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Effect of Playful Balancing Training – A Pilot Randomized Controlled Trial

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Abstract

We used the modular playware in the form of modular interactive tiles for playful training of community-dwelling elderly with balancing problem. During short-term play on the modular interactive tiles, the elderly were playing physical, interactive games that were challenging their dynamic balance, agility, endurance, and sensor-motoric reaction. A population of 12 elderly (average age: 79) with balancing problems (DGI average score: 18.7) was randomly assigned to control group or tiles training group, and tested before and after intervention. The tiles training group had statistical significant increase in balancing performance (DGI score: 21.3) after short-term playful training with the modular interactive tiles, whereas the control group remained with a score indicating balancing problems and risk of falling (DGI score: 16.6). The small pilot randomized controlled trial suggests that the playful interaction with the modular interactive tiles has a significant effect even after a very short time of play. The average total training time to obtain the statistical significant effect amounted to just 2h45m.

Introduction

Research into playware [1] and modular playware [2] puts emphasis on the design of (modular) intelligent hardware and software that creates play and playful experiences. Often, it is believed that such playware can mediate other actions, for instance actions such as social interaction and physical movement. It has been outlined how the playware may act as a play force that pushes the user into play dynamics [3]. When you are in such play dynamics, you may feel transformed from the normal state of being and feel as if forgetting about time and place. Sometimes we may feel being able to perform more or better when in play, which is interesting if such performance may have a desired side effect. Indeed, Vygotsky puts it like "Play creates a zone of proximal development in the child. In play, the child always behaves beyond his average age, above his daily behavior; in play it is as though he were a head taller than himself. As in the focus of a magnifying glass, play contains all developmental tendencies in a condensed form and is itself a major source of development." [4].

We believe that this quality of play may translate to many different groups of people. However, often accounts for the potential benefit of play e.g. on cognitive learning or physical abilities remain of a descriptive nature. Therefore, in this study, we engage in making a quantitative study of the effect of play, and we perform the study with a user group with whom play is often not attributed. In particular, to make such a study, our objective became to test for dynamic balancing of community-dwelling elderly as a result of short-term training playing with a specific playware, namely the modular interactive tiles [5].

Equipment - Modular Interactive Tiles

For the effect test of playful training, we used the modular interactive tiles as the training equipment. The modular tiles have been described before in details, e.g. [5, 6]. This is a fully distributed system made up of a number of tiles that can connect to each other to form a surface, on which people can play different games, either by themselves or by competing with each other. Each tile contains a microprocessor, battery, IR communication, an FSR sensor, and 8 coloured LEDs in a circle. The FSR sensor can sense a step or a hit on a tile, and the LEDs can shine up in different coloured patterns. This is used to create interactive games on the modular interactive tiles. Currently, there are more than 20 different games for the modular interactive tiles. The games used for the intervention are described later.

The tiles can easily be taken apart and put together to create different forms, which will demand different

interaction patterns by the users when playing the games, e.g. the tiles can be changed from a 3*3 square to a horse-shoe shape in less than a minute.

Figure 1: Left: The interior of the modular interactive tiles. Right: Assembling of a tile play field.

Intervention

We prepared a small randomized controlled trial as a pilot study of dynamic balancing of elderly training with modular interactive tiles, with the objective to evaluate the effect of short-term playful training.

Twelve community-dwelling elderly people (average age: 79 (66-88)) with balancing problems were recruited from the waiting list for voluntary balancing training amongst elderly in Lyngby-Taarbaek Municipality in Copenhagen, Denmark. The population of elderly with balancing problems was randomly assigned to control group (CG) or tiles training group (TTG). The random assignment was done by lottery tickets picked by a third person blinded to the intervention.

The population from both the tiles training group and the control group was tested for dynamic balancing using the Dynamic Gait Index test before (pretest) and after (posttest) the intervention. The tests were performed by two physiotherapists from Lyngby-Taarbaek Municipality, who were both blinded to the intervention and who did not take part in the intervention.

The Dynamic Gait Index (DGI) contains 8 different tests of balancing. The DGI was developed by Shumway-Cook and Woollacott [7] as a clinical tool to assess gait, balance and fall risk, and it is viewed as an especially sensitive task, since it evaluates not only usual steady-state walking, but also walking during more challenging tasks. The eight abilities assessed are: steady-state walking, walking while changing gait speed, walking while moving the head vertically and horizontally, walking while stepping over and around an obstacle, pivoting during walking, and stair climbing (each ability is scored 0-3). A DGI score lower than 19 points has been associated with impairment of gait and fall risk [7, 8].

DGI was collected before and after a 2-months period, during which the tiles training group performed an average of 12.5 group training sessions on the modular interactive tiles. On average, each individual performed 13 minutes of playful training on the modular interactive tiles at each of the group sessions (Fig. 2). The control group continued their normal daily activities during the 2-months period.

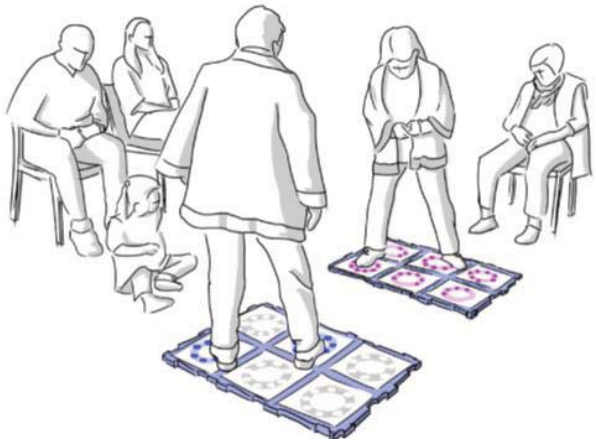

Figure 2: The group session for playful training in the tiles training group.

The training sessions with the elderly group was planned in cooperation with physiotherapists from Lyngby-Taarbaek Municipality. In order to secure a valid result, a protocol for the intervention was designed, in which 4 games were chosen that the elderly should try out: "Color Race", "Final Countdown", "Island" and "Concentration Color" (see Fig. 3 for the protocol). "Color Race" is a game where one of the tiles will light up in red. When stepped on, the tile will go black and another will light up. The player needs to step on as many tiles as possible within 30 seconds. In "Final Countdown" all the tiles will light up in purple and each tile will start counting down by turning off one of its 8 LED's every second. When the player steps on a tile, the countdown will restart. If any of the tiles gets all its LED's turned off, the game is lost. "Island" can be compared to the children game "The Floor is Made of Lava". Here, the player needs to move from green tile to green tile or island to island, without stepping on the other tiles. Once stepped on, the tile will start counting down and the player has to go on to the next before the tile turns off. This game will automatically adjust the speed according to the player's performance. The last game "Concentration Color" is a

memory game where all tiles turn white but they are hiding a colour 'underneath'. When stepped on, a tile will show the color it is "hiding". The object of the game is then to find all the matching color pairs (red, green, blue, yellow, purple, light blue).

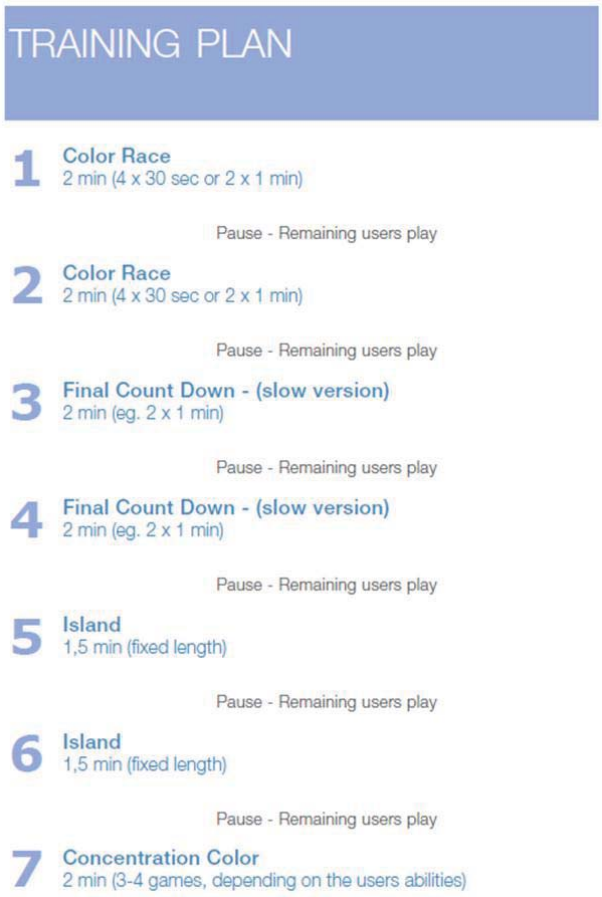

Figure 3: The training protocol for the tiles training group.

The training group was put into two groups where each group had one hour of training. The group was placed around the tiles that to begin with were placed in a group of 3x3 tiles. This setup of the tiles was changed before playing the game "Concentration Color" where the platform was changed to a "horse shoe" formation.

The sessions was built up of small "rounds" of play, where each participant played two minutes (though only 1,5 minutes for the game Island) of each game before having a small break while the rest of the group played.

Each training session was organized like this: 2 rounds of "Color Race", 2 rounds of "Final Countdown", 2 rounds of "Island" and 1-2 rounds of "Concentration Color" depending on the time available (see Fig 3).

Results

The population of elderly with balancing problems was tested with the DGI, and had an average score of 18.7. In the DGI test, below 19 is viewed as the threshold for having balancing problems and risk of falls. The population was randomly assigned to control group or tiles training group. Data were analyzed for statistical significant differences between the control group and the tiles training group, and for increase of mean score on DGI.

After the random division into the two groups, the control group and the tiles training group did not differ at baseline (DGI mean score: 18.3 vs. 19.0). After the 2-months period, there was significant difference in change of DGI score period with the control group decreasing DGI score by 9.3% and tiles training group increasing DGI score by 12.3% on average. A two way repeated measures ANOVA (Student Newman-Keuls method) resulted in no statistical significant differences at baseline. Also, there was no statistical significant difference in the control group's performance over time. There was statistical significant increase in performance of the tiles training group over time ($p<0.05$). Also, there was statistical significant difference between the control group and the tiles training group after intervention ($p<0.05$). DGI mean score after intervention was 16.6 for the control group, and 21.33 for the tiles training group, or an average decrement of 9.3% for the control group and an increase of 12.3% for the tiles training group.

The score for control group and intervention group is presented in table 1.

Table 1. Results of the DGI pre-test and post-test after two months of the 12.5 sessions training with modular interactive tiles.

	Pre-test	Post-test	Improve-ment	Significance
Control group	18.3	16.6	-9.3%	NS
Training group	19.0	21.3	12.3%	P<0.05

The community dwelling elderly with balancing problems seemed to be at high risk of falling if not subject to any training, whereas those who performed training increased their dynamic balancing abilities. A DGI score of <19 is associated with impairment of gait and fall risk [7, 8], so the statistical significant difference

between DGI score of 16.6 of the control group and DGI score of 21.33 of the tiles training group is important.

During the sessions the elderly expressed an increase in their abilities and endurance in normal day activities. At the posttest one participant expressed that others had told her that they could see and feel an increase in her general movements, endurance and balance.

Discussion and Conclusion

Despite the limited sample set, the trend of the pilot study is clear: there is statistical significant effect from short-term playful training with the modular interactive tiles. The community dwelling elderly with balancing problems seemed to be at high risk of falling if not subject to any training, whereas those who performed training increased their dynamic balancing abilities. A DGI score of <19 is known to signify risk of falling, so the significant difference between DGI score of 16.6 of CG and DGI score of 21.33 of TTG is important, as it indicates that it may be possible to ensure that such a test population may reduce risk of falling by training on the modular interactive tiles.

The study also shows how playful hardware (playware) can be used to create a quantifiable effect on people by using play as a motivator for engagement and training.

The study has certain, clear limitations. First and foremost, the study was performed as a pilot study with only 12 subjects. A larger randomized control trial (RCT) should be performed based upon the indications of this small pilot study. Despite such limitations, it is interesting that the effect of training with the modular interactive tiles amongst the community-dwelling elderly with balancing problems was obtained after just 13 minutes of training per session for an average of 12.5 training sessions. Hence, the average total training time to obtain this statistical significant effect amounts to just around 2h45m, which is very little training time.

Acknowledgement

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