Mobile Games Individualise and Motivate Rehabilitation in Different User Groups

Antti Koivisto*
Satakunta University of Applied Sciences, Pori, Finland
Sari Merilampi
Satakunta University of Applied Sciences, Pori, Finland
Andrew Sirkka
Satakunta University of Applied Sciences, Pori, Finland

ABSTRACT
Trials on Mobile Games are presenting a huge potential in cognitive, physical and mental rehabilitation. This paper is to discuss user viewpoints of trials with mobile games combining cognitive stimulation and physical exercise in rehabilitation: Game#1 controlled by tilting the mobile phone embedded in a balance board; Game#2 controlled by tilting the tablet pc; and Game#3 a modified game version of Trail Making A -memory test played by tapping figures on the tablet pc touch screen.

The total amount of participants was 89 of which 74% were older adults (women=24; men=33; average age 85.9 years) and 26% people with learning disabilities (n=23; $\bar{\alpha}$ 38,9 years). The gameplay setting was similar for all target groups, although the game graphics (Game#1) were slightly modified based on each user group.

Mobile devices were used as the game platform to create easily approachable games of low costs and suitable for the majority of people.

Keywords: mobile game; cognitive impairment; older adults; recreation; rehabilitation; user research

1. INTRODUCTION
People with special needs have too often been seen as a minor and marginalised group that have no use or even interest for game technology. However, alongside with the ageing of populations and dwindling resources, modern user-friendly technology applications have shown huge capacity in intensifying care and rehabilitation services. Active ageing, self-supported care, and other aspects in quality of life would take an enormous step forward with deployment of user-friendly technologies (Leinonen et al. 2012; McCallum 2012; Confalonieri et al. 2012).
The sense of having possibilities to be mentally, physically and socially active is an important part of well-being in all ages. People with special needs like cognitive impairment or physical limitations often feel unnecessarily disabled because of mental limitations and beliefs prevailing in the environment, including care professionals. To break the unnecessary impediments, new means and methods are required. Entertainment and therapy content are the elements put together into the mobile games investigated in this study to make games become a tool for rehabilitation adoptable for anyone. (Leinonen et al. 2012.)

Several studies show that both physical exercise and game play have positive effects on people, including older adults or people with learning disabilities, combating serious depression or even Alzheimer’s disease (e.g. Fairchild & Scogin 2010; Geda et al. 2010; Spector et al. 2003; McCough et al.11; Merilampi et al. 2014). Findings from scientific research studies show that, in general, playing video games can lead to changes in an individual's pleasure, vigilance, dominance, and therefore in the overall state of experienced well-being. Also in the case of older adults, simple and easy to play video games are well accepted and found to create positive feelings and enjoyment (Khoo & Cheok 2006; Koivisto et al. 2013; Sirkka et al. 2012; Snowden et al. 2011). Even few minutes regular gaming exercise on daily basis has cognitive benefits improving performances requiring skills like attention and concentration (Gao & Mandryk 2012). This knowledge has been the source of inspiration for Well-being Enhancing Technology research group (WET-RG) in generating games that combine physical movement with cognitive impetus and testing them in several target groups.

WET-RG at Satakunta University of Applied Sciences (SAMK), Finland, has set the focus on generating gamification tools to activate and assist people with special needs. Instead of investing in design for all, WET-RG has chosen to design for somebody. This paper presents three different cognitively stimulating mobile games and trials where the games were tested in different target groups. The paper also discusses the subjective experiences of participants and staff observations related to these trials.

2. DESIGN PRINCIPLES OF THE THREE GAMES
The three different games presented in this study are categorised based on the control method and the game display. Game#1 is controlled by tilting the mobile phone allocated in a balance board, and the game is played on a large TV screen. Game#2 is played with a tablet PC; game figures are controlled by tilting the tablet. Game#3 is also played on a tablet by tapping the figures on touch screen. Game#1 was tested in trials with older adults and people with learning disabilities. Game#2 and #3 are cognitively stimulating games, and were tested by a group of older men with diagnosed memory impairment. Each game version is explained in more details later on in this chapter.
As our target groups consisted of people with special needs (like diagnosed memory impairment, older old adults and people with learning disabilities), a special attention was paid on the game design. Due to the impaired perception and sensation skills in the target groups, the following accessibility principles were deployed in the game design: large target button elements, simplified and only necessary graphics, minimal amount of animation, colours used conservatively with high contrast, simple one-view display at the time, and placing important information in the middle of the screen. (Díaz-Bossini & Moreno 2014.) Apart from the above mentioned accessibility principles, the games were designed to use obvious logics without additional introductions how to play. This was seen especially important by people with learning disabilities even when assisted by staff to start the gameplay. (Sirkka et al. 2014.)

Time-up limit was also added to all three games. Time-up limit was needed to guarantee achieving both of the goals in gameplay, being entertaining and rehabilitation. Multiple but short gaming sessions with moderate-intensity on done regular basis have been proven more beneficial than less-frequent but longer play sessions (Gao & Mandryk 2012a; Gao & Mandryk 2012b).

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. Csikszentmihalyi (1990) 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. 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. (Kiili 2005; Kiili et al. 2012; Kiili et al. 2013; Koivisto et al. 2013; Merilampi et al. 2014; Wilson et al. 2002).

In summary, the focus in our game designing was set the focus on accessibility factors, minimal amount of required equipment in order to play, and to make the games appealing enough to generate the “flow feeling” to make gameplay activating, easy and fun to play but at the same time being a “serious game” with certain goal and purpose applicable in rehabilitation. These requirements led us to select components like mobile phone, internet connection and TV- or tablet PC display.
Game#1 Chase-the-square /Chase-the-cheese

The Game#1 concept employed a mobile phone embedded acceleration sensor to control the game play on a wide TV-screen. By constantly reading the acceleration data, the phone communicates it to a socket server via internet. The socket server determines the moves of game characters in the game run in mediating computer.

The reason to end up with socket server solution was to have multiplayer possibility in the trials. Node.js was used as the socket server to attain best possible interaction with the HTML5 game on a browser and mobile phones as game controllers. Game#1 was stored to web enabling any of mobile clients join game session, and also to use TV browser as game console.

Phonegap app was deployed in building the game controller application (inside the phone) due to its ability to accesses phone hardware quite easily and allowing application construction to all major mobile phone platforms. Deploying this app prevented complication in connections caused when phone in sleep mode also closed up the internet connection terminating the play.

The Game#1a concept focused on practicing motor coordination of hands or feet by catching the red square with a purple ball and cognitive stimulating as the player must react/observe where the next square appears. The game was tested in trials with older adults and adults with learning disabilities (Sirkka et al. 2012), which is why the design was kept visually clear and logically simple. The game field has two impenetrable obstacles to be bypassed (Figure 1).

Fig 1. Game#1a Chase-the-Square.

Movement of the ball was controlled by tilting the mobile phone. The steeper the tilt the faster the ball moved on the screen. Two different controlling modes were used: a) manually by wrist movement, or b) foot controlled movement with the phone attached into a balance board. In both modes players were seated during the game for safety reasons.

Game#1a graphics of square and ball were replaced with characters of mouse, chunk of cheese and cat for the second trial with adults with learning disabilities (Game#1b). The modification was based on the older adults’ feedback from the first trial. This modification
also increased the difficulty level in the game by adding adversary component into the game (Fig. 2). This modification made the game more cognitively challenging.

![Diagram of the game design](image.png)

Fig. 2 Design of Game#1b, Chase-the-Cheese (balance board) and Game#2 Chase-the-Cheese (tablet).

Game#1b was played only using balance-board control mode to collect as many cheese chunks as possible in one minute’s time. The game starts with no opponents except the impenetrable obstacle to be bypassed. The game becomes more challenging after collecting 5 cheese chunks, the first adversary, a cat, joins the game chasing the mouse. Another cat appears after 10 collected cheese chunks while the first cat gets faster and harder to evade. The third cat appears after 15 cheese chunks while the two existing cats start chasing the mouse even faster. The game terminates when the 1-minute time is up or when a cat catches the mouse.

**Game#2 Chase-the-Cheese (tablet)**

Games#2 and #3 are cognitively stimulating games designed in collaboration with professionals specialised in memory disorders. The Game#1 concept was found in previous trials cognitively stimulating developing attention and reaction skills. The game design was modified into a tablet PC version, which simplified the gaming event and data communication directly between the tablet (with NFC identification facilities) and the server. Otherwise the game play was identical to the Game#1b (Fig.3), only the phone being replaced by tablet as game controller eliminating additional computer-internet-TV screen requirements. The tablet versions of the Game#2 and #3 were tested in trials with a group of older men with diagnosed memory disorder. Based on the feedback of previous trials with Game#1b, the animal characters helped the players to catch the logics of the game and making the game exiting with gradually increasing difficulty levels.
**Game#3 Trail Tapping**

Game#3 is modified version of Trail Making Test A (TMT-A) used in memory diagnostics. The standardised test distributes the numbers 1-25 randomly over a sheet of paper. The testee should draw a line connecting the numbers in ascending order as quickly as possible without lifting the pen from the paper. The time to draw the trail is measured. The testee is allowed to correct possible errors which only increase the completion time reported in seconds; the longer the time, the greater the memory impairment. (Alaska Department of Administration 2013; Tombaugh 2004.)

In Game#3, the blue digits are randomly distributed over the screen and the testee is instructed to tap them in ascending order as quickly as possible (Fig. 3). Correctly tapped digit turns translucent while an error turns red. The size and colouring of numbers were made as visible as possible. The game ends when all digits are tapped in correct order, after four errors or when time runs out (240 seconds).

In our previous trials the difficulty level adjustment was found important, a menu to select desired difficulty level from 5 to 40 digits in five-digit intervals was added in the concept.

A game score registry system was built to follow-up personal progress. Each participant was provided with a personal Near Field Communication (NFC) identification card to log in the game. When starting the game, the player touched the tablets NFC reader with their personal card. Based on identification, the game presented the latest records on the screen. NFC technology registered the data of each play event enabling the analysis and follow-up of the progress of each individual player.

![Game#3, Tapping the Trail](image)

**Fig. 3. Game#3, Tapping the Trail**

### 3. GAME INTERVENTIONS AND STRUCTURED INTERVIEWS

Results discussed in this paper have been collected in several trials with various target groups. The trials are explained here in more details.

Game#1a was tested in non-recurring game events where volunteers had the opportunity to play the game as many times as wished. Professional staff, researchers, and other game
testers were observing the game play. The subjective experiences and perceptions, including commonly stated free comments over the trial, were collected right after each player’s experiment by a structured interview. The data was analysed by content analysis calculating frequencies and percentages in the variety of responses per themes.

Game#1a trials were organised in two different organisations in Finland within a two weeks’ time. The target group contained persons 70+ years of age living in assisted living conditions (N=34). The average age of the participants was 85.9 years. Women (n=17) and men (n=17) were equally presented in the sample.

Total number of 23 (N=23; male n=16; 69.6%, female n=7; 30.4%) adults with learning disabilities participated in the trial of Game#1b. Participants’ age varied between 21- 60 years (average age ca 39 years), and they all worked in a sheltered working facilities. Majority of the participants had no diagnosis apart from intellectual disability or mild learning disability; two (n=2) diagnosed with Asperger’s Syndrome, one Down’s syndrome (n=1), one cerebral palsy (n=1), one Tourette’s syndrome (n=1), and two with Autistic features (n=2). Seven of participants (n=7) had difficulties in attention and nine (n=9) in coordination and perceptive skills. The subjective user experience analysis was part of a larger study (Koivisto et al. 2013). The data was collected by thematic interviews with asking participants to assess and describe their subjective perceptions of the games and play settings. The qualitative results of the thematic interviews are presented in the following chapter.

Games#2 and #3 were tested in a 3-month trial setting with male war veterans. The aim of the trial was to measure possible impacts of cognitively stimulating mobile games on older people’s cognitive skills when played on regular basis. A group of Finnish male war veterans (N=9) in assisted living environment volunteered in this trial. Participants’ were 88-97 years of age (average 90.1 year), they were diagnosed with mild or medium level memory impairment but were cognitively active and lived in assisted living ambient.

The user experiences and usability issues were collected by structured interviews right after the 3-month gaming period. Each participant was interviewed privately in order to obtain as authentic and subjective information as possible related to their previous experiences on and use of mobile games and devices, subjective experiences about the trial period and its impacts on their cognitive skills and general well-being, subjective meanings set on gaming, and general comments on usability of the devices and games. Staff observations and comments were incorporate in the data as reflection base.

4. RESULTS AND DISCUSSION

User Experiences - Game#1, older adults (N=34)
Overall experiences of participating in the game trials were divided into two main categories: A) positive experiences, and B) negative or indifferent experiences. Most participants (n=30; 88 %) found playing a positive experience. The experiences were described as fun (n=11; 32%), interesting (n=7; 20%), easy to play (n=4; 12%), very positive (n=3; 9%), challenging (n=3; 9%), rewarding (n=3; 3%), and entertaining (n=1; 3%). The game was reckoned good for social activities and events (n=6; 18%).

Negative comments (n=4; 12%) were related to personal conditions: “game controlling created pain”, “my hands were shaking too much”, “the game elements were hardly visible”.

The game was experienced rehabilitating and activating (n=32; 94 %). The game was reckoned to assist in motor coordination (n=11; 32%), to give sensible limb activation (n=8; 24%) and activate brain (n=7; 21%). People with impaired mobility experienced gaming more rewarding and suitable rehabilitation method than able-bodied people who could participate in any other physical exercises.

**User Experiences, Game#1, people with learning disabilities (N=23)**

The majority (n=17; 74%) could play the game independently. The need for assistance limited to verbal instructions, mental encouragement or some physical support. The game idea was easily comprehended thanks to well-recognisable characters.

All participants (n=23; 100%) took the game positively and experienced the event entertaining, and providing good exercise for legs. 20 (87 %) wanted to continue the game also at home. The climate during the game play was described as comfortable (n=18; 77%) or excited (n=5; 23%). The excitement cumulated when the cat appeared increasing the difficulty level. Part of the excitement came from having audience or experiencing something completely new. All participants felt focused in the game play (n=23; 100%). The event was very social and loud with participants giving instructions and spurring other players.

Only few negative comments were stated: “The loud audience was distracting” (n=2; 8%), “I could not imagine playing the game on my own” (n=3; 13%), and “Playing game with legs was weird” (n=1; 4%). Four of the participants (n=4; 17%) found the use of the “balance board controller” challenging. Some comments were given about slipping or getting the board in the wrong position on the floor.

**Improvements to Game#1 concept**

The feedback obtained in Game#1 trials was utilised in modifying Game #2 and #3. Adding difficulty levels into the game was supported by some of participants (n=5; 9%) and one third of professional staff, meanwhile some participants (n=7; 12%) reckoned that higher challenges might discourage playing. Colouring of the game elements were required to be more distinguishable.
Three participants in the group of adults with learning disabilities wanted some sound effects to be added into the game. Also the variety of animal figures or animations was recommended as improvement in the game. Some of the older adults commented that the game was too difficult although the original game had already been modified adapting more flexibly to each individual player’s progress. Many players terminated the game at the first cat’s appearance on the screen. Multiple cheese chunks on the screen were also suggested to make scoring points easier.

**User Experiences - Game#2**

Game#2 (tablet version) was engaged in the war veteran trial. Prior the 3-month gaming period, all participants went through standardised MMSE and TMT-A tests. When compared the pre- and post-trial results, only couple of participants had improved their cognitive test results. Therefore no significant impact of gaming was detected. However, as to subjective experiences of the trial, the results were outstandingly positive. The majority of participants found the regular gaming activating, interesting, entertaining, and offering suitable cognitive rehabilitation. Gaming helped them to stay alert and active during the whole day time, which otherwise contained not too many cognitive impulses or things to do. Apart from mental stimuli, the games offered useful activity to train finger dexterity and attention skills. Games also had important role as social activator also involving staff, visitors and family members to compete and share experiences.

**User Experiences - Game#3**

The second game in the war veteran trial was modified version of Trail Making A-test. The game followed the key idea of standardised TMT-A test to connect numbers (by tapping instead of drawing the connecting line) in correct order as quickly as possible. This modification was made to test whether omission of line drawing made the test easier to complete. In this trial tapping the digits in correct order did not decrease the played time; rather on the contrary.

TMT-game had several difficulty levels. The participants were instructed to increase the difficulty level each week with adding 5 more digits on the screen. Participants played the game rather successfully until the level of 25 digits on the screen creating the ultimate top in the trial. Only one participant in the test group attempted all the difficulty levels (40 digits on screen) but could not complete successfully the task with 40 digits (Table 1).
Table 1. TMT – game shots per difficulty levels

<table>
<thead>
<tr>
<th>Difficulty level</th>
<th>played game shots in total 729</th>
<th>completed shots</th>
<th>success in percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>level 5</td>
<td>23</td>
<td>12</td>
<td>52 %</td>
</tr>
<tr>
<td>level 10</td>
<td>263</td>
<td>235</td>
<td>89 %</td>
</tr>
<tr>
<td>level 15</td>
<td>167</td>
<td>161</td>
<td>96 %</td>
</tr>
<tr>
<td>level 20</td>
<td>139</td>
<td>111</td>
<td>80 %</td>
</tr>
<tr>
<td>level 25</td>
<td>62</td>
<td>44</td>
<td>71 %</td>
</tr>
<tr>
<td>level 30</td>
<td>65</td>
<td>50</td>
<td>81 %</td>
</tr>
<tr>
<td>level 35</td>
<td>5</td>
<td>3</td>
<td>60 %</td>
</tr>
<tr>
<td>level 40</td>
<td>5</td>
<td>0</td>
<td>0 %</td>
</tr>
</tbody>
</table>

The overall play time of completed TMT – game shots shortened over the trial despite of increased difficulty levels indicating that even these aged people are able to learn and develop their skill in attention, reaction and dexterity with regular activities. The two most active gamers decreased the error numbers and percentages over the total trial period (Table 2).

Table 2. Errors per participants in various difficulty levels (TMT-game)

<table>
<thead>
<tr>
<th>Player ID</th>
<th>Games played in level 10</th>
<th>Errors in level 10</th>
<th>percentage in level 10</th>
<th>Games played in level 15</th>
<th>Errors in level 15</th>
<th>percentage in level 15</th>
<th>Games played in level 20</th>
<th>Errors in level 20</th>
<th>percentage in level 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 1</td>
<td>13</td>
<td>0</td>
<td>0,0</td>
<td>0,0</td>
<td>3</td>
<td>0,0</td>
<td>3</td>
<td>1</td>
<td>33,3</td>
</tr>
<tr>
<td>ID 2</td>
<td>38</td>
<td>0</td>
<td>0,0</td>
<td>0,0</td>
<td>3</td>
<td>0,0</td>
<td>3</td>
<td>1</td>
<td>33,3</td>
</tr>
<tr>
<td>ID 3</td>
<td>9</td>
<td>0</td>
<td>0,0</td>
<td>0,0</td>
<td>2</td>
<td>0,0</td>
<td>2</td>
<td>0</td>
<td>0,0</td>
</tr>
<tr>
<td>ID 4</td>
<td>22</td>
<td>11</td>
<td>50,0</td>
<td>22</td>
<td>13,6</td>
<td>21,9</td>
<td>42,9</td>
<td>3</td>
<td>1,333</td>
</tr>
<tr>
<td>ID 5</td>
<td>36</td>
<td>7</td>
<td>19,4</td>
<td>23</td>
<td>0</td>
<td>0,0</td>
<td>43</td>
<td>11</td>
<td>25,6</td>
</tr>
<tr>
<td>ID 6</td>
<td>17</td>
<td>0</td>
<td>0,0</td>
<td>14</td>
<td>0</td>
<td>0,0</td>
<td>14</td>
<td>0</td>
<td>0,0</td>
</tr>
<tr>
<td>ID 7</td>
<td>13</td>
<td>0</td>
<td>0,0</td>
<td>1</td>
<td>0</td>
<td>0,0</td>
<td>2</td>
<td>2</td>
<td>100,0</td>
</tr>
<tr>
<td>ID 8</td>
<td>42</td>
<td>4</td>
<td>9,5</td>
<td>24</td>
<td>2</td>
<td>8,3</td>
<td>14</td>
<td>3</td>
<td>21,4</td>
</tr>
<tr>
<td>ID 9</td>
<td>73</td>
<td>6</td>
<td>8,2</td>
<td>44</td>
<td>1</td>
<td>2,3</td>
<td>40</td>
<td>2</td>
<td>5,0</td>
</tr>
<tr>
<td>Tot.</td>
<td>263</td>
<td>28</td>
<td>10,6</td>
<td>167</td>
<td>6</td>
<td>3,6</td>
<td>139</td>
<td>28</td>
<td>20,1</td>
</tr>
</tbody>
</table>

The overall play time of completed TMT – game shots shortened over the trial despite of increased difficulty levels indicating that even these aged people are able to learn and develop their skill in attention, reaction and dexterity with regular activities. The two most active gamers decreased the error numbers and percentages over the total trial period (Table 2).
The clear majority of participants found the mobile games easy-to-play, interesting, and suitable for cognitive activation. The usability of tablets improved outstandingly when using silicon covers that improved the grip of the tablet, especially for older people due to dryness of skin.

In general, the tablet PC’s were commented being easy-to-use and light to handle. Worth mentioning might be rather frequent comments regarding the weak touch sensitivity of the tablet screens. The touch screen did not always react especially to older adults’ tapping, which naturally affected negatively on game results causing false errors and increasing game play time. The touch sensitivity was installed to be triggered with as sensitive as possible. In the test versions, a touch event was even triggered when the player lifted their finger from the screen. One detected reason for the weak touch sensitivity was poor conductivity of electricity due to dryness of skin in fingertips in older adults. This is one down side to the otherwise effective working of capacitive touch screens where function is based on the change in capacitance caused by an electrically conductive object such as human touch. For future trials with older adults, a touch pen or touch gloves could be used to increase touch sensitivity. Another option is to employ resistive touch screens which do not require any electrically conductive touching object.

**Similarities in various user groups’ subjective experiences**

Generally speaking the games were very well accepted. All the different user groups gave positive feedback about the games and their subjective experiences of the game events. The most important factor behind the positive user experiences is reported to be the right balancing of personal skills and game play which is also very well-known fact in game designing (cp. McClough et al 2011; Mountain & Craig 2012; Szturm 2011). Success in game play and increase of game scores boosted the motivation and was reported a part of the positive experience. Other identified motivating elements were: ability to experiment with something new and to play and to control a game in general (esp. participants not used to computer games).

Various user groups reported similar ideas for game improvement regarding adjustability of difficulty levels. If the difficulty level and general game play could be adjusted to an individual player’s health condition and skills, the subjective user experiences could be even more positive. This improvement could be realised by adjusting game tempo and difficulty setting (beginner, normal, and expert) in collaboration with users requiring highly individualised characteristics. Levelling the game difficulty is a challenge for game developers, especially in regard of maintaining the game interesting even in low difficulty levels.
The games used in this study were not specially designed for social activities. Nevertheless, in all trials the game events turned out to be very much of social events. Some were enjoying watching others play and giving mental support. Social aspects around the games extended to additional moments with a nurse or “having something common to do with my grandchild”. The majority of players assessed the presence of audience positively, which indicates a wide acceptance of social games also designed for people with special needs. Only Game#3 required more concentration and therefore was played privately. The social aspect in this game was restricted to sharing the results and experiences with other players.

Divergences in subjective experiences of various user groups

Despite of many similarities in our target groups, also some clearly defined target group centred requirements emerged. People with learning disabilities were more heterogeneous group than the groups of older adults (variety in ages and capabilities). Based on the feedback, adjustable difficulty levels, animations and sounds seem to be very important especially for the younger players. On the contrary, older adults disliked unnecessary elements in the game, and against all our expectations, the simple game setting was not experienced childish at all; rather did the simple logics and elements clarify the mission of the game. This indicates that well-known concepts and characters are helping people with special needs to grasp the idea in gameplay. Similarly, typical age-related impairments in senses should be notified when designing and adjusting the games for older adults.

The competition and players’ scores displayed on screen appeared to motivate the older adults to play and achieve higher scores. The group of people with learning disabilities was less competitive focusing only on each player’s own performance.

As to Game#3, the individual results varied a lot even within one day. The game was also reckoned rather boring to play in the long run. Even the challenge faced in higher difficulty levels did not motivate players to endeavour. It might be interesting to modify the game closer towards the original design combining the numbers with drawn lines.

Although the user groups studied in this paper have different characteristics and skills, the findings indicate that a clear concept and purpose of the game are enough to be applicable for several user groups only with slight modifications in graphics and difficulty level adjustments.

User experiences on rehabilitative elements in games

All user groups experienced games as potential rehabilitation tools despite the differences in participants’ health, cognitive and physical conditions. Some participants had motor skill limitations in all target groups. The challenge related to physical limitations in game designing is to find the ways to adapt the game control according to the player’s abilities. Mobile phone as game controller could easily be integrated in different kinds of assistive
technology or training equipment, or attached on different parts of the body. The use of a balance board in game controlling broadened the user groups to people unable to use their hands. The players testing the balance board games were seated during game for safety reasons.

For older adults with memory impairment the rehabilitative element was more cognitive than physical. However, also tilting the tablet or playing with balance board by feet required some light exercise.

To summarise the results, the motivational aspects required of a new self-rehabilitation tool is provided in gaming. Games can be adjusted and modified according to a user groups’ or most importantly personal capabilities, interests or requirements. The results of our trials indicate strongly that gamification has potential in rehabilitation. Therefore, the future challenge is to integrate wider palette of therapeutic contents in the games to maintain and enhance functional capabilities (social, cognitive, physical). Due to limitation in the trials discussed here, long-term research trials should be arranged to collect wider and measurable quantitative data about the impacts of the games in different user groups. The results have also convincing evidence that in a long term learning through games and activation through games is happening and game results are improved. At the same time attitudes towards mobile applications are better and possible thresholds are lowered. By this elderly people may use mobile devices more easily.

Table 3 presents the overall feedback rates of various target groups (N=107). Apart from the players participating in game trials, the feedback data was also gathered by interviewing the staff. The staff interviews contained their assessment of therapeutic usability of the games as well as their observations both on the gaming situations and on their clients over and after the gameplay.

Table 3. Summary of the feedback gathered from various target groups (N=107)
Even if the overall feedback was very positive, some challenges are still left there for further development. Except the sensitivity of tablet screens appeared to be challenging especially in older adults, the concept of care or rehabilitation seems to be rather conservative. Having fun at the same time as exercising somehow still as a mind-set is seen diminishing the value of professional rehabilitation. Even if there are loads of evidence available confirming how good tool games would be in maintaining and improving cognitive and motor skills, there is obvious caution in the air to impede deploying gaming as part of therapeutic pallet in long-term care.

CONCLUSIONS

New technology provides cost-effective, individualised, reasonable and mindful ways to activate and motivate people to be self-supportive, mobile and vigilant. Especially in long-term care facilities should encourage residents to maintain their cognitive, motor and social skills by deploying new and easy-to-use technology to provide meaningful things to do, individually and in groups.

As seen in Table 3, the positive experiences make the difference in overall well-being. Easy-to-use technology is available and more and more evidence confirm that it is useful for and accepted by older people as well as people with special needs. In these trials, the games were welcomed as potential self-rehabilitation tools that can be adjusted according to personal skills and limitations. They also give meaningful activities to those in care saving time and efforts from professional carers who very often feel guilty of not being able to socialise with clients as much as needed and wanted.

REFERENCES


