone was built using Android's own SDK and PhoneGap. PhoneGap was a good choice for the cell phone application development as it supports HTML5 and JavaScript, and allows the use of the same code for a variety of cell phone platforms. PhoneGap also provides the possibility to create customised plug-ins and enable access to sensor data through self-made custom plug-ins.

The Android platform was used to provide free development documentation and application generation. In addition, the socket connection being fairly simple to use in HTML5 provides an option to play multi-player games seamlessly and was used to exchange information between the game and the controller.

The communication between the cell phone and the Internet browser requires idle-free connections. If the game on the browser reacts to phone movement too slowly, the game becomes unpleasant to play. A socket server (in this case Node.js) provides a fast and accurate way to send data constantly between two or more devices.

A. The Catch-the-cheese Game for the Intellectually Disabled

The principles in generating mobile games for physically or mentally impaired people are easy logics, easy-to-play and ubiquitous playability. Since both of the games experimented in this paper are a product of the WTAL (wireless technologies in assisting autonomous living) project, they are able to deploy the wireless technology available in cell phones. Modern cell phones provide a variety of sensor data identifying the movement and positioning of the cell phone.

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The idea in the Catch-the-cheese game is to control the mouse with a mobile phone and collect as many chunks of cheese as possible in a three-minute period. After the three minutes, the time is up and the player's points are collected into a top score list in the top right-hand corner of the game screen, as shown in Figures 3 and 4.

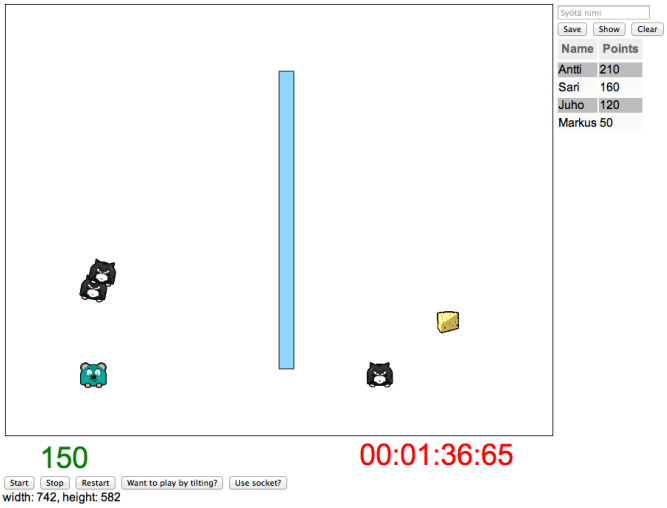

Fig. 3 The Catch-the-cheese game screen. The blue mouse is controlled via the cell phone
The idea is to collect the cheese and avoid the cats

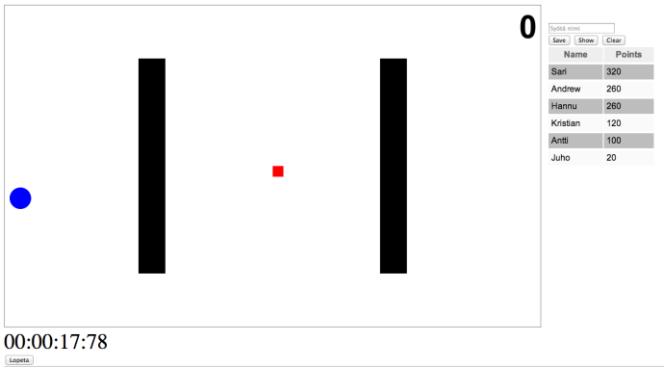

Fig. 4 The Chase-the-square game screen. The blue ball is controlled by the player and chases the red square

At the beginning of the game there are no opponents. The first opponent, being a cat figure, joins the game after the mouse has collected 50 points (5 chunks of cheese). The cat follows the mouse's movements constantly. This puts a little more difficulty into the game. The next cat joins the game after 100 points are collected. At the same time, the first mouse becomes faster and therefore harder to catch. The last opponent joins the game after 150 points, and all of the cats gain more speed, making the game more challenging.

In the middle of the screen is a blue bar. The bar is an obstacle that has to be overcome. The player can trick the cats into moving to the other side, but that makes the playing area more limited and every move must be considered carefully (especially if all the cats are on the same side as the chunks of cheese).

III. THE CHASE-THE-SQUARE GAME FOR OLDER ADULTS

The second game, the Chase-the-square game, is quite similar and is a simplified version of the Catch-the-cheese game. In the Chase-the-square game there are no opponents to disturb the play, only two impenetrable obstacles that need to be overcome. The design was intentionally simple in order to motivate those older people who saw controlling the ball with a cell phone as challenging enough. Also, extra visualisation of the design was avoided on purpose.

The game was designed in consideration of the special target groups of people with motor skill impairments. This visually clear and logically simple point-collecting game aims to practice hand or feet coordination by means of catching the red square with a blue ball (Fig. 4).

The game is controlled by tilting the cell phone. The direction of tilting controls the movement of the ball (by tilting the phone to the right, the ball starts to move to the right, and so on). The steeper the tilting angle, the faster the ball moves on the screen. Two different controlling modes were used: a) controlling the cell phone with the hands (wrist movements), and b) controlling the phone attached to a balance board by ankle and leg movements. The elderly players were seated when playing the balance board version for safety reasons.

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When using the balance board version of the game, a lunchbox was attached to the middle of the board and the cell phone was placed in the box. The cell phone constantly reads the acceleration data and sends it through the Internet to the socket server. The socket server determines where to move the character based on the given data and sends this information back to the game.

IV. EXPERIMENT

Gaming events were arranged separately for the two target groups, the older adults and the intellectually challenged people. In the game events the volunteer participants had the opportunity to play the game as many times as they wished. Professional staff members, researchers and other participants were present and following the play. The participants and the professional staff were interviewed after the events. The structured interview, which contained questions about the use of technology in general and experiences of playing the game, was slightly modified according to the target group. The professional staff members were asked for some background information on the players as well as their own opinions about the games as a tool for recreation and rehabilitation. The questionnaires are presented in Tables 1and 2.

In February 2012, a two-week period of gaming events for older adults was organised in two different service organisations in Finland. A total of 34 elderly people (70+ yrs) and 10 professional staff members participated in the experiment. In August 2012, similar gaming events were organised for intellectually disabled people in a sheltered work organisation in Finland. The total number of participants was 26 (N=26): 23 people with intellectual disabilities aged between 21 and 60 years, plus three professional staff members. In both experiments the interview data was analysed by a quantitative content analysis method that calculated the frequencies and percentages of responses to the interviewed themes.

TABLE 1 INSTRUMENT FOR THE STRUCTURED INTERVIEW - THE INTELLECTUALLY DISABLED

A) QUESTIONNAIRE FOR PARTICIPANTS – THE INTELLECTUALLY DISABLED

Gender
Age
Do you have a mobile phone?
Do you have a computer?
Do you have a game console?
Do you play/ have you tried playing video games?
Do you use any other technical devices as aids in your daily living?
How did you experience the game play situation?
What did you think about the presence of other participants in the situation?
Did you feel that you were only concentrating on the game?
What did you think about controlling the game with a mobile phone? Did you notice the mobile phone on the balance board?
Did you find playing the game entertaining? Would you play it again in your home?
Did you feel that you trained your legs during the game play?
Do you have any ideas on how to improve the game?

B) QUESTIONNAIRE FOR PROFESSIONAL STAFF – THE INTELLECTUALLY DISABLED

Does the participant have a diagnosis or any special behavioural characteristics?
Does the participant have challenges in concentration, coordination or perception skills?
Is there anything to take into consideration regarding the game play?
Is the game usable in rehabilitation, recreation and entertainment?

TABLE 2 INSTRUMENT FOR THE STRUCTURED INTERVIEW - ELDERLY PEOPLE

A) QUESTIONNAIRE FOR PARTICIPANTS - ELDERLY PEOPLE

Gender
Age
Do you experience coordination or balance problems?
Are you attending rehabilitation?
What is your opinion on the use of technical devices in general?
Do you have a mobile phone?
Do you have a computer?
Do you have any other technical ADL aids?
How did you experience the game play?
How did you feel during the game play?
What did you think about controlling the game with a mobile phone?
Did the game motivate you to move or become activate?
Is the game suitable as a tool for rehabilitation?
Is the game suitable as a tool for recreation and entertainment?
Do you have any ideas on how to improve the game?

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B) QUESTIONNAIRE FOR PROFESSIONAL STAFF - ELDERLY PEOPLE

How did you experience the game situation?
Is the game suitable as a tool for rehabilitation and/or recreation and entertainment?
Do you have any ideas on how to improve the game?

V. RESULTS AND DISCUSSION

A. Catch-the-cheese Game for the Intellectually Disabled

Background information of the participants, such as the person's age and gender, range of use, attitudes towards and experiences of technology, and special health characteristics was gathered before investigating the actual game experience. Health-related information was obtained from the professional staff. The results are illustrated in Tables 3-4.

TABLE 3 AGE AND GENDER OF THE PARTICIPANTS (INTELLECTUALLY DISABLED)

	n	%	Tot. n	Tot %
Male	16	69.6		
Female	7	30.4	23	100
Age 20-29	7	30.4		
Age 30-39	6	26.1		
Age 40-49	4	17.4		
Age 50-60	6	26.1	23	100

The age of the players varied from 21 to 60 years. The majority of the participants were male due to the fact that the majority of workers in the sheltered work were male. The majority of the participants were accustomed to technical devices and used a mobile phone on a daily basis. Less than half (n=10; 43.5%) owned a computer but over 65 % (n=15) of the participants had experienced video or computer games, of whom six (n=6) also possessed a game console. One participant (n=1) used an electronic sphygmomanometer and one (n=1) used a speaker engine. In general, the majority of the participants were used to technology, although there were some people who had no experience of any technical devices at all.

TABLE 4 FORMER EXPERIENCES OF USING TECHNICAL/ELECTRONIC DEVICES

	n	%
Owns a mobile phone	18	78.3
Owns a computer	10	43.5
Owns a game console	6	26.1
Plays regularly / has experienced playing video games	15	65.2
Uses other technical devices or aids	2	8.7

Most of the participants had no particular diagnosis, other than intellectual disability or mild learning disability. Two of the participants (n=2) had been diagnosed with Asperger's Syndrome, one with Down's syndrome (n=1), one with cerebral palsy (n=1), one with features of Tourette's syndrome (n=1), and two with Autistic features (n=2). Seven of the participants had difficulties in attention (n=7), and nine in coordination and perceptive skills (n=9). Some of the participants were challenged both in coordination and concentration skills. Based on the professional staff's comments, almost all of the participants had some sorts of challenge in perceptive skills.

In addition, one had a blind eye (n=1) and one had problems with hyper and hypo mobility of the ankles. According to the professional staff, two of the volunteers had very self-demanding personalities (n=2), easily getting frustrated whenever something did not match their wishes. One of the participants did not speak (other than simple yes or no answers); the professional staff assisted with the interview by stating the questions and interpreting the answers from this particular participant.

TABLE 5 THE INTELLECTUALLY DISABLED PARTICIPANTS' EXPERIENCES OF THE GAME EVENT (CATCH-THE-CHEESE GAME)

Feelings during the game (n=30; 100%)	Comfortable n= 23 (77%)	Excited n= 7 (23%)	Other = 0
Presence of other participants (n=26; 100%)	Encouraging 11 (42.3%) Did not notice it 8 (30.8%) Neutral 4 (15.4%) Distracting 2 (7.7%) Changeably encouraging, distracting and unnoticed 1 (3.8%)		
Focusing only on playing the game (n=23; 100%)	Yes 21 (91.3%)	No 0	Somewhat focused 2 (8.7%)
Experiences of using a cell phone as game controller (n=23)	Easy 19 (82.6%)	Challenging 4 (17.4%)	
Noticing hidden phone on the balance board (n=23)	Yes 12 (52.2%)	No 11 (47.8%)	

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The game/ game event was entertaining (n=23)	Yes 23 (100%)	No 0	
Would you play it again in your home? (n=23)	Yes 20 (87 %)	No 3 (13 %)	
Improvement in leg movements during the game (n=23)	Yes 23 (100%)	No 0	

All of the participants were able to play the game. The majority (n=17; 74%) could play independently and the rest (n=6; 26%) with some assistance from the staff or the researchers. The need for assistance depended on the player. The people with attention deficits needed encouragement and verbal instructions. It was found that actually touching the participants' legs and improving their position helped the people with perception or motor/coordination deficits. Compulsive movements and motor or coordination deficits also caused problems, especially when turning the ankles forward and backward. One participant needed extra mental support (n=1). In each case, the need for assistance decreased after playing the game for a short time. One participant commented that the gaming becoming easier after watching others play first. Table 5 illustrates the participants' overall experiences and opinions.

In general, the participants enjoyed playing the game. The audience was enthusiastic and excited, quite loud, sincerely cheering, applauding and advising other participants. Signs of flow experience were also noted: most of the players were concentrating on the game and some did not even notice the rather loud audience at all. One commented that the time passed very quickly when playing. The two participants with challenged concentration skills showed obviously improved concentration after playing the game for a while. Two of the most excited participants during the game play explained that the excitement was related to the cat that appeared after receiving 50 points. Otherwise the excitement was due to the audience and experiencing something completely new. The majority of the players would play the game again at home or in similar group gaming situations to those in this experiment.

Only three of the participants could not imagine playing the game on their own, even though all of them had enjoyed the game experience. None of these participants had any motor deficiencies; all of whom were over 48 years of age and "not particularly interested in games". However, the younger participants were far more eager to test the game than the older ones. No difference in the level of enjoyment with the game was found between the participants who had previous experience of videogames, who owned a game console, computer or mobile phone, and those without such experience. Almost all assessed the presence of the audience positively.

The balance board (with the "hidden mobile phone") was well accepted as a game controller. The majority felt that controlling it was easy; only a few of the players found it challenging. Almost half of the players noticed the mobile phone on the balance board (n=12; 52.2%). All of the players who had noticed the mobile phone found the balance board easy to control, so there was no relationship between knowing the game is being played with the mobile phone and finding the controlling challenging. One participant commented on the controlling being challenging but said it became easier after playing for a while (n=1; 4.3%). The participant with ankle problems also commented that the controlling was challenging at first but was much easier after playing for a while and getting used to the equipment. Two of the participants who experienced the controlling as challenging (n=4; 17.4%) were helped by the professional staff (n=2; 50%). One suffered from compulsive movements and the other needed more mental support. The others who needed assistance from the staff found the controlling easy, at least after finishing the game play. According to the staff, one participant who found the controlling challenging had concentration challenges whenever starting anything new. One player found controlling the game with his legs was weird, even though he scored the best in the game. Positive comments about the balance board were: "it is nice to play with your legs instead of your hands, as the games are usually played". Negative comments were related to slipping or getting the board in the wrong position on the floor.

According to the professional staff, it is very common that the moods of the people with learning disabilities are very much related to the motivation level in trying new things. The test event was a "good day" for all of the participants. Otherwise they probably would not have participated at all. Some part of the enthusiasm might relate to the fact that there were "new" people involved (the researchers) and that the gaming event broke the daily routine. In addition, the participants were rewarded with a pen and a notebook, which apparently encouraged some to participate. Most of the participants did not know about the reward in advance. However, these issues should be noted when analysing the results as they may seem slightly too positive.

According to the professional staff, some of the participants are easily excited about trying new things and the game was not an exception. As estimated by the professional staff, some of the participants might have done better in a peaceful environment without an audience due to deficiencies in their concentration and attention, especially when getting multiple simultaneous advice and orders. The professional staff also noticed that those participants who walk, ride a bicycle or take other exercise on a regular basis were able to control their ankles and the balance board much more easily.

The professional staff found this kind of game useful for rehabilitation and recreation as it had the potential to motivate people to move more and exercise their legs or other body parts (according to the game played). The gaming experiment also indicated possible improvements in perceptive skills, thus serving as a relevant cognitive exercise. The staff assessed the group game sessions as good social events.

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Some of the staff findings were related to the players' concentration. One player's delivery was seen to improve during the gaming session. One of the participants with autistic characteristics said that he enjoyed playing computer games in general. The professional staff found that this participant's autistic characteristics and compulsive movements disappeared while playing and concentrating on the game. Positive results with autistic children and videogames have also been found by Hung et al [21]. Their article points out autistic children's ability to enjoy interacting with computers and robots. A computer game was developed as a test to assess the children's visual-motor integration ability. The paper shows that it is possible to develop a computer game as a training and testing tool that covers all the functionalities needed (i.e. training, recording and evaluating) to assess the children's visual-motor integration ability. These findings are encouraging in further developing the exergames towards more specific user groups and for special purposes to improve certain characteristics.

The intellectually disabled people were also asked how the game could be improved. Several suggestions emerged, like adding sound effects to the game (n=3) or using different animal figures (e.g. "a snake could also eat the mouse"). The first game prototype was intentionally designed to be as clear and easy as possible without too many elements or visualisations.

The cat as a game figure was experienced as problematic. For many players the game ended when the first cat appeared. One player wanted more barriers for the cat so that it would not catch the mouse so easily. However, another player wanted even more challenges as the game went on. Multiple chunks of cheese on the screen were also suggested in order to make scoring points easier. Two of the participants pointed out that the game elements should be bigger for visually impaired people or the game should be played on a wider screen. However, none of the participants had problems with seeing the elements.

Almost all of the suggested improvements are related to changing the level of difficulty. The game should have various levels like beginner, regular and expert levels, and the game challenges could thus be more individually adjustable according to the player. The game should also turn more challenging as the game goes on. These difficulty levels could be realised in many ways, such as changing the speed of the cat, placement of the barriers, cat also eating the cheese, cat being able to penetrate the barriers, chunks of cheese disappearing and changing places after a certain time period, etc.

On the whole, the results from our first tests with intellectually disabled people indicate that the gaming events might provide a new form of recreation: a social event with light exercise and cognitive stimuli. The games have huge potential since they could be modified for any specific user groups, such as autistic people, people with motor skill deficiencies, people with cognitive impairments, etc. This will require dedicated collaboration between the professionals and the user group itself.

B. Chase-the-square Game for the Older Adults.

In order to compare the findings with different user groups, we will now discuss the experiment with the older adults related to the deployment of a cell phone controlled game as a means of activation, recreation and rehabilitation among elderly people living in assisted living environments. The data collected for this experiment consisted of background information about the participants. The target group contained 34 participants (N=34), all over 70 years of age and living in assisted living conditions. The average age of the participants was 85.9 years. Women and men were equally represented in the sample group. Only 12 % (n=4) of the participants were actively involved in weekly-based rehabilitation (light physical exercises with arms and legs whilst sitting on chairs). Three of the participants (n=3; 9%) used computers (net banking), and 20 (59%) used mobile phones on a daily basis. More detailed results can be found in the article by Sirkka et al [4].

The older adults' experiences of participating in the game were divided into two main categories: 1) positive experience, and 2) negative or neutral experience. The majority of the participants (n=30; 88%) found the game a positive experience, describing it with expressions like fun (n=11; 32%), interesting (n=6; 20%), easy to play (n=4; 12%), very positive experience (n=3; 9%), challenging (n=3; 9%), rewarding (n=1; 3%) and entertaining (n=1; 3%). The total number of negative comments was 4 (n=4; 12%), including the following single expressions: motion created pain in the shoulder joint (n=1; 3%), hands were shaking too much (n=1; 3%), the balls were just about visible to me (n=1; 3%) and "just another toy to play with" (n=1; 3%).

The game was considered suitable for activation and rehabilitation purposes by the elderly participants because it assists in motor coordination (n=11; 32%), gives sensible activation for the arms and legs (n=8; 24%), activates the brain (n=7; 21%) and would be good for social activities in small groups (n=6; 18%). Only 2 (n=2; 6%) of the participants were not sure whether the game was at all useful in activation or rehabilitation.

The findings indicate that people with impaired mobility experienced gaming as a more rewarding and more suitable rehabilitation method than able-bodied people who could still exercise by walking, skiing or other types of traditional physical activities. The elderly people participated in this experiment on a voluntary basis and gave their consent in writing. Other people, who did not play themselves, followed the event and were eagerly spurring on those who were playing, which confirmed the social activation side of the gaming event. Finally, it was noted that people with early or mid-stage dementia declined to participate at all.

Staff members (physiotherapists, rehabilitation instructors; N=10) from the assisted living organisations attended the gaming experiments as observers. Their comments about the gaming situation were very positive. From their observations, the huge majority of the elderly were excited and eager to play (n=9; 90%), the game was seen as very useful for social activation (n=7; 70%) with spurring each other on to gain high scores and having fun together. The physiotherapists and rehabilitation

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instructors saw playing the cell phone controlled game (either played with the hands or the feet) as very suitable for improving motor coordination, vigilance, attention and concentration (n=6; 60%). The professionals also estimated the game to be suitable for raising the spirits and self-esteem by giving successful experiences in gaining scores and providing an interesting and sensible distraction to the daily routines (n=10; 100%). Based on the staff's observations, the version played by foot (balance board) was best suited to those having early stage dementia.

Both the older adult participants and the staff members gave some comments about improving the game. The opinions were divided with regard to the degree of difficulty; different levels of difficulty were proposed by three of the participants (n=3; 9%) and three of the staff (n=3; 30%), while four of the participants (n=4; 12%) saw more challenging game versions as discouraging. Even though the display was designed to be as simple as possible, some comments were pointed at the colouring of the moving particles (purple ball, red square) as being not too easily distinguished.

To conclude, the overall experiences of the cell phone controlled gaming appeared to be a successful experiment, also proving that the elderly are not as reluctant to use technical devices or play virtual games as is often thought. Activation, rehabilitation and recreation in the homes or assisted living organisations could benefit from the deployment of new technology providing new and easy solutions to motivate activation, as well as new ways for self-motivated rehabilitation, which would also offer possibilities to measure and register follow-up information on the effects.

C. Comparison of the User Groups

Due to the great variation in age and skills, the group of intellectually disabled people was a more diverse and heterogeneous user group than the older adults. The help needed to start or play the game varied according to the player's personal characteristics. This means that in the case of designing games for the intellectually disabled, it is even more important to take account of the balance between the skills and the challenge of the game (see Figure 1). This is also seen in the feedback and proposals for improvement, almost all of which were somehow related to the game's challenges; some of the players needed more challenges and some wanted the challenges to increase gradually during the course of the game. This implies that the individual player should have more difficulty levels to choose from (beginner, regular, expert). Although the older adults created a more homogenous group than the intellectually disabled, similar proposals were received from both target groups. In general, the intellectually disabled people were more active in giving improvement proposals than the older adults.

A more difficult task than balancing between the challenge and skills is to adjust the game's intensity, and especially to make the controlling of the game adaptable according to the player's motor skills level. Game intensity could mean changes in different controlling modes - e.g., the player could stand on the balance board (hard physical exercise) or have the cell phone attached to other parts of the body, arms or legs requiring exercise. However, this is rather dangerous and often impossible for people with old age or physical deficiencies. As for the group of intellectually disabled people in this experiment, most of the participants were physically fit enough. This is interesting for future experiments.

The group of intellectually disabled people was less competitive in the game intervention than the older adults. The competition motivated the elderly people to play more and reach higher scores than the others. Another source of motivation was the improvement in their own scores (in both user groups), as well as being able to experiment with something new and being able to play and control the game in general (both user groups).

The balance board and the mobile phone were well accepted as a game controller by both user groups. The intellectually disabled people seemed to be more curious, with almost half of the players noticing the mobile phone "hidden" on the balance board.

On the whole, social activities as well as physical activation seem to be rather inadequate and restricted in assisted living organisations, as well as among the intellectually disabled. New technology can provide cost-effective, reasonable and mindful new ways to activate people both individually and in small groups. Elderly people need much more content in their days than just having a cosy room to live in and ready-made meals to attend to. Similarly, additional and relevant activities according to age and special personal characteristics would be more than welcome among the intellectually disabled too.

Our future goal is to improve the game according to the feedback obtained in this survey, such as a wider variety of controlling modes for the game as well as difficulty levels, developing the game to support different kinds of body movements and enabling the game to be easily modified according to the individual user's skills or needs for physical or cognitive exercise or rehabilitation. We will also emphasise the social aspects of the game by producing multiplayer versions.

A very important task would be to outline the user groups further or try other user groups. The balance board actually brings another opportunity for people without hands to enjoy playing. We will also investigate the effect of the game on elderly people with minor cognitive impairments. Later on, we can expand the studies to investigate multiplayer games and their effects on social abilities and functional capacities, and to investigate how games with harder physical exercise affect people's physical capacity.

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VI. CONCLUSIONS

Social activities and physical activation seem to be rather inadequate and restricted in assisted living organisations, as well as among the care and living environments of the intellectually disabled. New technology can provide cost-effective, reasonable and mindful new ways to activate people both individually and in small groups. Elderly people need much more content in their days than having a cosy room to live in and ready-made meals to attend to. Similarly, more activation adjusted to age and personal characteristics would be more than welcome among intellectually disabled people.

The development of the special exergames discussed in this study offers various opportunities but also requires dedicated work related to characterisation of the special needs of the target groups, as well as in game design. The results from the first tests with intellectually disabled people indicate that the games might provide a new recreation possibility: a social event with light exercise and cognitive stimuli. Also with the elderly, the overall experiences of cell phone controlled gaming appeared to be a successful experiment, proving that the elderly are not reluctant to play virtual games. Activation, rehabilitation and recreation in homes for the elderly or assisted living organisations could benefit from deployment of new technology providing new and easy solutions to motivate activation as well as new ways for self-motivated rehabilitation.

Intellectually disabled people are a more diverse and heterogeneous user group than the elderly adults. The assistance needed to start or play the game changed much more depending on the players. This means that when designing games for the intellectually disabled, taking the balance between the skills and the challenges of the game into account is of the utmost importance. However, both user groups need games that can be modified based on the skills of the player.

In conclusion, the games have huge potential since they can be modified for any specific user groups, such as autistic people, people with motor or cognitive impairments, etc. Developing exergames for rehabilitation requires dedicated collaboration with health and care professionals, researchers and representatives of various user groups.

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